BOTANICAL HERITAGE OF ISLANDS AT THE BRINK OF NIAGARA FALLS

P. M. Eckel

~ Botanical Services, St. Louis ~
Patricia M. Eckel, F.L.S.

Research Associate, Division of Botany
Buffalo Museum of Science
1020 Humboldt Parkway
Buffalo, NY 14211 U.S.A.

Presently: Research Scientist, Missouri Botanical Garden
P.O. Box 299, St. Louis, MO 63166-0299 U.S.A.
Email: patricia.eckel@mobot.org


Copyright © 2013 by Patricia M. Eckel
All rights reserved.
This book is written in recognition of the contributions of

Andrew Haswell Green
in preserving the integrity of New York State parks,

and, to honor

Orin Lehman
Commissioner of New York State Office of Parks, Recreation and Historic Preservation
for the years 1975–1993
The Niagara Reservation, later designated the Niagara Falls State Park, was established in 1885. It is the oldest continuously operating State Park in the United States. It is also the first State Park created under the power of eminent domain.

On May 23, 1963, it was declared to be a United States National Historic Landmark.

The illustration on the cover of this book is from the Gardner Report of 1880, being a “Map of Niagara Falls showing Proposed Reservations for Protection of the Scenery....” The map was prepared by Julius Bien, 1826–1909, famed lithographer, who was particularly prominent for his scientific and geological maps. He was well-known for well-executed and colorful charts of the Grand Canyon, localities in Colorado, and other Western areas. The map of Niagara Falls and its gorge is particularly striking.
# TABLE OF CONTENTS

**Introduction** .................................................................................................................. 1  
The Annual Reports .............................................................................................................. 2  
Acknowledgements ............................................................................................................. 2

**Part I: The Physical Features** .......................................................................................... 5  
**The Physical Setting** ........................................................................................................ 5  
Geology ................................................................................................................................ 10  
Glaciers .............................................................................................................................. 12  
Hydrology .......................................................................................................................... 12  
Erosion .............................................................................................................................. 18  
Ice ......................................................................................................................................... 21  
Climate .............................................................................................................................. 22  
Pollution ............................................................................................................................. 28  
Sediments .......................................................................................................................... 29  
Soil .......................................................................................................................................... 40  
Catalogue of Shells Found on Goat Island ........................................................................... 42  
Pre-1885 Land Use in the Goat Island Complex ................................................................. 44  
The Forest Condition in 1885 ............................................................................................. 51

**Part II: Vegetation** ........................................................................................................... 53  
Vegetation of Localities in the Goat Island Complex ............................................................. 53  
A. Goat Island ...................................................................................................................... 55  
1. Central Woods Remnant ................................................................................................. 55  
2. North Slope .................................................................................................................. 69  
   a. The Spring ................................................................................................................... 75  
   b. Flats on the North Side ............................................................................................... 78  
3. Crest Vegetation ............................................................................................................ 81  
4. Base of Goat Island ....................................................................................................... 91  
5. Terrapin Point Complex ............................................................................................... 101  
6. South Slope ................................................................................................................ 109  
7. Flats Just Upriver of the Horseshoe Falls .................................................................... 116  
8. The Eastern Meadow ................................................................................................... 120  
9. Ballast .......................................................................................................................... 124  
B. Islands in the American Channel ..................................................................................... 128  
C. Green (or Bath) Island .................................................................................................. 132  
D. Luna Island ................................................................................................................ 139  
E. The Three Sisters and Brother Island: General Discussion ............................................ 148  
1. The First Sister Island ................................................................................................. 148  
2. The Second Sister Island ............................................................................................. 154  
3. The Third Sister Island ............................................................................................... 163  
4. Brother Island ............................................................................................................ 174  
F. Old River Margin Habitats ............................................................................................. 179  
G. Rocky Banks and Boulder Habitats .............................................................................. 183  
H. Stone Bridge to the First Sister ................................................................................... 188

INTRODUCTION

In the following pages the botanical resources of Goat Island and to some extent the islands adjacent to it (the Goat Island complex) are listed, categorized and assessed. Specimens of the present flora were collected throughout 1988. It became apparent that there were large areas of the island that had been altered. Examination of published reports and over one century of collected botanical material residing in the herbaria examined revealed that the flora had changed through time. As more botanical data were assembled, it became clear that the flora of Goat Island was and remains important for more scientific and historical reasons than had been anticipated.

Botanical interest in the islands generally began with the geographical descriptions of the early explorers when it became early recognized that North America had a natural phenomenon at Niagara rivaling those already made famous by tradition or exploration on other continents. The genre of travel literature throughout the nineteenth century dutifully recorded obligatory visits to the cataracts by various authors. Their differing talents for emotional expression and inspirational description also contributed to the differing observations of conditions on the island, only a fraction of which could be examined for this report.

Many scholars were also involved in the exploration of the North American continent and good use has been made in this report of their published and unpublished observations as well. This report by no means exhausts the wealth of unexamined data that are still available for study.

The many published statements relevant to the flora proved to be, if not difficult to reconcile at times, then difficult to explain in ecological terms or to justify by proposing a possible mechanism for generating the phenomena observed. Pictorial evidence, from drawings to photographs, could not be ignored, and was used, it is hoped, with sufficient caution to assist in corroborating published observations and other aids to interpretation.

By far the largest inconsistencies to resolve were allegations as to the undisturbed character of the woods on Goat Island in 1885 and descriptions and photographs of it, including the first articulated policy on its proper maintenance (Olmsted & Vaux, 1887). All such evidence pointed to prior disturbance, rather than to forest conditions resembling classic descriptions of undisturbed, primitive, or climax woods. This fundamental problem had to be resolved before any sense could be made of the great scientific interest the island had a century ago, its public fascination over the years, and its present botanical condition. It is difficult to understand the value of what is left, or to begin to justify changes in policy which need to be developed before the historic flora is removed and replaced forever without some perspective on the nature of that flora.

Superficially, the present flora presents the same aspect as any other disturbed wood and landscape altered to lawns such that centuries-old accounts appear to be so incomparable as to resemble exaggerations or distortions regarding the biological character of Goat Island. However, many collections of species of an unusual character were found during the course of this study so as to force the present investigator to conclude that the biologically reduced aspect of the present condition is achieved by suppression of an unusual floral biology, and the biology of the area is uninteresting merely because it has been unexamined.

That the floras of Goat Island and the Niagara River Gorge appear to have lost their scientific interest is an assumption the present writer has met with among botanists across New York State and Ontario, and from the discovery that no botanical publications, except with passing mention, have been made dealing solely with the area since David Day's publication of 1887.

Several of the rarest native species in New York State either still exist here a century after their first report or were found to exist during the course of the present study—mainly because their habitats persist on dangerous boundaries or edges of the cliffs and river margins. That the conditions for rare dynamics with unusual biological consequences still exist at Niagara is borne out by the fact that several alien species never reported for western New York before were discovered here in the past year, and also rare taxa, only one or two found previously, or otherwise rare State-wide, were also found.
Accumulated evidence has shown that, based on published reports, on herbarium specimens and recent collections made over the past century, the immediate Niagara region (including the margins of the Niagara River just up from the cataracts and down through its seven-mile gorge), an area of around two square miles, has supported a floristic diversity amounting to around seventy-five percent of that of the surrounding 7,850 square miles constituting the Niagara Frontier Region (Eckel, unpublished manuscript)—a diversity nearly equal to that reported for Cattaraugus County, the seventh largest county in New York State (Eaton & Schrot, 1987). The cursory examination of the flora in the vicinity of Niagara Falls conducted by David Day (1887) amounted to 909 species, and that number has been increased by subsequent investigators by several hundred taxa, even allowing for the deletion of species due to misidentification or some other reason, and the increase in foreign taxa.

THE ANNUAL REPORTS

According to the same legislation that established the Commission for the Niagara Reservation, the members of the Commission were to provide the New York State Legislature an annual report of their accomplishments, recommendations, goals, budget and expenditures with respect to governing the Reservation. For the purposes of the present report, only the first thirty-three annual reports of the Commissioners were consulted, spanning the years 1885 to 1917. In them is a wealth of data of various kinds, including reprints of entire articles or passages of reports dealing with the geology of Niagara Falls and the Great Lakes; reprints of letters written by the Commissioners to federal offices; reprints of speeches given by politicians and interested citizens with respect to issues of legislation and public policy on many topics, primarily moves to protect the integrity of the Falls. There is biographical data on the politicians involved in the Reservation's establishment, lists of visitors, societies, organizations and the days they visited the Reservation, a valuable botanical resource, the Catalogue of the Niagara Flora by David F. Day and the General Plan for the Improvement of the Niagara Reservation by Frederick Law Olmsted and Calvert Vaux.

Researchers interested in the history of public lands—parks, forests, wildlife refuges, wilderness areas—may wish to consult these documents as they appear to be rarely explored, and perhaps may never even have been indexed, and deserve to be so. Not many libraries in New York State appear to have a set of these early reports—those in the Research Library of the Buffalo Museum of Science were consulted for this report. Another set is in the collections of the Niagara Falls Public Library, Niagara Falls, New York (Mr. Paul Westmore, personal communication).

Throughout the text, citations to these annual reports are in the following form: (1 Ann Rep Comm, 1885; 2 Ann Rep Comm, 1886, and so on). The activities reported are always for the year immediately preceding the year of publication.

Although what is essentially the present text has been posted on-line for several years, the illustrations, mostly photocopies taken from the Annual Reports, photographs taken before 1990, hand-drawn maps, and other material were never posted. Thanks to Richard Zander, these images from the 1990 manuscript have been modified digitally to suit the format of the present text.

ACKNOWLEDGEMENTS

Permission for this book to be published was kindly granted on August 21, 2012, by Rose Harvey, Commissioner, New York State Office of Parks, Recreation and Historic Preservation. Copyright reassignment to the author was facilitated by Thomas Alworth, Deputy Commissioner for Natural Resources. By agreement, all responsibility for this publication and its content is that of the author. Nothing in the work is an official or unofficial position of the Office of Parks, Recreation and Historic Preservation.

New York State funding in support of the original project, as submitted in 1990 during the administration of Governor Mario Cuomo, derived from efforts by Representative John Daly of Lewiston at the suggestion of the late Armand Castellani in his capacity as a Commissioner for the Niagara Reservation.
This project is an extension of a major study of the Niagara River gorge flora being undertaken by the author with a grant from the Niagara Frontier Chapter of the Adirondack Mountain Club. Permission to use data collected on that second project for use in the present study is gratefully acknowledged.

Gratitude is extended to Mario Pirastru, Regional Director, New York State Office of Parks, Recreation, and Historical Preservation for the Niagara area, for the formal approval for this study to be undertaken. Dr. Frank Kowsky, chairman of the Citizens Committee for Goat Island, and Dr. Eric Randall of that committee, were instrumental in having the study implemented. Dr. Randall, Dr. Kowsky and Dr. Charles E. Beveridge have provided guidance and encouragement through the course of this study.

On a number of occasions, the staff of the Schoellkopf Geological Museum, especially Ms. Doris Hampton and Maureen Currie, have been very helpful. Mr. Dario Violanti, Chief Engineer, provided valuable technical reports. Mr. Burt Rabuck provided helpful assistance on the Island, as did many of the maintenance and security staff, who were always ready to be of assistance. Mr. Robert Kessler, manager of the Cave of the Winds concession, was especially helpful in providing access to and assistance in exploring the base of Goat Island.

I would like to give special recognition to Mrs. Dorothy Westhafer, of the Kenan Center, Lockport, New York, who first brought public attention to aspects of this work, and Ms. Lisa Aug and Mr. Paul Westmore of the Niagara Falls Gazette. Mrs. Katherine Boericke and Armand Castellani of Niagara Falls early showed great interest in this project.

Leanore E. Thompson, Assistant Librarian, Royal Botanic Gardens, of Kew, Great Britain provided photocopies of the 1877 American botanical journal of Joseph Dalton Hooker. The pages copied pertained to Hooker and Asa Gray’s visit to Goat Island in which many plants were listed, several never before reported for the Island. Mr. Shaun Hardy, Librarian of the Research Library of the Buffalo Museum of Science kindly wrote to Kew requesting this information. He and Mr. Ed Ciszek proved indispensable as sources of information during the course of this study.

Dr. William Buck and Dr. Richard Harris, specialists in the sciences of bryology and lichenology, respectively, of the Cryptogamic Herbarium, New York Botanical Garden, agreed to come to the Reservation to conduct detailed fieldwork on Goat Island, Luna Island and the Three Sisters Islands. They were able to provide lists of the named specimens they collected within thirty days of their field work, and for this special effort I am especially grateful. Dr. Buck also generously extended me assistance in the research library and the extensive herbarium collections of the New York Botanical Garden during a visit made there in the course of this study. Dr. Harold Robinson, Curator of the bryophyte collections of the National Herbarium, Smithsonian Institution provided advice and assistance in searching the collections under his care for specimens related to Niagara Falls. Loans were made from both institutions to the Buffalo Museum of Science for detailed identification.

Mr. Ernst Both, late Director of the Buffalo Museum of Science, gave the ultimate approval for the use of Museum services and facilities for this study, and to examine and curate specimens from Goat Island in the Museum’s Clinton Herbarium. In his capacity as a specialist in mycology, especially of the Boletes of western New York State, he volunteered time from his busy schedule to assist in the determination of certain of the mushrooms from the islands.

Marcia Morrison, Research Librarian of the Buffalo Museum of Science before 1987, provided crucial support for this project.

I acknowledge the critical help of the late Dr. Norton Miller, Chief Scientist for the New York State Biological Survey, for helping me contact Dr. Elizabeth Shaw of the Gray Herbarium, Harvard University, for information regarding Dr. Asa Gray.

Dr. William Crins, a specialist in the Cyperaceae, now at the Albany State Museum, determined many of the significant specimens in the genus Carex, a notoriously difficult genus to work with. Dr. Steven Clemants of the Natural Heritage Program of the New York State Department of Environmental Conservation verified certain rare species and gave much useful information regarding rarities in the area.

Dr. Carol Sweeney, of Niagara University, provided guidance in setting up the quadrat and point quarter surveys presented in the original manuscript, and provided valuable discussion.

Francisca Saffron, Director of the Holland Land Company Project of the Reed Library, State University of New York, Fredonia, New York, provided
abundant material and useful suggestions regarding the Joseph Ellicott land survey records.

Thanks to Mr. William Snowden, Superintendent of the Queen Victoria Park School of Horticulture, Mr. Tom Laviolette, Instructor, and Mr. Melvin Dell, Curator of the School Herbarium (NFO) Niagara Falls, Ontario, for providing access to their herbarium and much useful information.

Many of the citizens of Niagara Falls and returning visitors to the Falls (many citizens of foreign countries) have shown enthusiasm for and interest in this study, and many, in the course of my field work on the island, have contributed information from their personal experience. All were concerned with the condition of the vegetation and were happy that attention is being directed toward its protection. Above all, I acknowledge the generosity of Dr. Richard Zander, then Curator of the Clinton Herbarium in the Division of Botany of the Buffalo Museum of Science, in assisting me in the free use of the research space and equipment, and access to herbarium material. He has assisted in all aspects of computerization necessary in this study, and contributed substantially to the organization of the final manuscript.
PART I: PHYSICAL FEATURES

THE PHYSICAL SETTING

The Goat Island complex lies just northwest of 43 degrees North, 79 degrees West in New York State. The boundary with Canada lies just off the southwest corner of Goat Island, the largest island in the complex. These islands lie within the Great Lakes Watershed which sustains the water volume of the five Great Lakes. The study area lies between Lakes Ontario to the north, and Erie to the south. The margins of the Great Lakes and their connecting streams, rivers and straits form an extensive inland coastline of which the study area is a part. Drainage in the lake system is roughly west to east, discharging into the Atlantic Ocean.

The islands lie within a thirty-three mile strait called the Niagara River, forming the boundary between the United States and Canada. The River begins at Buffalo, New York, on Lake Erie, and ends at Youngstown on Lake Ontario (Tesmer, 1981). The islands lie roughly twenty-two miles north of Buffalo. The western boundary of Goat and Luna Islands is continuous with the brinks of the cataracts of the Niagara River at the cities of Niagara Falls, New York, and that of Niagara Falls, Ontario, which cataracts are collectively called Niagara Falls. After passing the islands and the cataract, the Niagara River proceeds in a northerly direction some 250 feet below the level of the surrounding land in a seven mile gorge whose outlet lies at Lewiston, New York and Queenston, Ontario (Tesmer, 1981). Here the Niagara River continues across the Lake Ontario lake plain north until discharging into Lake Ontario.

Goat Island is in the shape of an ellipse with its long axis oriented in an east-west direction. The river channel at the location of the Island also runs east-west, bending westward upstream at the northern tip of Grand Island, New York, and Navy Island, Ontario, and turning roughly north after it passes the Goat Island complex and descends over its cataracts. The islands in the complex bear the brunt of the river current at their eastern ends, and the force of the prevailing winds at their west, southwestern end.

In 1900, Goat Island was reported to be one half mile long, and a quarter of a mile in width. The length of Goat Island indicated in a section across it in an east to west orientation was 2,500 feet (Lyell, 1845). There were 16 additional islands then “varying in size from an average of 400 feet to 10 feet in diameter” (16 Ann Rep Comm, 1900). In 1901 there were 62.46 acres of flat land and 11.44 of slope, for a total of 73.90 acres for the total island acreage in the Reservation (from a survey made for the Commissioners, 17 Ann Rep Comm, 1901). Mention will be made here of the four islands on the southeastern margin of Goat Island. The First, Second and Third Sister Islands are wooded islets of limited extent, each south of the other as they extend into the Horsehoe or Canadian channel of the Niagara River, and each separated from the other by small channels of water. The fourth island, Brother Island, is just west, or downstream, of the Third Sister, separated by what appears to be a joint in the dolomite bedrock.

The surface area of Goat Island has been increased since acquisition by the State of New York in the 1880's. Lowered water levels have made more land in the complex by increased river bed exposure at the particularly at the southwestern corner of Goat Island since 1954, and by exposure all along the southern margin of Goat Island of small “flats” areas, relatively recently vegetated mostly by shrubby willow species. Additions or reductions to the number of islands in the American channel was not investigated for the present survey. Access to these islands was not provided. A significant area of “made land” extending the area of Goat Island was created on the eastern extremity of Goat Island in 1959-60 (The American Falls International Board, 1971).

Elevation at the west end of Goat Island is 550 feet above sea level: at Terrapin Point near the water's edge at the Horseshoe Falls it is 511 feet. The Three Sisters Islands are at 550 feet. Elevation drops in the Canadian channel of the river from 550 feet at the Sisters to 511 feet at Terrapin Point: elevation of the river bed at the brink of the Horseshoe Falls is one foot higher than at Terrapin Point: 510 feet, and there is a forty foot drop in elevation along the south side of Goat Island with corresponding increase in the force of the current. In the channel of the American Falls, Green Island stands at 540 feet and Bird at
520 (statistics from Ontario Hydro Information in Tiplin, 1988).

At Goat Island's eastern end the water is only a few feet below ground-surface level. Its western end is composed of a 176 to 184 foot escarpment (NREP, 1972), forming part of the wall of the gorge of the lower river, with a forested talus accumulation at its base, presenting a 2500-foot shoreline to the lower river, flowing in a northerly direction. The island presents bluffs of various soil types on the north and southern boundaries, becoming deeper toward the western boundary and presenting distinct northern and southern exposures.

Soil characteristics, amount of sunlight, exposure or protection from prevailing winds, and availability of moisture are some of the features of the physical environment which influence the development of vegetation in any area. The following are some of the physical characteristics of the study area which contribute to some understanding of the character of the vegetation in the Goat Island complex.
Part I: The Physical Features

GREAT LAKES DRAINAGE SYSTEM

1. Lake Superior
2. Lake Michigan
3. Lake Huron
4. Lake Erie
5. Lake Ontario
Part I: The Physical Features

USGS Map 5170 11 SE, Zone 17, assembled from data compiled between 1944 and 1948. Changes have since been made in the Niagara River between Grand Island and Goat Island. Note that the international boundary is out in the river channel, whereas now it is nearly contiguous with Terrapin Point because the river bed has been exposed due to lowered water levels. Note also the bridge or boardwalk still in place out to a point surrounded by water - Terrapin Rock. Other area has been added to Goat Island on the eastern end and southern margin (see text).

T = Terrapin Rock (now Terrapin Point).
GEOLOGY

The islands are underlain by resistant dolomitic limestone which forms the bed of the river as well as the caprock of the cataracts and lower gorge. The islands' formation was controlled by isolated bedrock elevations in the river bed beneath the present soils, as can be seen in the series of four smaller islands situated in the river a few feet from the southern shoreline of Goat Island: the Three Sisters and Brother Island—part of the Cascade system.

The Cascades are the long, parallel rock ridges perpendicular to the flow of the Niagara River between the brinks of the falls and the western margin of the Grass Island—Chippewa Pool, or the body of water between these ridges and the joining of the two channels of the Niagara River as they converge below Grand and Navy Islands. The Cascades are quite exposed in winter just above the east end of the Three Sisters. These ridges may have provided access to Goat Island before there were bridges, perhaps by entering the river (New York side) "two miles above, so as to reach the dead water occasioned by the Island dividing the River into two Currents. From the Island a bar stretches far up the River, which principally enables you to reach the Island, as you pole your canoe along this bar," Maude, 1826. Occasionally, according to Mr. Maude, "Mr. [Steadman] remembers having once seen the bed of the River dry from the Fort Schlosser [i.e. American] side to the bar running from the South point of Goat Island." The bar may have arisen by breaking the force of the current in the river by favorable elevations in the Cascade bedrock formations. It is conjectured that these generally north-south-oriented ridges are erosional features of a north-south trending river ancestral to the present Niagara River.

The calcareous, dolomitic bedrock of the islands provides a tough, resistant cap to softer strata below it. It is this resistance to weathering that produced the Niagara Escarpment, a north-facing, east-west trending feature extending through southern Ontario and central New York State. The present cataracts of Niagara had their origin falling over the precipice formed by this escarpment seven miles downriver at Lewiston, New York and Queenston, Ontario, and so the escarpment may be said to extend up the gorge of the Niagara River, decreasing in elevation as it proceeds south in conformity with the regional dip of rock strata in the region.

Dolomite has a characteristic structure due to fracturing. As the weight of the advancing and receding continental ice sheets formed during the regional glaciations of the Pleistocene, the local strata were alternately depressed and then elevated, creating a flexion in the more rigid layers, resulting in the characteristic blocky fracturing or jointing of limestone and dolomite strata. Off-loading of superficial strata and sediment by glacial scour also contributed to fracture of the remaining bedrock. Accelerated jointing in the immediate vicinity of the gorge and cataracts is due to stress on the bedrock lost by excavation due to erosion (Krajewski & Liberty, 1981). Rainwater tends to run down through these joints rapidly, creating a drier environment at its surface than other types of bedrock, such as sandstone and shale.

Dolomite has a great deal of the element calcium...
Part I: The Physical Features

in it. Calcium is readily dissolved by acids. Rain-water is acidic and causes the great solution cavities formed in the native limestone of some of the more famous cave-formations in the United States, such as the Carlsbad Caverns of New Mexico, and the cavern-systems in West Virginia (Jones, 1973). Dolomite is limestone with the addition of magnesium, which makes it less easy to erode by solution than ordinary limestone (Krauskopf, 1967).

The texture of the Lockport Dolostone (actually the Goat Island Dolostone, type locality “Goat Island at the brink of Niagara Falls”) is not uniform but “stylolites and carbonaceous partings are common. Vugs containing gypsum, sphalerite (zinc sulfide), and calcite are common in thin zones” (Kilgour & Liberty, 1981). Dissolution of these deposits leaves the surface of the bedrock in the area of the Three Sisters pocked and irregular with circular depressions. These little pits may serve as natural “flowerpots” for the colonization of plants on recently exposed river bed.

In falls over limestone bedrock, such as Sitting Bull Falls, New Mexico, the redeposition of limestone on surfaces exposed to the spray of the falls and flowing water is pronounced whereas at Niagara such deposition is not very visible, unless as a result of biological action (personal observation; see “didymodontoliths” in the moss section). Groundwater in the Lockport dolomite formation underlying the Goat Island complex has been characterized as “a calcium sulfate or calcium bicarbonate water ... very hard and moderately mineralized. A highly mineralized water, characterized by higher concentrations of sodium and chloride than those measured in typical Lockport water, occurs in the lower two zones of the formation” (Johnston, 1964).

It appears that the water in the Niagara River, rather than rain-water, produces the most visible effects of dissolution in the joints of the dolomite caprock, if not because it is more acidic, then because of the added force of pressure. Joints become great fissures visible from the air (Krajewski & Liberty, 1981) and on the Three Sisters: the deep gap between Brother Island and the Third Sister, and the great fracture on the Second Sister, north-east end. These joints, pushed apart by hydrostatic pressure and widened from dissolution by river-water at the brinks of the cataracts contributes to the retreat of the gorge upriver together with the prior weakening by fracture of softer strata below (Krajewski & Liberty, 1981).
GLACIERS

During the last (Wisconsin) ice age, the region of the vicinity of Niagara Falls was covered by the Labrador ice sheet, only the most recent in a sequence of the advance and retreat of such continental glaciers throughout the Pleistocene. The last glacier, like the previous ones, mechanically removed all soil, and hence all vegetation on the areas over which it passed. The present flora, then, totally derives from vegetated areas south and west of the ice front. The Niagara region was essentially free of glacial cover around 12,300 years ago, with the establishment of Lakes Erie and Ontario (Glacial Lake Iroquois) (Tesmer, 1981).

“The surface of the rock, on which the deposit forming Goat Island is made, is smoothed and scratched, as are the surrounding surfaces, both in the rapids and on either bank of the river” (Hall, 1843), testifying to the passage of the continental ice mass over the area. Porter (16 Ann Rep Comm, 1900) also reported glacial markings on the exposed bedrock of Goat Island. In a popular account of the geology of the area, Tiplin (1988) indicated that at the east end of Goat Island and the Three Sister Islands, the visible ridges are “roches moutonnees”: eroded pre- or inter-glacial ridges formed first by river-erosion and subsequently modified, “polished,” by the glacial ice-mass.

Much of the aspect of the bedrock on Goat Island, once exposed in the southeastern portion of that island, is hidden beneath the topsoil deposited there in 1911 (28 Ann Rep Comm, 1912).

With the gradual retreat of the ice sheet came a period of time when the hydrology of the Great Lakes watershed system underwent many changes as the watershed rid itself of the mass of water liberated by the melting glacier. Since details of this complex history of shifting drainage patterns and volumes cannot be confidently related to conditions useful in explaining vegetation patterns in the Goat Island complex, the reader is directed to the extensive literature available on this subject, conveniently summarized by Otis (1982).

Between one quarter and one half of the surface sediment on Goat Island is composed of glacial deposits (Kindle & Taylor, 1913).

HYDROLOGY

Since the study area is defined by the water forming its boundaries, and its interest lies in the fact of its association with a series of great cataracts with their contribution to atmospheric moisture, water has much to do with past and present biological systems at Niagara. River water potentially has the effect of dissolution and leaching of the surfaces over which it passes, and of carrying within it nutrients, the residues of dissolving and leaching, as well as pollutants and other wastes which are dumped into it. It becomes enriched by aeration or oxygenation after its passage over the falls and rapids as it settles over the surrounding landscape.

The Niagara River is part of the Great Lakes Watershed system, which drains from rivers emptying into Lake Superior in the west to the Atlantic Ocean in the east. The lakes had a total water volume of 6,000 cubic miles at the end of the nineteenth century (6 Ann Rep Comm, 1890). The volume of flow in the Niagara River is related to the net natural runoff of the lake basins upstream—an area of around 260,400 square miles above the Niagara River (NREP, 1972).

The area of the river between Grand and Navy Islands to the Cascades at the east end of Goat Island is called the Chippawa-Grass Island Pool. From this section of the river most of the water for hydroelectric power is diverted.

At Goat Island’s eastern end the river divides into a north and a south channel and proceeds to a drop of about 180 feet to the western end of Goat Island. The cataracts formed at the brink of this drop are three: the Horseshoe, or Canadian Falls (nearly the entire brink is located in Canadian territory—the international border a stone’s throw off Terrapin Point) which is 2,200 feet, The American, 1,060 feet, and the Bridal Veil Falls, 15 feet wide. The Horseshoe Falls is eight feet lower in height than the American.

The volume of water carried by the Horseshoe Falls is eight times that of the American (NREP, 1972), with correspondingly greater erosive power.
and ability to charge the atmosphere with water. In the three-year period of 1925, 1926 and 1927 it was determined that the flow of water over the American Falls was only four percent of the total flowing out from the Grass Island Pool. Since 1925 “there has been a 24 percent increase in the flow of the American Channel” (The American Falls International Board, 1971), due to control structures built in the Grass Island Pool section of the river, and cessation of diversion of the Schoellkopf and Adams Hydroelectric Plants. Krajewski and Liberty (1981) report that the Horseshoe Falls “carries 90% of the water presently available.”

The waters at the cataracts are very shallow, especially after diversion. Prior to the major diversions of 1956 and 1962, water in the center of the Horseshoe falls was about 10 feet. Now it is 2 feet on average (Tiplin, 1988). Water depth at the rock ridge at the head of the American channel is around three feet (The American Falls International Board, 1971).

The flow or volume of water in the Niagara River “reflects the effects of all diversions into or out of the upper Great Lakes. The storage area of the lakes involved and the discharge capacity of their outlet channels fix the magnitude and timing of the effect ...” on river flow (The American Falls International Board, 1971). Diversions of the waters of the Great Lakes system include those of the Ogoki River between the Great Lakes and Hudson Bay drainage, Longlac Canal and the New York State Barge Canals (The American Falls International Board, 1971).

Many speculations have been made in the geological literature during the past century regarding the loss of water to flow over the falls of Niagara. James Hall, New York State Geologist, in 1843, made the prediction that “the mighty Niagara is destined to be, at certain seasons, but a diminutive representative of its former grandeur” not because of water diversion for hydroelectric purposes but due to the loss of the regional primeval forests still extant in the early nineteenth century in the Lake Superior region, and that the loss of this vegetation “opening ... the surface to the influence of the sun's rays will greatly diminish the supply of water flowing into its tributaries. These causes will sensibly diminish the quantity passing down the natural outlet ...” to be witnessed at Niagara.

The amount of water flowing in the little channel between Goat Island and the first of the Three Sisters Islands just south of it in the Canadian or southern channel of the river may be seen as some indication of lowered water levels in the Great Lakes by 1898. Some diversion for hydraulic purposes in the Niagara River had occurred by that time, but was apparently not considered to have a significant impact on local water levels. Although prior to 1850 there was a great sheet of water in this channel, by 1899 the channel had to be dynamited to produce a reasonable flow approximating earlier conditions (16 Ann Rep Comm, 1900; see section on the First Sister Island).

The first board of Commissioners, especially Andrew Haswell Green, recognized this dependence of Niagara Falls on water-use policy upstream, such that “the Commissioners deem it advisable that the National government be requested to appoint a commission to confer with a Canadian commission as to the means to be devised to prevent any excessive diversion of the waters of the Great Lakes, and to consider the whole subject of the uses and control of these waters, and to report its conclusions to Congress, with such recommendations as it may desire to submit” (15 Ann Rep Comm, 1899). The result of this action was legislation leading to the creation the International Joint Commission.

For general purposes the volume of water on average in the river is presently 202,000 cubic feet per second (Tesmer, 1981). Presumably this is the prediversion figure one might assume was the case throughout the last century, and also that it includes diversion rates of facilities taking water in the upper river other than the Robert Moses Power Authority and the Sir Adam Beck Power Generating Facility. The natural volume of water is the largest in North America for a river 33 miles long (NREP, 1972).

A hydraulic canal for diverting water for industrial purposes was built in 1857 in the city of Niagara Falls (Tiplin, 1988) which “Caleb S. Woodhull, Horace Day and others had dug and struggled unsuccessfully to make profitable” and later sold at a “sherriff's sale” (Mizer, 1981). Jacob F. Schoellkopf bought it for $71,000 in 1877. Other diversions, such as to serve the domestic water needs of the adjoining cities probably occurred at an earlier date.

A second tunnel for the diversion of water was under consideration in 1890, and eventually built by 1892 (by the Niagara Falls Power Company, Mizer, 1891): “in 1868 the volume of water passing over the

Part I: The Physical Features
falls measured by the corps of the US army was from 273,329 to 280,757 cubic feet per second—the tunnel being constructed meant to divert 10,000 cubic feet per second (Bogart, J. State Engineer and Surveyor, 1890, in the 7 Ann Rep Comm, 1891).

The Schoelkopf Power Plant on the American side was built from 1897 to 1925 and in operation till 1956; the Niagara Falls Park and River Railway Power House was built in 1892; the Canadian Niagara Power Generating Station began operating in 1905; the Ontario Power Generating Station in the early 1900’s, the Toronto Power Generating Station (date unavailable); the Sir Adam Beck Generating Stations from 1922 and the Robert Moses Niagara Power Plant from 1961 (Tiplin, 1988). For the diversion-rate data of these facilities see The American Falls International Board, 1971. This power-generating capacity transformed the lives of people in western New York and Ontario.

In 1912, “existing diversions have already seriously interfered with and injured the scenic grandeur of Niagara Falls at the Horseshoe, which injury and interference will be emphasized by the effects of lower stages sure to recur on Lake Erie and the upper lakes due to natural causes” (W. L. Marshall, Chief of Engineers, U. S. Army, War Department for Maj. Charles Keller, Corps of Engineers, in 28 Ann Rep Comm, 1912). Mr. Marshall also suggested the remedy was to place a “submerged dam placed in the bed of the river immediately above Horseshoe Fall, with the object of diverting a portion of the great volume passing over the center ... so as to increase the streams feeding the depleted ends of that fall ...” Major Keller was willing to discuss “the possibility of further concessions to the power companies.” Perhaps it is these recommendations that fueled the half century of river-bed modifications to “beautify” the impoverished cata-

tracts.

At present, fifty percent of the water in the Niagara River is removed for the purposes of generating power, etc. between April first and October 31 (tourist season); seventy-five percent is removed during the winter (non tourist) months (Bastedo in Tesmer, 1981).

When the water is high in the Great Lakes, as after heavy rains in the system, more water appears to flow around the islands, inundating low areas, such as at the western extremity of the Third Sister Island (personal observation, 1987). Also if there is a south-western wind across Lake Erie, especially during winter storms, a greater than normal mass of water may flow into the Niagara River raising its level temporarily, although the intensity of this phenomenon may be regulated by the present water diversion device in place above the Horseshoe Falls. Reduction in flow in winter, and its elevation in summer due to diversion manipulations all affect the rates of erosion and water availability at the islands.

The gorge of the Niagara River has been extending itself continuously from the moment the cascade began at what are now called the villages of Lewiston, New York and Queenston, Ontario. It has been eroding generally southward for over 9000 years. “The process of recession of the Falls has been quite rapid in geologic time, and even in terms of a human lifetime. The Falls reached Goat Island and separated into two about 600 years ago. Since that time, although the American Falls has receded very little (about 200 feet), the Horseshoe has retreated some 2,500 feet” (Otis, 1982).”

Goat and Luna Islands, then, developed the present rocky bluffs or escarpments on their western ends as recently as seven hundred years ago, whereas in the previous millennia, the level of shoreline presently bounding their other three sides also bounded...
the fourth. This will have implications for ease of accessibility of animals and aboriginal peoples to the island complex through time, and suggests the original forest at the western crest of Goat Island may have been a shoreline remnant, similar in origin to the crest forests all along the gorge of the river below the cataracts.

It is estimated that the Falls (presumably the Horseshoe Falls where the main channel lies) retreats one to two feet annually (Tesmer, 1981) from the force of the water presently allowed to fall over it. Recession at the Horseshoe Falls was intensified from the effects of early water diversion activities, which tended to concentrate the volume of river water in the center of the Horseshoe Falls (Tiplin, 1988). To compensate for this concentration, a submerged weir was built in 1942 to raise the level of water in the Grass Island Pool. The conspicuous, unsubmerged International Control Structure, built in 1953-54 to spread the remaining water allowed over the cataracts more or less evenly over the Horseshoe and American Falls, was accompanied by “remedial work” at the exposed edges of the Horseshoe Falls -including the Terrapin Point section on Goat Island. Remedial work included excavating deeper channels in certain areas above the falls. “Viewing areas” were areas of reclaimed land, shortening the width of the falls at Terrapin Point, on Goat Island and the Table Rock viewing area in Ontario. On Goat Island, a coffer dam was built just upriver from Terrapin Point. The coffer dam “dried off the river bed so that the area around Terrapin Point could be filled in” (Tiplin, 1988). The old area where the bridge to the Terrapin Tower was built was then graded and seeded to grass.

The jointed bedrock beneath the islands provides avenues for water seepage. The horizontal migration of ground water through joints along the bedding planes of the dolomite bedrock probably accounts for some or all of the seepage visible on Goat Island, such as the old Spring on the northeastern side and the three little seeps on the southeast side of the island facing the upper end of the First Sister. The soil along the elevations of the north side of Goat Island is moist and in places quite saturated. A series of culverts of various sizes and ages are located here, in the bank of soil, and one at the level of the river, which provide outlets for water runoff from a variety of sources, some perhaps draining storm sewers, and runoff from the grading required for the circumferential roadways, viewmobile path and pedestrian paths.

Three small, open seeps occur on Goat Island just opposite the east end of the First Sister, together with a culvert at water lever among Willow trees. A drain is located in the picnic area near the entrance to the Three Sisters, probably associated with road drainage. It is my understanding that deposition of ballast at the east end or upstream extension of Goat Island constructed in 1959-60 (The American Falls International Board, 1971), has altered the pattern of subsurface drainage or surface seepage (staff communication) by the force of current through the rock-fill, but I was unable to investigate the significance of this. How much of the soil hydrology evident today is due to human modification, such as road gradings, sewage facilities for buildings at the west end of the Island, drainage of extensive low areas, etc., could not be established at this time.

The deep and loose sediments overlying the bedrock on Goat Island, in addition to the dense vegetation of the primeval situation which existed at the Reservation’s establishment in 1885, would have served as sinks for water entering the ecosystem through horizontal migration of river water through bedrock. This seepage may have contributed to the effect of quicksands said to exist in the lower sedimentary layers, and springs and seeps on the island,
the relatively continual addition of spray from the Horseshoe Falls, and rain, snow and ice accumulations in winter.

The general wetness of the environment, especially the upper sediments made it very difficult to maintain the surface of the early road system on the island. Ceramic drain tiles were put in place during the early years of the Reservation to dry out the first gravel roads, but for years the island's caretakers lamented the high moisture beneath the forest canopy and took steps to eliminate it. Drainage modifications persisted throughout the early decades of the twentieth century whenever new structures were put in place. At times prior to 1885, attempts to modify drainage, for example, at the publicly used spring of potable water on the north shore of Goat Island, may account for the absence of likely wet habitats for hygrophytic species of plants, such as those reported by David Douglas in 1823—Skunk Cabbage (Symplocarpus foetidus) for example which grows in springy situations on the Ontario side of the falls (see section on collectors), but observed by no one subsequently. Tile drains were still being built in 1912 when the paths at the entrance to Goat Island were felt to be in poor condition due to high soil moisture. Rains continued to cause washouts and landslides, disturbing the roads and paths (29 Ann Rep Comm, 1913).

In the Evershed map of Goat Island of 1883, a swamp is indicated on the north east side of the island around where The Spring was located. The swamp was in the river margin, and is reminiscent of that drawn for the western extremity of the Second Sister Island. This swamp on the north side of Goat Island may have vanished by modification, as suggested above, or by lowering of the river volume as water levels in the Great Lakes lowered through diversion and stripping of the native forests in the upstream Great Lakes Watershed region throughout the nineteenth century and intensified local diversion for hydroelectric production in the present century.

The “drying up” of The Spring itself may be due to decreased water pressure in joints presumed to feed it in the Goat Island bedrock as water volume in the river decreased.

Low areas of poor drainage supporting wet vegetation, such as the two swampy areas just mentioned are the product of lowering of the volume in the Niagara River, mentioned by Kindle and Taylor on their geological map of the area (1913), before European settlement of North America. These areas of poor drainage on former river bed were much more extensive on the Canadian rim of the Niagara Gorge and area of the upper river at the cata- racts, and supported one of the most interesting plant communities in the area.

It seems probable in prediversion times that a higher degree of water pressure in the joints of the bedrock beneath the Goat Island sediments prevailed, and river levels were higher with the result that there was to some degree more water coming up as mist due to shattering of more water on the rocks at the base of the Horseshoe and American Falls. It is reasonable to expect that there was a higher degree of soil moisture available to plant populations on Goat Island than exhibited today. The original, denser vegetation would also hold more atmospheric water.
Part I: The Physical Features

of which there was locally an excess due to mist from the falls, especially on the west end. A constant regular provision for moisture in the environment would approach a more optimal environment for plant growth that is one factor in the historic testimonials accounting for an unusual abundance of individual species in the Goat Island complex.

A higher degree of topographic irregularity, or topographic diversity, prior to establishment of the present extensive graded lawns and particularly asphalted pedestrian and vehicular surfaces, would have provided significantly more microhabitats with complex and elevated moisture regimes, more ecological niches for occupation by various species and hence be a factor in the development of the unusually high species diversity reported for the island a century ago, before New York State ownership began in 1885.

Conversely, removal of normal, natural water regimes in the Goat Island ecosystem has been a factor in depletion of both the historic botanical abundance and species diversity through desiccation. Thinning of trees and shrubs, as is the present policy, for example, weakens the forest's ability to remove moisture from the atmosphere, be a less effective block to sunlight and prevailing winds which evaporate moisture in natural habitats.
EROSION

Peter A. Porter speculated in 1900 that Goat Island once extended much farther upriver than it appeared in his time “for at its eastern end, now called ‘the parting of the waters,’ a sandy bar extends some hundreds of yards up stream. On this bar and south of it the depth of water is today less than three feet, and in the winter its whole length is covered with ice that lodges there. This entire bar was no doubt at one time covered with soil and was a part of Goat Island, the land being gradually washed away by the water, aided in its work by frost and ice” (16 Ann Rep Comm, 1900).

In 1811, Augustus Porter applied to the State of New York for ownership of Goat Island, said in that document to be about 100 acres (Porter, 16 Ann Rep Comm, 1900). Maude (1826) reported Goat Island having one hundred and fifty acres in 1800. Maude was reassured by a guide that “much of the Island has fallen down since he first was acquainted with it.”

In 1893 Goat Island was said to have been around 63 acres with a circumference of about one mile (Niagara Book, 1893). The same source also indicated that at one time the Island comprised 250 acres, and that there was another elevation, Gull Island, south of the island which “is said to have contained two acres of land in 1840. There is hardly a trace of it now” (Niagara Book, 1893).

In the Gardner (1880) survey for the year 1879, an island matching the foregoing description was drawn in the Horseshoe channel in 1842—by 1875 it had disappeared according to the U.S. Lake Survey.

Of all the margin area exposed to the river current “it is fortunate that the southern shore only has been seriously affected by the water” (7 Ann Rep Comm, 1891). Superintendent Thomas Welch in the second report of the Commissioners, 1886, reported that “the southern shore of Goat Island, although protected at some points by piers and timber structures, is being gradually worn away in many places by the force of the current.” In the Olmsted and Vaux plan of 1887 for improvements to be made on Goat Island, evidence was given that a major slope collapse had occurred on the island’s south end, taking away all the vegetation, presenting a “raw surface” (see section on the south slope). The profile of the slope they describe is typical of a slumped sedimentary surface (Olmsted and Vaux, 1887).

River induced erosion was also happening elsewhere in the complex, notably on the Sister Islands. “Within a year or two the action of the water has...”
opened a fissure nearly half way through the western portion of the Third Sister island, and trees growing on the islands, undermined by the current, have fallen into the stream. Gull Island, south of Goat Island, said to have had an area of two acres in 1840, has virtually disappeared” (2 Ann Rep Comm, 1886). “It is stated that a storm ... occurring in the year 1847, entirely washed away Gull Island, about two acres in extent. Gull Island was situated south of Goat Island and just above the Horseshoe Falls “ (6 Ann Rep Comm, 1890). The washing away was attributed to sudden elevation of the water levels of the river by southwestern winds in Lake Erie.

Erosion in the Goat Island complex generally refers to:

a) erosion due to bedrock failure at the brinks of the Horseshoe, Bridal Veil and American Falls, and the west-facing bluffs on Luna and Goat Islands.

b) erosion on the margins of the islands where elevations in the levels of the river are such that soil is washed away.

c) slumping or landslides of the soil masses on the banks to the north, west and to a lesser degree the southern elevations on Goat Island—perhaps due to seepage within the bedrock and sedimentary masses, or to the accumulation of atmospheric moisture within them, especially in the spring,

d) scour by ice in winter (see section on ice below), and

e) runoff on slopes and river banks denuded by trampling.

The only area in the complex where this is happening is on the channel banks between the First Sister Island and Goat Island where people feed waterfowl, in certain path areas on the Three Sisters and where the thickets are removed on the bank on the south side of Goat Island. In the first example, actual runnels are eroded into the exposed, mineral soil.

The energy of erosion within the bedrock, which accounts for collapse of rock on the west-facing gorge wall exposures and gorge wall behind the falling water of the cataracts is partly due to the degree of hydrostatic pressure from ground water flow throughout the jointed calcareous bedrock (Krajewski & Liberty, 1981). Ground water percolates vertically through and horizontally along joints in the bedding plane. Jointing in the Lockport dolostone caprock increases with proximity to the falls crest line, as does hydrostatic pressure and hence ground water (Krajewski & Liberty, 1981).

This weakening of the bedrock is most significant at the brinks of the cataracts and the gorge walls where weathering also is an erosional factor, and certain of these areas on Goat Island have been modified by dynamiting the weakened outer faces and mechanically strengthening the resulting outer layers of rock (see sections on Terrapin Point and Luna Island).

The channel of the Niagara River as it eroded its seven-mile gorge narrowed and broadened throughout the course of its history. New gorge is formed at the weakest point in the subtinging caprock, currently in the center of the Canadian Horseshoe Falls. At present, the Horseshoe Falls section of the river is developing a narrow gorge:

“This narrowness of the channel is due to the concentration of the water at the center of the stream. It is easy to see that Goat Island and the other islands owe their existence to this concentration of the water; for at one time, as shown by the shell-bearing gravels, these islands were under water. The channel above the Horseshoe Falls has been cut more than 50 feet below the summit of Goat Island at the falls, while the upper end of the island is still at the level of the water in the river” (Grabeau, 1901).

Throughout the first decade of the Reservation’s existence, there were problems with the south shore erosion—this was due to slumping of the sediments from undercutting of the banks indicative of the higher energy of the river in the southern river channel, due both to the higher river volume there (90 percent of the river) and the fifty foot drop in the river bed from the brink of the falls to the preceding mile of river (6 Ann Rep Comm, 1890).

Early depictions of the south side of Goat Island show a bluff leading down to the water’s edge denuded of vegetation on its lower margin (11 Ann Rep Comm, 1895). To protect the south shore of Goat Island timber, crib-work and docking, filled with stone was built there in 1890 (7 Ann Rep Comm, 1891). To restore it to its “natural condition” there was intent to cover the embankment with loam, planting it with “vines, shrubs, willows and other suitable trees.”

Before river levels were lowered and river bed on the south side of Goat Island became exposed in this
century, there was a layer of “quicksand” above a basal layer of gravel on the south side of Goat Island which was vulnerable to scouring when the river was high, particularly during storm surges in the winter months.

Today, when water levels in the river are high, soil is washed away on low lying areas, as on the west end of the Third Sister, which is now nearly barren rock. Some breakwater is afforded by logs laid down on the marshy west end of the Second Sister, and a moss (bryophyte) community has established itself on the rotting wood.

Landslides on Goat Island have been referred to for various places in the Commission reports, as when the “high bank” or west boundary of Goat Island, south of the Biddle Stairway collapsed (20 Ann Rep Comm, 1904). Slumping and landslides on the west end were the most serious as this area was the highest concentration of visitors, and beyond which was a drop of over 100 feet to the talus slopes below.

A new source of erosion has to do with ground surface conditions: “... in certain instances, where man-made structures or artificial surfaces have been installed, water collects in low-lying areas after heavy precipitation, or runoff is directed into channels down unprotected slopes causing erosion. The earth slump which occurred in April of 1980 along the Niagara Gorge above the Cave-of-the-Winds walkway illustrated this phenomenon. Here, it appears that runoff from the blacktop area at the top of the bank has been concentrated into a relatively small linear section, worsening natural conditions. During heavy precipitation the top layer of gravels is eroded quickly and also carries water down to a layer of silty clays which became saturated and flow down the slope” (Otis, 1982).

Slumping today occurs in the soils of seepy, shaded areas in the northern, north-facing wooded slopes of Goat Island. Numerous culverts here together with the existence of muddy seeps and a running stream or two may indicate a higher degree of subsurface water here than elsewhere on the island. Here and there north-slope walls have been reinforced by stone shingles layered into the elevations so that they resemble the natural fracturing of limestone. Occasionally the bole of a tree has been laid sideways against the bases of trees at the water’s edge to protect the walker from the proximity of the river.

A twenty four percent increase in the flow in the American (north) channel of the Niagara River (The American Falls International Board, 1971) and a presumed corresponding increase in flow velocity and river height may have something to do with accelerated erosion on these slopes. The north island margin is not buffered from the level of the river by a swathe of land and quieter water which the south side of the island presently enjoys.

Mature specimens of Sugar Maple and Canoe Birch on the north side have pitched forward due to slumping so that their crowns are in the river.

As already mentioned, winter storms in Lake Erie, which under certain circumstances drives up the mass of water in the river, have contributed to erosion events on Goat Island, particularly with the layer of “quicksand” above a basal gravel layer on the southern margin of the island. “Ordinarily the water in the river does not rise above the lower layer of gravel, which averages about two feet in thickness.” During a storm on January 9, 1889, “where the southwestern portion of the island juts out into the river the swollen current washed away about ten feet of the bed of the island for a distance of 300 feet ... the washing away of the shore caused the embankment to cave in, undermining the footpath ....” “The tendency of the current is to wash away the southwestern portion of the island which curves outwardly into the rapids”
Part I: The Physical Features

(quotes from 6 Ann Rep Comm, 1890).

When the water is high in the Great Lakes, as after heavy rains in the system, more water appears to flow around the islands. Also if there is a south-western wind across Lake Erie, especially during winter storms, a greater than normal mass of water may flow into the Niagara River raising its level temporarily. There is a layer of “quicksand” above a basal layer of gravel on the south side of Goat Island which is vulnerable to scouring when the river is high. With the development of various control structures in the Grass Island Pool regulating the amount of water accumulation there, it is not clear how much control is exerted over these storm surges and their erosional impact on the islands downstream from these structures.

Reduction in flow in winter and elevation in summer due to diversion are factors affecting rates of erosion in the islands.

ICE

It is not unreasonable to expect that in an environment in which water plays such a large role, that the behavior of water in winter, as ice, would contribute much to the character of the natural environment at Niagara. Ice contributes to the erosion of structures, whether caprock or the boles of trees when joints and fissures are saturated with water which then freezes and expands. The weight of ice accumulating on the boughs of trees makes them top-heavy, bringing down branches that cannot sustain the added weight, especially in gale winds, and whole trees especially with shallow roots in shallow soil.

Ice accumulates during winter in the Maid-of-the-Mist Pool (a section of the river in the upper gorge extending from the cataracts to the Whirlpool or Railroad Bridges). The river may become bridged by this ice mass to 70 feet above water level. Ice builds on the talus at the base of the American Falls to the level of the brink (184 feet). Freezing mist and spray accumulates on all surfaces, including all vegetation (The American Falls International Board, 1971). The force of this ice accumulation is mechanically powerful, weighing down and scouring whatever it comes in contact with, from island margins and river banks, to weirs, to international bridges (collapse of Falls View or Honeymoon Bridge, 1938).

Ice scour on those island margins with exposed bedrock, such as on the eastern end of the Three Sisters, the old Terrapin Rock area, and ledges on the north side of Goat Island may have benefited the unusual types of vegetation once or presently found there, renewing each winter erosion cycles which prevent the development of typical growing conditions and the invasion by plant species and communities typical of the region.

During winter, seventy five percent of the river volume is diverted, and twenty five percent is allowed to pass over the cataracts at the head of the Niagara River gorge. Devil’s Hole, a natural cove in the gorge wall on the American side several miles north or downriver from the falls, was formed by the annual sloughing off of the exposed face of the dolomite caprock, according to James Hall, New York State Geologist (1843): “when we take into consideration the fact, that the water [from the stream called Bloody Run which empties into Devil’s Hole] penetrates all the fissures of the rock, and then during fall and winter, expands by freezing, we shall find means of explaining the mode of operation,” whereby this indentation in the gorge wall had been developed.” At Niagara Falls, however “the action of frost is not to be taken into consideration, as the water, probably, never freezes in the fissures behind the fall.” “the recession is by undermining and breaking down of the upper masses” (Hall, 1843).

As long as the flow of water at Niagara Falls was free, the processes of erosion by hydrostatic pressure and widening of joints in the dolomite bedrock by dissolution by action of acids on the calcareous rock prevailed. Reducing the flow of water in winter might then expose the bedrock at the falls to the same processes as Hall thought developed the Devil’s Hole cove. This seems to be implied in the statement that “low flows [in the Niagara River] in the winter period expose the rock to freezing and thawing processes, thereby contributing to the disintegration of the caprock through ice jacking and plucking” (The American Falls International Board, 1971). “Now I consider it as an established fact, that small streams, which freeze during winter, will excavate their beds more rapidly in proportion than large bodies of water which never freeze” (Hall, 1843). Although beyond
the present study to investigate, the possibility exists that before the present diversion regime, conspicuous erosion at the falls might have been due to different processes than those that prevail today. Certain kinds of erosion may have been checked by the modification of erosional processes, such as concentration of water mass in the central channel of the Horseshoe Falls, however, such checking may have exacerbated erosion in other areas by other means, such as frost heaving.

Formation of the ice masses seen on postcards at the American Falls, and their effects, however, is not altogether a natural, primeval phenomenon, but is, to some extent, a cultural artifact of water diversion. Lower water levels in the Maid-of-the-Mist Pool (15 feet in the tourist season and 26 feet thereafter) “have exposed considerable areas of previously submerged talus at the base of the American Falls and large areas of foreshore around the perimeter of the Pool.” “This growth in exposure of talus has been progressive since 1922” with diversions to the Sir Adam Beck power generating facility, up until the present level of diversion. “This series of events have created the impression that rock fall from, and deterioration of, the American Falls is occurring at a faster rate than is actually the case.” The force of the original magnitude of falling water probably destroyed the ice formations as they accumulated, much as the violence of the rapids below the Lower Arch Bridges breaks up the ice formation in the Maid-of-the-Mist Pool. But with the exposure, up to 100 feet in breadth as well as its height, of the dry talus, atmospheric moistures “condense, settle, and freeze, building up through the winter to ... imposing masses” (all quotes from The American Falls International Board, 1971).

Ice bridges, however, seem to have always been a natural annual event at the Falls. Ice develops in winter on the surface of Lake Erie. This ice enters the Niagara River at Buffalo and is borne down to and over the falls. The ice bridges are due to accumulations of this pulverized Lake Erie ice, which builds up from the lower shoreline until joining in the middle of the river. When the ice from the broad expanses of the upper river is dumped into the confinement of the plunge pool, the accumulation can be “6 to 15 times the volume of ice that the lower channel can ... carry away” (The American Falls International Board, 1971), especially if the water level in the river becomes lower due to changes in wind-direction on Lake Erie (Krajewski & Liberty, 1981). This buildup can create ice-jams in the Maid-of-the-Mist Pool up to 70 feet above the normal water surface.

To control this ice build-up, Ontario Hydro and the Power Authority of the State of New York built an ice-boom at the Lake Erie entrance to the Niagara River to keep ice from destroying or crippling power-generating facilities along the banks of the river above the falls, and to maintain “normal operating tolerances on the level of the Grass Island Pool.” Authorization came at a meeting of the International Joint Commission in 1964 (Ontario Hydro in Holt, 1968). Only excessive or large masses of ice are allowed past the boom into the Niagara River before the first of April. Whether this reduction in the normal ice mass in the river has a significant effect on the quality of habitats in the Goat Island complex has not been determined as of this writing.

**CLIMATE**

When the glacier had exposed what is now called Lake Ontario at the end of the last, or Wisconsin glaciation, around 12,300 years ago, climatic conditions in the Niagara area were similar to those in the tundra today, inferred from the presence of tundra vegetation in the fossil record in the southern Great Lakes (Terasmae, 1981). Arctic climate passed into subarctic climate supporting boreal forest vegetation, to a warmer condition deficient in rainfall lasting from 9000 up to 6000 years ago. “During the last 5000 years the climate has been rather similar to the present in the Niagara region” (Terasmae, 1981). A period called the Xerothermic, characterized by deficient rainfall, compared to present conditions, occurred between 1400 and 1200 B.C. (Gleason, 1922, Sears, 1932, Transeau, 1935, reported in Gordon, 1940). Another drought period was postulated by Huntington (1924) for the thirteenth century. These regional climatic fluctuations toward increased dryness may have had a significant effect on components of the present flora of the region as has been assumed by Gordon (1940) bringing about the “death and destruction to mesophytes and hydrophytes” in the regions under these climatic influences, including western New York State. Usually these climatic variations are used to explain the presence of species
Part I: The Physical Features

occurring in the east which have an affinity with the western flora. Although these climatic fluctuations perhaps can be demonstrated to have occurred, their influence on the distribution of plant species may not be as significant as, for example, the distribution of substrates such as limestone (see section on rare plants), a condition highly applicable to the calcareous flora of the Niagara River gorge, of which the flora of the Goat Island complex is a part.

In the present century, the moderating influence of Lakes Erie and Ontario on the length of growing season in the lowlands adjacent to these lakes in New York State, and Ontario, produces long growing seasons that are only exceeded in New York in the south-eastern counties of the state in the vicinity of New York City, under the influence of the warm currents of the Gulf Stream. At Niagara Falls the average growing season is 160 to 170 days (Zenkert, 1934), the averages decreasing in the elevated areas in the Allegheny uplands in the southwestern portion of the state. The flora of lowland areas in the extreme western border of the state along the Niagara River are contiguous with elements of the Ontario flora across the river in the Niagara Peninsula. Some floristic elements (western) may be derived from Ontario and the north shore of Lake Erie, rather than from the south along the Lake Erie shoreline. Stations of rare taxa, such as Kalm’s St. John’s Wort (*Hypericum kalmianum*) seem to suggest this, as in Ontario it is “abundant at intervals along Lake Erie from Crescent Beach to Point Abino and westward” (Zenkert, 1934), and is known from no other locality in New York State. The elevations of the Allegheny Plateau may be an adequate barrier to further incursions of western taxa into New York State from southern regions. The special habitat of exposed or shallowly buried limestone bedrock of the Niagara Escarpment at Goat Island and the Niagara River gorge further contributes to warmer, drier and alkaline microhabitats giving the competitive edge of western taxa against species more typical of the region.

The climate maps for New York State used by Zenkert (1934) generalized from Mordoff (1925) tend, as a result of the class limits selected, to show the Niagara Falls area in a series of climatic transition zones or zonal boundaries for characteristics such as length of growing season (boundary between 160-170 days and 170-180 days), mean precipitation for growing season (boundary between 14 inches and under, and between 14 and 16 inches), but unambiguously within the zone of mean annual snowfall (between 60 and 80 inches—a higher rank than the 40-60 inch rate of areas to the south, east and north. The relatively high snowfall in the Niagara Falls area contrasts with the very low amount of rainfall relative to the rest of the state (14-16 inches and under), such lows only being matched in the far northeastern corner of the state. The calcareous substrates of the Niagara Escarpment, especially at ecotonal boundaries such as the crest line or areas with little or no soil over the calcareous bedrock, tend to promote dryness and warmth which might intensify the impact on vegetation of low rainfall during the long growing season of summer. More water falls (as snow) during the winter months than summer within the study area, but the cold temperatures of winter deny the usefulness of this precipitation for plant growth.

Climatic conditions in the immediate vicinity of the cataracts are very complex and it is beyond the scope of this project to provide details as to its character. The prevailing winds are from the west-southwest (NREP, 1972), and so would be expected, as a rule, to come across the crest of the Horseshoe
Falls from the Canadian shore across Goat Island, bearing with it the burden of vaporized water from that cataract. Wind conditions at this place appear to be complex due to updrafts of ascending vapor and air displaced by the falling water. As is the common experience of visitors to the brink of the Horseshoe Falls, Ontario, far more atmospheric moisture is borne toward the west in gusts toward the Canadian shore than is borne onto Goat Island, although one would expect the reverse to be the case. Orientation of the wooded, sedimentary escarpment overlooking the cataract area on the Canadian side may shelter the Park below it, and distort the regional orientation of incoming wind, or produce a cell of quiet, moist air next to the slope. Moisture to the Canadian bank would be favored by southerly winds pushing the spray from the Falls onto the Niagara Moraine—the escarpment of sediments overlooking the Horseshoe Falls on the Canadian side of the river. Goat Island has no corresponding protection and is fully exposed to the prevailing winds. Frequently, one can feel intermittent descending moist air on Goat Island, even as far as its eastern end, especially when the wind is strong. Atmospheric moisture is sensibly strong on Goat Island in the vicinity of the Horseshoe Falls as also is evidenced by photographs of trees indicating heavy condensation (ice), and by the current winter condition of trees in that area, and less with distance from the cataracts. Heavy condensation on surfaces is general in the plunge pool area of both cataracts as may be seen in the early photographs of ice-bridges there in winter.

Without actual data, it is difficult to draw conclusions based on the premises discussed above, but the wind appears to be generally stronger on Goat Island and the shore of the American mainland near Prospect Point due to crossing the open water, than elsewhere in the vicinity. Superintendent Harries in 1911 referred to “the high winds which prevail throughout the greater part of the summer” on Goat Island and the Riverway (27 Ann Rep Comm, 1911). The numerous reports of fallen trees due to winter gales suggest this may be the case, for example, the storm of January 9, 1889 (6 Ann Rep Comm, 1890) and that of 1847 (“which washed away Gull Island, about two acres in extent,” Niagara Book, 1893). The 1889 “hurricane” blew down the “Monarch of the Isle,” a large Sycamore. Another storm, of January 13, 1890, occurred whose violence “caused serious damage to the Reservation, washing away soil, gravel walks, endangering bridges and blowing down thirty-six trees. On May 23, 1893, a “severe gale” toppled “twenty-five large trees on Goat Island” (10 Ann Rep Comm, 1894). A storm in 1909, with winds of seventy miles per hour, the “most violent ever recorded for April by the weather bureau,” damaged many trees on the Reservation, “many fine specimens being uprooted and many others torn down ... numbers of trees were destroyed which it will take long to replace.” This storm felled 248 trees on Goat Island, and ten at its base (26 Ann Rep Comm, 1910).

It should be borne in mind that weather records in western New York State only began in 1871 (by the United States Army Signal Corps, International Weather Service, public service information). These winter storms did not begin when Goat Island became state property, but were characteristic of winter conditions there in the nineteenth century. Tree loss by wind-throw is probably fundamental to the extraordinary diversity of the Goat Island flora (see discussion on the central woods).

Exposure to strong winds would also contribute to more air in motion for a given length of time than would ordinarily be the case on the mainland where more opportunity for wind deflection would occur.

Strong wind movement is often associated with a drying effect that is stressful to organisms. Air will continue to take up water molecules until equilibrium is reached with the source of moisture—even if that source is a plant or animal and water loss becomes life-threatening. Air is constantly in motion, generally due to rising when it gets warm. Warm air is more effective at holding moisture as well, so warm moist air ascends, and cooler, dry air takes its place. Moving air, then, typically tends to extract moisture from sources of water on the ground. Ordinarily, there should be more stress of desiccation in the Goat Island flora due to exposure to moving air (wind).

Air, then, is an important vehicle for the distribution of atmospheric moisture, especially when turbulent, as an inducement to evaporation, and also in a mechanical sense. If there is a nearby source of abundant water mechanically reduced to droplets with a mechanism for bearing the droplets aloft, moving air could become abundantly charged with water and then distribute it in the direction of its movement. Far from desiccating, it would enrich the surfaces with which it comes in contact, providing a humid regime typical of still air but in a high energy environment. Not very many opportunities for such interactions
Part I: The Physical Features

occur in nature. They are rare as much as sources of air-borne moisture from cataracts is rare, and produce rare biological responses, such as an enhancement of species abundance.

An abundance of water droplets is generated by the fall of water over the brinks at the Horseshoe and American Falls, and also along the fifty-foot descent of rapids or cascades within a mile upriver of the crest line. Originally, the water of these rapids “begins to rush with such a fearful velocity that in many places it turns as white as the strongest rapids, and shoots up into the air” (Kalm, 1770). The plume generated by the cataracts is famous, “we saw the vapor of the Falls rising high toward the sky like a thick cloud, and this could be seen during our whole journey, gradually increasing in size as we approached the falls” (Kalm, 1770).

“A large mass of vapors rise from the bottom of the falls that resemble a thick smoke rising high toward the sky. Caused by the violence of water contact these vapors [sic], if the weather is calm, rise straight up to a great height and look like the heaviest cloud. But if there is a wind they are blown about as in a driving storm, and anybody enveloped by them will get as wet as if he had been dragged out of the sea. A couple of the Frenchmen who accompanied me climbed down a short distance below the falls, to examine the spot. The wind drove the mist at them so turbulently that they stood as in an impenetrable fog and thought they would suffocate. They left at once, and when they came up they were so drenched they were forced to take off almost all their clothes and dry them in the sun ...” (Kalm, 1770).

Goat Island is situated in the midst of this high energy system and exposed to the prevailing winds. Temperate areas of the world on the western margins of continents experiencing high rainfall—most spectacularly developed in the Olympic Peninsula in Washington state—are called “oceanic” areas, and lush vegetative growth is characteristic. The ecological optimal provided in part by the perpetual mist or spray from the cataracts mimicked oceanic qualities in the early flora. Abundance of atmospheric water contributed to other biological effects also:

“Two foliose species collected in the 1870’s, Anaptychia setifera Raes. and Teloschistes chrysophathalus (L.) Th. Fr., are recorded otherwise in New York only from Long Island, perhaps attesting to the originally very “oceanic” character of the immediate falls area” (Harris in adjoining report, lichen section).

The spray from the cataracts is of a generally constant occurrence at the falls, the air growing less saturated with distance from the cataract. In summer the spray cools the area by providing moisture for evaporation, relieving the associated vegetation from the effects of drought in the region (Olmsted in Gardner, 1880).

It is to the cooling effects of the mist that Zenkert (1934) partly attributed the presence of boreal species such as Paper Birch (Betula papyrifera) and Arbor Vitae (Thuja occidentalis) on Goat Island and the Niagara Gorge. Springs of cool water, such as existed on Goat Island’s shaded north side may have supported populations of plants which find it more congenial in the cooler areas north of the Niagara Frontier Region.

When the Reservation was first established the Commissioners lamented that the asphalted roads, “the driveways and paths are exposed, not only to the rain, but to the constantly falling spray which settles upon them, so that during a large part of the year [my emphasis] the passage of vehicles is impeded, and walking is most disagreeable,’ (7 Ann Rep Comm, 1891). In the 6th report, 1890, “after rain the road through the woods on Goat Island is very heavy, and being shaded dries slowly.” “Portions of the roads on Goat Island are so thickly shaded by the primitive forest that mud remains upon them, deep and black, long after the rain has ceased, to the obstruction of vehicles and the discomfort of visitors” (6 Ann Rep Comm, 1890). The roads are “exposed at certain points to the spray from the falls which, settling upon them, keeps them drenched for days and even weeks” (8 Ann Rep Comm, 1892). Of course, with draining or run-off blockage, the hydrology changed. In 1890 a gutter was established on the south side of Goat Island and “tile placed at intervals to carry off the surface water” (7 Ann Rep Comm, 1891). Again, the “evaporation of the rain and spray so hindered by the shade of the trees along the roads” frustrated road maintenance.

Oceanic conditions may have deteriorated by a rate of fifty to seventy-five percent corresponding to the loss of available water in the river as a whole through diversion of similar percentages of the river volume. As the prevailing winds are from the west, southwest, the spray relative to Goat Island would
derive from the Horseshoe Falls, more than the American. Since more water has been diverted from the Horseshoe to the American Falls, this additional decrease in the amount of atmospheric water available to Goat Island must be taken into consideration.

Dense tree cover, inhibiting evaporation by insulation from the wind and heat stress from sunlight kept things wet. The dense forest and thickets received the burden of air-borne water (spray) and prevented to some extent, the wind carrying this moisture away. Loss of forest, perhaps never more rapid than in the past thirty-five years or so from management policies of “thinning” (Goat Island staff communication) contributes to the present more desiccating conditions.

The energy to reduce masses of water to droplets or spray is proportional to the mass of falling water, the force of gravity being the engine driving this process. Some idea of the potential energy present in the pre-diversion Niagara River may be inferred from the magnitude of hydroelectric power derived from the present Sir Adam Beck and Robert Moses Power Generating Facilities downriver. Between them they generate more kilowatt-power than any hydroelectric facility in the world—and that with only half the present volume of the Niagara River in the summer months. Prior to this diversion, all of this energy was distributed in natural systems, including the ecological systems which produced the intriguing landscape written of so enthusiastically when the Niagara Reservation was established and before.

Part of this energy was spent making air-borne water available to life on the river—part of it was spent eroding the bedrock lining the gorge walls. Calcareous bedrock underlies the Goat Island sediments and forms the bed of the river. It creates a micro-climate in itself by being impervious and riddled with systems of joints. Ordinarily, limestone substrates are drier and warmer than sandstone or shale-based rock because of higher run-off rates of surface water through these fractures, with little or no retention through absorption, etc. These substrates become drier, warmer quicker (Zenkert, 1934). Calcareous caprock along the top of the Niagara Gorge to Lewiston are typical, facing into the prevailing wind which increases evaporation. This substrate-related desiccation stress is modified by the presence of spray at the falls and contributes to a unique assemblage of plant
species growing on “flats” areas of exposed, flat bed-
rock (south side of the island, etc.), periodically in-
undated, or in seepage, or within the spray zone (Ter-
rapin Point).

It is this copious and constant mist that generates
rainbows when the light is right—so characteristic of
the Falls that attempts have been made by the Porter
family and others to change Goat Island to Iris Island
(see Kalm, 1770, for descriptions of Niagara's rain-
bows and the 16 Ann Rep Comm, 1900 for use of Iris
Island in the treaty ending the War of 1812). These
rainbow features are characteristic of all waterfalls all
over the world.

The build-up of water in the vicinity of the cata-
racts in the form of ice in winter has already been
discussed above. The effects of this ice accumulation
must have contributed to a micro-climate at the falls
that was unique to the region.

One would expect the ice-mass would present a
cooling mass in spring with a probable resulting de-
lay in warming locally with the advance of the grow-
ing season. This delay is addressed by Frederick Law
Olmsted (Gardner, 1880) “... the masses of ice, which,
every winter are piled to a great height below
the falls, and the great rushing body of ice-cold water
from the northern lakes in the spring, prevent at the
Niagara the hardship under which trees elsewhere
often suffer through sudden checks to premature
growth ...” due to premature warming, a consequence
of keeping the environment at the falls in spring
cooler longer.

However, George W. Clinton, as a young man of
nineteen and in the company of several distinguished
naturalists, wrote in his diary that on Goat Island on
May 20, 1826 “The Podophyllum peltatum [Mayap-
ple] was in flower, and vegetation seemed to be more
forward in the immediate vicinity of Niagara than at
points more remote, owing probably to the continued
moistness of the atmosphere. They say that they are
exempt from late frosts which are so injurious to the
agricultural interests of this section of the country.” It
is difficult to see a mechanism for the early growth
conditions to which he was referring, except for the
earlier dates for the last killing frost in the Erie-
Ontario lowlands in general, which are as much as
thirty days earlier than in the Allegheny uplands in
the south-western part of the state (Zenkert, 1934).

Whereas in the relatively primitive condition of
the vegetation in the 1880's the wet conditions near
the falls were correctly seen to favor a wild and luxu-
riant vegetation, commented upon by Olmsted
(Gardner, 1880). However, since State ownership,
artificial and unnatural conditions in these areas have
been present so long that the natural vegetational in-
teractions cannot be observed and the false or errone-
ous conclusion, based on the performance of exposed
plantings, regardless of species, is now drawn that
“plant growth is inhibited by mist and ice accumula-
tion, particularly at Prospect Point, Terrapin Point
and Luna Island” (The Promontory Partnership,
1981; Otis, 1982).

As discussed above, the energy of erosion within
the bedrock is partly due to the degree of hydrostatic
pressure from ground water flow throughout the
jointed calcareous bedrock—particularly at the gorge
face or brink of the falls (Krajewski & Liberty.
1981). Ground water percolates vertically through the
joints and horizontally along joints in the bedding
plane. Jointing in the Lockport dolostone increases
with proximity to the falls crest line, as does hydro-
static pressure and hence ground water (Krajewski &
Liberty, 1981). Atmospheric moisture, such as rain,
etc., probably contributes much to ground water vol-
ume, perhaps not significant in modifications in the
bedrock as it is in erosion features such as slumping
and landslides.

Loss of volume in the river, fifty percent in sum-
mer, seventy five in winter (Bastedo, 1981), curtails
much of this subsurface water pressure, hence the
 diminution of erosion by sapping and joint-block dis-
locations at the Horseshoe Falls, although perhaps
initiating new sources of erosion by freeze-thawing
(see section on ice above). Elements of diversion may
have affected the water table on Goat Island: lower-
ing the degree of hydrostatic pressure, reducing water
in the horizontal joint systems underlying and feeding
the Goat Island sediments, and lowering the level of
the river itself.
POLLUTION

In a diagram indicating the prevailing winds at the Niagara Falls area (NREP, 1972), the location of sources of airborne pollutants was shown just upwind (to the north and east) of the reservation (Cyanamid complex, Ontario; the Buffalo, Tonawanda, Buffalo Avenue (Niagara Falls, New York) and Stauffer Chemical complexes along the Niagara River). It is doubtful, then, that airborne pollutants from these industries have contributed significantly to deterioration of vegetation on Goat Island, other than regional effects in the Niagara Frontier Region which have not been documented to the present writer's knowledge.

Loss of some of the chemical-industrial base in the Niagara area, compliance with emission standards for the industries present and fuel regulations has probably had a positive effect on quantity of airborne pollutants. Since some plant groups are sensitive to air pollution, particularly sulfur dioxide, to some extent bryophytes, but especially lichens, which “are the first plants to disappear in cities” (Hale, 1967), there has probably been a small increased diversification and expansion of these communities in the study area.

If amelioration of air pollution regimes in the area continues, as it has “in the last ten years” (Otis, 1982), greater species diversity in populations of sensitive organisms will continue. Sulfur dioxide levels have been reduced, total suspended particulates, carbon monoxide levels and those of nitric oxide so toxic to evergreens, have been reduced (Otis, 1982, citing New York State Air Quality Report, 1980).

Water-borne pollution may be another matter. Pollutants built up in alluvium in the wet habitats of the west end of the First and Second Sisters which seem to contribute a special fragrance to the typical rank odor of this kind of soil. The present writer has found no negative effect on the vegetation that is related to pollutants: no apparent die-back, withering or monstrosities or effect on species diversity and abundance.

As already discussed, river water bears in it the material of dissolution and leaching of the surfaces over which it passes. It also carries in it waste matter of various kinds which seep or are dumped into it. Nutrients are constantly borne into proximity with the ecosystems in place in the island complex, enriching it, poisonous wastes come as well, but which effect could not be determined.

It should also be borne in mind that water pollution at the falls must have had a long history. The saw, grist, paper and pulp mills on the riverbanks in the nineteenth century doubtless all dumped their waste into the adjoining river.

As already mentioned, the spray from the cataracts is a constant occurrence at the falls. Recently (1988) there has been some controversy over water-borne contaminants becoming air-borne in the spray, with water pollutants being spread atmospherically within the area of the spray zone. Pollution of this type must have occurred from the time industry was established along the banks of the Niagara River, such as when pulp mill on Bath Island existed at the time of the establishment of the Reservation. Apparently no health hazard due to spray at the Falls exists since neither the American or Canadian governments has enacted protective measures there.

The limestone substrate acts as a buffer or neutralizer to acidic types of pollution, hence “the majority of lichens,” for example, surviving on Goat Island, and which are as a group very intolerant of atmospheric acidity, particularly sulfuric acid, “grow directly on the lime rock, on or among mosses on rock” (Harris, attached report on lichens). As a native woodland in the midst of urban atmospheric conditions, so much exposed dolomite within the Niagara River Gorge and on Goat Island is a positive factor in the maintenance of native ecosystems.
SEDIMENTS

In the present report, more information is presented on the sediments on Goat Island underlying the soils than the surface layer of the sediments themselves. The soils are derived from the substrates below and the vegetation above: either the calcareous dolostone caprock (Lockport Dolomite) or the riverine or alluvial sediments above them as described below, and the humic contribution from the primeval vegetation above as attested to by early reports. This is the substrate in which the seeds and seedlings of the past and present native vegetation find conditions leading to their establishment. Intensive analysis of surficial soils and their present and past relationship to the flora of the Goat Island complex must be the subject of a special study. The following information may be considered useful as background information.

Following Charles Lyell’s interpretation (1845) of the general outline of bedrock surfaces and subsequent deposition of sediments in the region about the Falls, there are:

a) First the bedrock strata themselves, all sedimentary: shales, sandstones, limestones and magnesiu m limestones (dolostones) all undergoing surface erosion by water at the beginning of the recent ice ages (of the Pleistocene). It was at this time that the escarpments and other cliff-features were formed in resistant layers over softer ones. Then,

b) The continental ice sheet stripped away all loose material, soil, boulders, the bedrock surface becoming “smoothed, polished and furrowed by glacial action” at the base of the ice mass;

c) As the ice retreated, the entire region including the lake floors, the table land above the escarpment, and the lake plain below it was covered with glacial drift: the deposition of sediments once suspended in the ice -“stratified and unstratified sand, gravel, and erratic blocks.”

d) The land was underwater, such that the glacial drift was to some extent rearranged by new water currents, and marine drift became deposited upon it, including the shells of mollusks still alive in the lakes and river today.

e) “As soon as the table-land between Lakes Erie and Ontario emerged and was laid dry, the river Niagara came into existence.”

Goat Island, like the surrounding territory, was covered with glacial drift, forming the basal layer of sediments. Carbon-14 dating of shells found on Goat Island indicate that of the 12,000 years since the area was liberated from glaciation, Goat Island has spent 9800 of those years as an island, that is, “unaffected by river erosion” (Brett in Tesmer, 1981), although theory based on geomorphologic evidence has traditionally set the date to 2000 to 3000 years (Calkin & Brett, 1978).

Above this, unconsolidated sedimentary layers on the island and in terraces along the Niagara River indicate that the land now comprising Goat Island was submerged in a river with lake-like conditions to a depth of 100 feet (Porter, 16 Ann Rep Comm, 1900), with a northern boundary, or dam, at the situation of Lewiston, New York. Coarser sediments indicate increasing river turbulence with time. The height of this body of water decreased in elevation until, when the falls had cut its way past the Whirlpool, or at any rate, at “a point nearly a mile north of the present location of the Horseshoe Fall,” the previously submerged surface of Goat Island, continuous with much land which now forms part of the mainland, became open to the air (Porter, 16 Ann Rep Comm, 1900). The channel of the American Falls had not yet been cut and Goat Island was still part of the eastern mainland, to which its sediments display great affinity (Kindle and Taylor, 1913). River gravel deposits of the same age and origin were mapped on Goat Island and Prospect Park, as well as in little cells on what is now the Queen Victoria Niagara Falls Park, in Ontario, by Kindle and Taylor (1913). This continuity of strata across what is now river bed was also noted by Agassiz (1850).

During this period the flora of the mainland would have established itself generally without interruption over these surfaces.

The mollusk layer below the surface of Goat Island has been dated at 9100 years B.P., suggesting deposition ceased at that time, and the land became exposed by lowered river levels. Spencer (1907, 1910) and Taylor (Kindle & Taylor, 1913; Taylor, 1933) give geomorphologic evidence that the Goat Island surface did not become exposed until 2000 to
3000 years B.P. (see Calkin & Brett, 1978). Calkin and Brett (1978) suggest “termination of deposition on Goat Island may have involved only shoaling rather than complete emergence of the surface.”
Part I: The Physical Features

GOAT ISLAND
West to East Section

Section of Goat Island from West to East, 2500 feet in length.
A. Massive compact portion of the Niagara limestone.
B. Upper thin-bedded portion of the Niagara limestone, strata slightly inclined to the South **
C. Horizontal freshwater beds of gravel, sand, and loam, with shells.
D. E. Present surface of the river Niagara at the Rapids.

(after Lyell, 1845)

*in Lyell's illustration, he indicated north when he should have made it west, and south when it should have been east. This lack of orientation was frequent throughout literature relating to Goat Island.

**the strata of the region dip to the south. It is possible the illustration is mistaken about the inclination of the bedrock, showing a tilting from west to east, due to the lack of orientation just mentioned.

a. The terrace with shells on the north* side.  c. The terrace on the b. Goat Island  L. Limestone S. Shale d. The ancient drift (i.e. glacial deposits)

*In Lyell's book this reads eastern. "a" is a south-facing elevation to the north of Goat Island. occasionally referred to as "the Terrace."

(after Lyell, 1845)
Botanical Heritage of Islands at the Brink of Niagara Falls

Section of the strata along the Niagara River, from Lake Ontario to Lake Erie (simplified from Lyell, after Hall, 1843).

1. Limestone - compact and geodiferous. Niagara limestone.
2. The upper thin-bedded portion of the Niagara limestone.
3. Onondaga salt group, including the hydraulic limestone, or beds of passage to the next rock.
4. Onondaga and Corniferous limestones, being all the limestones of the Helderberg division which continue so far westward.

"Length of section from north to south about twenty-eight miles."

"Mrs. Robertson endeavors to find shells at Terrapin Point, Niagara Falls" (Robertson & Blakeslee, 1948). The living and fossil mollusc faunas attracted members of the Conchological Section of the Buffalo Society of Natural Sciences to Goat Island.

Dr. Letson of the Buffalo Society of Natural Sciences did the first systematic study of the fossil mollusc fauna of the Goat Island gravels, (Robertson & Blakeslee, 1948).

Goniobasis livescens var. niagarensis (Lea), a fossil in the Goat Island gravels (Robertson & Blakeslee, 1948).
Some centuries after the exposure of this land, water, which had been draining from the three upper Great Lakes through an outlet to the north was redirected through the St. Clair outlet around Detroit into Lake Erie as the eastern land mass, once depressed by the weight of the continental glacier, rebounded upward, and water began to drain more through Lake Erie and the Niagara River, than northern outlets. The result was that “the volume of the Niagara river was suddenly and enormously increased,” raising the level of the river, and cutting across vulnerable low areas where the river changed course, flowing from east to west below Grand Island, and suddenly turning north at what is today the present position of the cataracts. The river “cut a corner” here, and created the American channel and cataract, eroding the glacial and riverine sediments formerly deposited there down to bedrock—its present condition (Porter, 16 Ann Rep Comm, 1900). Prior to this interpretation, both river channels flanking Goat Island were thought to have been created simultaneously with a decrease in the level of water in Lake Erie, and consequently in the Niagara River (Agassiz, 1850).

It is from this juncture that the destiny of the Goat Island flora would become separated from that of the mainland. It should be noted that in this scenario, the Three Sisters Islands, the islands in the American channel, Terrapin Rocks, Dufferin Islands, and all the land below or at the base of the little escarpment (the Niagara Moraine) in the Queen Victoria Park were still under water, inferred from geological relations depicted in the Kindle-Taylor map of 1913, although Porter inferred they emerged from the same event as that causing the emergence of Goat Island.

Lyell (1845) published two stratigraphic diagrams perhaps printed earlier by James Hall in a report of 1839 mentioned in Lyell’s work. The diagrams represent the geological strata and their composition on Goat Island. The first diagram showed “freshwater strata on Goat Island, above 20 feet thick” beneath which lies an 80 foot thickness of limestone, and an 80 foot thickness of shale below that. The diagram indicated the identical origin of similar deposits on the American shore (mistakenly indicated as “east” when in fact it is north). These freshwater strata overlie glacial drift on the mainland banks, but no glacial strata in Lyell’s map are indicated on Goat Island below the freshwater layers. Later interpretations suggest the lowest layers were in fact glacial drift deposits (Kindle & Taylor, 1913), that is, the basal sediments arose from the water flowing in the body of the glacial ice-mass and exiting from outlets in the base of the ice.

From examining a nine-meter section of the bank overlooking Luna Island, Calkin and Brett (1978) suggested the lowest section of sediment on Goat Island was the pebble-boulder gravel which extends down to the dolostone bedrock of the island, as it appears to do elsewhere in the gorge. The boulders are of dolostone (see Hall’s “limestone of Black Rock” below). Above this lies glacial till, over that glaciolacustrine deposits, all capped by the “ancient mollusk-bearing gravels which form most of the flat surface of Goat Island.”

Lyell’s second diagram showed a cross section of Goat Island showing an east-west exposure that would parallel the river as indicated in the text (not a north-south one as indicated in the printed figure). The bluffs of the Island, corresponding with the brinks of the cataracts are depicted to the left where a line shows the land comes to an end, and the eastern, or upriver, end of Goat Island is represented as indeterminate, or the strata continue to the right of the diagram. The natural excavation of the calcareous caprock in the west end of the island was reported by Porter (16 Ann Rep Comm, 1900) to have been gouged or eroded, when it is probably interpreted today as the bed of a pre- or interglacial river. “In this excavated cavity, drift was deposited by the ice. Many of the boulders brought here in the ice age ... have been collected in this section and used in the construction of the handsome stone bridges that have been built on the Reservation, on the main shore opposite Goat Island” (Porter, 1900, see section on bridges below).

There is a canted, dotted line passing from left to right across the diagram indicating the “present surface of the river Niagara at the Rapids” showing the steep grade of the river as it descends some fifty feet from the upriver to the downriver end of the Island. The single limestone stratum shown in the 80 foot section in the first diagram is drawn with a layer atop it of the “upper thin-bedded portion of the Niagara limestone” above the “massive compact portion of the Niagara limestone.”

For the purposes of reconstructing the original substrates of the Island at the time of the creation of the Reservation in 1885, it would appear that the
eastern end of the Island displayed the same character as the Three Sisters do now: bare calcareous rock to the east, alluvium to the west following the trend of the river. “The ledges of the cascades pass under the drift on both sides of the river and on both sides of Goat Island on continuations of nearly the same lines that they follow in the rapids” (Kindle & Taylor, 1913). These ledges are obscured on the southeastern side of Goat Island by grading and ballast deposited on their surfaces, although they must have been more exposed, with a different kind of habitat than is presently seen (see section on the eastern meadow).

“The island is mainly a deposit of gravel upon the Niagara limestone which forms the bed of the river. The soil varies in thickness from forty feet at the western margin to a thin wedge at the eastern end ... where the rock comes to the surface. The eastern and southern margins of Goat Island are rock-bound; the western margin is a steep, rocky bluff. Along the southern margin the bed of the island is composed of layers of gravel, clay, gravel, quicksand and gravel, downward from the surface in the order named” (6 Ann Rep Comm, 1890). A specimen of the moss *Hymenostylium recurvirostrum*, which never grows on soil, but only on rock, was collected “on ground towards 3 Sister Islands” by Eugene A. Rau in 1886 during a foray of the annual meeting of the American Association for the Advancement of Science. The “ground” was probably exposed bedrock in this area. When the eight acres of land constituting the eastern meadow in 1911 was covered with soil transported from the mainland, much of the area was originally covered with around three inches of topsoil over bedrock. When the area was covered, more than “six hundred cubic yards of stone were picked off the eight acres and piled up for future use on the roads” (28 Ann Rep Comm, 1912). Perhaps this stone indicated recently exposed river bed, as stones were also removed from the bedrock exposed with lowering of water levels at the Horseshoe Falls and represent glacial debris not yet eroded away by the river current. Hall also mentioned the stratum of shell-bearing sediment which “thins entirely out at its southeastern extremity” (Hall, 1843).

In 1823, Douglas noted on “the south side of the island there is very good limestone and a good kind of gypsum” (Douglas, 1823). Certain portions of this area may have been naturally open, and not cleared for farming. Trees were cut down for planting to turnips (see section on land use), but it is unlikely topsoil was removed, except by some kind of erosion. Significant portions of this area may have never been forested. Indeed, when Superintendent Harries considered restoring this area to “the original appearance of this part of Goat Island,” he felt that “holes must be blasted out of the solid rock and soil brought in before anything of greater growth than a sumac can be assured” (28 Ann Rep Comm, 1912) as though that area had once supported forest growth.

In Lyell's diagram, trees were drawn scattered not only on the loose sediment to the west, but on the thin soil or rock to the east. It is possible that the original vegetation of this area resembled that of the east end remnants visible today: Red Cedar (*Juniperus virginiana*) and Paniced Dogwood (*Cornus racemosa*), and to some extent, on the southeastern side, the vegetation on the eastern ends of the present Three Sisters Islands.

“Upon the southern side of this island, where there is an escarpment, the thickness of the superficial deposit is about twenty-five feet. The upper half consists of coarse gravel and sand, with abundance of ... shells,” (Hall, 1843). Along the southern margin the bed of the island is composed of layers of gravel, clay, gravel, quicksand and gravel, downward from the surface in the order named” (6 Ann Rep Comm, 1890). Panton (1890) also mentioned areas of quicksand across the river in the Queen Victoria Niagara Falls Park, where in some places the “soil is a rich loam underlain by quicksand” and the area “skirting the river below the terraces in front of Falls View ... is of a swampy nature with considerable quicksand.”

The quicksand just mentioned, and which contributed to much early erosion on the south side of Goat Island may be similar to, if not produced by the same processes, as the quicksands in the forested Whirlpool Ravine on the Canadian shore in the gorge of the river facing Whirlpool State Park in New York. There one year Albert Tiplin discovered a “four foot thick river of red mud and sand” flowing over the tops of ice piled up on the shore. The sand-sized clasts in this sediment were “bead-like or rounded rather than angular, and prone to slippage, especially when saturated with water” (Tiplin, 1988). The clays at the Whirlpool were produced when the ground moraine which covered the area, including Goat Island, were modified during subsequent submergence beneath ancient Lake Lundy (Kindle & Taylor, 1913).
After Kindle & Taylor (1913): stippled areas indicate outcrop exposures of Silurian rocks (SI on the 1913 map) Pleistocene and Recent sedimentary deposits representing "recently abandoned channel floors of Niagara River ... cut while falls retreated 1500 to 2000 feet south of Hubbard Point ... falls passing west end of Goat Island ... (and) slightly later cutting" are also shown in stipple, representing the lesser island areas.(Qmc areas on the 1913 map). Note that all the prospect areas, except Stedman's Bluff overlooking Luna Island on Goat Island, occur in these geologic areas and associated habitats. The rarest plants occur and occurred in these areas. Upper Niagara River

Artificially lowered water levels mimic this natural event, or event series, exposing new areas for colonization by plants and animals, such as in the flats islands on Goat Island's south side.
SEDIMENTS AND THEIR RELATIONSHIPS (after Kindle & Taylor, 1913). The 1913 geologic map indicated that there were dolomite pavements without or with little soil on Robinson, Luna and Green Islands, the dolomite flats area by the Spring on the north side of Goat Island, at Terrapin Rocks and on the mainland, New York, river margin. This latter area also supported significant gravel deposits. The sequence of exposed land due to natural loss in river volume through time is Green Island (and perhaps the other islands in the American channel, the flat by the Spring and the mainland river margin to Prospect Point all exposed in one event. Next Terrapin Rocks and the dolomite flat associated with it became exposed. Finally the Three Sisters Island complex on the south side of Goat Island in the Horseshoe channel.
Part I: The Physical Features

Lyell’s diagram also showed where the river current touched the lowest layers of sediment, indicating where the chief erosional problems were in the Reservation’s early years, especially when the river levels were high during storm surges. Some aspects of the early ground water relations on Goat Island may be suggested in this diagram—sedimentary strata touched by the river a century ago will not be affected now with the present lowered water levels in the Niagara River.

The lowest stratum of soil on Goat Island includes a clay, which “proves the first condition [of the area in which the island is situated] to have been that of a quiet lake,” with little current (Hall, 1843). Day also referred to this clay: “in a single place upon the island there is to be seen a small quantity of clay, possibly deposited by the glacier where it is found, but more likely to have been brought by the current of the river along with the other materials which make up the soil.” This clay is red “laminated glacial lake silt [which] overlies the till ... locally on Goat Island but has been eroded away prior to deposition of the overlying gravel along parts of the latter exposure” (Calkin & Brett, 1978). Barriers to water flow in the regional watershed causing impoundment were subsequently modified such that a current developed in the river with the corresponding energy to move larger and heavier sediment: pebbles and sand, which were deposited upon the clay (Hall, 1843). This layer is a “coarse pebble-cobble gravel, ... is very well bedded and sorted, and may in turn represent glaciolacustrine deposition following ... more vigorous melting during construction of the adjacent Niagara Falls Moraine” (Calkin & Brett, 1978). Above this is “brown, laminated lake clay and silt” representing final “ice retreat and glaciolacustrine deposition prior to development of the ancestral Niagara” (loc. cit.)

The Geologic Atlas of the United States of 1913 (Kindle & Taylor) displayed the distribution of surface sediment on Goat Island and correlated sediments on the mainland shores of Ontario and New York. There are generally four sedimentary types depicted:

1. Sediments marked (SI) and Qnc correspond to the Three Sisters and adjacent land on Goat Island to the east of the shelter built near the Sisters of the time, and to all the islands in the American Channel, the mainland shoreline in the Reservation and very small areas in the vicinity of The Spring and at the Terrapin Rocks and Terrapin Point on Goat Island, and extensively along the mainland river shore at and just above Prospect Point. From research into the original aspect at Prospect Point, the Commissioners discovered that area was a “solid uneven ledge of rock sloping gradually back from the river for some distance. The next views, which were photographs, portray it as a natural slope of grass covered soil with an occasional tree or bush” (26 Ann Rep Comm, 1910).

-Qnc3-7 indicates Pleistocene and Recent sedimentary deposits: “Recently abandoned channel floors of Niagara River, 4, cut while falls retreated 1500 to 2000 feet south of Hubbard Point, 5, falls passing west end of Goat Island, 6 slightly later cutting.”

The Second Sister has a mark Qnc6, Terrapin Point Qnc5, and Green Island Qnc4 indicating their relative ages, the lower numbers being the older deposits.

2. Sediments marked Qgmc and Qnc2 occur generally on the north and north east sections of Goat Island.

-Qgmc indicates ground moraine “made by and in conjunction with ice” during the Wisconsin stage of the Pleistocene, i.e. before the development of the subsequent glacial lakes Lundy, Tonawanda and Iroquois. This sediment is interpreted as ground moraine: “sheet of bowlder [sic] clay covering greater part of area” “forming floor of some abandoned channels”

Drainage in the northern part of Goat Island may be poorer than that on the southern due to higher fraction of clay-size sediments implied in the characterization “bowlder clay.”

3. Sediments marked Qrg2 constitute the majority of the Island surfaces along the south and western boundaries of Goat Island, and correlate with Prospect Park sediments.

-Qrg2 sediments were deposited during the final stages of the Wisconsin stage of the Pleistocene, constituting river gravels “mostly coarse gravel with cobble depos-
Botanical Heritage of Islands at the Brink of Niagara Falls

sted in bars or spread over channel floors, contains abundant fossil shells.”

Because of the coarser sediment fraction described for these areas, it may be assumed that drainage was more efficient on the south and southwestern sides of the island.

4. A narrow strip of sediment marked Qdb4 on the north slope, Qdb5 on the south toward Terrapin Point, and Qdb6 upriver from there occur on the periphery of Goat Island, ending just downstream of the Three Sisters on the south and at the promontory near the old spring to the northeast.

-Qdb4 indicates “[glacial] drift bluffs forming banks of abandoned [river] channels.”

Much of the sediment mantling the embankments or terraces above the crest of the Niagara Gorge, including the soils of Goat Island, are derived from riverine deposits, as is attested to by the inclusion of the remains of marine organisms in their matrix. Most sediments seem to derive from post glacial river deposition (Lyell, 1855, Hall, 1843) over the general sheet of moraine deposits characteristic of the region as a whole—note the numerous glacial erratics, constituting granitic boulders on the Three Sisters, west end, at Prospect Point, and possibly in the central woods. Peter Kalm (1770) noted that the “land about the falls is stony, and here and there a large bit of gneiss or granite is found” isolated out of the glacial drift. In 1898 the soils at the western end of Goat Island were undisturbed. Here “is the original drift, with the subsequent over lying alluvial deposits and accumulations, undisturbed by man” (Porter in 16 Ann Rep Comm, 1900).

As the geological strata, especially the resistant types, are higher in elevation at Lewiston than further south, at the falls, coupled with a gentle basin behind or south of the strata that form the present Niagara Escarpment, the orientation of the strata at Lewiston created a barrier to the river flow in early times, before the gorge had receded seven miles to its present locality. The river levels were correspondingly higher in the basin-like or lower elevations south of Lewiston. The brink of the falls became lower with recession, and the river channel in the gorge deepened in places with a corresponding lowering in the height of the river, exposing the old beaches with their shells at Goat Island and associated terraces on the Canadian and American mainlands (Tesmer, 1981).

The source of much of the stone in these terraces is “of the limestone of Black Rock [upstream at Buffalo, New York], and the harder layers of the Onondaga salt group, like the rock in place at the upper end of Grand island” (Hall, 1843). Day (1910) referred to Hall’s comments when he wrote of terraces “largely composed of water-worn stones and materials, brought and deposited by the river itself from more southerly localities.”

Three working gravel and/or clay pits were depicted on Goat Island in 1913 (Kindle and Taylor, 1913), the one described by Grabeau below (1901), one beside and just south of the American Falls shelter in the northwest side of the Island, and one toward the north east side inside the ring road to the east of the depicted structure (the Hermit’s Hut?). The Porter’s may have opened the large one on the island’s southwest side, in order to surface the first circuit-way on the island (see section on land use below). Commissioner reports through the years do not specify which pit was the focus of their activities. Compost at one time was collected in “the gravel pit on Goat Island, and turned and mixed from time to time during the year” (16 Ann Rep Comm, 1900 and 17 Ann Rep Comm, 1901). In 1907 an ice house was built in the gravel pit on Goat Island (24 Ann Rep Comm, 1908). In 1912, “the gravel pit has received several thousand yards of fill this winter” (29 Ann Rep Comm, 1913). Later, “the old and useless structures that were in the old gravel pit have been removed and the pit is being filled in.” “The old gravel pit near the spring has been graded and is now in condition to receive the barn and proposed labor centre” 29 Ann Rep Comm, 1913.

Grabeau (1901) mentioned that on the way to the Three Sisters from Terrapin Point, there is a spot “where a wood-road leads off to the left into the famous gravel pit of Goat Island, since there the shell-bearing gravels are exposed.” This pit had been made famous by the study of its shells and the deduction of their geological significance made earlier by Sir Charles Lyell and James Hall, Geologist of the New York State Survey (Hall, 1843; Lyell, 1855).

“This fluviatile deposit is made by materials brought down by the current, and doubtless mingled with a large accumulation of shells of Unio, Melania, Anculotus, &c., as these shells of Uniones are constantly brought down the rapids during the summer season” (Hall, 1855).
A similar soil mass occurs on the American mainland shore, on a terrace “upon the east side of the river,” that is, off the northeast boundary of Goat Island. A mastodon’s tooth was discovered there. This terrace of fluviatile deposits continues north as far as the Whirlpool where fossilized shells may still be observed. Hall mentioned a corresponding terrace on the west or Canadian side.

Some soils are glacially derived in the Niagara Falls and Gorge area, most evident at Whirlpool Ravine, Ontario, where the slopes are composed of glacial till which has completely buried a river valley (the St. David’s Gorge). Other sediments above these, mantling the walls of the Niagara Gorge and the terraces above the crest of the gorge, and the soils of Goat Island and Niagara Glen, are derived from riverine deposits, as is attested to by the inclusion of the remains of marine organisms in their matrix.

“The most notable” excavation in the old riverbanks of the Niagara River “and the one longest known is on Goat Island, perhaps a quarter of a mile inland from the edge of the cliff, at the Biddle stairway. In the section opened here, most of the material is seen to be coarse and rudely stratified. The pebbles are subangular, often quite angular, while some appear to be scarcely worn at all. Blocks a foot or more in diameter are not infrequent, the material being generally limestone from adjoining ledges, though fragments of sandstone and of crystalline rocks are not uncommon. Occasionally a lens of fine sand occurs which shows cross-bedding structure, the laminae pointing in a northwesterly direction. The shells are found on the cross-bedding planes, conforming with them, and indicating that they were spread there by the current which moved the sand grains. Among the coarse material the shells are mixed indiscriminately. In many cases the gravels are of the loose type, with scarcely any sand between them, indicating deposition by a powerful current. Along these zones air and water have most readily penetrated, and a deposition of iron oxide has been formed which stains both pebbles and shells. The shells are generally very fragile, and commonly show signs of wear. Gastropods are most abundant in the Goat Island gravels” (Grabeau, 1901). Lyell (1855) reported finding shells of the genera *Unio*, *Cyclas*, *Melania*, *Valvata*, *Lymnea*, *Planorbis* and *Helix* species in the “surficial deposit” of sediments on Goat Island, none of which were extinct. These shells indicate that Goat Island was once submerged.

Stratigraphic section of Stedman’s Bluff, a fifty-foot bank of sediments on Goat Island’s west and, where the sediments are of greatest thickness. Luna Islands, presenting a much lower accumulation of sediments on the same bedrock base, can be seen on the right-hand side of the diagram. The viewer is facing west, north is to the viewer’s right. Redrawn from Krajewski and Terasmae in Tesmer (1981).

Certain of these snails and clams are still living in the river, but some species and subspecies in these layers are presently extinct (Brett in Tesmer, 1981). This deposit: “is of greatest thickness toward the fall, and thins entirely out at its southeastern extremity. In some places the lowest part of this deposit is of clay, which has been subse-

Members of the Conchological Section of the
Buffalo Society of Natural Sciences would conduct field trips to the base of Prospect Point, to Luna Island “from whose rocky edges we pick *Goniobasis* up to a few inches of where the waters make their destined plunge over the brink. Some terrestrial forms may be found on the Three Sisters Islands” (Robertson & Blakeslee, 1948). “In years past fossil forms of *Goniobasis*, *Pleurocera*, and other species could be found, sometimes in abundance, in the interglacial Pleistocene sands and gravels of Goat Island” but “laws forbid any digging unofficially and so the site is apparently forever sealed” (Robertson & Blakeslee, 1948). Fossil shells “were obtained from an open gravel pit supplying material for activities on the island, but a few years ago [prior to 1949] the pit was closed and filled in, and at the present time no opportunity exists for further collection” (Robertson & Blakeslee, 1949).

Actually, the rarest plants in the Goat Island complex occur in areas corresponding to Kindle and Taylor’s *Qnc* sediments—the youngest in the complex (see above) at the edge of relatively newly formed soil mats which are still probably about a century old. Ice scour in winter with corresponding loss of soil and inhibition of the establishment of other, competing plants is probably essential to the continuation of these populations.

### SOILS

Soil, as distinct from the sediments on Goat Island, that is, the top layer of soil in which the vegetation is established and composed of decayed or disintegrated bedrock or sediment below, and the litter of dead or rotting plant material above, was not examined for this study, not could it be assessed how intact the original soil layers, or horizons, are. The great vigor of the vegetation on Goat Island, both in the size of the trees and vines, and the abundance and diversity of the species was attributed to a certain extent to the native soils there: generally alkaline, due to the dolomite bedrock and the calcareous sediments, and available humus.

The surface sediments or soil were heterogeneous on Goat Island: “the soil [on Goat Island] is variable, part rich and part sand and gravel” (Douglas, 1823). The “rich” soils were probably those not altered or eroded by the river, and were probably concentrated toward the center of Goat Island, or any of the other islands in the Goat Island group.

Occasionally in the literature, no distinction is made between soil and sediment: “the flow of the lake set towards the falls and brought down from the Erie basin fluvial deposits in large amounts during the succeeding years, depositing them all along the bottom of the lake. It is of these fluvial deposits, consisting of sand, and loam (excepting a comparatively small layer of drift next to the top rock [bedrock] that the soil of Goat Island is formed” (Porter, 16 Ann Rep Comm, 1900).

“A calcareous soil, enriched with an abundance of organic matter, like that of Goat Island, would necessarily be one of great fertility” (Day, 1910). “The vegetation of the island is that which might be expected to luxuriate upon a deep calcareous soil, enriched with an abundance of organic matter” (Day, quoted in Porter, 16 Ann Rep Comm, 1900).

The presence of the Goat Island shell beds was not unknown to Louis Agassiz when he visited the island on his way to Lake Superior prior to 1850. “The fossils form a bed extending horizontally to the river bluffs, but not beyond; they occur in great numbers, covering the surface of the soil everywhere, and contributing to the great luxuriance of the vegetation” (Agassiz, 1850). Agassiz also noted on his passage through New York from Massachusetts, that it was “remarkable how limestone favors not only vegetable, but also animal life.”

Zenkert (1934) also remarked on the soil: “remains of glacial till, enriched by deposits of humus, in places support a luxuriant vegetation on the limestone bedrock. Such an enriched area is Goat Island.”

Serious loss of species diversity in the island complex may have contributed to depletion of species of mycorrhizal fungi, bacteria, etc., associated with certain species of plants. Corresponding loss in soil fertility may be expected due to reduced accessibility to native nitrogen.

Through the years since the establishment of the Reservation in 1885, soils and gravels have been brought to the island from the mainland for a variety of reasons, primarily for the building of roads and paths, as well as landscaping, gardening, etc. In 1988 a pile of what was labeled as “garden soil” was observed by the author in the central woods which was used as a dumping and storage area for island main-
Part I: The Physical Features

tenance. Visually, one area in the northeastern section of the central woods is covered on the surface with a cindery introduced soil. Material used for fill came variously from either on (gravel pits) or off the island.

Perhaps the largest importation of soil from outside the native sediments on Goat Island occurred when the eastern meadow area was covered, its native regenerating vegetation cut and burned and the native soils plowed (27 Ann Rep Comm, 1911). Originally, the soil here was some three inches deep over bedrock. The new soil came “from construction work in the city ... [and] was used to deepen the soil in many portions where bed-rock was very close to the surface...” (28 Ann Rep Comm, 1912). These soils, then, did not derive from alluvial deposits in ponds on the Reservation as had been suggested in Commission reports just prior to the treatment of the eastern meadow.

Another extensive soil importation must have occurred when the low land was exposed on the south side of Goat Island, including Terrapin Point, due to lowered water levels from diversion. These areas presently support grassy lawns in contrast to the vegetation of the flats areas just to the south in the river bed which were also created due to low levels in the river.

Soil modifications through time were made for a variety of reasons. A small hill once existed at the entrance to the Goat Island bridge, now the pedestrian bridge. When automobiles began to regularly use Goat Island, drivers found themselves unable to detect the approach of other vehicles because this hill obstructed their view. Since accidents occurred here, “it was decided to cut down as much of these hills, on both sides of the entrance, as would enable the drivers ... to note the approach of others ...” Removal of this hill apparently opened up “a most delightful view into the interior of the island” (27 Ann Rep Comm, 1911).

Grading has always accompanied structural modifications to the islands, whether as additions or deletions, be it roads, paths, the construction or removal of buildings, etc. There is one instance (on Prospect Point) where the Commissioners graded in order “to secure the most natural appearance possible, large flat stone slabs were laid in such a manner that the joints between them are made to resemble quarry seams. From this ledge the grading has been carried unevenly to the level of the grading at the entrance to the elevator, giving the slope as far as possible the appearance of the natural rock” (26 Ann Rep Comm, 1910). The appearance of Goat Island presently is that grading now is done for the convenience of efficient lawn-mowing without consideration of natural topography.

The effects of compression through trampling on the soil can be seen by observing any path. Where trampling has lead to serious degradation of the soil is in the area where visitors feed the water fowl between the First Sister and Goat Island. Here the soil is eroded and sterilized, the banks are caving into the stream channel. The exposed roots of trees and shrubs are used by visitors as convenient steps for negotiating bank. Heavy infestations of urban weeds accompany this condition. Opening up the river banks along the south shore of Goat Island not only destroys the last native wet thicket community on the Island, but soil compaction and weed infestations attend visitors walking up to the open banks across the mown lawns to look out on the river. Paths which become swathes of compacted mud on top of the north bank on Goat Island are made by visitors leaving the asphalted path to obtain views of the river.

The degree of disturbance of native soil horizons associated with the extensive asphalted sidewalks, viewmobile way, road and parking lots on the surface of Goat Island was not investigated.

Where trampling is most serious, because of the quality of the plant communities in jeopardy (e.g. rarity, intactness, diversity and abundance) are on the Three Sisters. A careful plan to restrict access to these islands is highly recommended.
Catalogue of shells found on goat island

None other than the study of terrestrial, fresh water and marine snails contributed so much to the establishment of an institution devoted to natural history in Buffalo, the Buffalo Society of Natural Sciences (Robertson & Barcellona, 1939). The Conchological Section of that Society, now housed in the Buffalo Museum of Science, made many trips to the Niagara Reservation to explore its shelled creatures.

Dr. Elizabeth Letson was director of the museum from 1900 to 1909 and founded the Conchological Section in 1897. She published a checklist of the mollusks of New York State. “The Conchological Section became one of the foremost cultural clubs of Buffalo with a restricted membership and a long waiting list” (Robertson & Barcellona, 1939).

Molluscan species found in the study area and reported by Robertson and Blakeslee (1948) include the following. Voucher specimens may be sought in the collections of the Division of Invertebrate Biology of the Buffalo Museum of Science, the bibliography referring to collections made by Letson, given in parentheses below, are included in the bibliography.

Putting the name of the authorities in parentheses refers to Article 23 of the Paris (1889) code of zoological nomenclature (First International Zoological Congress) indicating that when the epithet is applied to a genus other than the one in which it was originally described, the author’s name is given in parentheses (Robertson & Blakeslee, 1948). The nomenclature follows Robertson and Blakeslee, 1948.


Alasmidonta truncata (Wright) Simpson. Goat Island (Letson, 1901).

Amnicola (Probythinella) binneyana Hannibal. Goat Island gravels (Letson).

Amnicola leightoni Walker. Goat Island (Letson, 1901).


Campeloma decisa Say. Goat Island gravel pit (Letson, 1901).

Cochlicopa ulubrica (Mueller) Niagara Falls.

Fossaria uobrussa (Say) Goat Island gravels (Letson).

Fossariella parva (Lea) base of American Falls.

Goniobasis haldemani (Tryon) “Miss Letson reported this species from the Goat Island gravels, and as not being represented in recent fauna.”

Goniobasis livescens (Menke) Tyron. Goat Island (Letson, 1901).

Goniobasis livescens niagarensis (Lea.) (Goniobasis niagarensis Lea.). “A small carinated variety found in Niagara River near the cataract and as a fossil in the Goat Island gravels.” Goniobasis livescens niagarensis is an extinct subspecies (now in Oxytrema, v. Calkin & Brett, 1978). Goat Island may be the type locality for this animal.

Hawaiiia minuscula (Binney) Goat Island (Letson).

Helisoma (Pierosoma) trivolv (Say) Three Sisters Islands.

Lampsilis rectus (Lam.) Smith. Goat Island (Letson, 1901).

Limnea catascopium Say. Goat Island (Letson, 1901).

Limnea columella Say. Goat Island gravel pits (Letson, 1901).

Limnea desidiosa Say. Goat Island (Letson, 1901).

Mesodon mitchellianus (Lea) Goat Island (Letson).

Obovaria olivaria (Rafinesque). “Niagara River at brink of cataract, collected when water was held back by an ice jam (Walker)” [no date].

Physa heterostropha Say. Goat Island.


Physa ellipitica Lea. Goat Island gravels (Letson).

Physa gyrina Say. Niagara River at ... Three Sisters Islands.

Physa integra Haldeman Niagara River at Three Sisters Islands and base of American Falls.

Pisidium abditum Haldeman. Goat Island gravels (Letson, 1901).

Pisidium dubium Say. Goat Island gravels (Letson).

Pisidium compressum Prime. Goat Island gravels (Letson, 1901).

Pisidium scutellatum Sterki. Goat Island gravels (Letson, 1901).

Pisidium virginicum (Gmelin) Bourg. Goat Island...
(Letson, 1901).

*Planorbis bicarinatus* Say. “Found only in the gravel on Goat Island” (Letson, 1901). POSSIBLE TYPE LOCALITY.

*Planorbis parvus* Say, Goat Island (Letson, 1901).

*Pleurocera acuta* Rafinesque. Goat Island gravels.

*Pleurocera subulare* Lea Goat Island (Letson, 1901).

*Pyrgulopsis letsoni* (Walker). Goat Island gravels, TYPE LOCALITY (Letson) [no date].

*Quadrula coccinea* (Conrad) Simpson. “Found in nearly all deposits” (Letson, 1901).

*Sphaerium striatinum* (Lam.) Prime. “Found in all the deposits on Goat Island” (Letson, 1901).

*Sphaerium stramineum* (Conr.) Prime. Goat Island (Letson, 1901).

*Stagnicola palustris elodes* (Say) Goat Island gravels (Letson).

*Succinea aurea* Lea. at the base of the American Falls.

*Succinea retusa* Lea. Niagara Falls (Letson).

*Triodopsis albolarbis* (Say) Niagara Falls Park.

*Triodopsis notata* (Deshayes) Niagara Falls Park.

*Triodopsis tridentata* (Say) Niagara Falls Park.

*Unio gibbosus* Barnes. “Found in nearly all localities. This species seems to have been the most common of the Unios” (Letson, 1901).

*Valvata sincera* Say. Goat Island gravels (Letson).

*Valvata tricarinata* Say. “Found in Goat Island gravel pits” (Letson, 1901).

*Ventridens intertextus* (Binney) Goat Island (Letson).

*Zonitoides arboreus* (Say) Goat Island (Letson).
PRE-1885 LAND USE IN THE GOAT ISLAND COMPLEX

In order to assess early natural conditions on Goat Island some idea must be had of the degree of human activity which is said to have occurred there prior to the time of the establishment of the Niagara Reservation in 1885. Evidence of human occupation of the area of what is now western New York for many thousands of years, and the unusual physical character of the study area, associated with a major waterway and with an unusual effect on native animal populations, suggests the probability of some interaction between man and island. The issue of whether the forest and other habitats on Goat Island were primarly in 1885, when there is evidence for clearing portions of the east end during the seventeenth century, is central to this issue.

An excellent recent treatment of archaeological and historical information relating to the Niagara Reservation was prepared by Scott and Scott (1983), and much of the following is based on information provided in this source.

The Niagara region was free of ice and accessible to the settlement of Pre-European peoples by around 9000 B.P. (Calkin & Miller, 1977). Big game animals of the Pleistocene did occur near the Niagara River, based on mastodon teeth found in the river gravels of the embankment overlooking Goat Island on the American side reported by Lyell (1855) and Hall (1843). The Paleo-Indian culture, widespread about 10,000 to 12,000 years ago, are associated with these animals. However no cultural remains have been found in the area of the Reservation from this period (Scott & Scott, 1983). Evidence for Indian occupation of subsequent periods has been found at Lockport and Grand Island, possibly representing the Archaic period of Indian cultures, beginning about 8000 B.P. At Lewiston a burial mound was excavated representing the Woodland archeological period from 1000 B.C. to 1000 A.D.

It is only with the sixteenth and seventeenth century literature of early missionaries, traders and merchants in North America that a clearer picture of Indian settlement in the Niagara area appears. A group termed the Neutral tribe emerges whose territory, it is believed, “occupied the heart of the Niagara Peninsula” (Scott & Scott, 1983), including the east bank of the Niagara River at Niagara Falls. Contemporary with their existence, a group of native peoples was described by Gendron in 1644-1645 (Dow, 1921) as scavenging in the vicinity of Niagara Falls on the abundance of freshly killed animals which had had the misfortune to be swept over the cataracts and be destroyed on the rocks below.

Paleo-Indian cultures appear to have relied largely on hunting large game for their subsistence. When the game animals became extinct, forage with more emphasis on plants as food became more important, as during Archaic period cultures. During the Woodland period it is suggested that there was “some seasonal movement with summer occupation along lake and river banks” (Scott & Scott, 1983). The Owasco-Iroquois cultures show “year-round villages to small, temporary hunting and fishing camps and isolated cemeteries” (Trubowitz in Scott & Scott, 1983). The Seneca, the nation of the Iroquois confederacy that destroyed the Neutral tribe mentioned above and settled their territory, were “village-dwelling agriculturists” with considerable social and cultural complexity (Scott & Scott, 1983).

All of these people took advantage of, in one form or another, the availability of natural food supplies for subsistence. The destruction of native animals by being swept over the falls was written about in several early accounts. “We often find on the shores of this basin fish, bears, deer, geese, ducks and various kinds of birds which have been killed in passing over, having been drawn in by the water, or the current of air formed by the falls. The Indians collect these...” (Pouchot in Dow, 1921). If this event occurred for centuries, this food resource must have been known to at least some native peoples. Although there is no evidence, animals could have been deliberately driven into the river above the falls, and picked up in the lower river after they had been killed.

Native animals were also reported to have arrived on Goat Island by the same processes that swept them over the falls. Occasionally their numbers were large enough that they were sometimes harvested by native peoples (Kalm, 1770). However, there were no bridges to the islands before the nineteenth century, and passage to the island for hunting would have been extremely perilous. How food could have been brought back to the mainland would be hard to say,
unless the animals were driven off the island, into the water and down onto the rocks and the lower river.

The cost in life and energy to forage vegetable material from the islands would have precluded the island ever becoming a source of forage or settlement such that there would be a significant effect on the plant communities there.

It must also be borne in mind that the brink of the cataracts was seven miles downstream when the last glacier retreated from the area. Whether Goat Island came into existence 9000 or 2000 to 3000 years ago is still a matter of conjecture (Calkin & Brett, 1978). These geological issues must be considered in theories of floral, faunal and human dispersal to and contact with the island over long periods of time. Goat Island, when it came to exist, was in a less dangerous situation when the cataracts were miles downstream, rather like Navy and Grand Islands upstream are today.

Scott and Scott (1983) report local newspaper accounts of “aboriginal village sites—one near Chippawa, one at Foster’s Flats and the third between the two” (Niagara Falls Gazette, Sept. 12, 1900). Foster’s Flats lies at the bottom of the Niagara Gorge. Subsequent discoveries of Indian remains in the village of Niagara Falls were reported for 1860 and 1912. However, on Goat Island it is exclusively mortuary remains which have been reported.

Porter (1894) indicated the native people’s “use of Goat Island as the burying ground of their chiefs and warriors, and their adoration of the island because of such use” although he cited no source for this information and reported no written source for native burials. The skeleton of a young woman was exhumed from Goat Island around 1834, where it had been buried in a sitting position, and later displayed in the Museum of the Boston Medical College. Porter quoted that “the graves on the island were in a sandy spot, each body in a separate grave, always in a sitting or squatting posture, and without ornaments” (16 Ann Rep Comm, 1900). In the Niagara Falls Gazette, July 22, 1912, a human bone was reported discovered on Goat Island while steps were being put in at the Spring, with a reference to “other bones found on Luna Island several years earlier” (Scott & Scott, 1983).

These burial activities have been referred to Seneca or Neutral Iroquois culture with the possibility that the “artifacts represent reoccupations of what were even earlier sites” (Scott & Scott, 1983).

Due to the precarious situation of the island, burial here would have been an achievement accomplished at great risk. This condition may have conferred a great honor to the persons buried there, and also protected them from depredation and possible desecration of the burial of tribal leaders by rival tribes or peoples. This may be true for islands in general, especially to peoples not accustomed to navigation on the lakes or rivers. Tribes who were accustomed to transportation by waterway may have depended on these islands more than those who didn't, such as the Neutral tribe, who were “notoriously poor canoesmen” (Scott & Scott, 1983).

The particular interest the Seneca had in the river margins and islands in the river may have had something to do with burial practices on the islands in addition to their proprietary interest in the waterways. Native peoples, however, have been given special rights to water systems in western New York, as several Indian Reservations have been designated along major waterways: the Cattaraugus Indian Reservation along Cattaraugus Creek, the Allegany Indian Reservation along the Allegheny River, and the old Indian Reservation in what is now the City of Buffalo, centered along the Buffalo River.

The activities of native people in the region appear not to have affected the flora of the Goat Island complex.

The region came to belong to the French who occupied the area from the time of LaSalle in 1678, to 1759, but perhaps not the islands in the river, which, according to subsequent treaties, the native peoples retained.

The English next controlled the surrounding region from 1759 to 1776, ending with events leading to the Declaration of Independence. The English continued to occupy the area until 1783 when effective control passed to the United States after the treaty of Paris was signed in that year (Porter, 1894). Throughout the various activities of voyageurs, soldiers and colonials on the mainland, there is no indication either people made any use of the Goat Island complex, other than as a diversion for soldiers who tested their mettle with forays across the rapids and back during the British period. Isaac Weld was reported to have said that in 1776, “it was a common practice for young men to go to the island in the middle of the Falls; that after dining there they used fre-
First European ownership of the islands at the brink of the cataracts at Niagara began just after the time when Fort Niagara, at the outlet of the Niagara River into Lake Ontario, then under French control, was lost to the English in 1759 with Sir William Johnson effectively in charge. In 1763 the Seneca Indians, who had been allies of the French, conducted a hostile operation later called the Devil's Hole Massacre, in which a supply train heading south from Lewiston was ambushed with British soldiers and allied individuals killed. A year later, Johnson created a supplemental treaty to the treaty with the French of 1763 ceding to England all former French possessions “this region and all her Canadian possessions.” The 1764 treaty was with the native peoples of the area, and England received title to “a strip [of land] eight miles in width, four miles wide on each side of the Niagara river for its entire length” (Porter, 10 Ann Rep Comm, 1894) although Porter later adjusted this claim to four miles wide, two miles wide on each side of the river (Porter, 16 Ann Rep Comm, 1900). The islands were ceded to Sir William Johnson personally, which real estate he transferred to British crown ownership.

At the time of the massacre, the portage from Lewiston up to an area above the Falls was conducted by a Mr. John Steadman or Stedman. Stedman himself was part of the Devil's Hole Massacre, being the only victim to escape without injury. Stedman had a partnership with Lt. Francis Pfister, an engineer associated with Fort Niagara who built the Stedman House along the shore of the upper river near Goat Island. “This house became a landmark between Fort Niagara and Buffalo, and many 18th century visitors recorded the Stedman House in their journals” (Scott & Scott, 1983). On one occasion at least, Stedman transported himself and five men over to the island by boat (Carver in Dow 1921).

In 1826 John Maude published a book of his travels in the United States in which a confabulation of information was related, apparently fed to him by a guide by the name of Coldrakes "who came to this country with Philip Stedman ...” who conducted the portage. According to Coldrakes it was John Stedman who received nearly the same property as was awarded by treaty to Sir Johnson by the Indians, who wished to make a gift of atonement to Stedman in recognition of his fabulous escape from the Massacre. Stedman even went so far as to petition the New York State legislature to have this land “returned” to him, after it was appropriated by the state subsequent to the Treaty of Paris.

According to Coldrakes, through Maude, it was the brother Philip who grew a “remarkably fine” crop of turnips on Goat Island—on crown property it seems—and loosed the hapless animals who died one winter in the year of their introduction—excepting the goat which survived and after whom the Island was named. It was John, according to Porter (16 Ann Rep Comm, 1900), who “cleared a portion of the upper end ... and raised thereupon a fine crop of turnips.” This is the only evidence of clearing or grazing on Goat Island prior to ownership by the Porter family in 1815 (see Pool, 1897).

Throughout the development of saw mills on the mainland by Goat Island during the French and English period, wood was still plentiful there, and too difficult to transport from Goat Island since there is no evidence the island woods was cut for the purposes for which these mills were established (see Scott & Scott, 1983 for history of these early milling operations).

Access to the Island was very difficult, made initially by taking advantage of shallows presented by one of the limestone ridges intersecting the Island at or near its east end on a day when the river levels happened to be lower than normal. The ice in winter may have proved sufficient deterrent to anyone farming the island (Maude, 1800), “when every thing on the Island is encrusted with ice from the frozen spray of the Falls.” Porter wrote that a horse could be gotten onto Goat Island by taking it in the water far upstream until reaching the sandy bar extending east from the Island, and walking to the island along it (16 Ann Rep Comm, 1900).

Porter (16 Ann Rep Comm, 1900) also related the claims by Stedman to “all the land between the Niagara river and the line of his flight, some five thousand acres...” which Stedman’s descendants pursued until 1823 when the State of New York “ejected them from such lands as they occupied under the claim.”

All the islands in the Niagara River were still con-
sidered to be under special ownership by native peoples after the governments of the United States and the state of New York had been established. The State felt an obligation to pay them for title to these areas. The islands appear to be part of the mile-strip (New York side) of land along the Niagara River but somehow separate roughly in line with the separation made by native peoples for Sir William Johnson in 1764. The Holland Land Company, although it owned all other land in Niagara County, did not own the mile strip of land extending the length of the Niagara River and constituting its shoreline and which was reserved by the State (The State Reserve). A map of the mile strip was reproduced by Scott and Scott (1983) indicating this land was “reserved to the State out of the cession to Massachusetts in 1786 ... and sold at auction February 26, 1805.” The survey was made “under the direction of Simeon De Witt, Esq. Surveyor-General.” The islands in the Niagara River are indicated, but, oddly enough, not Goat Island. The historic reason for this omission may have had to do with the fact that the island, unlike the other islands in the Niagara River, was never surveyed, for the simple reason that there was no bridge, and it was a treacherous crossing. It probably had never been seriously considered as a piece of real estate.

Lots 42 (now the Prospect Point area) and 43 east of it and extending perhaps to Gill Creek, constituting 19 acres and 100 respectively were purchased by Peter B. Porter and Benjamin Barton. Lot 44, extending east to Cayuga Creek, of 681 acres, was called the Stedman Farm and does not appear to have been sold, although Scott and Scott (1803) report that in 1806 Augustus Porter “moved his family into the old Stedman Farm.”

At any rate, the “State of New York patented this mile strip to individuals commencing in the first decade of [the nineteenth] century” (Porter, 1894). The developing village near the cataracts which would become the city of Niagara Falls fell within Range 9, Township 13 of the survey grid for the Holland Land Purchase. During the first years of that century “private individuals bought the land from the State on account of its adjacent water power, and established here a village which they named Manchester.” By 1815, Augustus Porter acquired title to Goat Island and other properties near the cataracts, deeding half interest to Gen. Peter B. Porter, his brother. It was only in 1815 that the State “extinguished the Indian title to the islands” (Porter, 16 Ann Rep Comm, 1900).

Olmsted and Vaux (1887) wrote that “in 1806 the State sold the property which it has lately re-acquired at Niagara,” which indicates a somewhat different version than that given by Porter.

The Porter's built the first bridge to Goat Island in 1817 above Green Island, but ice destroyed it that winter. In 1818 they erected another and Goat Island became fully accessible to the public. Buffalo's first railroad went to Niagara Falls in 1836, a venture supported by General Peter B. Porter of (Black Rock) Buffalo (Brown & Watson, 1981) whereas a previous horse-drawn coach line “from around the time of the War of 1812” operated “through Niagara Falls from Canandaigua by way of Buffalo” (Scott & Scott, 1983).” This was probably the railroad that Judge George Clinton would so often take to go to Niagara Falls early in the morning to spend the day botanizing (see section on Clinton's diary).

The island began to be developed by the Porter family. They cleared the first road around Goat Island partly on land that subsequently washed away by erosion. They built the first bridges to the Three Sisters in 1869, the bridges on Terrapin Point and to the Tower they built there subsequently. At some time, if not from the beginning, carriages were permitted to cross the bridges and drive on the circuit road on Goat Island, as Olmsted and Vaux refer to the added congestion of carriages at the Horseshoe Falls (Olmsted and Vaux, 1887). There was a foot-bridge to Luna Island more toward the crest of the Bridal Veil Falls “so placed as to mar a scene that in certain conditions of light and atmosphere is the most gorgeous of any of the falls” (Olmsted and Vaux, 1887). The subsequent bridge, built back from the brink served to get it “out of the direct line of view of the American Fall from Stedman's Bluff,” but also, unfortunately, fed visitor traffic to the back of the island to the detriment of the native vegetation which now stood between visitors and the object of their pilgrimage.

Erosion control structures were built on the south side of Goat Island: “deflecting piers of logs and stones, so slight as to be unnoticeable, placed at the water's edge by the former owners, have proved adequate to prevent the undermining process from going further” (Olmsted and Vaux, 1887).

The structures built by the Porters were extremely
durable and were most likely built in part out of the primeval timber they had to cut to clear the roads. In spite of development by the Porters, their the island property was returned to the state essentially “in its original and natural condition,” after around seventy years of private ownership (Porter, 16 Ann Rep Comm, 1900).

Before State ownership in 1885, A toll of fifty cents had been charged to go to the islands (6 Ann Rep Comm 1890). As early as 1823, the Sugar Maples “had all been tapped or bled and still seemed uncommonly vigorous” (Douglas, 1914).

On this map of Bath Island by Evershed in 1883 done for the Commission to determine the boundaries of the Reservation to be established in 1885, note the large complex at A. This was probably a small orchard, the lumber yard and later, perhaps, the site of a nursery in the first decades of the Reservation. At B., the location of the Spring, today there are old plantings of ornamental shrubbery—perhaps a legacy of the Porter’s attempt to gentrify this important source of water for visitors to the Island. The area concerned was altered pasture areas and possibly old cultivated land. Animals raised for food and the enjoyment of tourists were probably penned in this area as well. Buildings, appearing to be substantial, are also recorded for the caretaking complex at A. This area was completely removed by the first Superintendent.
In 1846 a map was made of the village of Niagara Falls (Buffalo and Erie Co. Historical Society) by P. Emslie showing that at that date a gravel circle “walk” had been made that roughly paralleled the present road system. It circled the island and then bisected it on a line with the bridge from the mainland to Bath (i.e. Green) Island, and from there to Goat Island. A bridge to a point off Terrapin Point was in place as was the area called Port Day at the eastern end of what would become the Reservation.

A large gap in the depicted forest cover on Goat Island represented in the map published in the 19 Annual Report of the Commissioners, 1903, occurred on the south side of the island, just west of the Horseshoe Falls. This was the largest of the Goat Island gravel pits, of which others were indicated on the geologic map of Kindle and Taylor (1913; see section on soils). The Porters may have initiated this pit when they built the first gravel road or walkways on the island.

A “cottage dwelling house” at the entrance to Goat Island, and visible in the early depictions of the bridges built out to the island was “razed into its own basement and the ground was leveled and seeded” (Scott & Scott, 1983) in 1902 (19 Ann Rep Comm, 1903). It had existed there for “half a century before the establishment of the State Reservation.” On the map drawn up for the Commissioners of the Niagara Reservation by T. Evershed in 1883, the cottage is drawn as part of a large complex, including an extensive garden. It is perhaps here that the Goat Island lumber yard existed, as this seems to have been removed with the cottage, as well as the nursery. In around 1862, “a cottage on Goat Island was remodeled to become a refreshment saloon selling strawberries and cream, ice cream, sodas, and fruit” (Scott & Scott, 1983) — probably this structure. “By 1863 there were two refreshment saloons on the Island” (Scott & Scott, 1983).

In the map of Goat Island, published in 1903 (18
Ann Rep Comm, 1903), the cottage and complex at the entrance to Goat Island was not represented. A tiny rectangle is drawn, however, in the area to the northeast between the Spring and the bridge to Green Island. This small structure appeared to be in the same place as one drawn in the clearing by the artist Catlin in 1831 (Adamson, 1985). Another tiny structure on the 1903 map also occurred in the meadow area, and might have been joined to the center road by a path (the trees drawn seem to occur in a line between this tiny building and the road).

Above the Spring, just west of the present vehicular bridge, and just south of the roadway as it passed there was an “unused hut” the previous use of which could not be determined. It was used for a year by a young man from England, Francis Abbott, who would bathe in the channel between the First Sister and Goat Island—the Hermit who appeared from time to time in the literature about the Falls. A drawing of this hut amid the pines on the northeast part of the Island is given by Porter (16 Ann Rep Comm, 1900). The hut was made of logs, with a fitted-stone extension in back (Porter in 16 Ann Rep Comm, 1900). This structure was made of large logs and may have pre-dated Porter ownership of the property, during the days of John Stedman—the stone addition perhaps added after construction of the first bridges by the Porters. This hut was indicated in the map accompanying the Porter article of 1900, just three years before the map of 1903. In the Porter map, this “Hermit’s Hut” was built close to the Spring and seemed to have a natural relationship with it—as though built near a constant potable water supply.

In 1903, a shelter for visitors occurred at the northwest corner of the forest road just as people came across the bridge from Green Island. A structure called The Pavilion existed in the approximate position of the present rest rooms near the Three Sisters Islands (16 Ann Rep Comm, 1900).

When the State of New York purchased the Porter properties in the channel of the Niagara River, natural and induced disturbance appears to have been concentrated on the periphery of Goat Island. Natural disturbance occurred by erosion and slumping on the island’s south side, and perhaps portions of the high sedimentary bank on the west end, together with winter winds blowing down trees and high water and ice scouring the margins of the Three Sisters and the part of Goat Island adjacent to the First Sister.

The central woods and most other areas on the island appear to have been left alone by the Porters except for paths leading to prospect and other areas of interest. Paths and roads were built primarily to focus people on the prospect areas, and the areas supporting structures (capital expenditures): the Terrapin Tower, the Biddle Stairs and the profit-making concession of the Cave of the Winds—all on the extreme margins of the island. Bridges were built to provide limited access to other islands, such as the Three Sisters and Luna Island. Maintenance facilities occurred at the very entrance to the island, and on Green (Bath) Island occurring midway on the mainland-Goat Island bridge.

The Porters chose not to remove vegetation, but to build out into the channel where the finest views were to be had after visitors emerged from densely vegetated areas. This must have contributed greatly to the dramatic impact of contrast between enclosure and sudden freedom into a tremendously dynamic river environment. This is in sharp contrast to the State’s subsequent “provision of delightful views” claimed every time the primitive riverbanks on Goat Island were cleared for a new trail, or some part of the island physically destroyed to make it more con-
part I: the physical features

Convenient, for example, to drive cars onto the island at the end of the bridge to the island from the mainland. As the State removed more and more woods to provide more and more views, the dramatic appeal of the island experience was continually reduced to the point where in the present day, one can sit in the middle of the central woods in autumn and see the river and surrounding mainland without mystery or expectation, where little contrast or drama is allowed to exist.

In sharp contrast again with conditions in the nineteenth century, even after more than half a century of private ownership, the prospect at Porter’s Bluff overlooking the Horseshoe Falls, and one of the most frequented spots by visitors on Goat Island, had by 1885 lost only about fifty yards of forest “beyond which point considerable bodies of foliage interpose that cannot be removed without detriment to the scenery. This space of fifty yards, therefore, is invaluable” (Olmsted and Vaux, 1887).

THE FOREST CONDITION IN 1885

No evidence could be found to refute the following published testimonials that the Goat Island forest of 1885, not including the early deforestation of parts of the eastern end of Goat Island, was uncut or unaltered, that is, its character was derived solely from the interaction of the species established there with their physical environment.

Previous to 1850, Louis Agassiz and a group of students and scholars from Harvard University and other academic institutions visited Niagara Falls on their way to Lake Superior. One of his students kept a diary and reported some of their experiences in western New York.

On June 17, these scholarly travelers departed Buffalo for Niagara. Along the way they witnessed “a continuation of the ... noble forest of “first growth,” but often broken by clearings.” Most of the trees observed along the way were elms. Prof. Agassiz noted the increased richness of the forest in western New York, with its limestone and marl deposits, versus eastern New York, where the flora was comparatively depauperate due to the poor quality of granitic substrates. He mentioned the great variety to be found in the forest trees and shrubs of New York State, compared to Europe, which calls to mind J. D. Hooker’s description of the great Eastern Deciduous Forest of which Goat Island was a special example (see Hooker section). This variety appears to be accounted for to some extent by the greater diversity of species in the American continent compared with that of Europe, such as in the genus Rhus or Sumach, and Quercus or Oak, and Vitis or grape (“mostly useless for the manufacture of wine”—an opinion also noted by Hooker in his journal). Central Europe, for example, possessed two species of Oak, whereas in the whole United States there were over forty—in Massachusetts there were eleven. The composition of American forest communities was also more diverse than Agassiz noted in Europe, where species combinations were more uniform. Agassiz noted that beech was abundant in the vicinity of Niagara.

Agassiz remarked that “here at Niagara, almost exclusively elm, beech, hickory, ash, and arbor-vitae” were to be seen—perhaps Sugar Maple so abundant as to be not worth mentioning (Agassiz, 1850). One of the members of Agassiz’s retinue wrote that they “blessed once more the good sense that has kept this place undisturbed.” The place was Goat Island.

In 1899 (16 Ann Rep Comm, 1900), Porter quoted an unknown source:

“It is interesting to consider that many of the trees now standing on Goat Island looked down on the first recorded visit of a white man to the Falls, and have remained the only living witnesses of those important scenes in the drama of European conquest in America ... the tribes and armies ... are gone, but the trees ... still remain ....” “While some lands and forests near here may not have been cultivated, the western end of Goat Island is an absolutely unique piece of virgin forest. Most of the time it has been, in general terms, inaccessible to man; and since accessible by bridges, no cutting of the trees, no clearing of the land nor cultivation thereof, no pasturing of cattle, in fact no disturbance of the soil, has been permitted” (Porter, in part quoting Gardner (1880), 16 Ann Rep Comm, 1900). “Goat Island and the adjacent islands were covered with an original bit of virgin forest, which, fortunately, has been conscientiously preserved in its primeval state” (Report of the Treasurer and Secretary, 17 Ann Rep Comm, 1901).

Gardner, in the report to the Legislature attesting to conditions on property that would become the Ni-
agara Reservation, stated that “on all of these [islands], except Bath Island, the hand of man has spared the primeval forest. Picturesque clusters of evergreens, rising out of dashing waters, the rich overhanging foliage of the high banks of Goat Island and deep seclusion of its woods, give to this spot a charm not shared by any other about Niagara” (Gardner, 1880).
PART II: THE VEGETATION OF GOAT ISLAND

VEGETATION OF LOCALITIES IN THE GOAT ISLAND COMPLEX

The following are individual treatments of the islands in the Goat Island complex beginning with Goat Island, then the islands in the American channel, Luna Island, Green Island, and in the Canadian channel, the First, Second, Third and Brother Islands. A final section treats of special all but vanished shoreline plant communities which once dominated the prospect onto the cataracts on both the Canadian and American shorelines.

A. Goat Island. The treatment of this island is divided into the following sections:
   1. the central woods remnant;
   2. the north slope river margin and associated features such as the Spring and rocky river flats;
   3. the crest, or west end topping the bluffs overlooking the plunge pools of the cataracts (the Maid-of-the-Mist Pool);
   4. the base of Goat Island, constituting the western margin at the lower river's edge some 160 feet below the crest;
   5. the Terrapin Point complex at the island's southwestern extremity overlooking the Horse-shoe Falls;
   6. the southern slope or embankment along the south margin of the island;
   7. the flats area of exposed and recently vegetated river bed just off the south margin of the island;
   8. the Meadow, or eastern end of the island composed primarily of made land and artificial lawns;
   9. the ballasted eastern extremity along the shoreline bordering the meadow.

B. Islands in the American Channel.

C. Luna Island.

D. Green (Bath) Island.

E. The Three Sisters Islands.
   1. The First Sister Island.
   2. The Second Sister Island.
   3. The Third Sister Island.
   4. Brother Island.

F. The Old River Margin Habitats.
A. GOAT ISLAND

1. Central Woods Remnant

In 1900 the forested area of the Goat Island Complex appears to have completely covered all areas (see map in the 19 Ann Rep Comm, 1903). The intact forest on Goat Island was bisected here and there by roads, some areas at the viewing stations at the American and Horseshoe Falls prospects were opened up, and remnants existed of the openings made in the north-eastern areas east of the bridge to Green Island. Contrary to expectations, the south-eastern portion of Goat Island was depicted as wooded, or covered with vegetation if less dense than elsewhere on the Island.

Day, and others, felt in 1901 that the Goat Island woods was “almost unchanged from its natural condition” (see section on land use), and yet Chamberlin, from Buffalo, New York, in a letter to the magazine Garden and Forest written in 1892, referring to the botanical richness at the Falls wrote “especially is this true on Goat Island, which is now one of the few spots in this vicinity that are covered with primeval growth. It is probable that even here the earlier timber has been removed, for that which remains is not very large, but the absence of stumps shows that no cutting of trees has taken place for a long time. The timber is chiefly of the ordinary hard-wood trees, Beach [sic] and Maple predominating, with an occasional Oak, Ash or Tulip-tree, and near the paths many small Cedars, white and red, Hemlock and prostrate Yew-bushes.”

Since Goat Island was said to have had a primeval forest in its first decades as a Reservation, one would expect the woods to be composed of relatively well-spaced trees of some maturity, a dense canopy above, darkness below and herbaceous vegetation or bare soil beneath the trees. Many old woodlands can be seen that present this kind of climax, such as Fonthill Preserve in Ontario, and as close as DeVeaux College Woods, several miles north on top of the gorge behind Whirlpool State Park, New York. The canopy is closed and where light-wells occur, small islands with dense populations of herbs are established. At DeVeaux, these islands contrast sharply with areas without vegetation characteristic of the deep shade. As a climax forest, species diversity in the Goat Island forest would be low, and most of the energy for potential species abundance would have been monopolized by the dominant vegetation—the Beech—Maple species.

The primitive Goat Island forest presented an aspect to Mr. Chamberlin, in 1892, of disturbance. The chief agent of disturbance with which he was acquainted was lumbering. The island looked as if lumbered, but he could not see the stumps to prove it. Mature trees one associates with climax-primeval

The Driveway, Goat Island. 17 Ann Rep Comm, 1901. Note the youth of the trees and their density. That they are coated on one side by frost indicates this scene was near the Horseshoe Falls.
forests are large—yet Chamberlin remarked on the youth of much of the island forest. There is a picture of what might be termed young, native growth in the Goat Island woods published in the 21 Annual Report of the Commissioners of 1905—the Reservation by then having been in existence for twenty years. Many of these trees are older than twenty years, and there are many saplings. The large stump in the picture is not the result of lumbering, but of “cleaning up” the forest after a storm has damaged a tree—a practice still in use on the island today. The wood's aspect in this picture seems to reflect what Chamberlin may have observed for himself in 1892.

“Thicket” is a term used by the first Superintendent of the Niagara Reservation, Thomas Welch, to describe a habitat or the condition of habitats on Goat Island. A thicket, in contrast to a woodland, usually implies an area of dense, rather impenetrable high growth of shrubs or young trees. Thickets may be ecotonal, i.e. associated with community boundaries, such as at the edges of woods and meadows or other openings, or a function of environmental gradients, such as shallowness of soil, exposure to incoming wind at the margins of land, on cliff edges, etc. Thickets may also be successional, temporary communities of vigorous young forest growth intergrading and in competition with shrub communities. One area of significant disturbance and secondary growth was the east end of Goat Island (the meadow) which appears to have been cleared some time in the eighteenth century. One shrub species in 1885 formed a monoculture there (Staghorn Sumac, *Rhus typhina*).

Young trees appear to have abounded on Goat Island for Welch reported in the 7th Annual Report of the Commissioners, 1891, that “young trees, 1,122 in number, have been taken from the thicket on Goat Island and planted in the nursery plot. They comprise 636 maples, 130 ash, ninety-one basswood, fifteen elm, twelve ironwood [*Ostrya*], one beech and four osier [Willow]. Seventy-five Norway spruce [*Picea abies*] and seventy-five white cedar [*Thuja occidentalis*] have also been procured for the nursery.” When Welch reported that “a great variety of young trees and shrubs, suitable for placing in the nursery, can be obtained in the woods on Goat Island,” he seems to imply that the “thicket” was nearly synonymous with the “woods.” Again, “the trees overturned by the storm of January 13, 1890 have been cleared away. A number of dead trees in Prospect Park, which were considered dangerous, have been removed and a large quantity of fallen branches removed from the thicket on Goat Island” (7 Ann Rep Com, 1891).

And yet the thicket “on the Reservation” also produced a quantity of shrubs: twenty ninebark [*Physocarpus opulifolius*], sixty euonymus [*Euonymus atrapurpureus*] and forty snowberry shrubs [*Symphori-
carpos albus] for the Goat Island nursery in 1891 (8 Ann Rep Comm, 1892)—species that could hardly have come from a forest-community.

Olmsted and Vaux (3 Ann Rep Comm, 1887), also made reference to the density of the central woods when they recommended “numerous trails through the thick woods.” Walkers on these footpaths would enjoy “forest seclusions,” indicating the visible impenetrability of the primal forest.

To Welch’s thinking, echoed by Olmsted and Vaux, there were thicket or dense shrub communities on Goat Island, and also that the woodland community was unusually dense. The young trees to which he referred may have been successional (post disturbance) regrowth in the cleared eastern section of the Island, or the forest may have had an intrinsic disturbance regime.

Evidence for the nature of this disturbance, with respect to the forest community on Goat Island, is given in the first several decades of the Reservation’s existence when winter storms were reported to have blown down many trees. It is unlikely that these storms were much different than winter conditions prevailing throughout the nineteenth century, and that toppled trees every winter was the norm. This likelihood is obscured in the annual reports because the custodians of Goat Island treated these events as somehow unnatural (although note that the explosion of the island Karakatoa near Sumatra occurred only a year or two prior to the Reservation’s establishment, and temporary intensification of winters may have resulted).

Other evidence that winter storms were typical of conditions on the Island comes from the decades of reference to the dead brush, fallen branches, etc. which were slated for removal by the Superintendents of the islands down to the present day.

The type of primeval or climax forest on Goat Island must have been a kind of disclimax, or modification of a primary climax forest, that is, a climax community depending for its maintenance on continuing disturbance (Daubenmire, 1968). The source of disturbance in the central woods was winter winds, aggravated, perhaps, by the lack of structural cohesiveness of the sediments underlaying the forest and by the weight of ice in the canopy. Climax communities without persistent disturbance in their environment, such as by fire, “usually exhibit a mosaic of rather well-defined climaxes that are relatively simple in their floristic composition. As disturbance begins, the distinctiveness of florae among the ecosystems declines and floristic complexity increases ...” (Daubenmire, 1968). A true disclimax community, classically, will eventually develop its own distinctiveness and reduction in floristic complexity. However, on Goat Island, the nature of the disturbance is not cataclysmic or uniform in space or time. Typical conditions prevail, and disturbance is random and patchy. The primeval situation appears to have been a typical climax forest with enough disturbance to permit invading species to flourish, but not to overwhelm the typical species communities. Enough variation in substrates, enough disturbance and conditions leading to ecological op-
timia for growth appear to have all contributed to the unusual character of the vegetation on the islands at the brink of the falls.

The frequency of what appears to be White Pine in the old photographs and drawings of the Goat Island forest may also be accounted in part by the relatively frequent blowdowns in the forest dominated by Sugar Maple, seedlings of White Pine requiring “at least 20 percent of full sunlight ... to keep ... seedlings alive” (Fowells, 1965). Although generally this species is considered a part of the climax forest throughout the extent of its range, “in Canada it is considered that many of the present white pine stands are edaphic or pyric relics and that present climatic conditions are against its maintenance as a major species” (Fowells, 1965).

Additional indirect evidence for the presence of White Pine in the Goat Island forest is in those old depictions showing the crowns of some conifer species overtopping the deciduous canopy. White Pines 150 feet tall “were not unusual in the virgin forests of Pennsylvania ... and New England” (Fowells, 1965). Hemlock trees, the other alternative, average around 54 feet in height in New York at age 140 years (Fowells, 1965).

Day makes the enigmatic statement that both the White Pine and the Hemlock “are not as plentiful upon the island as their beauty demands. They should be at once, and largely, replanted” (Day, 1901). The suggestion here is that by 1901 these species had been removed from the Goat Island forest.

Red Cedar (Juniperus virginiana) occurs in the literature of the Commission reports and in photographs. It enjoys growing on the crestline areas along the Niagara River gorge and competes on occasion with Arbor Vitae there. This is another conifer that could be seen as taking advantage of a changing environment, as it is associated with recovery after disturbance, or is successional.

It is possible that only the side of the islands exposed to the direct force of the wind suffered from extensive blowdown—especially in its oldest trees. It is convenient that the surface sediments on the south side of Goat Island are of coarse gravel, and those on the north side are composed of a “boulder-clay” (see section on soils). Perhaps the sediments here are less competent to support the mass of an old tree with a large canopy laden with frozen spray in a high wind, and a disclimax situation would prevail here more than in more protected situations on the island, with a corresponding difference in species abundance on the forest floor, and closure of the canopy above.

Again, the reported frequency of windthrow may have been in part the result of modifications in the natural woodland structure by the developers: “windthrow is most prevalent among trees growing in dense stands that, through logging or natural damage, are suddenly exposed to the full force of the wind” (Smith, 1966).

But for openings in the canopy by blowdown, or windthrow, the canopy appears to have been a dense and dark ceiling. How dark may be seen in a photograph of the forest just back from the crest of Goat Island, on the island’s western end, included in the 28 Annual Report of the Commissioners for 1912 (reprinted above). This area today is completely clear but for “shade trees.” In the first few decades of the Reservation’s existence, the canopy afforded such dense shade that the rain and mist did not evaporate and the dirt and gravel roads remained difficult. “Portions of the roads on Goat Island are so thickly shaded by the primitive forest that mud remains upon them ... long after the rain has ceased” (6 Ann Rep Comm, 1890).

In the 25 (1909) and 27th (1911) Annual Report of the Commissioners a photograph was included that shows another side of the density and complex structure of the primeval central woods. Vegetation along the path and beneath the tree/shrub layer was dense. In both pictures, however, there are extensive “light-
wells” from openings in the canopy above. These openings may have been made as the path was constructed and trees removed, but the density of the surrounding vegetation was well established by the time the pictures were taken. If winter storms removed some large trees every winter, open canopy in many places would result naturally.

The Superintendent described the woodland response to severe gales in 1909 as follows: “the soil, especially on Goat Island, was very soft affording but little support to the trees which first rocked gently then with increasing force until many of the finest ones, those overtopping the surrounding forest by many feet thereby presenting large areas of exposed surface, were blown down, carrying many smaller ones with them” (26 Ann Rep Comm, 1910).

For an alternative discussion of “thickets” see the section on crest vegetation below.

Perhaps it is through the open patches of the primeval canopy that can be attributed the unusual abundance of the woodland flora. Reports for woodland vegetation below.

The Superintendent described the woodland response to severe gales in 1909 as follows: “the soil, especially on Goat Island, was very soft affording but little support to the trees which first rocked gently then with increasing force until many of the finest ones, those overtopping the surrounding forest by many feet thereby presenting large areas of exposed surface, were blown down, carrying many smaller ones with them” (26 Ann Rep Comm, 1910).

For an alternative discussion of “thickets” see the section on crest vegetation below.

Perhaps it is through the open patches of the primeval canopy that can be attributed the unusual abundance of the woodland flora. Reports for woodland herbaceous species occurring in “profusion” by abundance of the woodland flora. Reports for woodland canopy that can be attributed the unusual section on crest vegetation below.

ones with them” (26 Ann Rep Comm, 1910).

For an alternative discussion of “thickets” see the section on crest vegetation below.

Perhaps it is through the open patches of the primeval canopy that can be attributed the unusual abundance of the woodland flora. Reports for woodland herbaceous species occurring in “profusion” by abundance of the woodland flora. Reports for woodland canopy that can be attributed the unusual section on crest vegetation below.

ones with them” (26 Ann Rep Comm, 1910).

For an alternative discussion of “thickets” see the section on crest vegetation below.

Perhaps it is through the open patches of the primeval canopy that can be attributed the unusual abundance of the woodland flora. Reports for woodland herbaceous species occurring in “profusion” by abundance of the woodland flora. Reports for woodland canopy that can be attributed the unusual section on crest vegetation below.

ones with them” (26 Ann Rep Comm, 1910).

For an alternative discussion of “thickets” see the section on crest vegetation below.

Perhaps it is through the open patches of the primeval canopy that can be attributed the unusual abundance of the woodland flora. Reports for woodland herbaceous species occurring in “profusion” by abundance of the woodland flora. Reports for woodland canopy that can be attributed the unusual section on crest vegetation below.

ones with them” (26 Ann Rep Comm, 1910).

For an alternative discussion of “thickets” see the section on crest vegetation below.
Cherry noted in the central woods measured sixteen inches. A “magnificent specimen” of Tulip-tree (*Liriodendron tulipifera*) grew in the woods (Day, 1901), a tree which can reach diameters of ten feet, with second-growth trees attaining diameters of 18 to 24 inches in 50 to 60 years (Fowells, 1965). The Basswood was of an “extraordinary size and beauty.” This tree on a good site can have a four foot diameter (Fowells, 1965); a far cry from the single five inch diameter tree which crossed the transect line in the present study. Much larger trees occur in the south slope and that to the north (to thirteen inches diameter). For comparison, fourteen of thirty-six trees blown down on the Three Sisters Islands in 1890 were each two feet in diameter (basswood, elm, beech, ironwood (hop-hornbeam), maple, Arbor Vitae, red cedar, pine, white oak and hemlock). “Two of the elms were three feet in diameter” (7 Ann Rep Comm, 1891).

The largest native tree diameters are presently those of the White Ash (31 inches on the transect), Sugar Maple (25 inches) and the occasional American Elm (*Ulmus americana*, 28 inches). The path-side Arbor Vitae and Red Cedars, the Hemlock and Yew (*Taxus canadensis*) noted by Chamberlin (1892) are all absent from the present forest.

The original and presumably central mandate of the Reservation administration was and is to preserve the native, primeval vegetation and to reforest or revegetate lands adjacent to Niagara Falls to conform with the intact forest on Goat Island. From the beginning of the Reservation’s existence, a plan for the maintenance of the forest in its primitive state was not created, nor was there a definition of “primitive” made based on the original conditions of the forest, nor an assessment made of its character so the forest could be monitored and master plans created which would protect its integrity.

Nowhere is this more apparent than in the decision to “clean” the woods up, that is, to remove dead trees from the central woods, both by cutting standing trees and removing those that have fallen, initiated after the death of Superintendent Welch in 1903. Without a rationale for such “improvements” to the primitive forest, the Commissioners declared in 1911 that “in the forests dead and dying timber must be replaced by young trees” (28 Ann Rep Comm, 1912). This presaged a purgation or sanitization of the woods. In that year began the “general cleaning up in the woods of the dead and fallen timber, brush and vines” (28 Ann Rep Comm, 1912). Under Superintendent Eckert, succeeding to Harries, “several hundred old tree stumps were dynamited and a large number of dead trees felled and removed from the forest” (29 Ann Rep Comm, 1913). In 1908 “a large amount of work has been done toward cleaning the forest on Goat Island of fallen trees, rotted stumps and the tangle of underbrush, vines, etc.” (25 Ann Rep Comm, 1909).

It was this very tangle of nameless underbrush and vines that was the essence of the native forest, the fallen wood, the blowdowns an essential part of the character of the primitive woods. Fallen tree trunks and branches also contribute to the visual complexity and aesthetic values of a natural environment, such as Goat Island’s is required to be. Regular sameness is a characteristic of an urban environment and its carefully maintained biological sterility.

At the same time as the woods was being “cleansed,” trees and shrubs were continuously being planted on the Reservation, such as the ten thousand trees and six hundred shrubs planted on the islands and the mainland in 1912 (28 Ann Rep Comm, 1913). Rather than planted according to a thoughtful plan regarding extending the primitive forest, these plantings were on the order of “shade trees”—a type of tree not present in the native forest. These were the sorts of trees which required pruning, trimming, spraying with arsenate of lead to ward off insects, characteristic of the policy of the Superintendent around 1910. Lawns invariably surround such trees—in other words, a totally different, artificial ecology was being instituted to replace the native one. “For twenty-six years conditions have been steadily improving, but year by year the burden of proper maintenance has become more exacting and more costly ... with the growth in the number of shade-trees and their insect enemies greater care and greater expense are required to hold these pests in check. In the forests dead and dying timber must be replaced by young trees” (28 Ann Rep Comm, 1912). The State thus began its expensive commitment to the maintenance and development of an urban park, rather than the primitive forest, and the New York State Legislature was asked to produce more money for “upkeep of the grounds.” This policy of removing “brush,” that is, Dogwood, Frost Grape, native Virginia Creeper is still in place today and is destructive of the
Part II: Vegetation

native ecosystem.

Fallen tree-boles, when they are well rotted, maintain a higher water-balance in the forest as well as provide centers of protection, warmth and moisture conducive to the germination of seeds in natural forest regeneration. Removal of fallen trees may terminate the ability of certain species, such as Hemlock, to regenerate in the forest and are notably absent from the central woods interior today. Nutrients provided by the environment spent in the growth and structure of the bodies of native trees and shrubs is continually being removed from that environment. The absence of ferns from the Goat Island flora may be due to loss of this vegetable mold, these natural bedding frames.

The process of decay involves many living things, and decaying tree boles provide a substrate for a wealth of inconspicuous organisms, primarily of fungi, of which Goat Island displays a great potential (see mycological list), and of lichens, mosses and liverworts, not to mention habitats for insects, snails and small animals. Standing trees provide habitat for bee and other insect colonies, useful or critical in the pollination of native plants and dispersal of their seed, and yielding a food source for other animals, such as birds. Birds and mammals nest in the dead boles. The species diversity and abundance of the island, remarked upon by eminent naturalists when it stood intact at the Reservation’s inception, is and has been impoverished by the removal of this material.

Part of the original forest was once described by Superintendent Welch as a thicket, that is, it was very dense and visually impenetrable, as can be seen in many of the photographs of woodland path systems established on Goat Island, and included in the reports of the Commissioners. The forest was thinned to some extent in the early years of the Reservation, of hundreds of trees and shrubs to provide native stock for replanting the naked sod in place after the shoreline buildings were removed. The present forest must be viewed as denuded in comparison. It is an open forest from which the roads and island traffic are visible looking from the north to the south margin. This opening of the central forest was not due to biological factors, but is a result of administration policy. I was told by one of the workmen on Goat Island that as little as thirty-five years ago, in winter one could not see out to the other side of the forest. Presently in winter, one can stand in the center of the woods and see the cities of Niagara Falls, New York, looking north, and Niagara Falls, Ontario to the south and southwest. All traffic can be seen circling the island from the center of the forest. All perimeters are visible. I was told by another official that the woods was being “managed.” Far from the aspect of a primitive forest, it resembles a young woodlot typical of the farms of western New York.

The central forest possesses little native thicket boundary typical of woods where the canopy ends, especially on the edge on the south facing the direction of the wind. What native thickets there are composed of Panicked and Red-osier Dogwood (Cornus racemosa and C. stolonifera), Purple-flowering Raspberry (Rubus odoratus and more in the shade, Elder (Sambucus pubens). On the southwestern margin of the central woods the understory of the forest has been removed, the trees thinned out and lawns established for a picnic area. This area is where the forest receives the most wind and the spray from the Horseshoe Falls and the direction of severe winter storms.

Unimpeded winds in the forest stress microhabitats, removing cells of moist, warm, still air from moisture-sensitive organisms, such as bryophytes and fungi, tending to reduce the number of microhabitats and hence the potential and actual species diversity.

Without the forest structure to block them, strong winds evaporate the moisture that drifts over the island intermittently, and carry more of it away. Mist can be felt at the extreme east end of the island during strong winds. This wind desiccates the woodland soils and habitats increasing evapo-transpiration regimes for spring ephemerals and other woodland species that would otherwise benefit from this added water. Desiccation may prevent the germination or success of the seedlings spring vegetation, to the detriment of natural forest recovery, especially without the development of a vegetable mold from rotted tree material.

In one recent study, it was recommended that “cluster plantings should be introduced, especially in viewing areas to provide wind breaks and shaded areas for moderating climatic extremes. Clustered groups also appear more natural and will require less staking than separately planted trees” (The Promontory Partnership, 1981). Clustered plantings would include a brake of shrubs on the windward side.

Perhaps the most important factor in maintaining
lush vegetation was the atmospheric moisture developed from the mist of the Horseshoe Falls. In winter this mist accumulates in the canopy probably farther back from the Falls than was once the case, because of loss of forest in the Terrapin Point area in the island’s southwest end. Such vegetation once “scrubbed” the burden of moisture from the air, so its mechanical effect on the forest was lessened as it traveled north and northeastward over the island vegetation. Now, there is little to remove or buffer the central and eastern portions of the island from ice build-up and freezing rains such that certain species of maturity (*Cornus alternifolia*) appear to have been wrenched from the soil and destroyed. Evidence of wind effects due to lack of a buffer may be seen today in the central woodland shrubbery being bent in a direction opposite to general direction of the wind.

This exposure to low temperature and ice burden, and strong wind may contribute to trunk rupture of various kinds at various times of year in trees, especially old or otherwise vulnerable ones. Many of the trunks in the central woods display bursting and deformations along their trunks. This stressful environment may contribute to vulnerability to disease, which compounds the problem.

If the forest is thinned of trees removed for aesthetic policy reasons, because of deformity, etc., associated increase in environmental stress from weakening of the forest structure may produce more diseased and deformed trees initiating a vicious cycle of a policy of continued woodland depletion leading to extermination of the forest.

The forest edge seems unusually naked for an old-growth forest. The cultivated lawns extend right up to the forest edge and the ground passes on into the canopied areas as exposed soil and gravel. Visually significant species of the present developing edge include several vines: two species of Virginia Creeper (*Parthenocissusquinquefolia* and *P. vitacea*), and especially River Grape (*Vitis riparia*). Occasionally the latter is so dense as to smother or destroy the vegetation over which it grows and this necessary growth and protective screen is the subject of concentrated efforts of removal. Natural, mature stands of Grape and Virginia Creeper are quite spectacular and visually attractive in addition to being essential members of the edge plant-community. The sacrifice of some trees and shrubs at the forest boundary as an auxiliary to their growth is part of the natural dynamics of the Goat Island ecosystem.

Pending further observation, it appears as though Grape populations are fundamental to the recovery of vegetated areas which have lost their forest cover. The apparent difficulty of horticultural species to survive in natural conditions in the wet ends of the islands does not appear to reflect any inability on the part of the native forest cover to establish itself in the original ecosystem. Observation of extensive populations of grape in these areas today, and from historic information suggests the native Grape actually may be critical in screening the destructive elements from the trees and shrubs developing beneath and behind it. In time the young (shade-tolerant) vegetation would emerge through the temporary Grape canopy, the entire community always dense and structurally able to withstand excessive moisture, ice and wind (see discussion on the crest vegetation).

Native thicket species are being presently replaced by the planting of ornamental shrubs, some known as noxious weeds, on some of the woods boundaries, such as Acanthopanax, Buckthorn (*Rhamnus cathartica*) and a horticultural species of Dogwood (possibly *Cornus sanguinea*, see species catalogue). The Buckthorn is already beginning to infest the depleted woods interior. How much of the occurrence of the ornamental Dogwood is due to planting or natural dispersal will tell whether this species will become noxious in the future.

Selective reduction to the point of elimination of the native understory, traditionally treated as “brush,” has exposed the forest floor to the invasion of Garlic Mustard (*Alliaria officinalis*). This alien species forms dark green carpets in all woody borders and throughout the central woods, vivid throughout the winter, when it gets an advantage over the present spring ephemeral flora. This species forms monocultures. In a stand of “naturally regenerating” woods along the lower Niagara River in Ontario, Garlic Mustard grows taller than the spring woodland wildflowers, shading them out and will perhaps destroy them in the decades ahead. Another potential weed pest in danger of infesting the natural wooded areas is Celandine (*Chelidonium majus*), which is already well established on the terrace or wooded slopes of the mainland facing Goat Island at the eastern entrance to the Reservation. Invasion of Celandine on the terrace is directly related to the recent stripping of the wooded slopes here of its natural shrubs and especially the Grape (*Vitis riparia*) and Virginia Creeper (*Parthenocissus sp.*) which forms an effec-
native ground cover. Celandine covers the disturbed forest floor in the same Ontario woodland just mentioned.
Approximate zone of increased biological response to atmospheric moisture. Higher number of tree blow-downs. Highest woods species diversity - only area with moss and fungus species.

Clearing of wood debris in spring obscures evidence for wind and ice stress on the central woods.

GOAT ISLAND
Local climate

Schematic view: west to east section of west end of Goat island. Black "shadows" behind trees represent distribution of mosses. Note direction of fallen trees.

WEST lawns parking lot
The establishment and maintenance of extensive lawns constituting monocultures of one or two grass species and alien weeds constitutes the most significant substitution for the native habitats. Mowing in particular contributes to the suppression of native forest recovery, especially at the forest edges. The road system, including the west parking lot, bounds the central forest on all margins except the eastern one. An extensive grassy verge is maintained beside all roads except the mid-forest road.

Selective thinning seems to have left behind an overabundance of two tree species (Acer saccharum and Fraxinus americana), both of which are now considered to be subject to disease, especially the latter species. Maximizing tree species diversity in the central woodland would have protected the native tree populations from decimation by host-specific disease-causing organisms. Although beyond the scope of this study to explore, there is the possibility that reducing the diversity of tree species once co-dominant with Sugar Maple, such as Beech (Fagus grandifolia) or Black Cherry (Prunus serotina) or Pine may have reduced the amount of mycorrhizal fungi in the soil, and decreased the availability of nitrogen throughout the forest.

Forest disease evidenced appears to affect mostly Ash species, such as Fraxinus americana, and many dead trunks are to be seen, many designated to be removed this year (1988). What contribution these trunks may make to the overall structural integrity of the central woods in resisting wind and ice stress will be lost with the removal of these trees. (They have since been removed).

Winter storms may still be seen to blow down trees in the native woodlands at Niagara Falls—this writer has seen Hemlocks blown down at Dufferin Islands, Ontario, in the past several years. During one field trip to Goat Island, undertaken on Nov. 10, 1988, high winds were prevalent there. The winds bore straight through the central woods, as there was nothing to block their force. Old specimens of Alternate-leaved Dogwood (Cornus alternifolia) within the past were observed uprooted from the soil and lying on the present forest floor, their crowns pointed away from the direction of the prevailing winds, as though exposure to wind caused their destruction.

In a condition with the woods very much thinned, dead standing tree boles may contribute significantly to what structural integrity the woods may still possess to withstand the prevailing winds, especially in winter, both in the upper layers, and maintaining unevenness or irregularity (microhabitats) on the forest floor. Olmsted and Vaux recognized both the destructive effect of the wind on the island's trees and the exposure to this effect by thinning or opening up the forest—“We feel ... that the road should be as narrow as it can be and tolerably answer its purpose, because at best many trees must be destroyed to make way for it, and the wider the opening the more havoc will storms make with trees left standing near by” (Olmsted and Vaux, 1887).

The eastern end of the central woods bordering on the Meadow area on Goat Island has suffered extensive thinning and reduction during the past twenty-five years (R. F. Andrle, personal communication). It is probably in the open areas at this end of the island that supported the pheasant populations, which prefer the open fields, hedgerows and marshy areas, rather than the deep woodlands,” (Beardslee & Mitchell, 1965). It is a policy of disturbance of habitat here that may have accounted for the extirpation of pheasant populations from Goat Island which existed earlier in the century, well within the recollection of local residents who once tended these birds like they presently do the Gulls, Mallards and Pigeons.

Examples of inappropriate use of the central forest is as a storage area for dumping garden soil, gravel, stakes, transplanted trees still with their roots in burlap, and other material used in maintenance of the Reservation. Large vehicles are used to dump and load this material, which destroys forest vegetation and soils and creates a large area of weedy plant and shrub species within the forest interior.

In a recent study, it was recommended to “allow existing forests to become more “natural” by establishing a “hands-off” maintenance policy that allows trees to age and die naturally, returning nutrients to the soil” (The Promontory Partnership, 1981).

A curious section of the central forest, on its eastern and northern boundary, is an area of extremely old trees associated with the old stone “horse barn” building that, during the past decade, has been in the process of being restored following nineteenth century records. Surrounding this building and adjacent to the central forest are a series of horticultural trees that must have been planted as part of a restoration scheme when, or shortly after, the Reservation was established.
In a history of Waterloo, Kingman County, Kansas website (2005) there is a curious quote or paraphrase from Irene Berghamp’s book: Kingman County, Kansas, and its People, modified by the Kingman County Historical Society, 1984 that may provide a glimpse into the mind of the designer of this section not only of Goat Island, but of the other little parks established to the north and downstream along the gorge rim at Devil’s Hole and Whirlpool State Park:

“A grove of trees, north of the ball diamond, still stands today as a living memorial to John W. Riggs, nurseryman. He came to Galesburg Township in 1885. He experimented with trees from different areas. [sic = lands?]: Tree lilacs from Japan, Eucommia from Manchuria; Chinese pistachio and junipers; Royal English Oak from England; different pines from France; buckeyes and mulberries from Ohio; Alligator cedar which is a native of Arizona; Bald Cypress, hackberry, sugar maples and various kinds of oaks. Mr. Riggs worked with the United States Department of Agriculture.”

Two very old trees of the Manchurian tree: * Eucommia ulmoides* Oliver, Hardy Rubber Tree (see vascular plant species list for Goat Island) occur in this area—one behind the stone building and another close to the road that cuts through the center of the forest. Behind the stone building also occur very old * Castanea mollissima* Blume Chinese Chestnut, and * Juglans regia* L. Persian or English Walnut. Native *Acer* (Maple), *Carya* (Hickory) and *Quercus* (Oak) trees of a similar age grow intermixed. Beside the pedestrian bridge, at the elevation on the east side beside some White Pine (*Pinus strobus*) grow several old specimens of the Sitka Spruce (*Picea sitchensis*) native to the Pacific Coast forest at the western extremity of the continent. Across the street, by the Euthamia tree grows an old specimen of the Eur-temperate of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-

treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-
treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-
treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-
treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-
treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-

treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-

treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-

treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-

treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-

treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-

treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-

treemine of the continent. Across the street, by the Euthamia tree grows an old specimen of the Euro-

---

**TREES**

*Acer negundo* BOX ELDER. Young—removal is highly recommended—this becomes a noxious weed (monoculture) as it presently is on the southwest slopes.

*Acer saccharum* SUGAR MAPLE.

*Acer nigrum* BLACK MAPLE.

---

Aesculus hippocastanum HORSE-CHESTNUT.

*Carya cordiformis* BITTERNUT HICKORY.

*Ceutis occidentalis* HACKBERRY.

[Fagus grandifolia] BEECH. Once abundant, none were observed in the interior of the central woods, it is doubtful if this tree should be considered a present member of the woodland community, al-
though one mature tree can be found beside the
loop road as the road leaves the vehicular bridge
on the edge of the forest and within its shade. It is
probable that at an earlier time, before the woods
was deeply modified, this species formed a larger
component of the forest.]

* Fraxinus americana WHITE ASH.
* Ostrya virginiana HOP-HORNBEAM. Frequent.
* Prunus avium BIRD CHERRY. Southwest section.
* Prunus serotina BLACK CHERRY.
* Tilia americana Basswood.
* Ulmus americana American Elm.

**SHRUBS AND VINES**

* Cornus alternifolia Alternate-Leaved Dogwood. Mature sizes throughout the woods.
* Lindera benzoin Spicebush.
* Menispermum canadense Moonseed. Ground cover, west end.
* Parthenocissus quinquefolia Virginia Creeper. Ground cover.
* Parthenocissus vitacea Discless Virginia Creeper. Ground cover.
* Prunus virginiana chokecherry.
* Rhus radicans Poison Ivy.
* Ribes cynosbatii Prickly Gooseberry.
* Ribes sativum Red Current.
* Rubus odoratus Purple-Flowering Raspberry.
* Rubus strigosus Red Raspberry.
* Sambucus pubens Red-Berried Elder.
* Viburnum lantana L. Wayfaring-Tree.
* Vitis riparia Frost Grape.

**HERBS**

Most of the herbaceous vegetation (spring ephemerals) occur only in the western section of the woods. Several delicate grasses were observed but not collected—these are probably a species of *Muhlenbergia* or *Poa nemoralis*.

* Alliaria officinalis Garlic Mustard.
* Allium tricoccum RAMP. Once abundant (Day, 1888), only one patch seen.
* Arisaema triphyllum Jack-in-the-Pulpit.
* Carex rosea Rose Sedge. Woods margins.
* Circaea quadrisulcata Enchanter's Nightshade. Abundant.
* Dentaria laciniata Cut-Leaved Toothwort. Abundant.
* Dicentra canadensis Squirrel-Corn. Reduced to one or two patches.
* Dicentra cucullaria Dutchman's Breeched. Frequent.
* Erythronium americanum Yellow Adder's Tongue. Frequent, especially at the bases of trees.
* Eupatorium rugosum White Snake-Root.
* Geum canadense White Avens. Frequent.
* Glechoma hederacea Gill-Over-the-Ground.
* Narcissus pseudonarcissus L. Daffodil. Scattered individuals were found escaped into the central woods from extensive populations planted on the woods margins.
* Phytolacca americana. Pokeweed. Especially on weedy margins and disturbed interior of the forest.
* Scrophularia marilandica Maryland Figwort.
* Smilacina racemosa False Solomon's Seal.
* Smilacina stellata Star-Flowered False Solomon's Seal.
* Solidago canadensis Canada Goldenrod.
* Trillium grandiflorum White Trillium. Abundant.
* Trillium erectum Red Trillium. Occasional.
* Triosteum perfoliatum var. aurantiacum Orange Horse-Gentian.

**EXTIRPATED FROM THE GOAT ISLAND WOODS**

(see species catalogue):

* Arabis lyrata Lyre-Leaved Rock Cress.
* Asarum canadense Wild Ginger.
* Aster divaricatus White Wood Aster.
* Aster macrophyllus Large-Leaved Aster.
* Botrychium virginianum Rattlesnake Fern.
* Cardamine douglasii Purple Spring Cress.
* Claytonia caroliniana Broad-Leaved Spring Beauty.
* Dentaria diphylla Two-Leaved Toothwort. “notable for their abundance and beauty,” Day,
1901.
*Disporum lanuginosum* YELLOW MANDARIN.
*Geranium maculatum* L. WILD CRANE’S-BILL.
*Hepatica acutilobula* SHARP-LOBED HEPATICA.
*Hepatica americana* BLUNT-LEAVED HEPATICA.
*Juniperus communis* LOW JUNIPER.
*Juniperus virginiana* RED CEDAR.
*Mitella diphylla* MITERWORT.
*Phlox divaricata* BLUE PHLOX
*Polemonium reptans* GREEK VALERIAN.
*Quercus alba* WHITE OAK.
*Saxifraga virginiana* FOAM FLOWER.
*Streptopus roseus* TWISTED-STALK.
*Taxus canadensis* GROUND HEMLOCK.
*Thalictrum dioicum* EARLY MEADOW-RUE.
*Tiarella cordifolia* FOAM-FLOWER.
*Uvularia grandiflora* LARGE-FLOWERED BELL-WORT.
*Uvularia sessilifolia* SESSILE-LEAVED BELL-WORT.
*Viola canadensis* CANADA VIOLET.
*Viola cuculata* MARSH BLUE VIOLET.
*Viola pubescens* DOWNY YELLOW VIOLET.
*Viola rostrata* LONG-SPURRED VIOLET.

CENTRAL WOODS BRYOPHYTES
*Fissidens bryoides*. Thin soil on limestone cobbles.
*Thuidium pygmaeum*. Thin soil on limestone cobbles.
2. North Slope

The north slope is a north-facing sedimentary bluff running in an east-west direction on the northern margin of Goat Island. The bluff lowers in height on the eastern end to just above the water level. Several interesting habitats occur at the base of the slope, the Spring, and the limestone flats at the water’s edge (see those sections below).

The north slope begins at Stedman’s Bluff—the high ground overlooking Luna Island, which is dealt with in the section on crest vegetation. Due to the frequent engineering and maintenance activities at the bluff, there is a heavy infusion of weedy taxa—although the native community here is an interesting mixture with Elderberry (*Sambucus canadensis*) in good quantity. The only station remaining for Fragrant Sumach (*Rhus aromatica*), one of the less common Sumachs in our area, has been recently discovered here.

At the eastern extremity of the north slope lie the remains of the Spring, an old swampy area and a dolomite promontory densely infested with Buckthorn (*Rhamnus cathartica*), which has been made a grove here, Wayfaring Tree (*Viburnum lantana*), and of Lilac (*Syringa vulgaris*). The slope peters out before the vehicular or eastern bridge to the mainland.

Slumping presently occurs on these slopes which seem wetter than the corresponding southern slope. Part of this may be due to natural seepage occurring in the north slope, such as the famous Spring, and not obviously on the south (although there are culverts there), part may be due to the fact the slope is north facing and hence more in the shade and out of the direction of the prevailing wind. On the geologic map of Kindle and Taylor (1913), the soil type here is referred to as a boulder-clay, indicating finer sediment fractions than elsewhere on Goat Island and consequently poorer drainage. Mucky portions are especially evident between the west and east bridges. Placement of “stepping stones” may be the way to treat this area, rather than attempts to change the drainage and dry out the soil and otherwise making an artificial environment here. Sections might benefit from a surface dressing in conformity with early retaining wall structures still evident, and which effectively mimic natural limestone bedding planes.

Corresponding primarily to the reduced sunlight here, the abundance of herbaceous and shrub vegetation is markedly less than elsewhere in the Goat Island complex. Occasionally, perhaps where some sunlight gets through, such as on the river margin away from the slope, occur significant woodland populations of Laciniate Toothwort (*Dentaria laciniata*). A severe infestation of Garlic Mustard (*Alliaria officinalis*) occurs on the slopes, and there are frequent representations of weedy taxa.

In the disturbed slope sections by Luna Island along the river’s edge toward the west end occur many Elms (*Ulmus*), many of which were dead or dying. A number of these were young Slippery Elm (*U. rubra*), a species tending to colonize disturbed river margins, such as in the relatively recent ballast area at the east end. Some American Elm (*Ulmus americana*) occur as well.
Botanical Heritage of Islands at the Brink of Niagara Falls

Note the swamp near the Spring and the extensive dolomite flat under the Goat Island end of the Green Island Bridge (hatches). The Spring drawn from the Evershed map of 1883.

Note the swamp near the Spring and the extensive dolomite flat under the Goat Island end of the Green Island Bridge (Hatches). Drawn from the Evershed map of 1883.
Large (mature) trees, such as a forty-six inch diameter Sugar Maple, are presently pitched forward into the river due to slope instability, and are dying. Also unlike the shore of Goat Island to the south, the river is close to the base of the slope and there are a few minor areas of erosion because of it. Some areas of dolomite shelving are not from erosion, but from natural lowering of the river levels during the pre-Reservation history of the Niagara River (Kindle & Taylor, 1913). Here and there are instances of attempts to restrain slumping by retaining walls built according to the plan of the flooring of the Spring “composed of ledges of natural rock, laid in sand” (15 Ann Rep Comm, 1899), which duplicates natural rock strata.

On October 21, 1865, George Clinton recorded in his journal “commencing at the end of the Bridge, explored the bank all the way down to opposite the middle of the island [i.e. Goat Island] above Luna Island.” He was looking for the moss Anomodon viticulosus which his friend Leo Lesquereux had reported finding there (see section on Clinton’s journal). Clinton “found no rock till I got there—a ridge of the bank, & there, quite close to the bank, was a large rock, in the earth on top of which was” the moss he wanted.

In 1907 “a new trail has been constructed along the water's edge on Goat Island from the entrance to Luna Island Bridge by which many beautiful views heretofore inaccessible are thrown open to the public” (24 Ann Rep Comm, 1908).

The native trees here are diverse and of good size. Except for the loss of the conifers, the woods, judging from old photographs when the trail was constructed, appears relatively undisturbed. The large cut timber visible in the photographs may be the result of disposing of blowdowns in the forest above the slope. There should have been sufficient protection from high winter winds in the forests along the north slope otherwise.

There appears to be several Chipmunk populations here, and people with fishing rods were observed. Fishing in the American channel may have a long tradition, for the new trail built along the north slope in 1905 to the Spring was called the “Fisherman Trail” (Scott & Scott, 1983) and seems to have been favored over the Canadian channel.

### TREES
* Acer platanoides NORWAY MAPLE.
Acer saccharum SUGAR MAPLE.
Acer saccharinum SILVER MAPLE.
Fagus grandifolia BEECH. Many suckers circle this old tree, one of the few remaining on the island.
Fraxinus americana—pennsylvanica ASH. Abundant throughout [obs. 1988].
Morus alba WHITE MULBERRY.
Ostrya virginiana HOP-HORNBEAM [IRONWOOD].
Populus deltoides COTTONWOOD.
* Prunus cf. avium SWEET CHERRY. Of immense size.
Prunus serotina BLACK CHERRY. Occasional, on slopes.
Prunus virginiana CHOECHERRY. Abundant.
* Salix cf. alba-fragilis WHITE or CRACK WILLOW. By Luna Island.
Ulmus americana AMERICAN ELM. Young, by river margin, several dead and dying, 1988.
Ulmus rubra SLIPPERY ELM. Young, by river margin, several dead and dying, 1988.

### SHRUBS
Cornus alternifolia ALTERNATE-LEAVED DOGWOOD. Slope east of pedestrian bridge, abundant in places, young [obs. 1988].
* Cornus sanguinea BLOODTWIG DOGWOOD (see species catalogue). Slope east of pedestrian bridge [obs. 1988].
* Ligustrum vulgare PRIVET. Established at slope base [obs. 1988].
Lindera benzoin SPICEBUSH. The largest thicket of this species in the Reservation. Appears to tolerate moist shade well, slope east of pedestrian bridge, water's edge [obs. 1988].
* Lonicera tarata TARTARIAN HONEY-SUCKLE. East of pedestrian bridge [obs. 1988].
Parthenocissus vitacea DISCELLS VIRGINIA CREEPER. Slope east of pedestrian bridge [obs. 1988].
* Rhamnus cathartica BUCKTHORN. Slope east of pedestrian bridge [obs. 1988].

Rhus aromatic a FRAGRANT SUMACH. Slope overlooking Luna Island.

Rhus typhina STAGHORN SUMACH. Thicket occurs top of slope by vehicular bridge [obs. 1988].

Ribes americanum WILD BLACK CURRANT. Slope east of pedestrian bridge [obs. 1988].

* Ribes cf. sativum RED CURRANT. No resinous glands, slope east of pedestrian bridge [obs. 1988].

Rubus odoratus PURPLE-FLOWERING RASPBERRY. Slope east of pedestrian bridge [obs. 1988]. This might be a good shrub to reestablish along here.

Sambucus canadensis ELDERBERRY. Frequent on slopes overlooking Luna Island [obs. 1988].

Sambucus pubens. RED-BERRIED ELDER. Slope east of pedestrian bridge [obs. 1988].

Symphoricarpos albus [var.?] SNOWBERRY. Slope east of pedestrian bridge [obs. 1988].

* Syringa vulgaris LILAC. Area of the Spring (see below) [obs. 1988].

* Viburnum opulus var. opulus GUELDER ROSE. Slope east of pedestrian bridge [obs. 1988].

* Viburnum lantana WAYFARING TREE. Established in the cove by the old spring and spreading in various places at the slope base, especially east of the pedestrian bridge, 1988.

Vitis riparia FROST GRAPE. East of pedestrian bridge, up to the canopy [obs. 1988].

HERBS

* Acanthopanax sieboldianus ACANTHOPANAX. Planted on the crest [obs. 1988].

Achillea millefolium COMMON YARROW. East of pedestrian bridge, base of slope [obs. 1988].

* Alliaria officinalis GARLIC MUSTARD. Throughout, an infestation [obs. 1988].

Allium canadense WILD GARLIC. Open area near vehicular bridge [obs. 1988].

* Arctium sp. BURDOCK. All along open paths [obs. 1988].

* Barbarea vulgaris WINTER CRESS. Slope east of pedestrian bridge [obs. 1988]. Possibility of becoming an infestation.

* Cichorium intybus CHICORY. Slope crest by lawn margin [obs. 1988].

* Daucus carota QUEEN ANNE'S LACE. Along path, open west end, and slope crest, lawn margin [obs. 1988]

Dentaria laciniata CUT-LEAVED TOOTHWORT. Slope east of pedestrian bridge, by bridge abutment [obs. 1988].

* Eranthis hyemalis (L.) Salisb., WINTER ACONITE Slope facing Luna Island just east of Luna Island bridge, near the water’s edge; appears to have been planted.

Erythronium americanum YELLOW ADDER'S TONGUE. Slope east of pedestrian bridge [obs. 1988].

Fragaria sp. STRAWBERRY. Open area toward vehicular bridge [obs. 1988].

* Lotus corniculatus BIRD-FOOT TREFOIL. Slope crest, lawn margin [obs. 1988].

Phytolacca americana POKEWEED. Moist slopes west end [obs. 1988].

* Poa cf. nemoralis Occasionally abundant [obs. 1988].

* Rumex crispus CURLED DOCK. Pathside, moist slope base [obs. 1988].

Sanguinaria canadensis BLOODROOT. Small population of a few plants, on the slope [obs. 1988].

Smilacina stellata STAR FLOWERED FALSE SOLOMON'S SEAL. Slope east of pedestrian bridge [obs. 1988].

* Solanum carolinense HORSE-NETTLE. In a row along path facing Luna Island, 1988.

* Solanum dulcamara BITTER NIGHT-SHADE. [obs. 1988].

* Solidago canadensis CANADA GOLDENROD. Throughout [obs. 1988].

* Solidago flexicaulis ZIGZAG GOLDENROD. Slope surface east of pedestrian bridge [obs. 1988].

* Sonchus oleraceus SOW THISTLE.

* Taraxacum officinale DANDELION. Throughout along path edges [obs. 1988].


* Vinca minor PERIWINKLE. Dense growth established by the pedestrian bridge, choking out native Toothwort here (Dentaria laciniata) [obs. 1988].

NORTH SLOPE LICHENS

Note that most of these species are growing on rock, from construction (retaining walls) and the native bedrock exposed at the base of the slopes.

Arthonia lapadicola. North side on slope near water just E of Luna Is. bridge, on rock, Harris 22855 (NY) NEW TO NEW YORK STATE.
Part II: Vegetation

Bacidia sp. North side, on flat rock partially in water, Harris 22839 (NY).

Bacidia sp. North side, at base of Populus, Harris 22831, Harris 22841

Bacidia granosa. North side, on bank near water, on rock, Harris 22837 (NY); north side, on rock, Harris 16297 (NY).

Buellia punctata. North side near Luna Island bridge, at 1 m on Robinia, Harris 22835 (NY); near Luna Island bridge, at base of Robinia, Harris 22850 (NY).

Caloplaca feracissima. North side, retaining wall at river’s edge, Harris 22856 (NY); north side, on rock, Harris 16299 (NY).

Endocarpon pusillum. North side, on rock, Harris 22832 (NY).

Lecanora dispersa. North side, retaining wall at river’s edge, Harris 22856 (NY); north side, on rock, Harris 16299 (NY).

Lepraria finkii. North side, at base of Betula, Harris 22819 (NY); north side, at base of Tilia, at river’s edge, Harris 22821 (NY); north side near pedestrian bridge, on rock, Harris 22825 (NY); north side, at base of dead Ulmus, Harris 22829 (NY); north side, on rock, Harris 16305 (NY).

Mycobilimbia sabuletorum. North side, rock at river’s edge, Harris 22845 (NY); north side, on rock, Harris 16302 (NY), Harris 16312 (NY).

Parmelia sulcata. North side, on Fraxinus at river’s edge, Harris 22834 (NY).

Verrucaria muralis. North side, near water, on rock, Harris 22824 (NY); north side, small rocks in clay bank, Harris 22849 (NY); north side, on rock, Harris 16306 (NY), Harris 16303 (NY).

Verrucaria sp. North side, on small rock in clay bank, woodland taxon, Harris 22838 (NY); Harris 22846 (NY); Harris 22848 (NY).

Verrucaria sp. North side, near Luna bridge, near water, Harris 22830 (NY).

Verrucaria sp. North side, near Luna bridge, near water, Harris 22823 (NY).

NORTH SLOPE FUNGI

It appears that the cool, shaded stations in this area, with their old wood, support a diversity of fungus species—more than elsewhere in the Reservation. Perhaps it is along this slope that Clinton found specimens that he sent to Charles Peck (see section on fungi). Old growth areas should be protected in the Reservation because these “plants” may not naturally establish themselves again once destroyed.

Bisporella citrina. North slope, on rotten log, 1 Nov 1988, Buck 16294 (BUF, NY).


Coryne dubia. North slope, on rotten log, 1 Nov 1988, Buck 16288 (NY).

Flammulina velutipes WINTER MUSHROOM. North slope, on tree trunk, 1 Nov 1988, Buck 16310 (BUF, NY); stump, Eckel w. R. Zander, Nov. 1, 1988 (BUF).

Ganoderma applanatum. North slope, on dead tree, 1 Nov 1988, Buck 16314 (BUF, NY).

Gibellula pulchra. North slope, on dead spider, 1 Nov. 1988, Buck 16307 (NY).

Lecanidion atratum. North slope, on rotten log, 1 Nov. 1988, Buck 16290 (BUF, NY).

Marasmius sp. Moist, rich soil by culvert in wood, north end of the island, east of the pedestrian bridge, Eckel w. R. Zander.


Ustulina deusta. North slope, on dead tree, 1 Nov. 1988, Buck 16296 (NY).

NORTH SLOPE BRYOPHYTES

Amblystegium serpens. (Three collections.)

Amblystegium tenax. On brickwork, west end, north slope.

Anomodon attenuatus.

Barbula unguiculata.

Barbula unguiculata fo. apiculata. On brickwork, west end, north slope.

Brachythecium rutabulum. Wooded slope, west of vehicular bridge.

Bryum lisae var. cuspidatum.


Eurhynchium hians.


Funaria hygrometrica.
<table>
<thead>
<tr>
<th>Botanical Heritage of Islands at the Brink of Niagara Falls</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Orthotrichum anomalum</em>. (Two collections.)</td>
</tr>
<tr>
<td><em>Orthotrichum pumium</em>. Base of Maple.</td>
</tr>
</tbody>
</table>

- 74 -
2a. “The Spring”

On the northeast margin of Goat Island, below the crest of the north slope, there occurred a natural spring of good water. Early in the island's history, a cabin was built near it (the “Hermit's Hut,” 16 Ann Rep Comm, 1900). In 1912 (July 22) the Niagara Falls Gazette reported that workmen unearthed a human bone in this area while building steps down the slope leading to the spring (Scott & Scott, 1983). Perhaps this natural feature was not unknown to native peoples who may have visited Goat Island for burial purposes (see land use section), and may prove to have additional archaeological interest.

As the Porters made the island accessible to visitors, the spring was used as perhaps the only source of refreshment, outside of eating the native gooseberries and currants (Gurney, 1841) or obtaining beverages and other fare from a rest-house on Green Island (see section on Green Island).

A great deal of attention was paid this area by the Superintendent in the first fifteen years of the Reservation, most of the attention due to the fact visitors drank from the spring to slake their thirst. It was not very far from the bridge to the Island. In 1890 “An additional substantial stairway is much needed to take the place of the dilapidated steps leading to the Spring on Goat Island” (6 Ann Rep Comm, 1890). The stairway was “made of oak with iron risers set on stone piers” (Scott & Scott, 1983). “A suitable stone spring house has been erected about the spring on Goat Island, which protects the spring from falling leaves and adds to the convenience of the public” (7 Ann Rep Comm 1891). This spring received a stairway to it consisting of “four flights and four landings” (7 Ann Rep Comm, 1891). “Permanent oak seats have been built into the balconies of the stairway at the Spring” (9 Ann Rep Comm, 1893) and a picture of a little stone-enclosed area with children drinking from a cup with a flight of wooden steps in the background is appended to the 11th annual report of the Commissioners for 1895. In 1894 a gravel walk was built “from the head of Goat Island to the spring” (11 Ann Rep Comm, 1895).

In the 15th annual report of the Commissioners (1899), the frame platform at the Spring was replaced by a flooring composed of “ledges of natural rock, laid in sand.” A similar kind of surfacing may be seen in other areas of the north slope, and appears to be an attractive way to face the slope. This surfacing almost duplicates natural rock strata.

The usefulness of the Spring was maintained for many decades and the public was encouraged to use it as a public drinking fountain. Carriage parking was established there.

In 1905 or 6 “a new trail called “Fisherman Trail” was constructed to the Spring along the island's north shore” (Scott & Scott, 1983).

Modifications in the natural surroundings continued, with the eventual replacement of all the native vegetation. Presently, very old horticultural embellishments remain near here: dense groves of Lilac (*Syringa vulgaris*), Buckthorn (*Rhamnus cathartica*) and Wayfaring Tree (*Viburnum lantana*). The Buckthorn is unfortunately seeding itself throughout the vegetation on the slopes and river margins. Once a grove of this has been established, little grows beneath it. Most of the trees in this area are alien, mostly Norway Maple (*Acer platanoides*), and of considerable age. The presence of alien trees at this locality is in sharp contrast to the high native tree diversity characteristic of the rest of the northern
Botanical Heritage of Islands at the Brink of Niagara Falls

slopes of Goat Island.

It is probable that at a much earlier date, such as at the time of David Douglas’ visit to the Island in 1823, that this area was very much boggier than now, and was altered perhaps during the Porter ownership for the convenience of visitors. Somewhere on the island, David Douglas observed Skunk Cabbage (Symlocarpus foetidus), probably the remnant of a larger population, isolated by drainage modification of some sort and other wet-soil species, such as Green Dragon (Arisaema dracontium) and Poison Sumac (Rhus vernix) (see section on Douglas’ diary). Running streamlets might also have supported the hydrophilic False Mermaid plant (Floerkea proserpinacoides) and other wet-woodland species still present at Dufferin Islands across the River in Ontario, but now absent on Goat Island.

These cool, wet slopes once supported stands of Arbor Vitae, which were visible from the mainland (Michaux, 1819) perhaps in the manner of trees along the slopes facing Dufferin Islands today, only more dense.

On the 1883 Evershed map of land to be purchased for the Niagara Reservation, the spring is drawn leading down to a small alluvial channel at the river margin corresponding to its outlet. Just east of it, there is a small swamp drawn, just as one was drawn for the western extremity of the Second Sister Island. The north shore swamp area with its plant community has since disappeared, probably due to lowering of river volume (see section on hydrology). It is highly probable that the species composition of this wet area, on the north slope of Goat Island in a wooded situation with canopy, would be quite different from that of the open, sunny alluvial area at the Second Sister’s west end.

Around 1898, the neighboring city of Niagara Falls was experiencing a scourge of typhoid fever. A state expert was brought in that year to investigate local wells and found “only two wells of 43 checked contained water fit for use. He also said the spring on Goat Island was contaminated” (Mizer, 1981). Before the city could control the impurities in its water, Superintendent Thomas Welech, a native of the city, tragically died of the disease in 1903 (20 Ann Rep Comm, 1904).

“The frame platform at the Spring on Goat Island has been removed, and the space floored with ledges of natural rock, laid in sand. The Board of Health of the city of Niagara Falls has called attention to the probable pollution of the water by persons dipping pails and other vessels into the spring to obtain water. To guard against possible contamination, it may be well to close the opening in the stone canopy of the Spring, so that the water may be obtained only through a tube” (15 Ann Rep Comm, 1899).

Today, a cove-like area between the two bridges to Goat Island with a stone or concrete stair leading down to a wet area near the water’s edge is what is left of the Spring. Saturated soil here is a remnant of this outlet. This wet, northward-sloping area is presently dense with the water-loving Spotted Touch-Me-Not in the latter part of summer. Water to the spring was probably fed through a joint in the bedrock below the overlying sediments. The flow of
this water appears to have been interrupted. Just west of the vehicular bridge, a grassy rivulet runs out of the bank which may be a descendent of the Spring.

During the foray to Goat Island, part of the 1886 meeting in Buffalo of the American Association for the Advancement of Science, the American bryologists C. R. Barnes, Elizabeth Gertrude Britton and Lucius M. Underwood collected an unusual moss in this vicinity (see bryophyte section). These populations may still be seen.


2b. Flats on the North Side  There were and are several areas of limestone flats here (as noted on Kindle & Taylor’s geologic map, 1913), which have a geologic history similar to the flats at Terrapin and Prospect Points, the shoreline on the Canadian side and all the islands in either channel prior to 1913. It was to a flats area on the north side of Goat Island to which George Clinton referred on June 8, 1863: “the little flat above the bridge ... collected two” specimens of sedge (*Carex*), and Kentucky Blue-grass (*Poa pratensis*). On August 22, 1864, Clinton found “on the American side of the Island, by the river, & above the Bridge found ... *Carex eburnea*.” On June 1, 1865, Clinton went “up the American side, to the rocky flat by the River. Took, from a stump, a small lead colored fungus in the gills, & a larger one, perhaps the same and one or two mosses collected before.” On July 23, 1865, on the “American side” of Goat Island, above the Bridge, he found the weedy Deptford Pink (*Dianthus armeria*) “abundant & nearly accessible.”

In the Evershed map drawn in 1883 a dolomite flat was drawn on Goat Island beneath the “Bath Island Bridge” from what we call Green Island today, to Goat Island. Kindle and Taylor (1913) also drew a flats area, or area of low ground on the river’s edge, corresponding geologically to the low ground on the Three Sisters and adjacent southeast margin of Goat Island, Terrapin Point, the islands in the American channel and the shoreline on the mainland leading to Prospect Point.

Water seeps along bedrock shelves in the cove area upriver from the present stone pedestrian bridge, in the north section at the river’s edge. Moss and liverwort communities grow here, including the unusual moss *Fissidens grandifrons* that nineteenth century botanists were happy to find growing in these continuously wet horizontal fissures. Downriver, above Luna Island, another small limestone ledge occurs with a rush-sedge community of plants containing, among other plants, a species of Horehound or Bugleweed (*Lycopus* sp.), some grasses, one rooted (?) specimen of Eel-grass (*Valisneria americana*) in a pocket of quiet water, a specimen of Bulrush (*Scirpus* sp.) and a population of Flowering Rush (*Butomus umbellatus*). These communities are restricted to such habitats on Goat Island and are an important source of the diversity of species in the Goat Island complex.

Note also that several of the lichens reported above for the “north slope” were collected on these bedrock flats.
William J. Bennett, “Niagara Falls, American Fall from the Goat Island,” 1831 (Adamson, 1985). The path with goat at the bottom of the picture was the top of Stedman’s Bluff. Note the young conifers and general lowness of the vegetation. The old Luna Island flora is seen across the Bridal Veil Falls channel.
Botanical Heritage of Islands at the Brink of Niagara Falls

GOAT ISLAND
Crest on the western margin

Schematic diagram section, vertical, of the island on the west end. Sediments supporting crest vegetation hatched.

Looking south. This is a generally dry, exposed habitat when not bathed by the mist from the cataracts, particularly on the eastern crest of the Niagara River gorge.

Area of crest vegetation shown stippled (on Evershed's 1883 map)
3. Crest Vegetation

The crest refers to the brink of the gorge on the western extremity of Goat Island, also known as the high bank. The brink or crest is composed of the deepest sedimentary deposits on the island, or anywhere else within the Goat Island complex. At the island’s north- and south-western corners occur approximately forty-foot bluffs of sediment which overlook the upper riverbed. The bluff on the north, overlooking Luna Island, is called Stedman’s Bluff, that on the south, overlooking the Horseshoe Falls and Terrapin Point is Porter’s Bluff.

In Olmsted and Vaux’s 1887 plan, Stedman’s Bluff was to support a stair with a series of viewing platforms for those descending to Luna Island. Those leaving that island, sated with the view, could mount the bluff on a different set of stairs.

The view from Porter’s Bluff was the most spectacular. Around fifty yards of vegetation had been removed to enhance the prospect “beyond which point considerable bodies of foliage interpose that cannot be removed without detriment to the scenery.” The stairs leading down to the Terrapin Rocks were to be removed and an inclined path made in a small gully, or ravine, already existing in the bank.

This area receives the brunt of the prevailing winds, for the most part, and may or may not receive benefit from the spray of the cataracts. Portions of it may experience desiccation stress as do other sections of the seven-mile crestline all along the gorge of the Niagara River from Goat Island to Lewiston, New York.

Slumping and landslides attest to the instability of the soil banks here, such as the one reported in 1907 at the Biddle Stairs. To remedy this “sliding holes were drilled in the solid ledge rock and heavy iron pins placed in them with the upper ends projecting five or six feet. Back of these pins heavy cedar and oak logs were placed and the excavation filled with brush and soil” (24 Ann Rep Comm, 1908). Olmsted and Vaux (1887) refer to this condition when they object to replacement of the Biddle Stair on the west face of Goat Island because “as the face of the cliff recedes a readjustment of the affair would soon be necessary,” further that “twenty years ago the carriage way between Stedman’s Bluff and Porter’s Bluff ran upon ground much of which has since been undermined and fallen.”

Early realistic drawings such as that of Niagara Falls painted by Frederic Church in 1856 (Niagara Jasper Francis Cropsey, “Niagara Falls” 1860 (Fig. 72 in McKinsey, 1985). Prospect areas have been cleared. Note the Oaks and low evergreen vegetation. The growth habit of Arbor Vitae in the dolomite caprock is well indicated and characteristic of the vegetation at the crest along the gorge as well. The Oaks have been replaced today with the alien Black Locust (Robinia pseudoacacia).
Falls, Fig. 59 in Adamson, 1985) show extensive areas of crestline totally devoid of vegetation in the midst of relatively dense woods, a condition due to collapse on the western margin of the sediment bank. Evidence of such catastrophic conditions are not apparent today.

White Pine (*Pinus strobus*) may be a likely candidate for the conifer in early depictions of Goat Island on the high bank or upper crest of Goat Island, on analogy with records of such pines at "Whirlpool Woods" reported by George Clinton in his diary (see sections included). Whirlpool Woods constituted the crest vegetation near what is now Whirlpool State Park. This area also has a deep layer of fluviatile sediments at the crest, as does Goat Island. The original Whirlpool Woods was cleared after that area became a State Park, but before that there was much there of a rare botanical character. The presence of a population of White Pine is inferred from the occurrence of a rather robust station of Pine-drops (*Pterospora andromedea*) at this locality (see Clinton's diary) in the latter half of the nineteenth century.

Unless conditions such as aspect were unfavorable, a component of Red Cedar probably existed because elsewhere in western New York this small tree enjoys the crests of gorges and ravines (Zenkert, 1934).

A conifer border was depicted in early pictures of the crestline, starting with Hennepin's illustrations, although to some extent these were caricatures of reality based on Hennepin's verbal description. Subsequent paintings by certain leading landscape artists, however, also emphasize a dark evergreen border, especially on the islands in the American channel (see section on the pictorial tradition).

As recently as seven hundred years ago, the sub-tending bedrock of Goat Island extended continuously across to the Ontario shore, much as it does today in the land above the falls, and the level of water in the river reached up to at least the base of the sedimentary bluff, or high bank, on Goat Island's west end. This was at a time when the cataracts were just north of Goat Island, presenting one continuous crestline (Otis, 1982). The aboriginal Goat Island crest forest of around two hundred years ago during ownership by the Porters, then, had its origin as a shoreline, not a crestline, as would be the case for the early crest forests all along the present seven mile length of the Niagara Gorge. Two shorelines were created as the gorge extended southward—one along the shore of the Niagara River above the falls, later to become abandoned as a crestline, the other being created at the base of the gorge and extending south with the lengthening of the gorge. Pictorial evidence, geological relationships and aspects of the present gorge flora suggest that these borders were dominated by conifers, at least in basal shelving areas such as at the Whirlpool—frequently depicted on the Canadian shore.

As has been stated elsewhere in this manuscript, the crest areas were among the first forests to be cleared along the gorge rim, due to their usefulness as prospect areas. By the time cameras came into common use, the crestline woods had probably been completely altered, favoring domination by deciduous trees with scattered evergreens.

No evergreens exist in the present crest woods, although an occasional Arbor Vitae (*Thuja occidentalis*) might be found at the precipice, growing out of the bedrock. Presently, infestations of alien taxa occur with a rather strong, if young, growth of native species. The weeds are concentrated by the asphalted path, with native woodland species tending toward the brink. Serious weeds are primarily introduced shrubs: Tartarian Honeysuckle, Privet, Wayfaring Tree, Buckthorn, Rugose Rose with mixture of path-side weedy herbs. With judicious removal of the weed shrubs, the native vegetation which is clinging to the far brink of the precipice would recolonize and naturally restore the crest forest to a community of native species.
A beautiful autumn sight must have been the population of Climbing Bittersweet (*Celastrus scandens*) growing “as though this were their chosen home of all the earth ... the largest Bittersweet clusters hang far over the western bank, growing in very indifferent soil ...” (Chamberlin, 1892). Although absent from the present crestline, this plant grows on the talus at the base of the island and elsewhere along the crest of the Niagara River gorge. It apparently was once much more abundant there, but were cut out by people selling bunches of this brilliant and aromatic vine to tourists (personal communication from a person met while botanizing).

Apparently, after the original trees were removed, Black Locust (*Robinia pseudacacia*) trees were substituted. Any of the native trees present today could be made to replace them, but it is likely that Yellow Oak (*Quercus prinoides var. acuminata*) was the original crest Oak. The Black Locusts are very large and tree ring data would help date the event of the removal of the original trees and planting of these substitutes.

On June 26, 1862, George Clinton collected “on top of the bank” Lyre-leaved Rock Cress (*Arabis lyrata*) after climbing up the Biddle Stairs - so presumably he meant the “high bank” or western boundary of Goat Island. He also found there the Fringed Houstonia (*Houstonia canadensis*) and native Snowberry (*Symphoricarpos albus*) typical of the wooded crest vegetation all along the Niagara Gorge on both sides of the River, and characteristic of dry woods facing the wind.

The plants of the crest are important because they shed their seeds on the naturally vegetated slopes below. Care should be taken that plants which become noxious are not introduced at the crestline. This is true for parklands all along the seven mile crest of the Niagara River Gorge.

Presently there are “ongoing periodic scaling of the gorge walls above major viewing areas, such as the Cave-of-the-Winds” (The Promontory Partnership, 1981) in order to stabilize the rock face as “this action greatly reduces the potential of small rock slides” from above onto areas below. It is recommended that a policy be developed to accomplish this to reduce impact on the crest vegetation and to allow regeneration on areas denuded for the sake of ease of access by workers, such as exists on Stedman's Bluff. There is a danger that maintenance policy has been established to maintain Stedman's bluff as a lawn. Presently it is in that condition. It may be that native vegetation will not be allowed to reestablish itself, and this area, as well as many other areas on Goat Island, will be lost.

Regrowth, when permitted, may be designed to screen the area when the crest is trimmed or reinforced. One suggestion is that River Grape (*Vitis riparia*) be reestablished here: “in few other places does the Wild Grape climb so high or spread so far or swell itself into such tree-like proportions. Nowhere, especially on the American side and in the vicinity of Luna Island, is the visitor out of sight of these rampant vines. The slope leading down to Luna Island is covered with small trees so overgrown by vines that one wonders how the trees can grow at all, yet they appear to thrive under the load” (Chamberlin, 1892). Chamberlin also writes of how successful the Bittersweet vines were (see above). The conspicuous presence of vines was noted by many people, such as Robinson (1875) quoted by Olmsted in Gardner (1880) where the islands were “undisturbed in their peaceful shadiness, garlanded with wild vine and wild flowers ....”
A likely candidate for the occurrence of a great thicket of Burning Bush, or Wahoo (Euonymus atropurpureus), is here, due to Chamberlin’s exclamations over the extraordinary growth of shrubs and vines in the areas subjected to spray and mist—even weedy shrubs such as the Barberry (presumably Berberis sp.). Gardner also referred to this abundance when he refers to the “rich overhanging foliage of the high banks of Goat Island” (Gardner, 1880). The “thicket” mentioned frequently by Superintendent Welch, from which he extracted hundreds of native shrubs may very well have come from exotic groves on the west end in response to moisture. Indirect evidence for this is the curious shrub layer drawn by Cockburn (1833) in a painting done of this area, discussed in the section on pictorial tradition.

Note: the grapes and small trees noted by Chamberlin should not be taken as the climax or aboriginal community by the time of European settlement—which historically was a conifer forest. The primitive trees had probably been removed here by Chamberlin’s time, and sections of the crest slope had collapsed into the gorge. The grapes and small trees reported were successional—much like the sumach on the east end of the island in 1885. Such successional today can be seen in a small community on the slopes on the island’s south side by the Horseshoe Falls. Grape vines actually may have been critical in the ability of the forest to regenerate in areas subject to high moisture, ice-load and wind on the island’s western margins—another reason why the present maintenance policy of removing them from the trees may be destroying the island forest. Deep thickets, as just discussed and suggested in the remarks made by Chamberlin (1892) may, however, have been the aboriginal condition.

Further investigation of conditions in certain sections of the Reservation subject to spray zone moisture and prevailing wind might wish to consider the biological response of species interacting with elevated moisture regimes in the spray zones. “Cold is more penetrating when the air is moist, and high temperatures are more noticeable when relative humidity is high” (Smith, 1966). Certain aspects of “krummholz” or elfinforest communities of some tundra (Janic, et al., 1974) and alpine vegetation (Raven and Curtis, 1970) may yield practical insight into conditions at the crestline at Terrapin and Prospect Points and the bluff on Goat Island overlooking Luna Island. “Where strong winds come in from a constant direction, the trees are sheared until the tops resemble close-cropped heads, although the trees on the lee side of the clumps grow taller than those on the windward side. While the wind and cold generally are regarded as the cause of the dwarf and misshapen condition of the trees, Clausen (1965) has demonstrated that the ability of some trees to show a ‘krummholz’ effect is genetically determined” (Smith, 1966).

Oil painting by John P. Beaumont, ca. 1820 (in Tiplin, 1988). Note the pine border on the crestline just north of the American Falls, and the tiny picnickers. Wherever picnics are drawn, the crest “prospect” vegetation has been removed, as here. The original forest extended out to the brink.

When terminal branch shoots are lost by desiccation and ice, strong lateral shoots develop, contributing to thicket formation in trees and shrubs ordinarily tall and loosely branched. Olmsted himself referred to a process like it: “something of the beauty of the hanging foliage below the falls is also probably due to the fact, that the effect of the frozen spray upon it is equivalent to the horticultural process of ‘shortening in’; compelling a denser and closer growth than is, under other circumstances, natural” (Gardner, 1880).
Part II: Vegetation

Trees, often depicted in early photographs, and some of which may be seen on the Ontario side near the Horseshoe Falls, may become “flagged” by the destruction of their twig-forming buds on the side facing into the prevailing wind and killing frost (Smith, 1966). Such effects on natural vegetation are beautiful to see and are signatures of the power of the Niagara River and its cataracts.

One species of native Rose occurs here which is rare in western New York State (*Rosa virginiana*).

<table>
<thead>
<tr>
<th>TREES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acer negundo</em> BOX ELDER. One or two.</td>
<td></td>
</tr>
<tr>
<td><em>Acer saccharum</em> SUGAR MAPLE.</td>
<td></td>
</tr>
<tr>
<td><em>Aesculus hippocastanum</em> HORSE CHESTNUT.</td>
<td></td>
</tr>
<tr>
<td><em>Betula papyrifera</em> PAPER BIRCH.</td>
<td></td>
</tr>
<tr>
<td><em>Carya</em> HICKORY.</td>
<td></td>
</tr>
</tbody>
</table>
| *Fraxinus* CF. *
| *Juglans* PAPER WALNUT. |
| *Morus* WHITE MULBERRY. |
| *Ostrya virginiana* HOP HORNBEAM. |
| *Prunus* CHOKE CHERRY. |
| *Rhus* STAGHORN SUMAC. |
| *Robinia pseudacacia* BLACK LOCUST. Frequent and mature (early establishment). |
| *Tilia americana* BASSWOOD. |
| *Ulmus rubra* SLIPPERY ELM. |

<table>
<thead>
<tr>
<th>SHRUBS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ligustrum vulgare</em> PRIVET.</td>
<td></td>
</tr>
<tr>
<td><em>Lonicera</em> TARTARIAN HONEY-SUCKLE.</td>
<td></td>
</tr>
<tr>
<td><em>Rhhamnus cathartica</em> COMMON BUCKTHORN.</td>
<td></td>
</tr>
<tr>
<td><em>Rhus radicans</em> POISON IVY.</td>
<td></td>
</tr>
<tr>
<td><em>Rosa rugosa</em> RUGOSA ROSE.</td>
<td></td>
</tr>
<tr>
<td><em>Rosa virginiana</em> MILL. PASTURE ROSE</td>
<td></td>
</tr>
<tr>
<td><em>Rubus odoratus</em> PURPLE-FLOWERING RASPBERRY.</td>
<td></td>
</tr>
<tr>
<td><em>Rubus strigosus</em> RED RASPBERRY.</td>
<td></td>
</tr>
<tr>
<td><em>Sambucus pubens</em> RED-BERRIED ELDERBERRY.</td>
<td></td>
</tr>
<tr>
<td><em>Symphoricarpos</em> SNOWBERRY.</td>
<td></td>
</tr>
<tr>
<td><em>Viburnum lantana</em> WAYFARING TREE. Large shrub with escapes in several places.</td>
<td></td>
</tr>
<tr>
<td><em>Vitis riparia</em> FROST GRAPE.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HERBS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Achillea millefolium</em> YARROW.</td>
<td></td>
</tr>
<tr>
<td><em>Agropyron repens</em> QUACK-GRASS.</td>
<td></td>
</tr>
<tr>
<td><em>Allium canadense</em> WILD GARLIC.</td>
<td></td>
</tr>
<tr>
<td><em>Aralia nudicaulis</em> WILD SARSAPARILLA.</td>
<td></td>
</tr>
<tr>
<td><em>Arctium</em> BURDOCK.</td>
<td></td>
</tr>
<tr>
<td><em>Asclepias syriaca</em> COMMON MILKWEED.</td>
<td></td>
</tr>
<tr>
<td><em>Brassica kaber</em> CHARLOCK.</td>
<td></td>
</tr>
<tr>
<td><em>Bromus inermis</em> BROME-GRASS.</td>
<td></td>
</tr>
<tr>
<td><em>Carex</em> SEDGE.</td>
<td></td>
</tr>
<tr>
<td><em>Chrysanthemum leucanthemum</em> OX-EYE DAISY.</td>
<td></td>
</tr>
<tr>
<td><em>Cichorium intybus</em> CHICKORY.</td>
<td></td>
</tr>
<tr>
<td><em>Circaea quadriradiata</em> ENCHANTER'S NIGHT-SHADE. Typical of the central woods.</td>
<td></td>
</tr>
<tr>
<td><em>Cirsium</em> THISTLE.</td>
<td></td>
</tr>
<tr>
<td><em>Dactylis glomerata</em> ORCHARD GRASS.</td>
<td></td>
</tr>
<tr>
<td><em>Daucus carota</em> QUEEN ANNE'S LACE.</td>
<td></td>
</tr>
<tr>
<td><em>Eupatorium rugosum</em> JOE-PYE-WEED.</td>
<td></td>
</tr>
<tr>
<td><em>Leonurus cardiaca</em> MOTHERWORT.</td>
<td></td>
</tr>
<tr>
<td><em>Lotus corniculatus</em> BIRD-FOOT TREFOIL.</td>
<td></td>
</tr>
<tr>
<td><em>Monarda fistulosa</em> WILD BERGAMOT.</td>
<td></td>
</tr>
<tr>
<td><em>Oxalis stricta</em> WOOD-SORREL.</td>
<td></td>
</tr>
<tr>
<td><em>Parthenocissus vitacea</em> DISCLESS VIRGINIA CREEPER.</td>
<td></td>
</tr>
<tr>
<td><em>Poa cf. nemoralis</em> WOOD BLUEGRASS.</td>
<td></td>
</tr>
<tr>
<td><em>Rumex crispus</em> CURLED DOCK.</td>
<td></td>
</tr>
<tr>
<td><em>Sanguinaria canadensis</em> BLOODROOT.</td>
<td></td>
</tr>
<tr>
<td><em>Smilacina racemosa</em> FALSE SOLOMON'S-SEAL.</td>
<td></td>
</tr>
<tr>
<td><em>Smilacina stellata</em> STAR-FLOWERED FALSE SOLOMON'S-SEAL. Abundant.</td>
<td></td>
</tr>
<tr>
<td><em>Solidago canadensis</em> CANADA GOLDENROD.</td>
<td></td>
</tr>
<tr>
<td><em>Sonchus oleraceus</em> SOW THISTLE.</td>
<td></td>
</tr>
<tr>
<td><em>Triosteum perfoliatum</em> HORSE-GENTIAN.</td>
<td></td>
</tr>
<tr>
<td><em>Vicia cracca</em> COW VETCH.</td>
<td></td>
</tr>
</tbody>
</table>
Old Wooden Stairway to Luna Island, 24 Ann Rep Comm, 1908. The complex vegetational community on Stedman’s Bluff is depicted near the beginning of the Reservation’s existence.
Walk to Bridge to Luna Island, 19 Ann Rep Comm, 1903. Modifications by the State have caused profound changes in the native vegetation here.

New Stone Stairway to Luna Island, 24 Ann Rep Comm, 1908. Note the original vegetation has been completely removed or altered.
Botanical Heritage of Islands at the Brink of Niagara Falls

Although rock-fall is continuous, catastrophic events vivid in people's memory include the collapse of Terrapin Point and Prospect Point, the Schoellkopf power plant disaster and the rockslides which eventually terminated operation of the Great Gorge Route Railroad. Plant communities have existed in this catastrophic regime for millennia.

Stippled area = base of Goat Island (drawn from Eveshied's 1883 map)

V = vegetation occurs in patches due to periodic catastrophic rock fall which buries continuous plant communities. Such events provide empty habitats suitable for re-colonization. White Birch often occurs in swarms after these events. In wet areas such as below Terrapin Point, dense, jungle-like monocultures of Jewelweed (Impatiens) colonize the bare rocks. High energy environments such as at the base of the island promote plant diversity.
Sketches from Porter (1900, private reprint edition) showing recession of the falls and giving an idea of the habitat available for the development of a shoreline plant community, which evolved into a “crest” community after recession left these areas high and dry. The west end of Goat Island evolved from a shoreline to a bluff. Plants of the old shoreline probably colonized the new river margin created on the lower banks (talus slope margin) by dropping seeds and other diaspores down on the rocks below.
Botanical Heritage of Islands at the Brink of Niagara Falls

Sketch from Porter (1900, private reprint edition), showing an extended “table” of dolomite caprock with its overburden of sediment and vegetation. Shelves of caprock like this are characteristic of the Niagara Escarpment, of which the Niagara gorge is an extension, and can be seen in places up as far as the Manitoulin district in Ontario, Canada. The famous Table Rock directly across the river was one such dolomite shelf. Most of these extensions have been dynamited away, due to their inevitable collapse onto the rocks below. The plant community of the original shoreline may have clung to this ledge before falling en masse onto the talus below when the ledge eventually collapsed. Note that when Church painted this area in the mid 19th century, most of this boundary had fallen into the gorge below, either through erosion of the caprock, or soil slumping, such as occurred on the Island’s south side.

Another ecological regime, occurring between the shoreline and bluff events would have been a habitat, on both upper and lower land margins, when the vegetation was bathed in mist while in the spray zone of the cataracts, and subjected to the mechanical characteristics of winter ice, much as Terrapin Point, Stedman’s Bluff and Prospect Point were in the historic period.
4. Base of Goat Island
The western boundary of Goat Island presents a west-facing bluff into the plunge-pool area of the cataracts. There is the high bank of sediments on the top of the bluffs, a sheer, vertical face of bedrock, a talus slope of primarily dolomite rubble that extends in most places down to the surface of the river and below.

A review of maintenance activities on Goat Island will probably show much of the present talus or rubble to be relatively recent due to trimming the cliff face above to prevent rock collapse and soil slumping off the “high bank” and generally stabilizing the upper surfaces to protect visitors and structures above. Such activity had a long history for in 1829 “crowds were attracted to both sides of the River ... to witness the advertised blasting of cliff overhangs (Stone in Dow, 1921; Scott & Scott, 1983). Presently, there is “ongoing periodic scaling of the gorge walls above major viewing areas, such as the Cave-of-the-Winds” (The Promontory Partnership, 1981). This new rock probably covers what original vegetation may have existed. From evidence in other areas of the Niagara Gorge, when rubble falls, it is catastrophic, totally destroying everything on the talus slopes below, no matter how well established the talus forest may have been, and exposing new surfaces for colonization by vegetation.

Rare bryophyte communities existed below Terrapin Point before it was blasted away in the 1980s—there may be persistent populations, but the area of the spray zone at the Horseshoe Falls could not be investigated for this report. A station of the only populations of Kalm's St.-John's Wort (Hypericum kalmianum) in New York State was lost near the area of the Cave of the Winds by human activity there. The base of Goat Island should be considered one of the more sensitive natural areas on the island pending further study.

Certain early realistic drawings such as that of Niagara Falls painted by Frederic Church in 1856 (Niagara Falls, Fig. 59 in Adamson, 1985) show little tree and shrub vegetation at the base of Goat Island, and that which is drawn appears as it does today, in patches between areas of rock fall.

Levels of water in the plunge pool are lower today (15 feet in the tourist season and 26 feet in the cold months due to water diversion) than previously, so more of the talus slope is exposed in its basal or shoreward area, and that exposure is relatively young (American Falls International Board, 1971). The shoreline in the Maid-of-the-Mist Pool is nearly 400 feet from the vertical face of the American Falls, “some 100 feet of this has resulted from lowering of the Pool” since 1922 (American Falls International Board, 1971).
In addition to disturbance by rock fall, old photographs show how the winter ice would build up in the plunge pool and migrate down stream scouring the lower shoreline generally free of anything that was free or loose. In 1909 one of the worst winter storms on record for April created conditions in the river such that the level of the lower river extending up to the Falls rose to approximately forty feet above its normal level (26 Ann Rep Comm, 1910).

Access to the base of Goat Island must have been using mechanical means. One of the earliest depictions of a ladder built to the lower slopes appeared in a later rendition of the Falls drawn from Hennepin's original illustration. The picture with ladder is duplicated by Porter (16 Ann Rep Comm, 1900), and is given the date 1751 (see section on pictorial tradition). This structure must have predated ownership of the Island by the Porter family (1815) and the first bridge to Goat Island (1817). This ladder, if it ever existed, may have been built by soldiers from the local forts, or simply been meant to indicate, by artist's convention, a means by which native peoples were said to descend to the lower slopes, on analogy with the “Indian Ladder” on the Canadian side.

Construction of the Biddle Stairs made public access to the base of Goat Island possible. This well-built wooden structure, named after Nicholas Biddle “of United States Bank fame,” who suggested its construction and either helped pay for it (16 Ann Rep Comm, 1900) or had his contribution declined (17 Ann Rep Comm, 1901), was built in 1829 by the Porter family, then owners of Goat Island (Porter, 16 Ann Rep Comm, 1900). These stairs were structurally sound and lasted nearly a century, ultimately to be replaced in the twentieth century by the present elevator. The Biddle Stairs was the way to the base of Goat Island and the Cave of the Winds. The Stairs were between the American and the Horseshoe Falls where the “view was unparalleled,” and about where the present elevator is located. In 1896, one could easily walk “along the edge of the water from the American to the Horseshoe Falls” (13 Ann Rep Comm, 1897).

An early natural draw to the base of the Island was Aeolus' Cave, or, the Cave of the Winds—a name the Canadians were also to use later for a similar attraction on their own side, arousing complaints from the American operators.

Talus slope below Terrapin Point after the crest was blasted away in 1985 (in Tiplin, 1988).

Previous vegetation has been buried and in the past four years an extraordinarily lush plant community has replaced the old—primarily of Spotted Touch-me-not (*Impatiens biflors*).
This attraction may have been relatively recent although the following quote may have been mistaken about its locality, or since it is doubtful that there were two attractions on the American side with the same name: “people from time to time had ventured into what is now called the “Cave of the Winds,” but it was only in the 1870s that group tours behind the Falls *from below Prospect Point* [my emphasis] were seriously undertaken” (Scott & Scott, 1983). In 1882, the cost to visit this Cave of the Winds was $1.00 when entrance to Goat Island cost half that (Scott & Scott, 1983). At any rate, the Goat Island “caves” appear to have been created from a projecting “table” of rock comprising the resistant caprock at the top of the gorge. Such projecting ledges can be viewed throughout the Niagara Escarpment at least west to Manitoulin Island in Ontario. When located at the brink of the cataracts, the water would be borne away from the gorge wall, permitting passage behind the curtain of falling water. The Cave of the Winds trip was “the passage behind the small sheet of water that flowed between Goat and Luna Islands, and out beyond amidst the waters dashing and plunging in the sunlight, and the journey from rock to rock, and over rushing torrents, in front of this fall and back to Goat Island” (Porter, 16 Ann Rep Comm, 1900). Visitors to the old Cave of the Winds, American side, were able to experience an interesting “pressure of the atmosphere behind the sheet of water” (Porter, 16 Ann Rep Comm, 1900).

The Cave of the Winds walk below the Bridal Veil Falls was permanently altered in 1955. The projecting ledge of Lockport dolomite at the crest of the Bridal Veil Falls, approximately nine meters (30 feet) deep, was “judged to be unsafe and removed by blasting in 1955” (Krajewski & Liberty, 1981).
In 1908, a “pathway has been constructed along the western end of Goat Island on the talus slope, leading from the foot of the stairway at the bottom of the Biddle Stairs to about twenty feet above the water level, thence to the Horseshoe and the American Falls, at the latter point connecting with the system of bridges leading through the Cave of the Winds” (25 Ann Rep Comm, 1909). I could find no evidence for such a path in 1988—it probably lies buried beneath subsequent talus. Portions of these early paths were constructed directly under the overhanging caprock, such that in 1906 part of the talus path to the Cave of the Winds had to be brought down to midslope “as any rock falling from the face of the cliff will strike on the old walk at the top of the talus slope and remain there” (23 Ann Rep Comm, 1907). Care was taken that whatever “scenery” there was then was not defaced during this operation, suggesting perhaps that an intact community of plant species existed here.

Earliest depictions of the Falls show the talus slopes at the base of Goat Island to have supported a forest in which conifers were dominant. The same conifer element also ringed the lip or crest areas at the river margins, including the high bank or crest forming the western end of Goat Island. Testimonial evidence supports this reconstruction (see also discussion on crest woods). It is probably the Hemlock (*Tsuga canadensis*) that was the primary conifer in the lower woods, with a secondary component of Arbor Vitae (*Thuja occidentalis*). Both may be still seen in isolated stations along the Niagara gorge, and there is presently a well-developed bank of Arbor Vitae by the elevator along the path to the Cave of the Winds. These conifers appear to have tolerated the natural disturbances presented by talus conditions. Also the length of daylight in this north-south trending gorge is much curtailed compared with the length of daylight available at the top of the gorge, for example, on one field trip conducted for the present study (July 28) it was nearly 11:00 A.M. and the base of Goat Island was still in shade, sunlight just touching the shoreline. Lack of typical insolation and conditions of late ice-flow in the river may produce cooler conditions favoring conifer development over the typical beech-maple forests of the region, and of Goat Island above.

Visitors with an interest in botany made use of this access to the unusual environment near the water’s edge, and close to all three cataracts. There were not many other ways down to the base of the gorge throughout the gorge’s seven-mile length. Botanists involved in the study of algae (phycolologists) were early drawn to the promise of a significant wet environment to explore.

In 1849, Prof. William Henry Harvey, Trinity College, University of Dublin, collected the green...
alga *Scytonema alatum* (as *Petalonema alatum*) “on dripping rocks under Biddle stair-case,” one of only two stations for this algae in North America (Smith, 1933). Harvey was to publish the first complete treatment of the green algae of North America (Harvey, 1841; 1857). Another phycologist, H. C. Wood, was to follow, collecting three species new to science, two at the Cave of the Winds (*Zonotrichia mollis* and *Z. parcezonata*) (Wood, 1872) and a third “on the rocks below the great cataract” (*Scytonema cataractae*) (Wood, 1871). Francis Wolle, subsequently a distinguished scholar of freshwater algae of the United States, was to collect at the base of Goat Island as well, issuing specimens from “Rocks, Niagara” from around 1876 in an exsicat entitled “Fresh Water Algae of the United States” (see section on algae).

Today there is a black growth or organic coating on cobbles near the top of the talus in areas away from the Horseshoe Falls, making it difficult to walk. Perhaps this may be the alga *Diplocolon heppii* noted by Wolle (1877) growing “as a blackish-brown stratum of considerable extent” (Smith, 1933). This alga was first collected in the United States from the “limestone cliffs at Niagara Falls” (Smith, 1933). (It could not be determined as of this writing whether Wolle’s *Scytonema hagetschweilerii* “forming a dark brown coating on wet rocks, Niagara Falls” is the same as *D. heppii*). *Scytonema alatum* is also a “subaerial species” (Smith, 1933) with a preference for limestone cliffs.

For flowering plants, on June 26, 1862, George Clinton was able to collect a fern “below the Biddle Stairs,” and on August 8, 1865, recorded in his journal finding Kalm’s St.-John’s-wort (*Hypericum kalmianum*) growing on “rochers au bas de la chute de Niagara.”

The entire area that is not dolomite bluffs is talus to the water’s edge and below the water surface. All substrates appear to be on rocks or soil below a layer of rocks of cobble size. Great boulders are strewn here and their with their own characteristic plants. Seepage occurs below the rocks in areas covered extensively with *Impatiens biflora*. Woodland patches occur just below the top of the talus slope, not at the bottom.

The vegetation today is very interrupted, or patchy, isolated remnants of possibly larger vegetated communities reduced by rockfall from above, or limited by the possibility of subsurface seepage into the talus slope from the bedrock, and is of four general types:

1) Isolated areas of native trees, shrubs and herbs with some soil located near the top of the slope, with Grape (*Vitis riparia*) and Virginia Creeper (*Parthenocissus* sp.) vines making walking difficult. These patches appear to be relatively dry. Wooded patches of forest species occur here: Red Ash (*Fraxinus pennsylvanica*), American Elm (*Ulmus americana*), Slippery Elm (*Ulmus fulva*) and Basswood (*Tilia americana*), Paper Birch, *Betula papyrifera*. The ground is not wet here, the moisture collecting on the surfaces of the canopy. Some moss occurs in shade on protected rocks and logs. Star-flowered False Solomon’s Seal (*Smilacina stellata*), typical of the woods above, occurs here, as do probably other woodland species in the spring.
2) Areas of weedy growth, toward the American Falls and along the naturally disturbed shoreline, with extensive populations of crucifers, such as *Diploptaxis* and *Brassica*. Weedy taxa seem to a large extent associated with the elevator due to planted trees and introduced soil, as well as the constant traffic from above during the summer months. Probably the single major source of introduced seeds derives from populations established near the crest-line above. Species at the base area under discussion include Sweet Clover (*Melilotus alba*), Black Mustard (*Brassica nigra*), Box Elder (*Acer negundo*), Black Locust (*Robinia pseudoacacia*), Sow-thistles (*Sonchus oleraceus*). These taxa were not very apparent toward the middle to southern areas of the Island face.

3) Areas with dense growth in response to the spray of the Horseshoe Falls, mostly species of Touch-me-Not (*Impatiens biflora* or *pallida*) and Angelica (*Angelica atropurpurea*). There does not appear to be a lot of shrubby growth here, outside of several Elder shrubs (*Sambucus canadensis*) and one Ninebark (*Physocarpus opulifolius*).

4) Boulder vegetation occurs on the continuous surfaces of large blocks of solid dolomite. Grasses and other plants occupy the solution cavities and crevices in the rock surface. It is here that the Rough-stemmed Wheat-grass grows (*Agropyron trachycaulum* var. *unilaterale*), Spear-grass (*Poa annua*), and weedy Erigerons (*Erigeron strigosus* or *annuus*).

No path to the Horseshoe Falls was observed—it could be buried under talus. Public access is restricted. The impression received during field collections was that moist air is constant, and mist is continually distributed toward the Horseshoe Fall. The talus slope is very unstable, cobbles of all sizes are easily dislodged. Wooded areas support shrubby growth and vines (Grape and Virginia Creeper) making progress extremely difficult. Species composition changes as you approach the Horseshoe. The shrubby material exists here.

Extensive colonies of Ring-necked Gull occur here, with nests in the rocks and eggs, punctured. Workers at the Cave of the Winds report occurrences of Racoons. Little piles of bones were observed. All the while collections were made (until 1:00 P.M.) the slopes were in shade.
TREES AND SHRUBS

* Acer negundo BOX ELDER. Well developed, associated with the elevator.

Betula papyrifera PAPER BIRCH. In one or two places in wooded patches.

Carpinus caroliniana AMERICAN HORNBEAM.
Single, large tree on talus; cluster of 10 trunks, young.

Celastrus scandens CLIMBING BITTERSWEET.
Over rocks, good to introduce on ballast above.

Cornus alternifolia ALTERNATE-LEAVED DOGWOOD. Wooded patch.

Cornus stolonifera RED-OSIER DOGWOOD.
Abundant throughout.

Fraxinus pennsylvanica RED ASH. Abundant; one 40 inches in circumference.

Juglans nigra BLACK WALNUT. Mature tree.

Lonicera tartarica TARTARIAN HONEYSUCKLE.
Well developed specimens.

* Morus alba WHITE MULBERRY.

Ostrya virginiana. Big tree up slope.

Parthenocissus vitacea DISCLESS VIRGINIA-CREEPER. By elevator; in drier areas abundant.

Physocarpus opulifolius NINE-BARK. Single shrub seen, toward the Horseshoe.

Populus deltoides COTTONWOOD. Colonizing, young shoots and a few trees.

Prunus virginiana CHOKECHERRY. In wooded patches.

* Pyrus malus APPLE. Single specimen seen, fruiting.

* Rhamnus frangula ALDER BUCKTHORN. Abundant on talus slopes in drier, wooded sections.

Rhus radicans POISON IVY. In drier areas between the two Falls, especially associated with wooded patches.

* Robinia peuecadacia BLACK LOCUST. Only near the mother tree, probably planted, by elevator.

Rubus odoratus PURPLE-FLOWERING RASPBERRY. Abundant in patches, more in the central, drier areas, with Solidago; path by elevator.

Salix bebbiana BEAKED WILLOW. Toward the Horseshoe Falls.

Salix interior SANDBAR WILLOW. Few, toward the Horseshoe Falls.

Sambucus canadensis ELDERBERRY. More abundant than the following and also out in the open.

Sambucus pubens RED-BERRIED ELDER. Found in wooded patches.

Tilia americana BASSWOOD. Abundant with many saplings, shoots.

Ulmus americana AMERICAN ELM. One of the bigger trees seen.

Ulmus rubra SLIPPERY ELM. Young, abundant; one 40 inches in circumference in one patch.

Vitis riparia FROST GRAPE. By elevator; upslope, more abundant in drier areas between the Falls.

HERBS

Agropyron trachycaulum var. unilaterale ROUGH-STEMMED WHEAT-GRASS. On rocks, frequent, the only station so far discovered in the Niagara River Gorge.

Ambrosia artemisiifolia COMMON RAGWEED.

Anemone canadensis CANADA ANEMONE.

Angelica atropurpurea PURPLE-STEMMED ANGELICA.

* Barbarea vulgaris WINTER CRESS. Scattered throughout.

* Berberis thunbergii JAPANESE BARBERRY. Single shrub seen.

* Brassica nigra BLACK MUSTARD.

* Chenopodium album LAMB’S QUARTERS.

* Chrysanthemum leucanthemum OX-EYE DAISY. Abundant.

* Cirsium arvense CANADA THISTLE. By elevators.

Convolvulus sepium HEDGE BIND-WEED.

Cucumba DODDER. Extensive, early, in one area.

Cystopteris bulbifera BULBLET-BLADDER FERN. Frequent on boulders.

* Daucus carota QUEEN ANN’S LACE. Abundant, by elevator path.

Dennstaedtia punctilobula HAY-SCENTED FERN.

Here and there toward the Horseshoe Falls.

* Diploptaxis sp. Either SAND or WALL ROCKET. Abundant.

Eupatorium maculatum JOE-PYE WEED.

Eupatorium rugosum WHITE SNAKE-ROOT. In drier areas between the Falls, more toward the elevator area.

* Galinsoga ciliata CILIATE GALINSOGA.

Geranium robertianum HERB ROBERT. Single group, in wooded patch

Geum canadense WHITE AVENS. Wooded patches.
**Impatiens biflora** SPOTTED TOUCH-ME-NOT. Becomes more abundant as you approach the Horseshoe, till it completely covers the cobble-boulder slope, making it difficult to walk; also by elevator.

**Juncus tenuis** PATH RUSH.

**Lepidium virginicum** COMMON PEPPERGRASS.

* **Linaria vulgaris** BUTTER AND EGGS.

* **Lythrum salicaria** PURPLE LOOSESTRIFE. In seepage coming out near the elevator and in wet areas along the talus near the shoreline all the way toward the Horseshoe.

**Melilotus alba** SWEET CLOVER. Near elevator.

**Nepeta cataria** CATNIP. Along path by elevator; in drier areas, wooded patches. Mints abundant, especially toward the Horseshoe.

**Oxalis stricta** UPRIGHT YELLOW WOODSORREL.

**Pilea cf. pumila** CLEARWEED. Species becomes more abundant as one approaches the Horseshoe, even occurring on near vertical boulder surfaces.

* **Plantago major** BROAD-LEAVED PLANTAIN.

* **Poa annua** SPEAR GRASS. On boulders.

**Poa palustris** FOWL MEADOW-GRASS.

**Polygonum** spp. Various species abundant, increases toward the Horseshoe.

**Polygonum convolvulus** BLACK BINDWEED.

**Polygonum pensylvanicum** PENNSYLVANIA SMARTWEED.

**Potentilla norvegica** ROUGH CINQUEFOIL.

* **Rumex crispus** CURLED DOCK. Throughout.

**Scrophularia marilandica** MARYLAND FIGWORT.

* **Senecio vulgaris** COMMON GROUNDSEL.

**Smilacina stellata** STAR-FLOWERED FALSE SOLOMON’S SEAL. In drier, wooded patches only.

* **Solanum dulcamara** BITTER NIGHTSHADE. Has an affinity for this cobbly place.

**Solomon’s Seal**. CANADA GOLDENROD. Abundant in patches in drier areas with **Rubus odoratus**.

**Solidago canadensis** CANADA GOLDENROD. Abundant in patches in drier areas with **Rubus odoratus**.

**Solidago graminifolia** NARROW-LEAVED GOLDENROD. Infrequent, more toward the Horseshoe.

**Sonchus arvensis** FIELD SOW-THISTLE.

**Sonchus asper** SPINY-LEAVED SOW-THISTLE.

**Sonchus oleraceus** COMMON SOW THISTLE. By elevator.

* **Stellaria media** COMMON CHICKWEED.

**Teucrium canadense** AMERICAN GERMANDER. Abundant.

* **Taraxacum officinale** DANDELION. Scarce.

**Verbascum thapsus** COMMON MULLEIN. Rosette seen.

**Verbena uralitifolia** WHITE VERVAIN. In flower, toward elevator area.

**ALGAE** (see discussion above):

**Trentepohlia velutipes** WINTER MUSHROOM.


**Fungi**

**Flammulina velutipes**. WINTER MUSHROOM.


**Lichens**

**Collema tenax**. On soil, Harris 16357 (NY).

**Protoblastenia rupestris**. On rock, Harris 22884 (NY).

**Verrucaria muralis**. On rock, Harris 22880 (NY); on rock, Harris 22883 (NY).

**Verrucaria sp**. Harris 16352 (NY).

**Verrucaria sp**. Harris 22881 (NY); Harris 22882 (NY).

**Bryophytes**

**Amblystegium serpens** var. juratzkanum. Spray area of Horseshoe Falls, near river, thin soil over rocks, base of falls, with **Fissidens cristatus**, Zander 3475b, Oct. 28, 1979 (BUF).

**Amblystegium tenax** var. tenax. Base of island, 1 Nov. 1988, Buck 16356 (BUF, NY).


**Brachythecium rutabulum**. Base of island, 1 Nov. 1988, Buck 16359 (BUF, NY).


**Calliergonella cuspidata**. Base of island, 1 Nov. 1988, Buck 16353 (BUF, NY), 16358 (NY).

**Campylium chrysophyllum**. Base of island, 1 Nov. 1988, Buck 16360 (BUF, NY).

**Campylium stellatum**. Base of island, 1 Nov. 1988,
Part II: Vegetation

Buck 16362 (BUF, NY).


*Fissidens adianthoides.* Spray area of American Falls, talus, crevices, rock piles along path, Zander 3450a, Oct. 28, 1979 (BUF); spray area of Horseshoe Falls, near river, underside of large boulder, Zander 3466a, Oct. 28, 1979 (BUF), soil under boulder, Zander 3477, Oct. 28, 1979 (BUF); base of island, 1 Nov. 1988, Buck 16350 (BUF, NY); spray zone of American Falls, talus, soil over boulder, Zander 3448, Oct. 28 (BUF).

*Fissidens cristatus.* Spray zone of Horseshoe Falls, near river, thin soil over rocks, base of falls, with *Amblystegium serpens var. juratzkanum*, Zander 3475a, Oct. 28, 1979 (BUF).


*Hymenostylium recurvirostre.* Just outside spray area of Horseshoe Falls, boulder, thin soil, midslope, with *Tortella fragilis, Hyophila involuta, Trichostomum crispulum*, Zander 3484d, Oct. 28, 1979 (BUF), on rubble, talus slope, Zander 3491b, Oct. 28, 1979 (BUF); just outside spray area of Horseshoe Falls, vertical rock face of gorge, with *Preissia quadrata*, Zander 3492a, Oct. 28, 1979 (BUF); spray area of Horseshoe Falls, near river, soil under boulder, Zander 3478, Oct. 28, 1979 (BUF); spray zone of American Falls, talus, thin soil, crevices of rock, Zander 3444a, Oct. 28, 1979 (BUF); base of island, 1 Nov. 1988, Buck 16354 (BUF, NY).

On August 8, 1865, George Clinton recorded in his journal that this moss was “everywhere common on wet rocks” below the Biddle Staircase.


*Preissia quadrata.* Spray zone of Horseshoe Falls, near river, underside of large boulder, Zander 3467, Oct. 28, 1979 (BUF); just outside spray area of Horseshoe Falls, vertical rock face of gorge, with *Hymenostylium recurvirostrum*, Zander 3492b, Oct. 28, 1979 (BUF).

George Clinton noted in his journal on August 8, 1865 “on wet, wettish rocks, at & above top of talus, everywhere here [at the American Staircase] & on Goat Island, below Biddle Staircase *Preissia commutata [= P. quadrata]*, now past fruit, abundant.”

*Tortella fragilis.* Just outside spray area of Horseshoe Falls, boulder, thin soil, midslope, with *Hyophila involuta, Hymenostylium recurvirostrum, Trichostomum crispulum*, Zander 3484b Oct. 28, 1979 (BUF).

*Trichostomum crispulum.* Just outside spray area of Horseshoe Falls, boulder, thin soil, midslope, with *Hyophila involuta, Hymenostylium recurvirostrum, Tortella fragilis*, Zander 3484a Oct. 28, 1979 (BUF). This species may be new to eastern North America.
Today the entire Terrapin Rock-complex has been dewatered, sodded and maintained as a barren lawnscape, like Stedman's Bluff overlooking Luna Island. This area is closed to the public now, in winter. Dotted line shows approximate area dewatered. Hatched area shows the area of the Terrapin Point floral remnant of this rare habitat included in the present report.
5. TERRAPIN POINT COMPLEX
Terrapin Point is located in the southwestern extremity of Goat Island, where the eastern edge of the crest of the Horseshoe Falls touches the Goat Island soil. It is a low area several feet above the river and overlooked by a bluff composed of sediments approximately forty feet high and called “Porter's Bluff.” The political boundary between the United States and Canada exists only a short way beyond this boundary, although it was reported by Porter (1894) to have been established “through the middle of the Horse Shoe Falls and through the deepest channel of the river, both above and below them,” after the Treaty of Ghent concluding the War of 1812. Another island, Gull Island, comprising about two acres, “was situated south of Goat Island and just above the Horseshoe Falls” (6 Ann Rep Comm, 1890). This island may be comparable to islands presently near the brink of the Horseshoe Falls, which are all probably new, due to lowered water levels, and the vegetation on them also relatively new and derived from what vegetation has been available to them for the past thirty or so years. One rather large exposure of bedrock just at the brink of the Horseshoe Falls near Terrapin Point, with a flora on it as old as the flats islands upriver to it, may be a relict of Gull island whose loose, upper sediments were washed away as noted above.

The low area on the southwestern tip of Goat Island below the bluff is referred to here as the Terrapin Point Complex to account through time for the area of exposed rock and soil surfaces, and shallow water supporting emergent vegetation at the river margin which occurred below the present-day grassed-over bluffs overlooking the Horseshoe Falls. In the nineteenth century, a rock or series of rocks was exposed in the bedrock here such that Grabeau (1901) referred to this area as the Terrapin Rocks. Probably it was Terrapin Rock at first, then with progressively lowered water levels more rock became exposed, the name changing to the Terrapin Rocks, and now that all the area is above water, to Terrapin Point.

That the rocks in the channel resembled the backs of turtles gave the name to the rocks at this corner of Goat Island. Here there was an area of relatively shallow water, due to the recession of the Horseshoe Falls, a process which tends to capture water away from the extremities of the curving brink, and which capture is accelerated with the lower water levels due to diversion.

The rapids could be viewed from the Terrapin rocks, reached by bridges out to them. In 1827, the Porters built a bridge out to one of these rocks to offset “the great attraction on the Canadian side at this time” being Table Rock (Porter, 16 Ann Rep Comm, 1900). This bridge was 300 feet long and projected some ten feet beyond the brink “forming an absolutely unique and dangerous [but safe!] point of observation.”

The Porters also built a stone tower here in 1833 which stood for forty years, of rustic construction. It was “the one objective point of all visitors, the Mecca of all pilgrims” and not objected to by anyone as “unharmonious” with the natural landscape (Porter, 16 Ann Rep Comm, 1900). A picture of the tower and bridge was printed in Porter's essay on Goat Island (1900), but erroneously dated 1829 since the tower was built in 1833. Indeed, the Tower is fea-
tured in many landscape paintings of the period. It was “needlessly” torn down in 1873 as a concession to a competing commercial interest which had just bought from the Porter family “the last spot of land on the American shore, from which a near view of the Falls could be obtained” (Porter, 1900).

The experience to be had here may be imagined according to the words of the Duke of Argyle:

“When we stand at any point near the edge of the falls, and look up the course of the stream, the foaming waters of the rapids constitute the sky line. No indication of land is visible—nothing to express the fact that we are looking at a river. The crests of the breakers, the leaping and the rushing of the waters, are still seen against the clouds as they are seen in the ocean, when the ship from which we look is in the trough of the sea ....” (Grabeau, 1901).

Part of the power of this view is the display of a fifty-foot drop across ridges in the riverbed extending perpendicular to the flow of the river in the short distance from above the Three Sisters to Terrapin Point (a picture of this view: 16 Ann Rep Comm, 1900).

As discussed in the section on the pictorial tradition, by the time the camera was invented or generally used at Niagara, the native forest at Terrapin Point had most likely been totally lost. Pictures of the slope overlooking the Horseshoe Falls (Porter's Bluff) in 1833, taken together with a variety of other illustrations and indirect evidence, indicate that this slope was probably entirely composed of conifer forest with a rather sharp transition to the deciduous forest more typical of the Goat Island platform (area not on the margins or slopes). Early paintings show that this area was one of the very first to be stripped of its native forest. All subsequent photographs of the wooded slope at Porter's Bluff taken in the early decades of the twentieth century show a replacement forest here of a different character.

Tiplin (1988) published a fine photograph in the Niagara Falls New York Public Library in the early 1860's of the Terrapin Tower taken by George Barker. “Descending a winding path, we reached the south end of the Horseshoe Falls, where a wooden bridge, some forty yards long, or more, resting on a succession of small rocks parallel with the very brink of the Fall but three or four feet from it carried us to the foot of a little tower, whence we ascended a spiral stair to a platform at its summit, surrounded by a light iron railing literally overhanging the great cataract itself” (Kingston, 1956).
Part II: Vegetation

A small ledge of rock with a vegetated mat on it is visible in the picture. It resembles the mats on rock on the east end of the Second Sister, with its central shrub and surrounding low herbs. Based on the species characteristic of these mats on the Second Sister, the species composition here can probably be inferred (see section on the Second Sister). The shrub may be a willow. The other rocks in the picture are quite bare. What seldom appears in photographs is the ledge of limestone bedrock against the shore at the base of the sedimentary slope. Photographs are always too high, showing the wooded bank, or are made from above the bank and not down on the ledge, so its is only from maps that one knows of its existence. A “rather abundant” patch of Water Willow (*Justicia americana*) once grew here in shallow water “on limestone off Goat Island just above the Falls” (Zenkert, 1934).

A picture of the Terrapin Point bank taken in 1938 appeared in Tiplin (1988). Rocks at the base appear in ledges. A flat area existed at the bottom of the picture below the pedestrian bridge, because two small boys are standing on it, their feet, unfortunately, below the picture frame. The area below this bridge must have been periodically inundated, but otherwise walkable (unattributed photograph, Tiplin, 1988, p. 130).

The primitive flora of the river margin at Prospect Point on the mainland part of the Reservation probably had the same vegetation as that of the old and present dolomite ledge at what is now called Terrapin Point, the rocky flats presently at the Second Sister and other similar areas now lost on the upper shoreline and flat areas on the brink of the chasm near the falls on the Canadian side. The present flora of the east end of the Second Sister and at Terrapin Point at the crest of the gorge face are indicative of the primitive flora of these areas. Actually, similar habitats probably exist on bedrock ledges on the north shore of Lake Erie, Ontario, rather than in habitats upstream in the Niagara River, or even on the shores of Lake Ontario. This is due to the fact that the northern Lake Erie shoreline is emerging due to isostatic rebound of the region as a whole, presenting new habitats based on naked rock, just as similar habitats are formed near the falls due to lowered water levels in the early history of the Niagara River.

When Olmsted and Vaux suggested revegetating portions of the shoreline on the mainland part of the Reservation they suggested using native plants characteristic of these habitats (Olmsted & Vaux, 1887). Without insight into the particular kind of habitat once existing on these same areas, inappropriate kinds of native species could have been introduced, producing an artificially conceived “native habitat.”

The depiction of the Terrapin Rocks, with tower and bridge in the Porter publication (1900) mentioned above, showed the vegetated bluff or high bank overlooking the area called Porter’s Bluff. As in most drawings and photographs, the shoreline and water level is not in view. Extensive scattered White Pine or trees are depicted although this exposed, open area may have been moist enough to have permitted the growth of Hemlock. Dense shrubby growth around the old stairs to the Terrapin Rocks, continue down onto a shallow shelf in the river, thickly overgrown with shrubbery (16 Ann Rep Comm, 1900).

A fine prospect of the Horseshoe Falls and the river could be had above, on the bluffs as well, a fact to which Olmsted and Vaux referred in their plan of 1887 (3 Ann Rep Comm): “At a point about a hundred feet southward [from the falls, but really eastward] a wall of stone was built many years ago to sustain a made bank of earth where, before, there must have been a recess in the face of the bluff and
probably a gully extending a short distance back” (Olmsted and Vaux, 1887).

Winter ice must have always been a significant factor of disturbance here, especially if the thin water layer froze. Today, on Terrapin Point, “winter ice may accumulate to a thickness of over 6 m (20 feet)” (Krajewski & Terasmae, 1981).

That there was a ledge of bedrock such as exists presently on the eastern end of the Second Sister and in places on the north shore of Goat Island may be inferred from the geologic map of Kindle and Taylor (1913). The lowering of the level of the river which exposed the Three Sisters, the shore at Prospect Point and all along the front on the Canadian side, and the islands in the American channel also exposed this ledge (Kindle & Taylor, 1913). This ledge is also illustrated in the map for the proposed reservation published by Gardner (1880), and is the only map found that shows the flat separated from the shore and base of the bluffs of Goat Island by a stream of water.

Although seldom captured by pen, brush or photograph, the Terrapin Point Complex had a rich and important flora. Details of its nature may be derived from the botanical journal of George W. Clinton. On June 26, 1862, “at the level of Terrapin Bridge,” he was able to find Cooper’s Milk-Vetch (Astragalus neglectus) and a species of Vetchling (Lathyrus). Up on the wooded bluffs, he found Thimble-weed (Anemone virginiana). At a later date he referred to Grass of Parnassus (Parnassia glauca) “on the flat near Terrapin bridge,” which species he also found on Table Rock, Ontario—a not dissimilar habitat. On July 5th, he observed an orchid: the Northern Leafy Green Orchid (Habenaria hyperborea), Variegated Scouring-rush (Equisetum variegatum), and Kalm’s St. John’s Wort (Hypericum kalmianum). The Goat Island stations were the only known localities for Kalm’s St. John’s Wort in New York State. With the loss of these stations the species has been extirpated from the New York State flora.

Later that year, on August 1, Clinton collected a Vetchling (Lathyrus palustris) along with Kalm’s St. John’s Wort, probably at Terrapin Rocks. On September 11, “On the right of the path to Terrapin Tower saw a hundred Gentians” (Gentiana procera, the Smaller Fringed Gentian), and collected Grass of Parnassus. Again, the similarity of the floras on the Canadian shore where the riverbed had been abandoned, the bedrock close to the surface and in poor drainage to the Terrapin Point Complex flora with similar substrates is indicated by Clinton’s finding abundant populations of Smaller Fringed Gentian “in springy fields below Table Rock & also on Goat Island near Terrapin Bridge,” and Gerardia and Grass of Parnassus. In 1864 Clinton collected Bluejoint Grass there (Calamagrostis canadensis), which is now frequent all along the south shore of Goat Island. On the bluffs overlooking the flat grew Oaks and Paper Birch (Betula papyrifera), and on the wet limestone itself, as indicated above, Water Willow (Justicia americana).

The vegetation appears to have derived from the Canadian flora, indicated by with the presence of Hypericum kalmianum. This species, which, in Ontario, is “abundant at intervals along Lake Erie from Crescent Beach to Point Abino and westward” (Zenker, 1934) in New York State is only known from
Goat Island, where its presence was recorded from 1843 (Torrey, 1943). Torrey reported it also from Table Rock, on the Canadian margin of the Horseshoe Falls, and Abbe Provancher from the talus at the base of the Falls, presumably in Ontario (Provencher, in Day, 1888). Another station occurred at another island in the Horseshoe channel, Cedar Island, Ontario, which possessed a population “in the vicinity of the bridge crossing to the mainland on the way to Dufferin Islands” (Panton, 1890). The Cedar Island station was destroyed in 1904 (Siebel, 1985). Day (1901) reported seeing it growing on Goat Island “in a damp situation.” The belief that this species occurred in an area in the Canadian channel may be based on a specimen collected from the First Sister Island by Townsend, 1892 (BUF).

Certain elements in these relatively young habitats on both sides of the river appear to have been similar: thin soil (gravels) over dolomite bedrock, ice scour or ice deposition in winter, flushing by the fluctuating river heights, and spray, all seem to be characteristic.

In 1954 the “Terrapin Point the area was permanently dewatered and backfilled to create a large artificial viewing space. A much smaller artificial extension was constructed at Table Rock [Ontario]. These projects are intended to prevent sections of the Horseshoe crestline from dewatering during low water levels and to control the rate of crestline recession” (Krajewski & Liberty, 1981).

Terrapin Point was subjected to “remedial work,” similar to that performed at Luna Island in 1972, wherein the bedrock was stabilized with dowels, bolts and cable tendons, and drains were placed to discharge the pressure of groundwater on the caprock. At Terrapin Point a “large overhang must first be removed by blasting. Then, rock bolts, possibly cable tendons and a subsurface drainage system will be used to stabilize the remaining surface” (Krajewski & Liberty, 1981). This blasting was accomplished in 1983. Such blasting further reduced the aboriginal flora of Terrapin Point, and the species listed below are what remains.

Happily, one of the last populations of the Smaller Fringed Gentian (Gentiana procera) in New York State, and of a State Heritage species of Willow-Herb (Epilobium glandulosum), escaped destruction.

Presently, Terrapin Point is a section of the dolostone crest of the Niagara River Gorge overlooked by sedimentary bluffs, isolated by an elevation on which visitors wishing to view the Horseshoe Falls might stand. The entire section below the bluff is old riverbed recently exposed due to reduction of water flow over the falls. The dolostone ledge is isolated from the river current at the ledge’s southern edge by a low breakwall, to the east is the elevated visitor’s platform, to the west the precipice, to the north after some yards a weedy, shrubby vegetation prevails and continues north into the sloping sedimentary bluffs with wooded crest vegetation. The dolostone exposed section supports a water-favoring flora of Sedges, Rushes, Sneeze-weed (Helenium autumnale), and others, due to the constant seepage of river water through joints and fractures onto this natural ledge, and the more or less continuous spray of the cataract. There always seem to be wet pools or puddles present, and little or no soil. Visitors may view this “native garden” simply by looking down as they enjoy the prospect across the plunge pool of the Horseshoe Falls.

The entire area of “made land” at Terrapin Point has been filled with soil, graded and planted with lawn grass. No policy of reforestation appears to be presently in place. The absence of trees and shrubs here not only impoverishes a potentially unusual native habitat, wetted almost continuously by the spray from the Horseshoe Falls, but removes substrates that could prevent so much atmospheric moisture from drifting back into the impoverished central woods, and damaging native trees and the shade trees maintained in front of the Terrapin Point restaurant (see section on the central woods).
Ice Scenery on Goat Island, from Terrapin Rocks, 16 Ann Rep Comm, 1900. The shrubbery is dense and Porter’s Bluff is well vegetated. The shrubbery continues down onto the ledge over which the bridge passes. Note original stair system.

Old Wooden Stairway to Terrapin Point compared with the Present Loping Pathway to Terrapin Point (Ann Rep Comm, early 20th century). These two pictures demonstrate rather different attitudes towards preservation of the natural scenery in policies for the improvement of Goat Island.
The present dolomite projection area below the viewing wall on Terrapin Point is probably indicative of the kind of habitat existing prior to dewatering. It is one of the most floristically interesting of the areas left of the young shore-line floras.

Terrapin Point also provided an interesting habitat for land snails. The Conchological Section of the Buffalo Society of Natural Sciences enjoyed collecting these animals on Terrapin Point—one of their number being photographed bravely standing on the rocky shelf near the edge of the precipice (Robertson & Blakeslee, 1948).

VASCULAR PLANTS: HISTORICAL RECORDS


VASCULAR PLANTS: RECENT RECORDS

Note that the following flora is not of what is called Terrapin Point on maps today, which is a barren lawn-scape entirely covering the old wooded bluffs. These species represent only the flora of the wet dolomite ledge at the precipice beyond the observation deck. Visitors look down on this vegetated rocky surface, which is exposed riverbed. Its flora is the remnant of that of the dolomite ledge examined by Asa Gray and probably J. D. Hooker, George Clinton, David Day, Charles Zenkert and other botanists before 1940.

*Angelica atropurpurea* PURPLE-STEMMED ANGELICA. 1986.

*Aster lateriflorus* STARVED ASTER. 1986.


*Butomus umbellatus* FLOWERING RUSH. 1986.

*Chenopodium album* LAMB’S QUARTERS. 1987.

*Cornus racemosa* PANICLED DOGWOOD. 1986.


*Epilobium glandulosum* WILLOW-HERB. 1986.


*Eupatorium perfoliatum* BONESET. 1986.

*Eupatorium rugosum* WHITE SNAKE ROOT. 1986.

*Gentiana procera* SMALLER FRINGED-GENTIAN. 1986.


*Helenium autumnale* SNEEZEWEED. 1986.


*Lonicera japonica* JAPANESE HONEYSuckle. 1986.

*Lycopus americanus* CUT-LEAVED WATER HORESHOUND. 861224021.

*Lycopus virginicus* VIRGINIA BUGLEWEED. 1986.


*Plantago major* COMMON PLANTAIN. 1986.


*Salix interior* SANDBAR WILLOW. 1986.

*Sambucus canadensis* ELDERBERRY. 1986.

*Scirpus validus* GREAT BULRUSH. 1986.

*Solidago caesia* BLUE-STEMMED GOLDENROD. 1986.

*Solidago canadensis* CANADA GOLDENROD. 1986.


*Verbena hastata* COMMON VERVAIN. 1986.


*BRYOPHYTES

*Amblystegium tenax* var. *tenax*. Terrapin Point, 2
Nov. 1988, Buck, 16440 (NY).

*Brachythecium rutabulum.* Terrapin Point, 2 Nov. 1988, Buck, 16444 (BUF, NY).

*Bryum flaccidum.* Terrapin Point, 2 Nov. 1988, Buck, 16441 (BUF, NY).

*Calliergonella cuspidata.* Terrapin Point, 2 Nov. 1988, Buck, 16445 (BUF, NY).

*Cratoneuron filicinum.* Terrapin Point, 2 Nov. 1988, Buck, 16447 (BUF, NY).

*Fissidens adianthoides.* Terrapin Point, 2 Nov. 1988, Buck, 16446 (BUF, NY).

*Philonotis marchica.* Terrapin Point, 2 Nov. 1988, Buck, 16439 (BUF, NY).

**LICHENS**

*Protoblastenia rupestris* (Scop.) Stainer. On rock, Harris, 16443 (NY).

*Verrucaria muralis* Ach. On rock, Harris, 16443 (NY).

Blasting the caprock at Terapin Point, July 8, 1983 (Niagara Falls New York Public Library) in Tiplin, 1988. Note how extensive was the ledge (viewing elevation at left). It is probable that over half the Gentian population was lost that day.
6. SOUTH SLOPE

The southern shore of Goat Island presents a south-facing bluff or bank of sediments, with maximum elevations toward the west and thinning out as it runs eastward. The south slope is set back from the river's edge by a low, flat area sodded into a lawn which appears to have been relatively recently dewatered (compare Evershed map of 1883 in attached illustration). In 1885 the south slope was the southern shore-line of the island, and its sediments were directly into the current toward the central part of the island. Toward the eastern and western ends, naturally lowered water levels created dolomite pavements or flats at the base of the slope especially at the western or old Terrapin Rocks end. The eastern end was also a flat, occasionally scourred by winter ice and flood, just as the east end of the Second Sister Island. The Goat Island sediments had decreased to nothing toward the east end.

Porter's Bluff formed the western terminus, overlooking the Horseshoe Falls at Terrapin Point, and the eastern one occurred near the center of the First Sister Island. In early pictures, there was a number of native conifer trees which grew on these slopes, including Arbor Vitae (*Thuja occidentalis*, see species catalogue).

Historically, the most serious erosion from high water levels occurred on this side of the Island where around 90 percent of the river's volume was and is still concentrated.

“Upon the southern side of this island, where there is an escarpment, the thickness of the superficial deposit is about twenty-five feet. The upper half consists of coarse gravel and sand, with abundance of ... shells” (Hall, 1843). Soils here are “mostly coarse gravel with cobble” (Kindle & Taylor, 1913) and more well-drained than, for example, the north slope with its finer-size sediment (see discussion of north slope).

The embankments that run in an east-west direction are the basally eroded bluffs seen in an early depiction of the south side of the Island in a picture published in the 11th annual report of the Commissioners (1895) and duplicated above in the section on erosion. The first road constructed on Goat Island by its first American owners, the Porter family, was washed out here (Porter, 16 Ann Rep Comm, 1900). Erosion control structures were built on the south side by the Porters and replaced throughout the first years of the Reservation, and variously planted.

At the time of the Reservation's establishment, the original vegetation appears to have been catastrophically altered due to this erosive process and subsequent slumping of the soil bank.

This bank has “at times been slightly undermined by the river, and thus made a graceless inclined plane, with a raw surface and an angular crest,” (Olmsted and Vaux, 1887, mistakenly referring to it as the west bank)—the profile of sediments which have slumped from being undercut at the base, disrupting everything rooted in its soil. Olmsted and Vaux suggested sculpturing the profile into rounded crest and base before covering it in “foliage and verdure.” The present wooded aspect of this area is the result of natural regeneration, if the very mature native trees to be seen there today were not planted by Welch and his successors. In 1890, “trees and vegetation upon the southern shore ...” were carried off “causing the bank to look raw and unsightly” (7 Ann Rep Comm, 1891). Funds for cribwork were appropriated, in 1891 and “the raw embankment covered with loam, and planted with vines, shrubs, willows, and other suitable trees .... The damaged bank has been almost entirely covered by vegetation in one season” (8th Ann Rep Comm, 1892).

“The space behind the docking and crib-work recently constructed and the cavities in the damaged bank have been filled with dead and decayed wood, taken from the thicket on Goat Island so as to restore as nearly as possible the natural slope of the banks. The filling has been covered with wood mold, loam and a margin of green sward, and the bank planted with 3,317 cuttings, trees, shrubs and vines, comprising 700 cuttings of yellow willow, 110 cuttings of weeping willow, 1,900 cuttings of dwarf willow, thirty-six snow ball trees, fifty-eight purple lilacs, twenty-four white lilacs, nine red cedars, fourteen spireas, twelve euonymus, and 440 Virginia creeper” (8 Ann Rep Comm, 1982).

In 1896, there was the “planting out of the crib-work on the southern shore of Goat Island.” Pockets were dug in the cribwork and “willows and vines planted,” to cover and disguise it (13 Ann Rep Comm, 1897). The largest willows on the south bank today are the White or Crack Willow (*Salix alba* or *S. fragilis*) or hybrids, and hence from imported nursery
In 1911, a trail has been built running from the Horseshoe Fall up along the south bank of Goat Island toward the Three Sister islands, gradually rising from the level of the river to that of the main path and the road above. It made accessible many points from which “new and charming views of the Horseshoe Fall and Canadian Rapids may be obtained and completes the circuit of trails on Goat Island” (28 Ann Rep Comm, 1912). This was the Terrapin Trail—the complement of the Lunar Trail on the north side of Goat Island. It appears that portions of this trail were built through virgin wood “hitherto inaccessible” (28 Ann Rep Comm, 1912). In 1912, “the bank at the upper end of the new Terrapin trail was washing out rapidly with every rain storm. A retaining wall of field stone and cement has been built at this point” (29 Ann Rep Comm, 1913). It is not noted whether construction of the trail itself contributed to this instability.

It is possible that portions of the present low strip of land between the embankment to the north and the river on the south was recently created through lowered water levels, and that the plant communities, waterside thickets here are relatively young. This low area may have been created along with the land at Terrapin Point and sodded over, rather than letting native plant communities establish themselves on newly exposed riverbed as they had on the flats south of the southern shore of Goat Island.

Originally, dense thickets, attractively decked in winter with frost from the falls, covered the southern embankment as it overlooked the Terrapin Point stairs (16 Ann Rep Comm, 1900, see Terrapin Point section). A conifer element was visible. A later photograph made at the opening of the Terrapin Trail showed a vegetation that was visually impenetrable.

As the south slope or embankment is generally south-facing and open to the sun, in addition to being open to incoming moisture from the spray of the Horseshoe Falls, some idea of the former luxuriance of the native vegetation can be imagined, especially near Terrapin Point. If the lawns were eliminated here, the native vegetation would probably be visually striking. The conditions promoting the vegetation here are not present in the north slope except historically, at Stedman’s Bluff, overlooking Luna Island, due to the north aspect and darkness, with a correspondingly sparse herbaceous and shrub slope cover.

Today the south bank extends from the crest of the gorge on the west end of Goat Island to the stone bridge connecting Goat Island with the First Sister. Many fine old specimens of Ash and Sugar Maple occur here, as do Basswood, Hop-Hornbeam (Ironwood) and Yellow Oak (Quercus prinoides var. acuminata), and an occasional Hickory and Black Cherry. Historically, based on photographs of the southern slope at Porter’s Bluff at Terrapin Point, many conifer trees grew here, as mentioned above, but none exist today. It is possible that the central
portions of the south slope were totally denuded by soil slumping prior to 1885, and that this entire plant community regenerated since that time. If that is the case, then this is a fine example of the possibility of natural reforestation to climax community from bare and altered sediment. Another example may be seen in the native wooded element on the crest of Goat Island on the west end. There is evidence that areas of the crest have also experienced total forest loss due to slumping. The native woods has always been able to reestablish itself if left alone to do so.

Many plantings of alien species are, however, presently being established to replace the older trees: Schwedler Maple or Norway Maple, Small-leaved Linden (Tilia cordata), Black Locust (Robinia pseudacacia), Honey Locust (Gleditsia triacanthos), and Box Elder (Acer negundo), and others. Lawns are maintained beneath these alien trees, altogether eliminating the native forest.

Everywhere on this slope the Ash is in recovery, seeding itself. Sugar Maple seedlings are visible as well. The vegetated slope is sandwiched between a lawn above with alien trees and weeds and a lawn below, and so many urban species have infested these slopes. One serious problem is the extensive colony of Giant Hogweed (Heracleum mantegazzianum; see note) that has established itself on the shoreline at the water's edge. Attempts to eradicate it have not been successful. The fact that this species produces a highly toxic dermatological reaction in some people, causing scarring blister-burns on the skin, is one reason for controlling this species. The other is that it forms monocultures. The source of these populations is upriver at Buckhorn Island State Park which has a dense population on the water's edge by the north Grand Island Bridge. Removal of the stand on Goat Island will not prevent further reestablishment of this species on Goat Island as seeds come downriver from the State property a few miles upriver. Another population has established itself on Green Island at the water's edge.

NOTE (2004): The report of this species of Heraclium in 1990 was based on an erroneous determination. All reports associated with the Goat Island work in 1990 are Heracleum lanatum, a harmless species, both on Goat Island and upstream at Buckhorn Island. This species can be reintroduced in the places designated.

On the expanse of land parallel to the embankment between the slope and the water's edge a lawn is maintained. At the shoreline, wet thickets have established themselves with native willows, Cottonwood, Trembling Aspen, etc. This appears to be a relatively new community, related in time and event to the creation of the flats communities in the waters south of the island shoreline.

Unfortunately here, as well as on the embankment, especially toward the Horseshoe Falls where the spray is heavy, this area is densely populated with Box Elder (Acer negundo), which tends to form monocultures at the expense of species diversity. The source of this infestation is the old trees planted long ago in the upper lawns in view of the Terrapin Point Restaurant. Norway Maple (Acer platanoides) has also infested the wooded slopes.

On the river margin, native trees and shrubs are presently being cut back to provide unimpeded access to the water's edge. People walk there to view the water and compact the soil so that eventually both native vegetation and soil are be destroyed as on Goat Island facing the First Sister. Weedy lawn species are recolonizing areas where native vegetation is removed and replaced by lawns. Expansion of mowed areas and continuing to open up the same vistas on the River to visitors probably promotes the experience of sameness here, and does not enhance the visitor experience in addition to destroying a nationally, historically significant native island flora.

There are some areas with beautiful pebbly deposits with abundant native shells washed ashore and crayfish. These areas could be protected and interpreted to the public. The area becomes biologically sterile and depauperate where the lawns come to the edge of the land. Weedy taxa include Plantain, Ox-eye Daisy, Chickweeds, young Tartarian Honeysuckle, etc. Visitors are unaware of the heritage they are destroying in their curiosity.

If attempts are not made to remove weedy species, and to cease replacing native species with alien trees which become noxious weeds after the mature native trees have been removed, the vegetation here will be constituted of monoculture-forming weeds of no scientific or historic value and lawn-species: Box Elder, Norway Maple, Tartarian Honeysuckle (present all along the slopes), Lilac (Syringa vulgaris), Privet, Burdock (Arctium spp.), Garlic Mustard (Alliaria officinalis), etc. Native species will be reduced to Goldenrods, Asters, Thistles, Grapevines, etc.
For further discussion, see the Flats section. Weedy species associated with disturbance that are replacing the native species include the following:
In 1883 the water in the Canadian channel was high enough to cover the river bed (after Evershed’s 1883 map) completely.

Lowered water levels today have exposed the riverbed to colonization by plants, creating vegetated islands in the river. The dashed line represents the old Goat Island margin (at right).

Three Sisters

GOAT ISLAND
Flats on the south shore

Probable absence of ice-scour in winter will produce a different plant community on the flats-islands than on the Three Sisters.
Botanical Heritage of Islands at the Brink of Niagara Falls

TREES (all escaped from plantings)
* _Acer negundo_ BOX ELDER. Heavily infested toward the Horseshoe Falls.
* _Acer platanoides_ NORWAY MAPLE. Infestation in one area.
* _Prunus avium_ BIRD CHERRY.
* _Salix fragilis_ CRACK WILLOW. Dominant tree on water's edge.

SHRUBS (all escaped from plantings)
* _Cornus sanguinea_ BLOODTWIG DOGWOOD.
* _Lonicera tartarica_ TARTARIAN HONEY-SUCKLE. Abundant [noxious].
* _Rhamnus cathartica_ BUCKTHORN. Abundant [noxious].

HERBS (alien)
* _Barbarea vulgaris_ WINTER CRESS.
* _Bromus inermis_ HUNGARIAN BROME-GRASS.
* _Cerastium sp._ CHICKWEED. On rock, shorelines.
* _Chrysanthemum leucanthemum_ OX-EYE DAISY.
* _Cichorium intybus_ CHICKORY.
* _Daucus carota_ QUEEN ANNE'S LACE.
* _Dipsacus sylvestris_ TEASEL.
* _Galinsoga ciliata_ CILIATE GALINSOGA.
* _Heracleum lanatum_ COW PARSNIP. [Reports of _Heracleum mantegazzianum_ are erroneous.]
* _Hypericum perforatum_ COMMON ST. JOHN'S WORT.
* _Lotus corniculatus_ BIRD'S FOOT TREFOIL.
* _Lythrum salicaria_ PURPLE LOOSESTRIFE. Emergent vegetation in the river.
* _Melilotus alba_ WHITE SWEET-CLOVER.
* _Phleum pratense_ TIMOTHY.
* _Plantago lanceolata_ ENGLISH PLANTAIN.
* _Poa compressa_ CANADA BLUE-GRASS. On rocks.
* _Rumex crispus_ CURLED DOCK.
* _Solidanum dulcamara_ BITTER NIGHTSHADE. Abundant on slopes.

TREES (native)
* _Fraxinus pennsylvanica_ RED ASH. Abundant.
* _Populus deltoides_ COTTONWOOD. Dominant trees.
* _Populus tremuloides_ QUAKING ASPEN.
* _Rhus typhina_ STAGHORN SUMACH.
* _Ribes sp._ Currant.
* _Rosa sp._ Thorny, no flowers or fruit.

Salix interior SANDBAR WILLOW.
Salix rigida HEART-LEAVED WILLOW.
* _Ulmus [americana]_ ELM.
* _Ulmus rubra_ SLIPPERY ELM.

SHRUBS AND VINES (native)
* _Cornus racemosa_ PANICLED DOOGWOOD. Few.
* _Cornus stolonifera_ RED-OSIER DOOGWOOD. Dominant Dogwood.
* _Physocarpus opulifolius_ NINE-BARK. Abundant on river margins.
* _Sambucus canadensis_ ELDERBERRY. Water's edge, single population.
* _Vitis riparia_ FROST GRAPE. Abundant especially toward the Horseshoe Falls.

HERBS (native)
* _Agrostis sp._ BENT-GRASS. In undisturbed areas.
* _Allium canadense_ WILD GARLIC.
* _Asclepias syriaca_ COMMON MILKWEED.
* _Carex hystricina_ PORCUPINE SEDGE. Typical where undisturbed water's edge.
* _Cirsium sp._ [small and large] THISTLE.
* _Clematis virginiana_ VIRGIN'S BOWER.
* _Cuscuta gronovii_ COMMON DODDER.
* _Epilobium [coloratum]_ WILLOW-BOWER.
* _Eupatorium maculatum_ JOE-PYE-WEED.
* _Eupatorium perfoliatum_ BONESET.
* _Galium obtusum_ WHITE SNAKEROOT.
* _Geum canadense_ WHITE AVENS.
* _Impatiens biflora_ SPOTTED TOUCH-ME-NOT.
* _Juncus articulatus_ JOINTED RUSH. Typical where undisturbed water's edge.
* _Lamium ciliatum_ FRINGED LOOSESTRIFE. Typical of the thickets.
* _Monarda fistulosa_ BERGAMOT.
* _Scirpus americanus_ CHAIR-MAKER'S RUSH. By culvert, showing habitats which could be made.
* _Solidago canadensis_ CANADA GOLDENROD.
* _Solidago graminifolia_ NARROW-LEAVED GOLDENROD.

BRYOPHYTES (native)
* _Amblystegium tenax_.
* _Barbula unguiculata_.
* _Fissidens taxifolius_. Covers the damp shaded soil
below shrubs or trees along wet soil margins. Three Sisters.

*Orthotrichum anomalum.* On boulders toward the

Shrubby flats areas, on and just off the south shore of Goat Island, winter diversion, 1988. Note texture of riverbed and gravels.
7. FLATS JUST UPRIVER OF THE HORSE-SHOE FALLS

Along the southern shoreline of Goat Island, west of, or downriver from, the Three Sisters Islands in the channel of the Horseshoe Falls, are a series of relatively recent bedrock exposures which have become vegetated. The survey made by Thomas Evershed in 1883 of land proposed for the Niagara Reservation showed no islands on the south side of Goat Island except the Three Sisters and Terrapin Rocks. Lowered water levels have created these “islands” and several bedrock exposures are still without vegetation except for the occasional colonizing moss, such as Ceratodon purpureus or Barbula unguiculata. These flats are biologically distinct from the island system once existing at Terrapin Point which is now (apparently) part of the mainland. The flora is depauperate in species compared to similar habitats on the Three Sisters and this is probably due to the fact that it is still in succession, or that ice-scour or other periodic natural disturbances which favor diversity do not occur (see discussion on the Second Sister Island).

The flats vegetation is dominated by willow species (mostly Heart-leaved Willow—Salix rigida), with native species colonizing the land furthest from shore. Flats closer to shore are dominated by Red-Osier Dogwood (Cornus stolonifera) and support more exotic species of Goat Island lawns, such as Dandelion (Taraxacum officinale) and Ox-eyed Daisy (Chrysanthemum leucanthemum), and exotic planted trees such as Black Locust (Robinia pseudoacacia).

The native thickets form a rich, highly textured area with dense grassy margins of, for example, Bluejoint Grass (Calamagrostis canadensis).

Weedy emergent vegetation, such as Flowering Rush (Butomus umbellatus) and Purple Loosestrife (Lythrum salicaria), is an element in this flora.

This is a relatively intact ecosystem, although young, so far an human disturbance is concerned, and deserves protection—this may become an important refuge for plant species of the Goat Island and Three Sisters Island margins. Ducks may possibly be nesting here, and this area could become an important source of habitat if a wildlife program were to be initiated to deal with the problem of duck and pigeon feeding at the First Sister Island.

This area, with its rocky surfaces washed by the river, may be seen as an alternative habitat for species presently growing on Terrapin Point, if that area is to be dynamited for structural reasons, primarily for the Smaller Fringed Gentian (Gentiana procera), one of the last habitats in New York State in which that species occurs.

Problems may arise with the present destruction of the wet thickets fringing the southern margins of Goat Island. These thickets prevented visitors and weedy plant species from invading the flats areas and disrupting community integrity. Wet thicket communities on the south shore of Goat Island should be maintained where they face onto the flats-vegetated area.

VASCULAR PLANTS
* Agrostis stolonifera var. compacta CREEPING BENT. Flats above the Horseshoe Falls, 1988.
* Agrostis stolonifera var. major REDTOP. Flats above the Horseshoe Falls, 1988.

Butomus umbellatus FLOWERING RUSH.
Part II: Vegetation

Calamagrostis canadensis BLUEJOINT GRASS. Flats above the Horseshoe Falls, 1988.
Carex stipata [obs. 1988.]
* Cirsium arvense CANADA THISTLE. Flats above the Horseshoe Falls, 1988.
* Cirsium vulgare BULLTHISTLE. Flats above the Horseshoe Falls, 1988.
Convulvulus sepium HEDGE BINDWEED. 1988.
Equisetum SCOURING RUSH.
Erigon strigosus DAISY FLEABANE.
Eupatorium maculatum JOE-PYE-WEED.
Eupatorium rugosum WHITE SNAKE-ROOT.
Fragaria sp. STRAWBERRY.
Geum canadense WHITE AVENS.
Impatiens biflora SPOTTED TOUCH-ME-NOT.
Lycopus sp. HOREHOUND.
Populus deltoides COTTONWOOD. Flats above the Horseshoe Falls, 1986.
Populus tremuloides QUAKING ASPEN. Flats above the Horseshoe Falls [obs. 1988].
Pycnanthemum virginianum VIRGINIA MOUNTAIN MINT. Flats above the Horseshoe Falls, 1988.
* Salix alba WHITE WILLOW. Flats above the Horseshoe Falls, 1988.
Scirpus validus GREAT BULLRUSH. Flats above the Horseshoe Falls, 1988.
Sisyrinchium montanum MOUNTAIN BLUE-EYED GRASS. Flats above the Horseshoe Falls, 1986.
* Sonchus oleraceus SOW THISTLE. Flats above the Horseshoe Falls, 1988.
Sphenopholis intermedia INTERMEDIATE BUNCH-GRASS. Flats above the Horseshoe Falls, 1988.
Typha angustifolia NARROW-LEAVED CATTAIL.
Vitis riparia FROST GRAPE.

BRYOPHYTES
Amblystegium fluviatile. Just west of Three Sisters, island margin of Cornus stolonifera.
Amblystegium tenax. Just west of Three Sisters, island margin of Cornus stolonifera.
Amblystegium varium. Just west of Three Sisters, island margin of Cornus stolonifera.
Brachythecium rivulare. Just west of Three Sisters, island margin of Cornus stolonifera.
Brachythecium salebrosum.
Cratoneuron filicinum. Just west of Three Sisters, island margin of Cornus stolonifera.
Mnium affine var. ciliare.
Mnium cuspidatum. Wet hummock, roots of Cornus.
Philonotis muhlenbergia. Wet hummock, roots of Cornus.
Pohlia wahlenbergii. Just west of Three Sisters, island margin of Cornus stolonifera.
Water flow through intact flats vegetation, autumn, 1988 (photo: Al Schotz). Note Turtleheads (Chelone glabra L.) on the left.
Part II: Vegetation

GOAT ISLAND
Eastern Meadow

The stippled area is added to the 1883 Evershed map in this drawing (from a map in the Engineering Dept. of the Niagara Frontier State Park Commission). It represents new land added to the island recently by the Power Authority of the State of New York. The shoreline of this created land is buttressed by great dolomite boulders (ballast), which constitute a habitat in themselves, similar to the talus slopes in the gorge downstream of the cataracts.

Copy of the east end of the Goat Island map accompanying the Olmsted-Vaux Plan of 1887.
8. The Eastern Meadow

Bedrock comes closest to the surface on Goat Island's eastern end than anywhere else on that island excepting minor erosion on its margins. This distribution of sediments in section, becoming deeper in the western half of the island, is indicated in a diagram by Charles Lyell (1855), and represented on an early geologic map by Kindle and Taylor (1913, see section on soil). The thinnest soil on Goat Island was near the Three Sisters. The soil appears to have been so thin in places, that one might well imagine that certain areas on the eastern end of Goat Island never supported much vegetation, due to exposure to ice coming down the Niagara River, piling up, rafting over or scouring the soil or bedrock surface here. No reference is made in the early Commissioners reports to this event happening. Perhaps erosion events could have reduced what vegetation there was—but not to the extent depicted in the Catlin illustration mentioned below.

Due to variation in soil depth, tree composition may have changed from west to east, perhaps with more Oaks and Hickories, or more White Pine or Ash toward the east—but it is likely that the Beech-Maple-Ironwood component would decrease in numbers in an easterly direction with decrease in soil depth.

Early “aerial” views of Goat Island, such as those depicted by George Catling in 1831 (Adamson, 1985), show the eastern end of Goat Island with the pale green of the surrounding cleared land on both mainlands, and a forest cover over the rest of the Island. This absence of vegetation is generally attributed to clearing by John Stedman with his famous goats.

When the Reservation was established in 1885, this area seems to have supported the secondary growth of an environment in the process of recovery and colonization. One might imagine here an autumn abundance of native Asters, Goldenrod and White Snakeroot (Eupatorium rugosum). Certain of the weedy or pioneering species, such as the thistles, reported by Day in 1888, were probably abundant in the shrubby secondary growth.

Olmsted and Vaux (1887) noted the “artificially cleared ground” on Goat Island's east end, with the additional note that “a few small clearings have been made at other points, in some of which a thick young growth has sprung up.”

In this relatively dry nutrient-poor area on the east or south-eastern side of Goat Island grew great colonies of Sumac (Rhus typhina), targeted by the first Superintendent for removal in the early years of the Reservation (see species catalogue). The “sumach, thistles, plantain and other undesirable weeds ... formerly held full sway there. Over six hundred cubic yards of stone were picked off the eight acres and piled up for future use on the roads” (28 Ann Rep Comm, 1912). Perhaps it is in the regrowth vegetation of this extensively disturbed area where Day's (1901) autumn flora was most spectacular, with its Sumachs, thistles, plantain and other undesirable weeds... formerly held full sway there. Over six hundred cubic yards of stone were picked off the eight acres and piled up for future use on the roads” (28 Ann Rep Comm, 1912). Perhaps it is in the regrowth vegetation of this extensively disturbed area where Day's (1901) autumn flora was most spectacular, with its Sumachs, thistles, plantain and other undesirable weeds... formerly held full sway there. Over six hundred cubic yards of stone were picked off the eight acres and piled up for future use on the roads” (28 Ann Rep Comm, 1912). Perhaps it is in the regrowth vegetation of this extensively disturbed area where Day's (1901) autumn flora was most spectacular, with its Sumachs, thistles, plantain and other undesirable weeds... formerly held full sway there. Over six hundred cubic yards of stone were picked off the eight acres and piled up for future use on the roads” (28 Ann Rep Comm, 1912). Perhaps it is in the regrowth vegetation of this extensively disturbed area where Day's (1901) autumn flora was most spectacular, with its Sumachs, thistles, plantain and other undesirable weeds... formerly held full sway there. Over six hundred cubic yards of stone were picked off the eight acres and piled up for future use on the roads”. (Chamberlin, 1892). A
hint at this kind of habitat can be found today in autumn on the southeast margin of Goat Island facing the eastern end of the First Sister Island. Here there are a series of three little seeps where the mower cannot go, and a dense tangle of Goldenrod springs up here, mixed with Spotted Touch-me-not (Impatiens biflora) and somewhat earlier, the pale blue flowers of Water Speedwell (Veronica anagallis-aquatica).

The word “Meadow” at an early date in the Reservation’s history, was perhaps a euphemism, suggesting that this area was a grassy, herbaceous habitat. On June 1, 1865, George Clinton collected on what he called “the naked pasture on the head of the Island” ... “an umbellifer, probably Carum carvi” (Clinton Journal).

Olmsted and Vaux (1887) recommended that in the eastern areas the “dense young growth” be treated “by thinning and planting ... that all these spaces shall be refurnished with trees ... but less closely, as the foliage is not intended as a screen, and some variety in its disposition ... will be pleasing.”

In 1893 “one hundred and thirteen maples, seventy-six ash, fifty-five bass-woods, thirty-six larch and thirteen elms, in all 293 trees, have been taken from the nursery and planted in the meadow on Goat Island” (10 Ann Rep Comm, 1894). In 1894 “one hundred and thirteen maples, 76 ash, 55 basswoods, 36 larches and 13 elms have been taken from the nursery and planted in the meadow on Goat Island” (11 Ann Rep Comm, 1895).

As the eastern meadow was always considered one of the Reservation’s problems to be solved, the caretakers of the Reservation, in addition to removing Sumac, decided more vigorous measures would be taken to deal with the east end of Goat Island. “A portion of the upper part of Goat Island was cleared of woods over a century ago. The Commissioners have directed the planting of forest trees in that section, thus restoring Goat Island to its primitive and natural condition so far as possible. For this we ask an appropriation of $1,500” (17 Ann Rep Comm, 1901).

In 1910 it was suggested than silt from one of the ponds in the Reservation on the mainland, “rich in organic matter,” could be used on the “shallow soil on the upper end of Goat Island [which] might be replenished and turf and trees made to flourish, where now they can scarcely obtain a foothold” (27 Ann Rep Comm, 1911). The eastern meadow “presented a most barren and untidy aspect. It was overgrown with weeds and brush, and what little grass there was became sere and brown at the first summer drought ... over an area of large extent there being scarcely three inches of soil covering the bed rock ... the upper portion of the Island was neither forest nor meadow ...” Having formed this opinion “during a period of drought in early autumn the brush was cut out and the entire area burned over and plowed. It is intended to impart to this portion ... a rolling woodland-meadow treatment, entirely natural in character ...” (Superintendent Harries in 27 Ann Rep Comm, 1927). Natural in character is not the same as natural in reality. The next year all the meadow area was graded and seeded, several hundred trees planted “following out naturally the lines of the original growth” (28 Ann Rep Comm, 1912). No attempt appears to have been made to assess what that original growth could have been in an area with little or no topsoil.
Most of the vegetation of the eastern meadow today appears to be of recent introduction. The area is kept as an urban landscape, such as is seen in a city park, and native vegetation is not permitted to establish itself. Several species of Larch (Larix sp.) have been established, recently planted Ashes, the Rowan Tree (Sorbus aucuparia), the elongate form of White Poplar (Populus alba; see species catalogue), the reddish-leaved variant of the Norway Maple (Schwedler Maple), some flowering Hawthorn and Cherry. Several White Mulberry (Morus alba) trees of great maturity exist here, and are probably the source for the weedy establishment of these trees in surrounding areas with native or young vegetation, such as the Three Sisters, and on the ballast surrounding the meadow on the island's margin. A grove of White Pine (Pinus strobus) has been successfully established, and White Birch, horticultural Poplars, Red (Scarlet?) Oak on the margins, and White Spruce (Picea glauca), and Austrian Pine (Pinus nigra). Horticultural Chestnuts (Aesculus hybrids?—see species catalogue) are being planted, as are native Silver Maple (Acer saccharinum) which will contribute to the developing ballast forest, and Black Walnut (Juglans nigra) which appears to be a good choice both in terms of revegetating with native forest trees, in suitable habitat, with historic reports, if only on the adjacent mainland, and for the source of food for fauna. There is a great Black Willow at the eastern extremity, with Black Locust (Robinia pseudoacacia) and on the margins the horticultural willows: Weeping Willows (Salix babylonica), Crack Willow varieties or hybrids with White Willow (S. fragilis), and S. alba).

In addition to plantings, there are several seemingly relictual tree and shrub populations, for example, a series of Red Cedars (Juniperus virginiana), some perhaps quite old. Populations of this tree species, which is successional and does not tolerate shade well, probably were part of the regenerating vegetation present here in the 1880's. Perhaps in some way influenced by David Day's comments (1901) regarding the disappearing populations of Red Cedar on the island, allowance has been made for several trees to flourish here. No rejuvenation was detected elsewhere on the island, although young individuals readily establish themselves in woodlands along the crest of the Niagara River Gorge nearby (especially on the Canadian side).

Here and there are small islands of “spontaneous” kinds of vegetation, heavily infested with alien weeds. One of these is a tiny thicket of what appears to be Panicled Dogwood (Cornus racemosa), a species which can form dense thickets (Gleason & Cronquist, 1963). It is probable that this is very old and hence very interesting in terms of being able to find examples of early vegetation and its character on the island. This little patch is very dense, and may give some idea of what the word “thicket” meant when this word was used by Commissioner Thomas Welch in the early Reservation years.

Other thicket-forming species which may have inhabited this area are Wahoo (Euonymus atropurpureus), which prefers moister conditions, Snowberry (Symphoricarpos albus), which likes dry or rocky soil, Ninebark (Physocarpus opulifolius), which will grow in rock talus by the river, presently forming a terrific patch in the Niagara Gorge just below the Whirlpool.
In 1959-60 land was created on the eastern end, extending the area of the island upstream (American Falls International Board, 1971). This area is ringed with ballast in the form of dolomite boulders which forms a separate habitat treated below (see ballast section). A parking lot was established over this made land, and a helicopter pad and concession stand, a shed and roadway for the viewmobile. Residents and other visitors are encouraged to use this end as a picnic area, much as in an urban park, and events, such as antique automobile displays and sales are staged here in summer on the grassy lawn. The eastern roadway may mark the limits of the old shore-line.

At one point during the summer, when an automobile exhibit and sale was taking place, the air at the eastern end was filled with the sound of the helicopter's landing and departure, cars were parked on the grass and in the parking lot (thus resembling a used car dealership), more cars were navigating the ring-road, the viewmobile was stopping to load and unload passengers, and bicyclists were weaving in and out of pedestrian traffic. Overall, a metallic, industrial and mechanical aspect dominated the environment rivaling in noise and business that of any of the major business streets in the nearby city.

Some alien species of the lawns include:

* *Bellis perennis* ENGLISH DAISY.
* *Malva neglecta* CHEESES.
* *Polygonum pensylvanica* PENNSYLVANIA SMARTWEED. Garden soil beneath tree.
* *Potentilla argentea* SILVERY CINQUEFOIL.
* *Rumex crispus* CURLED DOCK. Weedy area below young tree.
* *Taraxacum officinale* DANDELION.
* *Trifolium repens* WHITE CLOVER.
9. Ballast (along eastern perimeter of Goat Island)
Fill was deposited on the eastern extremity of Goat Island in 1959-60, increasing the total surface area of the Island. This extension appears to have been built out over the natural divide in the riverbed separating the river current into the north and south channels of the American and Horseshoe Falls, respectively. The eastern end of Goat Island is now ringed with a ballast of dolomite boulders.

Vegetation has not established itself much on this habitat, and the rocks bear a bleak and sterile aspect. This is a shoreline habitat much like that of the talus slope at the base of Goat Island, which is mainly calcareous rubble. The ballast flora is more depauperate, with a somewhat different suite of alien weeds and fewer native species.

Far from a sterile environment, the barren rocks are beginning to be covered by young vegetation, mostly of exotic species. Even bryophytes are colonizing moist depressions near water-line.

Excellent possible cover for the ballast, which might stabilize it and make its erosion-control features more effective, in addition to hiding it from view, is to allow the saplings of native Birch, Cottonwood, Quaking Aspen, Silver Maple, Slippery Elm and Willow, which have established themselves, to flourish. Care must be taken to remove Buckthorn, Old World Honeysuckles, Privet and White Mulberry, which tend to become noxious, and which have established themselves on the ballast.

It might be desirable to establish additional cover of Nine-bark shrubs (*Physocarpus opulifolius*, Red Osier- or Panicled Dogwood (*Cornus stolonifera* or *racemosa*), Virginia Creeper, and others native species appropriate to this habitat, depending on a plan to permit natural regeneration. This might be an opportunity to reintroduce Climbing Bittersweet (*Celastrus scandens*) onto the island (it grows on a similar habitat at the base of Goat Island in talus), and Virgin's Bower (*Clematis virginiana*), which is well established on the Second Sister and grows throughout the gorge on the talus slopes there. Frost Grape (*Vitis riparia*), already abundant on Goat Island and established on the ballast, may also be encouraged to effectively cover these rocks.

For analogous habitat supporting additional native taxa, examination may be made of the ballasted section of the Niagara River from Goat Island east to the Grand Island Bridge. Ballasted sections of the river may be examined all the way to Buffalo, and along similar situations on the Ontario side. Recreational ideas could also be noted in these sections.

Small areas where the force of the river can be broken by making the shoreline somewhat irregular, by the placement of logs rock, and brush could make an area of quiet water where attractive vegetation could be introduced of find its way there naturally. Blue Flag (*Iris versicolor*) is native to the area, and typical of this kind of habitat, and a very lovely sight in summer. For other alluvial shallows habitat ideas see the western ends of the First and Second Sister.

These dolomite boulders will probably accumulate more bryophyte cover, and the habitat seems perfect for the development of red algae communities. *Bangia atropurpurea* has already been collected on the extreme east end (see algae section).

**TREES AND SHRUBS.**

*Acer saccharinum*. SILVER MAPLE.
Part II: Vegetation

* Betula papyrifera CANOE BIRCH.
* Cornus racemosa PANICLED DOGWOOD.
* Ligustrum vulgare PRIVET.
* Lonicera tartarica TARTARIAN HONEY-SUCKLE.
* Morus alba WHITE MULBERRY.
* Parthenocissus sp. VIRGINIA CREEPER. Cover.
* Populus deltoides COTTONWOOD.
* Populus tremuloides QUAKING ASPEN.
* Rhamnus cathartica COMMON BUCKTHORN.
* Rhus radicans POISON IVY.
* Rosa rugosa RUGOSE ROSE.
* Rubus strigosus RED RASPBERRY.
* Ulmus rubra SLIPPERY ELM.
* Vitis riparia FROST GRAPE.

HERBS.
* Anthemis arvensis CORN CAMOMILE.
* Aquilegia vulgaris GARDEN COLUMBINE.
* Arctium minus SMALLER BURDOCK.
* Arrhenatherum elatius TALL OAT-GRASS.
* Asclepias syriaca COMMON MILKWEED.
* Barbarea vulgaris WINTER CRESS.
* Capsella bursa-pastoris SHEPHERD'S PURSE.
* Centaurea jacea BROWN KnapWEED.
* Chrysanthemum leucanthemum OX-EYE DAISY.
* Cirrhum vulgare BULL THISTLE.
* Dactylis glomerata ORCHARD GRASS.
* Dipsacus sylvestris COMMON TEASEL.
* Hieracium pratense KING-DEVIL.

* Hypericum perforatum COMMON ST. JOHN'S WORT.
* Lepidium campestre FIELD PEPPERGRASS.
* Linaria vulgaris BUTTER-AND-EGGS.
* Lotus corniculatus BIRD'S FOOT TREFOIL.
* Lychnis alba EVENING LYCHNIS.
* Medicago lupulina BLACK MEDICK.
* Physalis heterophylla GROUND-CHERRY.
* Plantago lanceolata ENGLISH PLANTAIN.
* Potentilla recta SULPHURY CINQUEFOIL.
* Rumex crispus CURLED DOCK.
* Saponaria officinalis BOUNCING BET.
* Solanum dulcamara BITTER NIGHTSHADE.
* Sonchus oleraceus SOW THISTLE.
* Trifolium repens CREEPING WHITE CLOVER.
* Ulmus rubra SLIPPERY ELM.
* Verbascum thapsus MULLEIN.
* Vitis riparia FROST GRAPE.

BRYOPHYTES
(mostly typical pioneer species)
* Barbula unguiculata.
* Bryum argenteum.
* Bryum lisae var. cuspidatum.
* Ceratodon purpureus.
* R Didymodon tophaceus. (Rare—New York State Natural Heritage Program).
* Funaria hygrometrica.
* Plagiothecium denticulatum.
End of ballast, southeast shore of Goat Island. Low water during winter diversion, 1988. The meadow and east end parking lot is the low, flat area above.
ISLANDS IN THE AMERICAN CHANNEL

Goat Island

Lowered water levels have joined peripheral islands to other islands: note increase in size of Robinson Island. Other islands have been created, see area around Ship and Briggs Islands, and above Green Island.

Luna Island

Drawn after the Evershed map, 1883

American Mainland

Green (Bath) Island

map, 1953, Intern' Joint Commission.

Some islands may have washed away, such as Gull Island in the Canadian channel, others appeared only during periods of low water, such as in winter: Seldom Seen Island. Some were named after the dominant tree: Cedar Island, Salix Island, some after people: Robinson Island, and some after near and actual disasters: Chapin's Island and Avery's Rock.
B. ISLANDS IN THE AMERICAN CHANNEL

Porter (16 Ann Rep Comm, 1900) reported 16 islands or rocky outcropping in the Niagara River at the cataracts in addition to Goat Island. Five of these were connected by bridges, as they are today. “Many years ago the two small islands above Green Island were also thus accessible” (Porter, 16 Ann Rep Comm, 1900).

In the American channel are Luna Island, Crow Island immediately upriver from it, and Bird Island between Crow and Green Island (called Bath Island at the beginning of the Reservation), the last being the largest of this group (for a picture of Bird Island see section on the North Slope of Goat Island). Robinson and Chapin islands lie north of these, Brig and Ship Islands, are just upriver, or east, of Green Island. Ship Island was once joined to Green Island by a bridge. Other islets occur here as well (Porter, 1900). A tiny bit of land northeast of Chapin Island came to be called Avery’s Rock (17 Ann Rep Comm, 1901), most likely to commemorate the tragic drowning of Joseph Avery, commemorated in a poem by William Dean Howells “about the day-long struggle and ultimate failure to rescue a man stranded on a log near the brink of the Falls” (Adamson, 1985). Other islands, probably the smallest ones, include Crow, Rock, Juniper and Salix Islands (1 Ann Rep Comm, 1885).

In the present day, after water diversion has lowered the river levels at the brinks of the falls, the area of the original islands mentioned above has increased. Islands, or islets, separated from each other by small channels in 1883, have been joined together today, and numerous small bodies of land have appeared (compare adjoining maps). Ship and Brig Islands, once the only two above, or east of Green Island, are now joined by several more. It would be interesting to examine these new areas to see how they differ botanically from the central core, by what species are they being colonized, and what the patterns of succession may be.

Calkin and Brett (1978) reported that “on Luna Island, a compact red sandy silt till up to 1 m thick lies directly on the glacially polished and striated bedrock surface.” The till is a “compact, dark reddish-brown deposit with silty sand matrix and 10 to 18 percent rounded dolostone and red sandstone pebble clasts derived from the Grimsby Formation” (exposed upriver in the Niagara gorge from the Whirlpool, Tesmer, 1981). These soils may characterize those of others in the island group in the American channel, and may have been the condition of the contemporaneously exposed present shore on the Ontario and New York (Prospect Point) sides. These islands were, as the case with the Three Sisters, exposed by the Niagara River due to a lowering of the volume of water in the river in pre-European settlement times, subsequent to the event by which Goat Island and the inland shore of the mainland rose above water level (Kindle and Taylor, 1913). Consequently, both their native soils and their vegetation are younger than those of Goat Island or the mainland. The presence of much conifer growth on the islands in early reports and drawings may indicate the relative youth of their primeval vegetation.

As the American channel only received around
ten percent of the total volume of water in the Niagara River, there are no reports of serious erosion in the early Commission reports, such as from storm surges, as occurred in the Canadian channel (see section on the Three Sisters Islands). Ice would damage the bridges. Green and Luna Islands early received rip-rap dressings on their margins to prevent what erosion there was.

Wied-Neuwied (1843) mentioned that portions of the islands in the channel of the falls “are covered with pines, some green, others in a decayed state ... the pines being frequently broken and snapped and here and there piled up in the water.”

In an illustration published in 1900 (16 Ann Rep Comm), the first bridge to Goat Island, built in 1817, is represented. There, either Ship or Brig Island is depicted as dense with Hemlock or White Pine, as is the shoreline of what might be Green Island or Goat Island (a cottage, is drawn at the “Goat Island” end of the bridge). The drawing appeared to Porter to be fanciful for Porter offered his own interpretation that the island “shown in the engraving [upriver from the bridge], if it ever existed, has long since been washed away” (16 Ann Rep Comm, 1900). Actually, the only gross inaccuracy may be the people on the land area in the bottom of the picture, and the perhaps artificial placement of Ship or Brig Island above the bridge. This first bridge to Goat Island stood upriver from Green Island. In depictions of the second and third bridges, the buildings at the Goat Island end are drawn as well. These bridges were built to cross Green Island (Porter, 16 Ann Rep Comm, 1900).

Another picture illustrated the bridge (Lover’s Bridge) to Ship Island. Here the evergreen trees are carefully drawn. Willow vegetation, such as is visible today, appears to be reduced, as are any other kind of tree, although shrubs are clearly drawn. A photograph included in the 20 Ann Rep Comm, 1904, showed Ship and Brig Islands and the northeast shore of Goat Island. The vegetation appears more complex than is usually drawn, with evergreens mixed with deciduous trees. Extensive evergreens are evident along the shore of Goat Island. In 1853, one visitor noted that behind the pavilion, or refreshment building on Green Island “a little wooden bridge led us to another small island [i.e. Ship Island], on which grow several writhing twisted cedars” (Kingston, 1956). Agassiz’s scholarly group, on their way to Lake Superior (1850) noted that on Ship Island, that is, on “the little islet (only a few feet in extent) connected by a foot-bridge with the toll-house” on Green Island, Prof. Agassiz pointed out seven different kinds of trees, viz., arbor vitae, red cedar, hemlock, bass-wood, chestnut-oak, white pine and maple.”

Agassiz’s remarks as quoted by one of his students above are interesting although one must explore the implications of such a rich arboreal flora confined to such a limited area (“a few feet in extent”). The habitat preferences of each species seem to be confounded on this little isle: dry-and wet-, open- and shade-preferring trees are growing together. This is not to suggest they could not in nature, but conditions for growth at the Falls were apparently unusually hospitable to have produced such a community. This arrangement, probably with the evergreens on the periphery, was would have been duplicated on the other islands. An analogous situation may be seen in the zoned herbaceous vegetation on the flats on the east side of the Second Sister Island.

The Olmsted and Vaux plan of 1887, accepted by the Commissioners of the time, stated that “nothing would be gained by making these islands accessible.
that would compensate the injury which the bridges and the people who would be seen upon them and upon the islands would bring to the scenery” (Olmsted and Vaux, 1887).

When the American Falls was dewatered in 1968, Dr. Alfred M. Beeton, an ecologist at the University of Wisconsin, was hired to evaluate the condition of the vegetation on the islands in the American channel, which would be left without water during the three or so months the bedrock was exposed. “The vegetation was watered periodically throughout the time the American Falls Channel was dry” (American Falls International Board, 1971). Dr. Beeton reported that these smaller islands supported populations of alder, birch, maple and elm. Alder is presently absent from the flora of the Goat Island complex, although it may be present in the islands above the American Falls. A copy of Dr. Beeton’s report could not be located as of this writing.

Access was not permitted to any unbridged island during the course of this study, and so the degree of alteration of the island vegetation could not be assessed. It should not, however, be assumed that these islands have not been altered. For one thing, their entire conifer populations have been lost for some reason, and so much of the arboreal vegetation now seen must be relatively recent. The island just upstream from Luna Island presently appears to have Cattail borders, white birches (Betula papyrifera), lots of young Sugar Maple (Acer saccharum), Equisetum, Dogwood (Cornus) borders, Willows (Black Willow, perhaps, unless the horticultural Crack or White Willows and hybrids), Ash, and perhaps young Cottonwood (Populus deltoides). These appear to be successional species and bear no resemblance to early testimonials as to their primitive plant communities.

Another possibility is that the areas observed at the periphery of these islands are recently dewatered due to lowered water levels, and these are colonizing communities on the edge. However, increase in island area could not be assessed. It is unlikely, with so little water historically in the American channel, that much reduction in water level over the past century was tolerated. The diversion structure in the Grass-Island-Chippawa Pool upstream from Goat Island ensures a degree of natural volume in that channel. It does not appear that any new riverbed has been exposed on the north side of Goat Island due to any such dewatering.

The American channel in 1969 was completely dewatered from June 12 to November 15 (The American Falls International Board, 1971). Several trees, mostly willows, died during this procedure (staff communication), and their dead branches are visible today. These islands are presently vegetated, the larger with wet emergent vegetation, such as Cattail, and perhaps infested with Purple Loosestrife and Flowering Rush. No conifers of any kind are visible. The character of the islands in the American channel with their grassy lawn or meadow appearance is in striking contrast to the densely shrubby Brother Island in the Canadian channel. Since access was not provided to these islands, the degree of disturbance or of preservation could not be determined for this report. There may be a population of Water Willow (Justicia americana), a native herb which is rare in western New York on the wet margins of one of the islands.
Part II: Vegetation

View from Goat Island facing north. Bath (Green) Island, almost completely built over by 1876 (Beveridge, 1985).
Green Island
Green Island is the largest of the islands in the American channel of the Niagara River at Niagara Falls. About half of its acreage is “made land,” extending downriver (see survey map of 1883).

The flora of this island was first altered by the Porter family, who owned it after 1815, when they constructed the second and third bridges across it to Goat Island, starting in 1818 (Porter, 16 Ann Rep Comm, 1900). They next built a “commodious bathing house” and toll-keeper’s dwelling, followed by Porter and Clark’s Paper Mill (Kenyon in Dow, 1921; Scott & Scott, 1983). Billiard rooms were added to this complex (Bernard in Dow, 1921).

The proximity of such a mill to the rich Goat Island forest, located in the middle of the American channel, renders strong implications of possible selective use of the Goat Island timber for the mill, although no evidence of cutting in the forest nearby has ever been observed by any published testimonial. The Porters themselves characterized their decision to built the Green Island mill as a “desecration” (Porter, 1900).

The disbursements to Peter A. Porter for stationary, listed in the budget accounts in the early reports of the Commissioners, may indicate the Porter's operated a printing and stationary business based on their own paper products derived from their Green Island mill.

Description of the paper mill industry and its processes is beyond the scope of this paper, but rags may have been the initial source of raw material for Porter's paper, as the first ground-wood pulp mill established in New York was in 1866 on the Hudson River (Recknagel, 1923). In 1867 the sulphite process for pulping wood without cotton (rag) fiber was developed and the pulping industry began to flourish to the detriment of New York's unprotected forests. Production peaked in 1917 in New York, declining ever since due to exhaustion of trees as a natural resource. The mills were mainly in the Adirondacks, with several “in the vicinity of Niagara Falls.” In 1923, five pulp mills were located at Niagara Falls, one in the village of Tonawanda on the Niagara River—these due to the availability of wood from Canada, good markets, and the water power nearby (Recknagel, 1923). Resource material (i.e., timber) was scarce in western New York, but Niagara Falls was considered a “consuming center” for this material, and its pulping industry was strong as long as material could be shipped in from sources outside the state. Early tourists wrote of these mills, including William Kingston, who passed through a lumber yard on the way to the Goat Island bridge “belonging to one of many saw-mills with which the American Falls are adorned” (Kingston, 1956). Some of the names of these mills were the Niagara Falls Paper Co., later to become the International Paper Company which used water from the Niagara Falls Power Company canal (26 Ann Rep Comm, 1910), the Pettibone-Cataract Paper Company, operated by L. W. Pettibone, the Cataract City Milling Company, managed by Capt. Gaskill (29 Ann Rep Comm, 1913, Mizer, 1981), the Cliff Paper Company, operated by Jacob Schoellkopf, Niagara Wood, by Walter Jones (Mizer, 1981). Later would come Defiance Paper, Niagara Wallpaper and Kimberly-Clark Paper, Warder Paper Box, etc. (Mizer, 1981). It would not be too improbable to assume that some of the eradication of the softwood forests of the Niagara River Gorge went to satisfy the mills, perhaps during their

Green Island today looks almost exactly as it did in 1912, still awaiting restoration (29ARC, 1913). This island would be an excellent place to develop an overall strategy for ecosystem restoration, before restoring Goat Island and the mainland sections of the Reservation.
Part II: Vegetation

declining years.

Green Island, in addition to supporting various industries, besides the paper mill, conducted a warm and a cold bath (Wied-Neuwied, 1843)—hence the island’s first name: Bath Island. Around 1831, one visitor discovered on Green Island “a large paper mill, as well as other mills, in operation; there is also a house where the weary traveler may find most comfortable refreshment, and where I partook of ... dinner” (Fowler, 1831). This establishment also sold “Indian curiosities, walking-canes,” and housed the “custos” of Goat Island “to whom, by payment of one shilling for each person, we were made free of the insular territory” (Kingston, 1856). “Bath Island was once almost entirely covered by buildings when the reservation was established .... The Island is almost bare of trees or shrubbery, and presents a bleak and unnatural appearance. It should be properly graded and planted as soon as possible” (6 Ann Rep Comm, 1890).

In 1899, the island’s name was changed from Bath to Green Island in honor of the Hon. Andrew H. Green who strove so zealously and efficiently to protect the Reservation, the Falls and, incidentally, the Queen Victoria Park in Ontario from incursions by private industry (16 Ann Rep Comm, 1900).

In their zeal to remove anything artificial from the Niagara Reservation, Olmsted and Vaux recommended (1887) that the erosion control structures be removed and all the “made land” be washed away until the contours of the island returned to their natural condition. Somehow, this action “shall have accomplished a most attractive view will be had of the rapids and the shores of Goat Island—dark and exceedingly beautiful.” This recommendation was never followed.

Green Island “is composed largely of made land, the material being stone and coal cinders. A covering six inches in depth of excellent loam from the embankment has been spread over the upper end of the island.” In 1891 “the margin of the island has been graded and covered with green sward .... The island has been sown with grass seed, and planted with cedars and spruce” (8 Ann Rep Comm, 1982). In 1893, twelve plants of a horticultural variety of Discless Virginia Creeper (Parthenocissus vitacea) and six of Boston or Japanese Ivy (P. tricuspidata) were planted around the Commissioner’s office (10 Ann Rep Comm, 1894); the following year eighteen more Japanese Ivy vines were planted. In 1896 the “artificial cribwork on the southern shore of Bath Island has been removed and the greater portion of the shore of the island riprapped with large stones ... of a most important and permanent character in protecting the banks from erosion and giving the shores a natural and rustic appearance”; subsequently, the shores “have been graded and planted with shrubs and covered with turf” (13 Ann Rep Comm, 1897).
A picture of the island published in 1893 showed the little office building for the Commissioners maintained there at the time, and the denuded surface dotted with what appear to be small trees (evergreens). None of these evergreens exist there today. Because Green Island supported the main bridge to Goat Island, there was perpetual construction on it, for example the island was disrupted in 1902 by the construction of the stone bridges, and regraded and sown with grass seed (19 Ann Rep Comm, 1903). In 1909 the road across the island was completely rebuilt and “concrete walks six feet wide on either side constructed between the bridges, a grass plot being left between the road and walks” (26 Ann Rep Comm, 1926). Fixing, improving and replacing the roads, paths and bridge, and laying water, telephone and electric lines, etc., continued as the decades wore on.

It may be assumed that Green Island was totally denuded at the time of the Reservation’s establishment. If one examines the photographs of this island beginning with those submitted by Thomas Welch, first Superintendent, little has been done to reforest it after Welch had the buildings removed, their basements filled and the surface graded. Once Welch brought a surface up to sod, to prevent erosion and hide the disturbance of structures, policy has rested content not to proceed to reforestation. Exotic species of trees and shrubs have been planted about the present lawns. The extensive thicket of Japanese Barberry (Berberis thunbergii) on the island’s eastern end may have been planted for the same reasons this species of alien shrub was planted on Luna Island (see below). It appears from the presence of certain native species on today’s river margins that to some extent the native vegetation had established itself, but that it has been subsequently removed.

The oldest trees on this island appear to be on the north end, toward the mainland. It is at this end that the most natural wooded thickets occur today. Evidence is abundant that these native populations can gradually spread over the island without further assistance, but the establishment of their seedlings is stopped by the current practice of mowing, except for the wet margins. A tiny population of Laciniate Toothwort (Dentaria laciniata) at the western extremity may indicate a more extensive wooded thicket there previously. It is primarily Choke Cherry (Prunus virginiana) that readily recolonizes this island.

Holes in the banks on the southeast side indicate populations of native mammals.

Acer saccharum SUGAR MAPLE. One specimen 110 inches in diameter, 1988.
* Aesculus hippocastanum HORSE CHESTNUT. West end. 1988.
* Berberis thunbergii JAPANESE BARBERRY. “Planted, forming thickets on the eastern and western margins,” 1986.
Betula papyrifera PAPER BIRCH. One young tree,
Part II: Vegetation

W end, N shore, 1988.
* Cercis canadensis REDBUD. Three trees planted, SW grove.
* Chenopodium murale NETTLE-LEAVED GOOSEFOOT. Day, 1883 (problematical). Day may have reidentified this specimen as Chenopodium urbicum for his 1888 publication.
Dentaria laciniata CUT-LEAVED TOOTHWORT. Extreme west end, 1986.
Fraxinus sp. ASH. Abundant all along the island margins, 1988.
* Ginkgo biloba GINKGO, MAIDENHAIR TREE. Along asphalt path, male and female trees, 1988.
* Lythrum salicaria PURPLE LOOSESTRIFE. Along wet island margins, west end, 1986.
Ostrya virginiana HOP-HORNBEAM.
Parthenocissus sp. VIRGINIA CREEPER. On rocks on island margin, 1988.
* Parthenocissus tricuspidata Planch. JAPANESE or BOSTON IVY. On stone pedestrian bridge, 1988.
Platanus occidentalis SYCAMORE. Several, 1988.
Potamogeton alpinus var. tenuifolius ALPINE PONDWEED. “Rapids of the Niagara River, near Bath Island,” Zenkert, 1934.
Prunus virginiana CHOCKECHERRY. Abundant and conspicuous all along the margins of the northwestern side, some 18, 10, 15 and 21 inches in diameter, 1988.
* Rhodotypos scandens JETBEAD. “Planted,” 96122617.
Rhus radicans POISON IVY. [obs. 1988].
* Rosa eglanteria SWEETBRIAR. Day, 1888.
Rosa cf. rugosa RUGOSE ROSE. [obs. 1988].
* Salix alba WHITE WILLOW. 1988.
Salix rigida HEART-LEAVED WILLOW. West end, river edge, 1988.
Sambucus sp. 1988. Doubless this is Sambucus canadensis L., the edible richly purple-berried Elderberry. The other, not so palatable, species, S. pubens or Red-berried Elder, grows to the north near the gorge at Whirlpool Woods and Schovell's Knoll at Artpark in Lewiston in limestone or sandstone scree or rubble. The Elderberry enjoys the rich, moist soils of the river margin.
Taxus sp. GARDEN YEW. Island margin, east end [obs. 1988].
* Taxus cuspidata Sieb. & Zucc. JAPANESE YEW. A deep old planting of this alien species occurs on the island margin on the eastern end, as mentioned above. It is currently (April 20, 2007) obscuring the presence of the plinth of a bust commemorating Jacob Schoelfopf, as well as the view of the rapids of the northern channel of the Niagara River where it divides upstream before plunging over the brink of the American Falls.
Tilia americana BASSWOOD. Young sapling observed, 1988.
Typha latifolia BROAD-LEAVED CATTAIL. Western river margins, 1988.
* Verbascum thapsus MULLIEN. 96122616.
Viburnum opulus var. opulus GUELDER ROSE. SW river margin, 1988.
* Vinca minor PERIWINKLE. Dense carpet on island margin, 1988.
Luna Island, seen from Goat Island (Stedman’s Bluff) (11 Ann Rep Comm, 1895). Olmsted and Vaux (1887) noted the loss of vegetation on this island which they were afraid they would totally lose by visitor trampling unless some regulation was imposed. The Vaux-designed bridge here had been placed toward the east end or back of the island relative to the prospect side (west). This photo gives some idea of their intent to protect the view by vegetated screen of those on the bluff from those below. The photo takes advantage of the fact that the east end of the island still retained some of its forest cover when the State purchased it. The photo does not show the severely trampled west end. This area is shown below (17 Ann Rep Comm, 1901). Olmsted and Vaux wished to remedy the visual problems of the west end with forest growth so viewers on the bluff and on the island could not see each other. The area was never reforested by the administration, indeed, it appears that the State itself removed the native woods and replaced it with a lawn—the present condition both of Stedman’s Bluff and on Luna Island. The only native vegetation exists on the extreme periphery on the east end.
The object of the legislation passed to preserve and restore the vegetation of the Niagara Reservation is depicted here in an illustration to convey to the New York State Legislature the intent of the movement to preserve Niagara. Note Green Island (connected by bridges) is densely vegetated to resemble the other islands in the American channel. Note the shoreline was also restored to resemble the shoreline on Goat Island. In the photograph below (24 Ann Rep Comm, 1908) structures have been removed and young trees or shrubs established (perhaps all Willows and Poplars). Today the plant community is essentially the same: mature Willows, weedy shrubs such as Tartarian Honeysuckle and other urban and exotic plant material at the edge of a lawnscape on the riverbank. No restoration policy appears to have ever been enacted for either Green Island or the riverbank after 1904.

The illustration on the previous page is a projected view after a restoration policy had been enacted (Gardner, 1880).
Luna Island

Luna Island lies at the southern extremity of the American Falls, and is separated from Goat Island by the Bridal Veil Falls. At one time, during ownership by the Porter family, this island was called Young America (Kingston, 1856).

Luna Island may have been an Indian burial site. Archeological remains in the form of burial artifacts (bones) were reported in an article appearing in the Niagara Falls Gazette (July 22, 1912; Scott & Scott, 1983).

A picture included in the 11th Annual Report of the Commissioners (1895) shows the stone bridge erected in 1894 between Luna and Goat Islands. Luna Island was heavily wooded, as was Robinson's Island just north of it. There was no vegetation to be seen along the island margins, unlike the thickets which occur there now. No railings or other obstructions were in place at the time the photograph was taken. Among the trees were several Arbor Vitae trees on the northwest end of the Island—interpreted as such because of the narrow conical form of the trees, by their growth on the river's edge, and by their clumped habit in shade, great size and the characteristic thinned tops of old trees (as opposed to Red Cedar). The understory seems bare of shrubs and herbs. Two long-dead and tall tree trunks appear in the center of the island, the tops of the Junipers were naked of leaves but otherwise the crowns seem to be intact, in spite of what must have been heavy frost deposition in winter.

An old picture is appended to the 11th Annual Report of the Commissioners (1895) showing the girth of certain of the trees that occurred on Luna Island, including what look like Basswood trees with large-leaved stump sprouts. The diameter of one tree was broader than that of the lady leaning on it.

A winter photograph was published in the 17th Annual Report of the Commissioners (1901) in which the west part of the island is shown without vegetation, excepting a small area surrounded by paths on the southwest corner. The island seems well wooded in its eastern half, as discussed above. Snow damage to vegetation only occurred in the area directly in line with the prevailing wind on the western extremity. A summertime photograph of the island's west end shows a proliferation of paths, really areas where the vegetation has been destroyed by trampling.

In 1887, Olmsted and Vaux's accepted recommendations for the maintenance of this island were:

"The intention of the plan is, that the walk from the foot-bridge to this island shall be carried, as at present, to the verge of the fall at its west end, but that visitors shall be prevented from crowding upon the side of the island toward the bluff, and that bodies of foliage shall here be grown sufficient to secure the larger part of the ground which visitors will be allowed to occupy from the sight of those looking from the superior point of view on Steadman’s [sic] Bluff."

In 1909, the Superintendent removed all of the "dead wood" from Luna Island and “its shore ripp-rapped, graded and planted with Berberis thunber-
This Japanese Barberry makes “a low but very dense growth and as it is covered with very sharp thorns it will prove a better protection to the river bank than an iron railing, with none of the objectionable features” (26 Ann Rep Comm, 1926).
George Barker, “Indian Women with Wares on Luna Island” ca. 1868 (in Adamson, 1985, Fig. 102). During the Porter ownership, the island appears to have been stripped of vegetation on its north side, but for a mossy or low-clumped soil vegetation and the two Arbor Vitae or Red Cedar trunks shown. The center of the island was probably deeply wooded, as subsequent photographs show.
Luna Island, 11 Ann Rep Comm, 1895.
Part II: Vegetation

American Falls, from Goat Island, 17 Ann Rep Comm, 1901.

Luna Island, 34 Ann Rep Comm, 1918. Probably the same view as above with summer foliate. Note only the western crest at the prospect is bare.
Today the vegetation is heavily managed and artificial, with a lawn in the center, increasing in elevation to the east or upriver. On this grade are several trees, mentioned below. Willow and Poplar thickets exist at the river’s edge on the north and eastern sides, and low thickets on the south. There is no apparent reason to keep the central area denuded. Alien plants, such as the ground covers provided by Periwinkle (Vinca minor) and English Ivy (Hedera helix) prevent development of the native vegetation competing with them on the island’s margins. Tartarian Honeysuckle and an alien species of Dogwood, possibly Cornus alba (Tartarian or Siberian Dogwood), occupies part of the river banks. Buckthorn is infesting this area, as is Privet.

The back or eastern side of Luna Island could all be revegetated with a small, rustic path from which beautiful views upriver may be had. This policy would not compete with island use, for, from observing the behavior of visitors during the summer season, they almost exclusively use the asphalted viewing platform at the island’s western extremity.

Natural regeneration presently favors saplings of Willow, Cottonwood (Populus deltoides), Sugar Maple (Acer saccharum), Ash (Fraxinus), Chokecherry (Prunus virginiana).

Over a century ago, Elizabeth Gertrude Britton and Eugene A. Rau collected specimens of mosses on Luna Island during the 1886 foray of the American Association for the Advancement of Science, held in Buffalo that year (see bryophyte section). Before the Island became State Property, George Clinton collected specimens of mosses on Luna Island during the 1886 foray of the American Association for the Advancement of Science, held in Buffalo that year (see bryophyte section). Before the Island became State Property, George Clinton collected a specimen of fungus from one of the conifers, Tartarian Honeysuckle and an alien species of Dogwood, possibly Cornus alba (Tartarian or Siberian Dogwood), occupies part of the river banks. Buckthorn is infesting this area, as is Privet.

The back or eastern side of Luna Island could all be revegetated with a small, rustic path from which beautiful views upriver may be had. This policy would not compete with island use, for, from observing the behavior of visitors during the summer season, they almost exclusively use the asphalted viewing platform at the island’s western extremity.

Natural regeneration presently favors saplings of Willow, Cottonwood (Populus deltoides), Sugar Maple (Acer saccharum), Ash (Fraxinus), Chokecherry (Prunus virginiana).

Over a century ago, Elizabeth Gertrude Britton and Eugene A. Rau collected specimens of mosses on Luna Island during the 1886 foray of the American Association for the Advancement of Science, held in Buffalo that year (see bryophyte section). Before the Island became State Property, George Clinton collected a specimen of fungus from one of the conifers, Tartarian Honeysuckle and an alien species of Dogwood, possibly Cornus alba (Tartarian or Siberian Dogwood), occupies part of the river banks. Buckthorn is infesting this area, as is Privet.

The back or eastern side of Luna Island could all be revegetated with a small, rustic path from which beautiful views upriver may be had. This policy would not compete with island use, for, from observing the behavior of visitors during the summer season, they almost exclusively use the asphalted viewing platform at the island’s western extremity.

Natural regeneration presently favors saplings of Willow, Cottonwood (Populus deltoides), Sugar Maple (Acer saccharum), Ash (Fraxinus), Chokecherry (Prunus virginiana).

Over a century ago, Elizabeth Gertrude Britton and Eugene A. Rau collected specimens of mosses on Luna Island during the 1886 foray of the American Association for the Advancement of Science, held in Buffalo that year (see bryophyte section). Before the Island became State Property, George Clinton collected a specimen of fungus from one of the conifers, Tartarian Honeysuckle and an alien species of Dogwood, possibly Cornus alba (Tartarian or Siberian Dogwood), occupies part of the river banks. Buckthorn is infesting this area, as is Privet.

The back or eastern side of Luna Island could all be revegetated with a small, rustic path from which beautiful views upriver may be had. This policy would not compete with island use, for, from observing the behavior of visitors during the summer season, they almost exclusively use the asphalted viewing platform at the island’s western extremity.

Natural regeneration presently favors saplings of Willow, Cottonwood (Populus deltoides), Sugar Maple (Acer saccharum), Ash (Fraxinus), Chokecherry (Prunus virginiana).

Over a century ago, Elizabeth Gertrude Britton and Eugene A. Rau collected specimens of mosses on Luna Island during the 1886 foray of the American Association for the Advancement of Science, held in Buffalo that year (see bryophyte section). Before the Island became State Property, George Clinton collected a specimen of fungus from one of the conifers, Tartarian Honeysuckle and an alien species of Dogwood, possibly Cornus alba (Tartarian or Siberian Dogwood), occupies part of the river banks. Buckthorn is infesting this area, as is Privet.
Part II: Vegetation

* Corylus avellana EUROPEAN FILBERT.  
* Daucus carota QUEEN ANNE’S LACE. Rocky west end [obs. 1988].
* Diploax sp. ROCKET. Rocks at brink [obs. 1988].
Eupatorium maculatum JOE-PYE-WEED. Crest [obs. 1988].
Fraxinus sp. ASH. Thickets, north side and east [obs. 1988].
* Hedera helix ENGLISH IVY. Dense, masses choking all margins of the island, 1988.
* Ligustrum vulgare PRIVET. Thicket on the east side [obs. 1988].
* Lythrum salicaria PURPLE LOOSESTRIFE. Wet crest area [obs. 1988].
* Morus rubra RED MULBERRY. 1896.
* Parthenocissus quinquefolia VIRGINIA CREEPER. North and eastern thickets, 1988.
* Poa compressa CANADA BLUE-GRASS. Rocks by brink [obs. 1988].
Populus deltoides COTTONWOOD. Two trunks, northern thickets [obs. 1988]; crest area [obs. 1988].
* Prunus malus APPLE. 1988.
Quercus prinoides var. acuminata YELLOW OAK. Several trees by bridge [obs. 1988].
* Rhamnus cathartica BUCKTHORN. Abundant in eastern thicket [obs. 1988].
Rhus radicans POISON IVY. Northern thickets [obs. 1988].
Rubus odoratus PURPLE-FLOWERING RASPBERRY. Northern thickets [obs. 1988].
Rumex crispus CURLED DOCK. Rocky west end [obs. 1988].
Solidago sp. GOLDENROD. Rocky west end [obs. 1988].
* Taraxacum officinale DANDELION. [Obs. 1988].
Tilia americana BASSWOOD. [Obs. 1988].
* Vinca minor PERIWINKLE. Covers edge by river [obs. 1988].
Vitis riparia FROST GRAPE. Abundant on north and eastern sides [obs. 1988].

Fungi

Lichens
Bacidia sp. On rock, Harris 16326 (NY), on rock, Harris 16327 (NY), on rock, Harris 16328 (NY).
Caloplaca cerina. On bark, Harris 16333 (NY).
Lecanora dispersa. On rock, Harris 22858 (NY).
Lepraria finkii. At base of Ulmus, Harris 22842 (NY), on Quercus root over water, Harris 22847 (NY).
Phaeophyscia orbicularis. On dead Ulmus, Harris 22843 (NY), on Ostrya, Harris 22851 (NY), on rock, Harris 22861 (NY).
Protoblastenia rupestris. On rock, Harris 16324 (NY).
Pyrenocollema strontianensis. GENUS AND SPECIES NEW TO NEW YORK STATE. On rock, Harris 16317 (NY).
Verrucaria sp. Harris 22852 (NY).
Xanthoria fallax. On dead Ulmus, Harris 22843a (NY).

Bryophytes:
Historical Collections
Funaria sp. Luna Island, Niagara Falls, Aug. 21, 1886 [New York Botanical Garden] (NY)
Verrucaria sp. Harris 22852 (NY).

Bryophytes:
Historical Collections
Funaria sp. Luna Island, Niagara Falls, Aug. 21, 1886 [New York Botanical Garden] (NY)

BRYOPHYTES:
MODERN COLLECTIONS

Amblystegium tenax. var. tenax. 1 Nov. 1988, Buck 16318 (BUF, NY), 16332 (BUF, NY).
Brachythecium rutabulum. 1 Nov. 1988, Buck 16321 (BUF, NY).
Bryum caespiticium. 1 Nov. 1988, Buck 16325 (BUF, NY).

Bryum flaccidum. 1 Nov. 1988, Buck 16316 (BUF, NY), 16320 (BUF, NY).
Fissidens taxifolius. 1 Nov. 1988, Buck 16323 (BUF, NY).
Funaria hygrometrica. 1 Nov. 1988, Buck 16330 (NY).

Hymenostylium recurvirostrum. 1 Nov. 1988, Buck 16331 (NY).
Schistidium alpicola. 1 Nov. 1988, Buck 16319 (NY).
Tortula mucronifolia. 1 Nov. 1988, Buck 16329 (BUF, NY).

Weissia controversa. 1 Nov. 1988, Buck 16315 (BUF, NY).
GOAT ISLAND
Three Sisters and Brother Island

A. Evershed map, 1883.

B. Olmsted-Vaux map, 1887

A. The margins of the islands show boulders separated by water and an uneven edge, due to ignoring the canopy. Note the old swampland area on the upper end of the Second Sister - still present, the channel separating the lower (east) end of the First, the small area on the lower end of the Second Sister and the wider channels between the islands.

B. In the Evershed map, there is no evidence the Porters built paths - hence much of the plant communities remained intact. One unfortunate consequence of the Olmsted-Vaux plan – as suggested in this drawing, is the proliferation of paths here and throughout Goat Island. This policy contributed much to subsequent deterioration of forest areas. The Porter's concentrated on the periphery, not the interior, as this is what people seemed to be interested in. The new paths appear to promote the idea of leisure.

C. Today the channels are narrowed due to lower water levels. The channel between Goat Island & the First Sister was blasted deeper when the stone bridge was built in the early years of the Reservation. Note the extension of the Second Sister upriver and the appearance of new island material. The First Sister had become attached to its upriver member. There is still a rather deep channel between the Third Sister and Brother Island.
E. THE THREE SISTERS AND BROTHER ISLAND: GENERAL DISCUSSION

The Three Sisters is a group of three islands in the Canadian channel of the Niagara River leading to the Horseshoe Falls south of Goat Island. They are part of a north-south oriented dolomite ridge which passes under Goat Island. Brother Island would have been continuous with the Third or outermost Sister but for a large break in the bedrock forming a channel of swift water between them. Each island is elliptic in shape, with their long axes oriented in the direction of the river current. The uneven surfaces of the dolomite substrate, due to solution of crystalline deposits, provides for the establishment of a variety of cryptogams, for the retention of soil and the establishment of vascular plant communities.

The upper, or eastern ends of each of these islands, and the adjacent shore of Goat Island has always borne the brunt of the current. Winter storm surges frequently scoured these ends. The First and the Third Sisters have rock platforms facing the current, the Second is barely above water level. Several rare plants in New York State grow in association with habitats formed from soil washed away and ice scour on the islands’ eastern ends.

In early photographs of the Sisters, the bedrock margins of the islands are bare of vegetation—more recently, with absence of scour and greater accumulation of soil and root masses on the dolomite, the vegetation is presently more dense and complex in these same areas.

These sunny, islands have suffered erosion events just as the south shore of Goat Island has, and for the same reason: high water volume, high current, and the prevailing south, southwesterly winds.

In the third report of the Commissioners, published in 1887, the violent windstorm of October 13, 1886 was reported when “the water in the river rose until it covered the surface of the Three Sister Islands. The greatest loss sustained was the destruction of many trees, overturned by the wind. Twenty-five maples, 33 basswoods, 6 willows, 2 hickories, two ironwoods, two ash, one walnut and one cedar were destroyed .... Many of the trees overturned were old, large and thrifty.” These statistics may apply to the reservation as a whole, rather than the Three Sisters Islands alone. “At the times of very high water the group of the Three Sisters Islands obstructs the water in the river, causing it to rise above those islands to a higher level than in other places in the river. During the storm of January ninth (1889) the water covered a portion of the First Sister Island, the ends of the bridge between the First and Second Sisters Islands and flowed over the Second Sister Island, doing considerable damage to the surface. The upper end of the Third Sister Island was submerged and the soil and vegetation carried away from that locality, leaving the rocks bare to a much greater extent than formerly and overturning a number of trees at the margin of the island” (6 Ann Rep Comm, 1890).

Again, a “violent wind” of January 13, 1890 “caused serious damage to the Reservation. The bridges to the Three Sister islands, were endangered by the high water that flowed over the Three Sister Islands, and over the bridge between the First and Second Sister Islands. The bridges were also in great danger from floating logs ... The gravel walks on the islands, and a large quantity of the soil were swept away. Thirty-six trees were blown down on the islands, to wit: eleven basswood, five elms, six beeches, four ironwood, three maples, two white cedar, two red cedar, one pine, one white oak and one hemlock .... Fourteen of the trees were each two feet in diameter. Two of the elms were three feet in diameter” (7 Ann Rep Comm, 1891).
In 1907 the river rose again and flowed over the Three Sisters, “practically all of the soil was washed off of the Third Sister Island, the gravel walk and soil washed off of the upper end of the Second and considerable damage done to the First Sister Island,” and the “damage to the Islands has been repaired by placing more soil thereon” (24 Ann Rep Comm, 1908).

There is presently little if any threat made by the river flowing over the islands in winter due to the diversion 75 percent of the river volume, and due to the control structures just upriver in the Grass Island-Chippawa Pool. In winter there is only an interrupted sheet of water passing between these islands (see photographs).

Each island supports a variety of microhabitats for example the east section of the Second Sister with its clean, low dolomite floor and the central portions of the First and Second Sister which support a forest with some humic topsoil. Portions of the river margins have been relatively recently exposed since the drop in water levels. Each island has its own floristic character.

In contrast to the scoured eastern ends of the islands, the western ends receive some alluvial deposition since the force of the current is broken by the eastern ends. Both the First and Second Islands possess wet-alluvial plant communities at their lower ends, especially the Second Sister which has a small marsh still. It was depicted on a map as long ago as 1883 (see Second Sister section). The lower end of the Third Sister is broken by a joint in the bedrock and is bare rock.

The Porter family, who were the first private citizens to own the Goat Island group, built bridges to the Three Sisters in 1869; the islands appear to have been otherwise undisturbed. In 1896 there were three wooden bridges to the Three Sisters Islands (13 Ann Rep Comm, 1897).

In 1895 Lady Theodora Guest reported “these sister islands were fascinating. Little rocky paths wound about them, bordered with Maple, Balsam [probably Hemlock, see the species catalogue], Mulberry and Black Walnut trees, as green and fresh as possible, though there were not many flowers. Pink Crane’s bill, the inevitable Dandelion, a bright scarlet Columbine, and Podophyllum, whose large leaves make the children call it the umbrella plant, were nearly all I noticed.”

Naturalists of all kinds have enjoyed these relatively isolated areas. The bryologist Elizabeth Gertrude Britton visited there and collected bryophytes (liverworts and mosses) during the 1886 meeting of the American Association for the Advancement of Science. Mary L. Wilson, a botanist associated with the Buffalo Society of Natural Sciences, collected lichens on the Three Sisters rocks around 1870 as did her contemporary Judge George Clinton. Terrestrial snails were hunted in years gone by on the Sisters by members of the Conchological Section of the Buffalo Society of Natural Sciences (Robertson and Blakeslee, 1948). Members of the scholars accompanying Louis Agassiz on their way to Lake Superior prior to 1850 took their bath in the cascade in the channel between the First Sister and shore of Goat Island.

With the establishment of the bridges in 1869, came paths bisecting each island at their middle, forming eastern and western sections.

The Three Sisters has recently been reported as “primitive woods”, or at least the least altered of any other area in the Reservation, other than the islands in the American channel (q.v.). The best that may be said is that these three islands may be the least damaged of the ecosystems present in the complex.

The vegetation of the Third Sister has been nearly
completely destroyed by trampling due to the practice of allowing busloads of visitors to discharge their passengers for a twenty or thirty minute “romp” on the island furthest out in the river. It is difficult to assess the condition of the Second Sister, except that its century old marsh on the west end is becoming damaged by trampling. The First Sister, west end should be completely blockaded from visitors until a natural resource policy is developed, as this little section does possess the community structure and species diversity for which these islands became legendary. On the east end of the First Sister, what native vegetation still exists is in serious competition with dense colonies of monoculture communities alien shrubs. Certain areas of the First Sister, east end, and of the Second Sister, east and west ends, were observed to have been cut extensively for shrubs, and selectively for trees, in 1985 or 1986, as was the slope on Goat Island facing the west end of the First Sister. Such cutting encourages the establishment of robust and invasive monocultures of native and alien species, particularly White Snakeroot (*Eupatorium rugosum*), and Buckthorn (*Rhamnus cathartica*), Tartarian Honeysuckle (*Lonicera tartarica*), and Privet(*Ligustrum vulgare*).

Accompanying the asphalted path leading out to the Third Island is a mowed-lawn grass margin. The bases of trees along this stretch show damage by mowing devices which appear to find it difficult to cut the grass here. It is recommended that these lawns be eliminated and a thoughtful plan created to reestablish the native vegetation.

The lawns support weedy vegetation familiar to people in their urban experience: Dandelions, for example. The large basal leaves of Burdock (*Arctium lappa* and *A. minus*) are particularly conspicuous. The lawns are connected across all three islands and form a corridor by which alien weeds, deriving from the extensive lawn systems maintained on Goat Island, are presently invading the Three Sisters. Weeds established on the lawn margins of the Sisters then proceed to establish themselves up the dirt-path systems on all three islands and into the native plant communities.

The response of the public (various personal communications during field work) is that the weeds should be cleared out—weeds are disturbing to their experience of Niagara Falls. Unfortunately, because they do not fully understand the processes involved, they believe it is the native vegetation that is promoting the weedy infestation, and not the existence of lawns. Indirectly, visitors at the Falls indicate they would like the removal of plants characteristic of urban vegetation, and this cannot be done without the elimination of grass monocultures (lawns).

Exposed dolomite or calcareous flats are good habitat for invasion by both rare and weedy taxa—establishment of rare taxa should be monitored and encouraged. Weedy pioneers, whether native or alien, known to develop monocultures should be monitored and carefully removed or modified in the interests of high species diversity. Relationship between the benefits of weedy pioneers that may be colonizing recently exposed land surfaces and preparing successional habitats and rare plants that may colonize habitats already established by weeds must be considered when making decisions to remove weeds in recently exposed rock surfaces (river bed). Several rare or interesting plants grow at the edges of grass mats, but are not first colonizers (Kalm's Lobjelia, Small-flowered Purple Gerardia, Linear-leaved Loosestrife).

Invasive non-native taxa are to be removed carefully so as not to expose shade-loving species to too...
much sun or exposure to the wind, or disturb the soil too much, as on shaded boulder tops with their associated cryptogamous species (First Sister west).

The plant communities in these islands appear to be the most intact of any area on the Reservation. They have recently been reported as “primitive woods”, or at least the least altered of any other area in the Reservation, other than the islands in the American channel. The best that may be said is that these three islands may be the least damaged of the ecosystems present in the complex. Their flora appears to be more intact than those in the American channel, the larger of which have never been connected by bridge. This may at first seem odd. Although access to these islands was not permitted for this project, I base this guess on the fact that the American channel islands were heavily colonized by conifer species—all of which are gone, and the trees seen today do not appear to be particularly mature (see discussion above).

The flora of these islands is considered old in this paper due to its complexity and diversity relative to other areas studied in the Reservation.
**GENERAL REPORTS FOR THE THREE SISTERS:**

**VASCULAR PLANTS**

*Arabis lyrata* LYRE-LEAVED ROCK CRESS. Day, 1888.

*Aralia nudicaulis* WILD SARSAPARILLA. Day, 1888.

*Epipactis helleborine* HELLEBORINE ORCHID. “Frequent on all three islands,” 1984, specimen (BUF). “Goat Island ... where originally introduced by Day” (Zenkert, 1934).


*Lobelia kalmii* KALM'S LOBELIA. On wet rocks, Grace B. Craw, Union School Herbarium, Lockport, N.Y., 1894 (BUF).


*Panicum depauperatum* STARVED PANIC-GRASS. “In rocky places” (Day, 1888).


*Polypodium vulgare* var. *virginianum* COMMON POLYPODY. Day, 1888.

*Populus grandidentata* BIGTOOTH ASPEN. Day, 1888.

*Scirpus atrovirens* DARK-GREEN BULLRUSH. 1988.

**HEPATICS**


*Reboulia hemispherica*. (As *Preissia hemisphaerica*). Three Sisters, Niagara Falls, N.Y., Aug. 21, 1886, comm. E. G. Britton, 1890 (NY). [Collected during the 1886 meeting of the American Association for the Advancement of Science.]
LICHENS:

ALGAE
Algae blooms are readily observable in the shallow waters about the islands in the cooler months of autumn, winter and spring, and in the slower water at the west end of the Second Sister.
A reddish-orange species of algae of the genus *Trentepohlia* grows on the channel boulders on the margins of the Three Sisters, conspicuous from the bridges. The colorful masses are most evident in late fall through early spring (see phycology section).
1. The First Sister Island
“A small fall known as “The Hermit's Cascade” lies between Goat Island and the First Sister. In the pool at the foot of this fall Francis Abbot, the Hermit of Niagara, was wont to take his daily bath” (Grabau, 1901). Other bathers included the troop of scholars Louis Agassiz was leading to Lake Superior prior to 1850. They bathed by moonlight in this cascade “eight or ten feet in height; ... the water is shallow, and just below the pool a large log extends across the stream, which is only some twenty feet wide,” (Agassiz, 1850). This pool “is so shaded and shut off by the overhanging trees of the island, that one might fancy it a mountain stream a hundred miles from any human habitation .... We crawled in at the side of the Fall, and found a hollow underneath the shelving edge, large enough for several to sit at once, quite free from the water, which shoots over like a miniature of the great cascade below. With some difficulty, from the pounding of the falling water, we penetrated through the sheet in front, and came out into the pool, the bottom of which is smooth rock.”

A fine early photograph of this cascade and the bridge over it that had been built prior to the present stone structure may be seen in the ninth Annual Report of the Commissioners published in 1893. The water flow was substantial then, compared to the shallow sheet of water permitted now. There was no vegetation in the bed of the channel then, and the trees and shrubbery were lavish right to the water's edge on both Goat Island and the First Sister. A White Pine silhouette with horizontal branches, trunk exposed and gently upturned branch ends can be seen in the photograph on the First Sister, east end.

This abundance of water was not constant, as in 1866 Judge Clinton and a Mr. Pettibone found the channel dry. Here Hypnum nudum (= Leskea polycarpa) was “abundant” (unpubl. journal G. W. Clinton). It was also at the foot of the Cascade that Clinton found the moss Fissidens grandifrons, a population that still exists today (see bryophyte section). The presence of this uncommon species was reported based on a specimen from the Cascade by Day (1883).

A picture of the present stone bridge in winter, completed in 1898, appeared in the 15 Ann Rep Comm (1899). Conifers appear on the First Sister, northeast end—either Red Cedar or Arbor Vitae where dense thickets of Privet and Tartarian Honeysuckle appear now. Hemlock or White Pine occurred on the facing Goat Island shore.

With completion of the stone bridge between Goat Island and the First Sister, the channel between the banks was deepened (dynamited) and “a larger volume of water, usual in former years of higher water in the great lakes, obtained, thus restoring the beauty and attractiveness of that part of the Reservation” (16 Ann Rep Comm, 1900).

When the stone bridge was built, the vegetation
Part II: Vegetation

beside the entrances, especially on the east end, according to photographs published in the annual reports of the Commissions, never did recover. The river banks on the eastern side of the stone bridge on the First Sister are presently bare mineral soil with runnels of erosion or centers of alien weeds and thickets of Tartarian Honeysuckle and Privet.

The First Sister has a relatively high rocky promontory on the east end which elevation descends in blocky steps to the lower western end. Both ends of the Island are composed of great dolomite blocks and fissures.

The flora on the west end today has the most intact flora of any area in the Niagara Reservation accessible to the public. The western extremity of this island is captured in a photograph in the 28 Ann Rep Comm, 1912 without the dense willow concentration in existence now, but showing the graminoid, emergent vegetation presently seen.

In the west end occur granitic glacial erratics, similar to those on the west end of the Second Sister.

The east end did not fare as well. At one time it probably had more trees in the areas now dense with Privet (Ligustrum vulgare) and Tartarian Honeysuckle (Lonicera tartarica). The east end understory had forest herbs, such as the False Lily-of-the-Valley (Maianthemum canadense), woodland grasses, Herb Robert (Geranium robertianum referred to by Lady Guest (1895) and the Star-flowered False Solomon’s Seal (Smilacina stellata), which may still be seen being shaded out and chlorotic by the two weedy shrubs just mentioned.

These shrubs are in direct competition with regeneration of a native plant community. In the area dense with the two shrubs mentioned, the native trees must have blown down or been otherwise removed. These shrub populations were probably planted there to fill an opening, with subsequent loss in species diversity.

There are presently no conifer species that grew there originally as seen in early photographs. Much of the regenerating trees are Ashes (either Fraxinus americana or F. pensylvanica). Seedlings and saplings of this species is evident in all disturbed wooded areas. Encouragement of the regrowth of this tree, and of Sugar Maple (Acer saccharum) will probably eventually shade out the shrub monoculture as the young Ashes are presently growing up, almost a monoculture in itself, through the shrub canopy. Selective cutting of these shrubs, not clear-cutting, to encourage the establishment of seedlings of native trees may be helpful in restoring this part of the island without disturbing the soil, eliminating shade, or what remains of the established native populations which still persist. Such a policy might preserve current populations of Aralia and Triosteum.

So many Ashes got started in the east end probably when the island was cut over to control a rat infestation (staff communication), as with the White Snakeroot (Eupatorium rugosum) on the Second Sister, east end. Such cutting also encouraged the proliferation of Buckthorn seedlings where old trees had become established.

Due to the State rarity of sedges and other species, it is recommended that people be kept away from the flats area at the extreme east end (see photo above), the paths broken up carefully to allow natural reseeding.

Note that in an 1836 map of the Goat Island complex, what we call the First Sister Island, the first island south of Goat Island, was called Moss Island, due to the abundance of these plants blanketing the dolomite boulders. The large Second Sister Island
was one of the Three Sisters, which included Brother Island (the island furthest out of all the island chain and isolated from what is now called the Third Sister Island by an open channel). Access to Brother Island was not provided for this study, although a large Horse Chestnut (*Aesculus hippocastanum*) can be seen today among the dense foliage there.

First Sister, west end, summer, 1988. The plant community structure is very complex and species rich, and is suggestive of early communities on Goat Island (photo: Richard Zander).
Part II: Vegetation

HISTORICAL RECORDS:
BRYOPHYTES

LICHENS

RECENT RECORDS:
VASCULAR PLANTS:
WEST END OF FIRST SISTER
Acer saccharum SUGAR MAPLE. [Obs. 1988].
Achillea millefolium YARROW. [Obs. 1988].
Anacharis canadensis WATER WEED. 1986.
Arabis nuditcalis WILD SARSAPARILLA. 1987.
Asplenium trichomanes MAIDENHAIR SPLEEN-

* Barbarea vulgaris WINTER CRESS. By asphalt path [obs. 1988].
* Berberis vulgaris COMMON BARBERRY. [Obs. 1988].
Bidens cernua NODDING STICKTIGHT. 1987.
*Butomus umbellatus. FLOWERING RUSH. 8612716.
Cardamine pensylvanica PENNSYLVANIA BIT-

Carex cephalophora SOUTHERN SEDGE. 1988.
Carex lasiocarpa var. latifolia WOOLLY SEDGE. 1987.
Carex laxiflora LOOSE-FLOWERED SEDGE. 1987.
Carex laxiflora var. blanda CHARMING SEDGE. 1988.
Carex vulpinoidea FOXTAIL SEDGE.
Chelone glabra TURTLEHEAD. 1988.
Convolvulus sepium HEDGE BINDWEED.
Cornus alternifolia ALTERNATE-LEAVED DOG-

Equisetum sp. HORSETAIL. [Obs. 1988].
Erigeron sp. FLEABANE. [Obs. 1988].
Eupatorium perfoliatum BONESET. [Obs. 1988].
Eupatorium rugosum WHITE SNAKE-ROOT. 1988 [Obs.]
Galium sp. BEDSTRAW. [Obs. 1988].
* Glechoma hederacea GILL-OVER-THE-

Fragaria vesca STRAWBERRY. [Obs. 1988].
Fraxinus americana-F. pensylvanica WHITE or RED ASH. [obs. 1988].
* Hieracium pratense KING-DEVIL. [Obs. 1988].
Hypericum kalmianum KALM’S ST-JOHN’S WORT. 1892. This is part of the only known lo-

– 157 –
Botanical Heritage of Islands at the Brink of Niagara Falls

Hypericum perforatum COMMON ST. JOHN'S WORT. 1986.
Impatiens biflora SPOTTED TOUCH-ME-NOT. [Obs. 1988].
Leonurus cardiaca MOTHERWORT. [Obs. 1988].
Ligustrum vulgare PRIVET. Boulder tops [obs. 1988].
Lithospermum officinale COMMON GROMWELL. [Obs. 1988].
Lonicera tartarica TARTARIAN HONEYSUCKLE. Abundant [obs. 1988].
Lythrum salicaria PURPLE LOOSESTRIFE. 1986.
Mentha piperita PEPPERMINT. 1986.
Ostrya virginiana HOP-HORNBEAM. Several [obs. 1988].
Parthenocissus quinquefolia VIRGINIA CREEPER. 1988.
Lichens: WESTERN HALF OF FIRST SISTER
Bacidium epixanthoides. NEW TO NEW YORK STATE. On Mnium thomsonii, Harris 16341 (NY).
Bacidium granosum. On rock, Harris 22867 (NY); west on rock, Harris 22869 (NY); west, on rock, Harris 22872 (NY); west, on rock, Harris 22874 (NY); west, on rock, Harris 22877 (NY); west, on rock, Harris 16348 (NY).
Caloplaca citrina. On rock, Harris 22866 (NY).
Part II: Vegetation

*Caloplaca flavovirescens.* On rock, Harris 16417 (NY).

*Caloplaca* sp. On rock, Harris 22870 (NY).

*Endocarpon pusillum.* On rock, Harris 22868 (NY); west, on rock, Harris 22877 (NY); west, on rock, Harris 16428 (NY); west, on rock, Harris 16420 (NY); west, on rock, Harris 16425 (NY).

*Lecanora dispersa.* On rock, Harris 22868 (NY).

*Lepraria finkii.* On rock, Harris 22875 (NY).

*Leptogium juniperinum.* NEW TO NEW YORK STATE, in rock crevice, Harris 16346 (NY).

*Mycobilimbia sabuletorum.* On moss, Harris 16339 (NY); west end, on moss, Harris 16422 (NY); west end, on rock, Harris 16428 (NY).

*Phaeophyscia adiastola.* On mosses over rock, Harris 22864 (NY); west end, on mosses over rock, Harris 22865 (NY).

*Verrucaria muralis* Ach. On rock, Harris 22871 (NY).

*Verrucaria* sp. West, Harris 22869 (NY); west, Harris 22871 (NY).

BRYOPHYTES: WESTERN HALF OF FIRST SISTER

*Amblystegium tenax* var. *tenax.* 2 Nov. 1988, Buck, 16421 (BUF, NY), 16427 (BUF, NY).

*Anomodon attenuatus.* Eckel 880723, July 8, 1987 (BUF); 2 Nov. 1988, Buck 16429 (BUF, NY).

*Anomodon rostratus.* Eckel 880726, July 8, 1987 (BUF); 1 Nov. 1988, Buck 16335 (BUF, NY).

*Brachythecium oxycladon.* 1 Nov. 1988, Buck 16334 (BUF, NY).

*Brachythecium recurvirostrum.* On dolomite boulders with *Fissidens taxifolius,* *Weisia controversa,* *Carex eburnea,* 87312, Sept. 12, 1986 (BUF); 2 Nov. 1988, Buck 16423 (NY).

*Bryum capillare* var. *flaccidum.* 2 Nov. 1988, Buck 16418 (BUF, NY).

*Ceratodon purpureus.* 1 Nov. 1988, Buck 16337 (BUF, NY).

*Conecephalum conicum.* 1 Nov. 1988, Buck 16337 (BUF, NY).


*Fissidens cristatus.* 880724, July 8, 1987 (BUF); (as *Fissidens dubius*) 1 Nov. 1988, Buck 16343A (BUF, NY).

*Funaria hygrometrica.* 880725, July 8, 1987 (BUF).

*Homomallium adnatum.* 1 Nov. 1988, Buck 16342 (NY).


*Lophocolea minor.* 1 Nov. 1988, Buck 16344 (BUF, NY).

*Mnium thomsonii.* Eckel 880720, July 8, 1987 (BUF); 1 Nov. 1988, Buck 16338 (NY).

*Orthotrichum anomalum.* 880721, July 8, 1987 (BUF).


*Preissia quadrata.* 1 Nov. 1988, Buck 16349 (BUF, NY).

*Theluia hirtella.* 880727, July 8, 1987 (BUF).

*Thuidium recognitum.* Dolomite boulder top, west end, Eckel 8712251, April 26, 1987 (BUF); 1 Nov. 1988, Buck 16345A (BUF, NY).


*Tortella humilis.* 1 Nov. 1988, Buck 16347 (NY).

*Tortella tortuosa.* 880728, July 8, 1987 (BUF).

*Tortula mucronifolia.* 880718, July 8, 1987 (BUF).

*Weisia controversa.* Small population, dolomite boulder, with *Tortula mucronifolia,* synoicous, 8706070, 1986; 1 Nov. 1988, Buck 16340 (BUF, NY).

VASCULAR PLANTS: EASTERN HALF OF FIRST SISTER

*ACANTHOPANAX.* By 2nd Sister Bridge, 1988.

*Acer saccharum* SUGAR MAPLE. 1987.

*Agrostis stolonifera* var. *compacta* CREEPING BENT. 1986.

*Alliiara officinalis* GARLIC MUSTARD. [Obs. 1988].

*Allium canadensis* WILD GARLIC. [Obs. 1988].

*Aralia nudicaulis* WILD SARSAPARILLA. 1988.

*Arctium sp.* BURDOCK. By bridge to Goat Island [obs. 1988].

*Asclepias incarnata* SWAMP MILKWEED. 8705287.
Barbarea vulgaris WINTER CRESS. Flats, eastern extremity [obs. 1988].

Berberis vulgaris COMMON BARBERRY. [Obs. 1988]. Another specimen was observed near the far eastern end on the dolomite flats.


* Bromus inermis fo. aristatus HUNGARIAN BROME-GRASS.

Carex garberi GARBER'S SEDGE. 1988.
Carex lasiocarpa var. latifolia WOOLY SEDGE. 1987.
Carex molesta TROUBLESOME SEDGE. 1988.

Carpinus caroliniana AMERICAN HORNBEAM. 1986.

* Cerastium vulgatum COMMON MOUSE-EAR CHICKWEED. 1988.

Cornus racemosa PANICLED DOGWOOD. Far end, dolomite pavement [obs. 1988].

Cornus stolonifera RED OSIER DOGWOOD. [Obs. 1988].

* Dianthus armeria DEPTFORD PINK. 1986.


Geranium robertianum HERB ROBERT. 1986.

* Glechoma hederacea GILL-OVER-THE-GROUND. Dolomite flats area [obs. 1988].

Fraxinus americana-F. pensylvanica WHITE or RED ASH. Abundant trees, seedlings and saplings [obs. 1988].


Hypericum perforatum COMMON ST.JOHN'S WORT. 1987.

Impatiens biflora SPOTTED TOUCH-ME-NOT. By bridge to Goat Island, stream margin [obs. 1988].


* Ligustrum vulgare PRIVET. Dense thicket [obs. 1988].

* Lithospermum officinale COMMON GROMWELL. [Obs. 1988].


* Lonicera tartarica TARTARIAN HONEY-SUCKLE. Dense monoculture with Ligustrum vulgare [obs. 1988].


* Lythrum salicaria PURPLE LOOSESTRIFE. Dolomite flats [obs. 1988].


Monarda fistulosa WILD BERGAMOT. 1987.

Morus alba WHITE MULBERRY. [Obs. 1988].


Ostrya virginiana HOP-HORNBEAM. Several [obs. 1988].


Parietaria 

Physocarpus opulifolius NINE-BARK. South side [obs. 1988].

* Poa compressa CANADA BLUE-GRASS. Flats, far end, 1988.


Populus cf. pendula GRAY BIRCH. Northern stream edge [obs. 1988].

Populus deltoides COTTONWOOD. Seedling on dolomite flats [obs. 1988].


Prunus virginiana CHOCOLATE CHERRY. 1987.

Pycnanthemum virginianum VIRGINIA MOUNTAIN MINT. 1986.

Quercus borealis var. maxima NORTHERN RED OAK. 1986.

Quercus prinoides var. acuminata YELLOW OAK. 1986.


* Rhamnus cathartica COMMON BUCKTHORN. 1986.

* Rhodotypos scandens JETBEAD. By bridge to
*Rhus radicans* POISON IVY. [Obs. 1988].
*Rumex obtusifolius* BITTER DOCK. 1986.
*Salix discolor* PUSSY WILLOW. 1988.
*Salix nigra* BLACK WILLOW. 1988.
*Scirpus atrovirens* DARK-GREEN BULLRUSH. 1988.
*Smilacina racemosa* FALSE SOLOMON’S SEAL. [Obs. 1988].
*Smilacina stellata* STAR-FLOWERED FALSE SOLOMON’S SEAL. Chlorotic plants below dense Honeysuckle and Privet shrubs, rock-tops [obs. 1988].
*Solidago nemoralis* GRAY GOLDENROD. 1988.
*Symphoricarpus orbiculatus* CORALBERRY. Streamside, by bridge to Goat Island [obs. 1988].
*Tilia americana* BASSWOOD. [Obs. 1988].
*Triosteum perfoliatum* var. aurantiacum ORANGE HORSE-GENTIAN. 1988.
*Ulmus rubra* SLIPPERY ELM. Stream margin by bridge to Goat Island [obs. 1988]. Rather large Elm near the far eastern extremity [obs. 1988].
*Viola* sp. On stone bridge to Goat Island [obs. 1988]. Another violet was observed in the wooded section.
*Vitis riparia* FROST GRAPE. By bridge to Goat Island, dolomite flats to the extreme east [obs. 1988].

**ALGAE:** EASTERN HALF OF FIRST SISTER
*Trentipolia* sp. On rock [obs. 1988].

**LICENS:** EASTERN HALF OF FIRST SISTER
* Bacidia* sp. On *Anomodon attenuatus*, Harris 16413 (NY); on lignum, Harris 16416 (NY).
* Caloplaca cirrochroa*. NEW TO NEW YORK STATE On rock, Harris 22917 (NY).
* Caloplaca citrina*. Bridge, on mortar, Harris 22863 (NY).
* Caloplaca fericissima*. Highest point, on rock, Harris 22916 (NY); limestone flat, on rock, Harris 22929 (NY).
* Candelariella aurella*. On rock, R. H. Harris 23028 (NY).
* Endocarpon pusillum*. Highest point, on rock, Harris 22916 (NY).
* Lecanora dispersa*. Highest point, on rock, Harris 22916 (NY).
* Mycobilimbia sabuletorum*. On rock, Harris 22930 (NY).
* Phaeophyscia adiastola* (Essl.) Essl. On rock, Harris 22933 (NY).
* Phaeophyscia orbicularis*. Highest point, Harris 22916 (NY).
* Sarcogynx regularis*. Shore rock, Harris 22921 (NY).
* Verrucaria muralis*. Along shore, on rock, Harris 23925 (NY).
* Verrucaria* sp. Harris 22918 (NY); on shore, Harris 22920 (NY).
* Verrucaria* sp. Harris 22928 (NY).
* Verrucaria* sp. On shore, rock, Harris 22926 (NY).

**BRYOPHYTES:** EASTERN HALF OF FIRST SISTER
*Brachythecium oxycladon*. 2 Nov. 1988, Buck 16415 (NY).
*Brachyphyllum recurvirostrum*. 2 Nov. 1988, Buck 16414 (BUF, NY).
*Tortula mucronifolia*. 880708, July 8, 1988 (BUF).
Shining Willow (*Salix lucida* Muhl.), one of the distinctive shrubby native willows of the First Sister, west end, summer, 1988 (photo: Al Schotz).

Sandbar Willow (*Salix interior* Rowlee), also found on the south shore of Goat Island and on Terrapin Point is the only willow with such narrow leaves, summer, 1988 (photo: Al Schotz).

Sneeze-weed (*Helenium autumnale* L.) also grows on Terrapin Point, autumn, 1988 (photo: Al Schotz).
2. The Second Sister Island
The Second Sister is the largest of the Three Sisters. It is barely above river surface level on the east, an area sporting interesting plant communities on the bare river-bed. The central portion of this end and that of the western end consists of blocky, rock-bound, uneven surfaces with deep jointing in the dolomite descending in elevation, in a step-down fashion, toward the western end where there is a marshy edge. The central sections are wooded.

A picture published in 9 Ann Rep Comm, 1893, showed the east end of this island with its characteristic bare rocky bedrock upriver exposure. These shallow surfaces appeared to have been frequently inundated and barely above the surface of the river. A surge in water in the river could have easily inundated this area. In 1890 water flowed over the Second Sister during a storm, from the eastern end, and removed material from the bridge there.

A striking photograph is included in the nineteenth Annual Report of the Commissioners, in 1903, of the “cascade above the First Sister Island,” at the eastern end, showing rocky flats with low, grassy vegetation. The east end of the First Sister is shown, but it is more likely to be that of the Second Sister. The ground is barely above water line, yet supports magnificent stands of White Pine. There is, additionally, a windthrow depicted. It is from this picture that it may be inferred that there is significantly more bedrock exposed in this area than formerly, due to lowered water levels.

“Four years ago a storm ... destroyed a fine stand of hemlock on the Second Sister island, and periods of high water have washed a large portion of that island bare of soil. A retaining break-wall has been built along the lower side of the island and soil filled in back of it so that tree growth may be restored” (28 Ann Rep Comm, 1912). The break-wall was 60 yards long “back of which several hundred cubic yards of clay loam were filled.” It was to be planted “and the island restored as nearly as possible to its original condition” (28 Ann Rep Comm, 1912). The lower, or downriver side refers to the west end. Remnants of a break-wall may still be seen there, and the area of saturated soil with its interesting plant community at the western extremity. A lovely photograph of this structure on the north side of this island is in the 28 Ann Rep Comm, 1912. A good silhouette of the island's central forest, with perhaps White Pine, may be seen as well.

Another picture in the ninth annual report of the Commissioners showed the Second Sister from the Third, about mid-island. The old barren bedrock is exposed below the bridge. The lack of any vegetation at all indicates ice scouring in winter. The forested east end appears to be somewhat sparse, perhaps due to the lack of topsoil generally here, and the brunt of river-borne material, particularly ice, and elevated river heights in winter. This habitat was probably analogous in certain ways...
with the original eastern extremity of Goat Island.

The flora of the Second Sister suffers from loss of its forest cover, invasion of Honeysuckle and Buckthorn, and disturbance resulting in monoculture of White Snake-Root (*Eupatorium rugosum*).

There is a small tree species in the Rosaceae, either an *Amelanchier* or a *Prunus* with frequent saplings, dying at maturity perhaps due to a virus or bacterium, and declining on both the east and west sides of the Island.

West end: trees include predominantly Sugar Maple and Hop-Hornbeam, with some Red Maples, Red Oak and one other species, possibly Bur Oak (*Quercus macrocarpa*, single tree), Bitternut Hickory, Slippery Elm and American Elm, one White Pine, etc. Vigorous regrowth is exhibited by Sugar Maple and White Ash.

Granitic glacial erratic boulders occur on the west end. The patch of wet alluvium of the west end is an old habitat in existence since at least 1883 when it appeared on the survey map made by Thomas Evershed in that year (Map of Land Proposed to be Taken by The Commissioners of the State Reservation at Niagara, Albany, 1883). This habitat supports high species diversity and an interesting community presently not duplicated anywhere else in the Reservation. A similar wet area, with probably a totally different set of wet-soil species because of the shaded character of that area, as opposed to the sunny one on the Second Sister, was depicted on the north side of Goat Island, toward its east end (see discussion above, The Spring). The north-shore alluvial area is no longer extant.

The swampy area on the Second Sister presently suffers trampling from visitors anxious to get a closer look at the water near the Falls at the downriver end. Here the vegetation, when not trampled, is very dense, with Bristle-leaved Sedge (*Carex eburnea*) beside the compacted clay paths, various species of *Juncus* in the wetter paths, with *Angelica* (*Angelica atropurpurea*), sedges, grasses (*Glyceria*), Elderberry, Jewel-weed, Joe-Pyes and an abundance of bryophytes on stones, pebbles, hummocky roots, dense thickets of Nine-bark. A log placed or fallen at the northern margins of this area deflects some of the current of the river, and provides a substrate for species requiring rotting wood as a substrate for growth. Crayfish were observed here during 1988. Logs or plantings of brush, if carefully placed, may deter visitors for habitat recovery, and if placed near the stream bank may curb erosion and provide areas for plant colonization enhancing species diversity with further stabilization of the soil. Efforts must be made to see whether Purple Loosestrife (*Lythrum salicaria*) or Flowering Rush (*Butomus umbellatus*) does not infest or dominate this area to the detriment of its present complex community structure.
Cascade above the First Sister Island, 19 Ann Rep Comm, 1903. If the island shown is really the First Sister as its caption originally made it out to be, then the foreground would be the original bedrock exposure on this side of Goat Island. Otherwise the foreground is the First Sister, and the island shown is actually the Second!
The grassy mats or patches of vegetation occurring on the east, or upriver, end of the island display a concentric zonation characteristic in some ways of the larger, more complex zonation of the islands themselves. The mixture of weedy and rare species demonstrates the affinity of both types of species for the same habitats, based on lack of competition with the typical species of the area.

Size of vegetated mat is directly correlated with community complexity. What apparently happens is that suitable space is colonized and stabilized up to the level of complexity (number of concentric rings) in the order given below, and stays that way until the mat increases in diameter, or mats converge.

Although not investigated in detail for this study, similar mats have developed in the dolomite flats areas above the Horseshoe Falls, relatively recently exposed and correlated with water diversion. The species in these mats are somewhat different from those at the east ends of the Three Sisters. The rarities at the Sisters are probably due to the greater age of these communities, as opposed to those in the Horseshoe river channel which may be still in succession. Another possibility is that periodic disturbance regimes occurred here, such as ice scour in winter, periodic inundation and periods of desiccation on the bare dolomite bedrock substrate. All of these processes except the last have been inhibited by the construction of the winter ice boom at the mouth of the Niagara River, tending to stabilize the island margins and increase their area. It is likely that without this natural disturbance, the peculiar flora of the island margins may disappear, as succession proceeds uninterrupted and typical climax vegetation replaces the present margin community.

1. MOSSES Fringe of mosses, Amblystegium varium, Philonotis marchica—P. muhlenbergia.
2. SEDGES Carex species: Carex aurea, Carex hystricina, Carex stipata.
3. RUSHES Juncus species: Juncus articulatus.
4. GRASSES Bent Grass (Agrostis stolonifera vars.), Bluejoint Grass (Calamagrostis canadensis), Panicum lanuginosum (Panic-grass), Reed Canary-grass (Phalaris arundinacea), Intermediate Bunch-Grass (Sphenopholis intermedia) (not Glyceria), and the weedy grasses Orchard Grass (Dactylis glomerata) and Timothy (Phleum pratense).
5. *HERBS, low: Water Horehound and Bugleweed (Lycopus spp.) are typical; Kalm’s Lobelia (Lobelia kalmii); Linear-leaved Loosestrife (Lyssimachia quadriflora); Small-flowered Purple Gerardia (Gerardia purpurea var. parivflora).
6. HERBS, high: Boneset (Eupatorium perfoliatum); Common St. John’s Wort (Hypericum perforatum); Joe Pye-weed (Eupatorium maculatum); Narrow-leaved Goldenrod (Solidago graminifolia); Purple Loosestrife (Lythrum salicaria); Virginia Mountain Mint (Pycnanthemum virginianum).
7. SHRUBS: Red-osier Dogwood (Cornus stolonifera).
8. TREES: Ash, Cottonwood, Willows.

HISTORICAL RECORDS:
VASCULAR PLANTS
Shepherdia canadensis CANADIAN BUFFALO-BERRY. With specimen of the fungus Aecidium allenii Clinton, 1870 (BUF).

LICHENS

FUNGI

RECENT COLLECTIONS:
VASCULAR PLANTS: WEST END OF SECOND SISTER
Acer saccharum SUGAR MAPLE. Abundant, with seedlings, saplings [obs. 1988].
Achillea millefolium COMMON YARROW. [Obs. 1988].
* Agrostis stolonifera var. compacta CREEPING BENT. 1988.
* Agrostis stolonifera var. major REDTOP. 1988.
* Alliaria officinalis GARLIC MUSTARD. [Obs.
Part II: Vegetation


Allium canadense WILD GARLIC. [Obs. 1988].

Angelica atropurpurea PURPLE-STEMMED ANGELICA. 1986.

Arabis laevigata SMOOTH ROCK CRESS. 1986.
Aralia nudicaulis WILD SARSAPARILLA. [Obs. 1988].

Aralia racemosa SPIKENARD. 1987.


* Barbarea vulgaris WINTER CRESS. [Obs. 1988].

Betula papyrifera PAPER BIRCH. Far end, 1988 [obs.].

Betula populifolia GRAY BIRCH. Far west end, 1988.


Carex spp. SEDGE. Several woodland species were noted, too late for collection, 1988. *

Campanula rapunculoides CREEPING BELLFLOWER. 1987.

Carex eburnea BRISTLE-LEAVED SEDGE. Pathside by west end [obs. 1988].


Carex rosea ROSE SEDGE. 1987.

Carya cordiformis BITTERNUT HICKORY. 1988.

Chelone glabra var. dilatata TURTLEHEAD. 2180587.


Cirsium sp. THISTLE. [Obs. 1988.]

Clematis virginiana VIRGIN'S BOWER. Southern exposures, 1986.

Cornus alternifolia ALTERNATE-LEAVED DOGWOOD. [Obs. 1988.]


Cornus stolonifera RED-OISER DOGWOOD. Abundant in west end, northern margins, alluvium, 1988 [obs.]. *

Dactylis glomerata ORCHARD GRASS. [Obs. 1988.]

Dentaria laciniata CUT-LEAVED TOOTHWORT. “Small colony, central woods” 1986. *


* Epilobium hirsutum HAIRY WILLOW-Herb. 1988 [obs.].


Eupatorium maculatum JOE-PYE WEED. Alluvium, 1988 [obs.].

Eupatorium perfoliatum THROUGHWORT. Alluvium, 1988 [obs.].

Eupatorium rugosum WHITE SNAKE-ROOT. Throughout, 1988 [obs.].

Fagus grandifolia BEECH. [Obs. 1988.]

Fraxinus americana-F. pensylvanica Abundant seedlings, saplings, trees [obs. 1988].

Fraxinus americana-F. pensylvanica Alluvium, 1988 [obs.].


Geum aleppicum var. strictum YELLOW AVENS. 1988.

Geum canadense WHITE AVENS. [Obs. 1988].

* Glechoma hederacea GILL-OVER-THE-GROUND. Abundant in woods section [obs. 1988].


Iris versicolor BLUE FLAG. 1987.

Juncus dudleyi DUDLEY'S RUSH. 1986.


* Leonurus cardiaca MOTHERWORT. [Obs. 1988].

* Lithospermum officinale COMMON GROMWELL. [Obs. 1988.]

Lobelia siphilitica GREAT LOBELIA. 1986.

* Lonicera tartarica TARTARIAN HONEY-SUCKLE. Abundant [obs. 1988].

Lysimachia ciliata FRINGED LOOSESTRIFE. Alluvium [obs. 1988].

* Lythrum salicaria PURPLE LOOSESTRIFE. Alluvium, 1988 [obs.].

* Morus alba WHITE MULBERRY. Abundant seed-

* Nepeta cataria CATNIP. Forested section, 1986.

Onclea sensibilis SENSITIVE FERN. 1987.

Ostrya virginiana HOP-HORNBEAM. Abundant [obs. 1988].

Oxalis stricta UPRIGHT YELLOW WOODSORREL. [Obs. 1988.]

Panicum lanuginosum var. septentrionale NORTHERN WOOLLY PANIC-GRASS. 1986.

Physocarpus opulifolius NINE-BARK. River margins, north side, dense, 1988 [obs.]

Physocarpus opulifolius var. intermedius NINE-BARK. River margins, 1985.


Pinus strobus WHITE PINE. 1986.

* Poa annua SPEAR GRASS. [Obs. 1988.]

* Poa compressa CANADA BLUE-GRASS. On rocks in center of the island [obs. 1988].


* Potentilla recta SULPHURY CINQUEFOIL. [Obs. 1988.]


Prunus serotina BLACK CHERRY. [Obs. 1988.]

Prunus virginiana CHOKECHERRY. [Obs. 1988.]

Quercus [cf. macrocarpa] BUR OAK [obs. 1988.]

Quercus borealis var. maxima RED OAK. Several, 1988.


* Rhamnus cathartica COMMON BUCKTHORN. [Obs. 1988.]

Rhus radicans POISON IVY. [Obs. 1988.]

Ribes americanum WILD BLACK CURRANT. [Obs. 1988.]

* Ribes sativum RED CURRANT. [Obs. 1988.]

Rubus odoratus PURPLE-FLOWERING RASPBERRY. Alluvium, 1988 [obs.].

Rubus strigosus RED RASPBERRY. Several in rocky center [obs. 1988].

* Rumex crispus CURLED DOCK. 1988 [obs.].


* Sambucus canadensis ELDERBERRY. 1986.

Sambucus pubens RED-BERRIED ELDER. [Obs. 1988.]

Scirpus atrovirens DARK-GREEN BULRUSH. 1986 [obs. 1988].

Scutellaria lateriflora MAD-DOG SKULLCAP. Wet area, 1986.

Smilacina racemosa FALSE SOLOMON'S SEAL. [Obs. 1988.]


* Solanum dulcamara BITTER NIGHTSHADE. 1986.

Solidago caesia BLUE-STEMMED GOLDENROD. 1987.

Solidago canadensis var. canadensis CANADA GOLDENROD. 1987.

Solidago canadensis var. scabra TALL GOLDENROD. 1988.


Teucrium canadense AMERICAN GERMANDER. [Sight record by Al Schotz, 1988.]

Thuja occidentalis ARBOR VITAE. Single small tree on boulder top by bridge to Third Sister [obs. 1988].

Tilia americana BASSWOOD. By alluvial area, 1988 [obs.].

Triosteum perfoliatum var. aurantiacum ORANGE HORSE-GENTIAN. [Obs. 1988.]


* Tussilago farfara COLTSFOOT. Alluvium, 1988 [obs.].

Typha latifolia BROAD-LEAVED CAT-TAIL. Alluvium, 1988 [obs.].


Ulmus rubra SLIPPERY ELM. 1988.

Verbena hastata COMMON VERVAIN. 1985.

Verbena cf. urticifolia WHITE VERVAIN. [obs. 1988].

* Viburnum lantana WAYFARING-TREE. [Obs. 1988.]

Vitis riparia FROST GRAPE. Especially near wet end [obs. 1988].

FUNGI: WEST END OF SECOND SISTER

Cladobotryum varium. Second Sister, west end, on Trametes versicolor, 2 Nov 1988, Buck 16367A
Part II: Vegetation

(GN).


*Hymenoscyphus calyculus.* On dead wood, 2 Nov. 1988, Buck 16374 (NY).


*Leucostoma persoonii.* In oak-maple forest; on dead *Prunus*, Buck 16366, November 2, 1988 (NY, BUF).

*Trametes versicolor.* On stump, 1 Nov 1988, Buck 16367 (BUF, NY).

**LICHENS: WEST END OF SECOND SISTER**

*Bacidia granosa.* In central woods, on rock, Harris 22895 (NY); Harris 22903 (NY); Harris 22924 (NY).

*Bacidia* sp. On lignum, Harris, 16375 (NY).

*Bacidia* sp. On decorticate stump, Harris, 22893 (NY).

*Caloplaca flavovirescens.* Large boulder on south side, Harris 22912 (NY).

*Caloplaca* sp. On ridge, south side, on rock, Harris 22888 (NY).

*Candelaria concolor.* On *Quercus*, Harris 16387 (NY).

*Candelariella efflorescens.* On *Salix*, Harris 16377 (NY).

*Cladonia humilis*—bourgeanic acid strain. On rotten log, Harris 16383 (NY).

*Endocarpon pusillum.* In woods, on rock, Harris 22895 (NY); on rock, Harris 22942 (NY).


*Hedwigia ciliata.* On glacial erratic, 2 Nov. 1988, Buck 16380 (NY).

*Homomallium adnatum.* On glacial erratic, 2 Nov. 1988, Buck 16380 (NY).

*Hypnum lindbergii.* 2 Nov. 1988, Buck 16390 (BUF, NY).


*Phacopsrella minor.* On rotten log, 2 Nov. 1988, Buck 16386 (BUF, NY).

*Philonotis muhlenbergii.* Tree roots, wet in high water, Oct. 29, 1988 (BUF).

*Plagiothecium cavifolium.* 2 Nov. 1988, Buck 16370 (NY), 16376 (BUF, NY).

*Plagiomnium cuspidatum.* On rock, Harris 22901 (NY).

*Platygryium repens.* On rotten log, 2 Nov. 1988, Buck 16369 (BUF, NY).

*Tetraphis pellucida.* Tree roots, wet in high water, Oct. 29, 1988 (BUF); west end, on rotten log, 2 Nov. 1988, Buck 16371 (BUF, NY).

*Thuidium delicatulum* var. *delicatulum.* Tree roots, wet in high water, Oct. 29, 1988 (BUF); west end, 2 Nov. 1988, Buck 16373 (BUF, NY).
VASCULAR PLANTS:
EAST END OF SECOND SISTER
A frequently appearing rosaceus shrub/small tree, Prunus or possibly Amelanchier, is diseased here, as it is on the west side. There is also a viny species of Vicia or Lathyrus near the southern end near the bridge.
Acer saccharum SUGAR MAPLE.
Achillea millefolium COMMON YARROW. 1987.
Agrostis stolonifera var. compacta CREEPING BENT. 1988.
Agrostis stolonifera var. major REDTOP. 1988.
Agrostis stolonifera var. stolonifera CREEPING BENT. 1988.
Arabis laevigata SMOOTH ROCK CRESS.
Asclepias incarnata SWAMP MILKWEED. 1986.
Arabis laevigata SMOOTH ROCK CRESS.
A clepsis incarnata SWAMP MILKWEED. 1986.
Atriplex patula var. littoralis SEASIDE ORACHE. 1987.
Cardamine pensylvanica PENNSYLVANIA BITTER CRESS. 1987.
Carex spp. Several Carexes were unsuitable for collecting in the 1988 growing season on both east and west sides.
Carex cephalophora SOUTHERN SEDGE. 1988.
Carex hystricina PORCUPINE SEDGE. 1988 [Obs.]
Carex lasiocarpa var. latifolia WOOLLY SEDGE. 1987.
Carex normalis LARGER STRAW SEDGE. 1987.
Dactylis glomerata ORCHARD GRASS. All along weedy margins of paths, 1988
Erigeron philadelphicus PHILADELPHIA FLEABANE. 1987.
Eupatorium perfoliatum BONESET. River's edge, 1988 [obs.].
Fragaria sp. STRAWBERRY. [Obs. 1988.]
Fraxinus sp. ASH. Abundantly regenerating itself throughout the island, 1988.
Gerardia purpurea var. parviflora SMALL FLOW-ERED PURPLE GERARDIA. 1986.
Helenium autumnale COMMON SNEEZEWEED. “Shrubby area ... wet dolomite,” 86121414.
Hemerocallis fulva DAY LILY.
Hesperis matronalis DAME'S ROCKET.
Hieracium pratense KING-DEVIL. 8705306.
Juncus articulatus JOINTED RUSH. 1986.
Juncus effusus var. solutus COMMON RUSH. 1988.
* Lithospermum officinale COMMON GROMWELL.
Lobelia kalmii KALM'S LOBELIA. 1986.
Lycopus virginicus VIRGINIA BUGLEWEED. 1988
Lysimachia quadriflora LINEAR-LEAVED LOOSESTRIFE. On edge of soil mat, east end, July 14, 1987
Lythrum salicaria PURPLE LOOSESTRIFE. Edge of mat, 1988 [obs.]
Medicago lupulina BLACK MEDICK. North
Part II: Vegetation

shore, open, rocky area. 1988.
Mentha arvensis var. glabrata AMERICAN WILD MINT. 1986.
* Nepeta cataria CATNIP. North side [obs. 1988].
Ostrya virginiana HOP-HORNBEAM. 1986.
Panicum lanuginosum var. lindheimeri LINDHEIMER'S PANIC GRASS, 1986.
Parthenocissus quinquefolia VIRGINIA CREEPER. 1988.
* Poa compressa CANADA BLUE-GRASS. [Obs. 1988.]
Pycnanthemum virginianum VIRGINIA MOUNTAIN MINT. 1986.
* Rhamnus cathartica COMMON BUCKTHORN. 1986.
Rhus radicans POISON IVY. 1988.
Rubus occidentalis BLACK RASPBERRY. 1988.
* Sagina procumbens PEARLWORT. 1987.
* Salix alba WHITE WILLOW. 1988.
Salix discolor PUSSY WILLOW. 1988.
* Salix fragilis CRACK WILLOW. Wet eastern end, shrub, hybrid with S. alba. 1988.
Sambucus sp. ELDERBERRY. 1988.
Scutellaria lateriflora MAD-DOG SKULLCAP. 1986.
Solidago canadensis var. canadensis CANADA GOL
GOLDENROD. 1988.
Solidago canadensis var. scabra TALL GOLDENROD. 1988.
Solidago juncea EARLY GOLDENROD. 1988.
Solidago nemoralis GRAY GOLDENROD. 1987.
* Symphoricarpos orbiculatus CORALBERRY. By bridge to First Sister, 1987.
* Taraxacum officinale DANDELION. [Obs. 1988.]
Tilia americana BASSWOOD. [Obs. 1988.]
* Trifolium hybridum ALSIKE CLOVER. 1988.
Ulmus rubra SLIPPERY ELM. By bridge [obs. 1988.]
* Verbascum thapsus COMMON MULLEIN. [Obs. 1988.]
Viola sp. [Obs. 1988.]

FUNGI: EAST END OF SECOND SISTER
Scolecosporiella typhae. On dead leaves of Typha angustifolia, 2 Nov 1988, Buck 16397 (NY).

-171-
STATE, on rock, Harris 22904 (NY).

*Lecanora dispersa.* Limestone flat, on rock, Harris, 22900 (NY), Harris 22908 (NY).

*Phaeophyscia adiastola.* At base of small *Fraxinus*, Harris 22913 (NY); on rock, Harris 22922 (NY).

*Phaeophyscia orbicularis.* On rock, Harris 22905 (NY).

*Physcia adscendens.* Face of stone block at river's edge, Harris 22897 (NY).

*Verrucaria muralis.* Limestone flat, on rock, Harris 23944 (NY).

*Verrucaria* sp. Harris 22923 (NY).

*Verrucaria* sp. Limestone flat, Harris 22914 (NY).

**BRYOPHYTES: EAST END OF SECOND SISTER**

*Amblystegium tenax* var. *tenax.* 2 Nov. 1988, Buck 16398 (BUF, NY), 16403 (BUF, NY), 16406 (BUF, NY).

*Brachythecium oxycladon.* 2 Nov. 1988, Buck 16399 (BUF, NY), 16412 (BUF, NY).

*Campylium chrysophyllum.* 2 Nov. 1988, Buck 16396 (BUF, NY).

*Cratoneuron filicinum.* 2 Nov. 1988, Buck 16408 (BUF, NY).

*Drepanocladus aduncus.* 2 Nov. 1988, Buck 16407 (BUF, NY).


*Hypnum lindbergii.* Thin soil over dolomite flats, open with *Salix, Cornus, Betula, Lythrum, Carices, Eckel 86121701, Sept. 12, 1986 (BUF); 2 Nov. 1988, Buck 16404 (BUF, NY).

*Philonotis marchica.* 2 Nov. 1988, Buck 16394 (NY).

*Plagiomnium cuspidatum.* 2 Nov. 1988, Buck 16401 (BUF, NY).


*Schistidium alpicola.* 2 Nov. 1988, Buck 16411 (NY).
Reclamation of the Second Sister, 28 Ann Rep Comm, 1912. The retaining wall is visible on the north side presented to the viewer.

View from Third Sister Island, 9 Ann Rep Comm, 1894.
3. Third Sister Island
The Third Sister Island is the farthest out from Goat Island of the Three Sisters. The Third Sister was drawn on the 1883 survey map for the first Commissioners of the Niagara Reservation by Thomas Evershed with its characteristic margins made uneven by large boulders. The vegetation then was intact but for a little path indicated on the north end of the island, extending to the west. The bridge to this island was built by the Porters in 1869 (16 Ann Rep Comm, 1900). Between that time and 1897 a walk had been constructed on this island, because it was replaced in 1897 (14 Ann Rep Comm, 1898).

The Third Sister Island may have been continuous with Brother Island just to the west, or downriver, of it: “within a year or two the action of the water has opened a fissure nearly half way through the western portion of the Third Sister island, and trees growing on the islands, undermined by the current, have fallen into the stream” (2 Ann Rep Comm, 1886). In years when the water in the Great Lakes is high, as in 1987, the shallow margins of parts of the Reservation become inundated as could be seen on the western extremity of the Third Sister. The present reason why there is no vegetation on the western end is partly due to removal of vegetation and loss of soil, but also by the soil being washed away during periods of high water (personal observation, 1987). Low areas on the west end of the Second Sister also become inundated for the same reasons.

The heavily wooded and densely shrubbed vegetation of Brother Island, only a few yards away from the denuded banks of the Third Sister give an impression of the density of the primary vegetation, although the absence of conifers there is suggestive of disturbance.

The Third Sister displays old ironworks, concrete patches and walls which are relics of earlier structures. For example, there may have been an electric cable out to the island and a lamp post installed. This island must have always been a pedestrian terminus of some sort away from Goat Island out into the great river.

Originally, the zonation of the flora would have been like that of the First Sister and other islands: trees in the center, such as Sugar Maple, Hemlock, White Pine becoming more open, with willows, etc. on the margins.

Today, the zonation is roughly polished stone in the center, this ringed by a zone of weedy native and alien vegetation, such as Milkweed (Asclepias syriaca), Dandelion, etc. The closer one is to the river's edge and inaccessibility, the more intact the native floristic remnant is; there are an especially large number of Chokecherry (Prunus virginiana) trees here, on the west end. The most intact and complex plant community exists in the thin strip of graminoid vegetation at the water margin and close against the bases of trees on the south-central to southeast portions of the outer margins, and somewhat on the northwest margin.

Boulder surfaces isolated from public access because they are surrounded by water have native vegetation. Other boulder surfaces, if they have vegetation at all, support urban weeds (compare boulder tops in the First Sister section above). The Willows, which are Salix alba—S. fragilis, have been planted a long time ago. The avenue by which weeds are introduced is the asphalted path connecting all the islands with Goat Island. If one follows the margins of this path, and that of the lawns beside them, one may see a strip of urban vegetation leading back to Goat Island.
Third Sister, summer 1988. Boulder tops are sentinel points by which visitors seek more compelling views of the rapids, and destroying all vegetated surfaces. Boardwalks or other viewing structures might be an alternative. The Three Sisters was once called the Moss Island, primarily because of the once dense bryophyte or moss communities that covered these rocks.
Third Sister, spring, 1988. Note the iron ring.

Third Sister, summer, 1988. Plant community on the river’s edge is only somewhat intact native plant community. It is composed of mosses, grasses, sedges and rushes, Bugleweeds (*Lycopus* sp.), and seedlings of shrubs.
VASCULAR PLANTS:
GENERAL DISTRIBUTION

**Arenaria lateriflora** SIDE-FLOWERING SANDWORT. 1886, Elizabeth C. Rochester (BUF).

**Aster ericoides** HEATH ASTER. 1988.
**Atriplex patula** var. *littoralis* SEASIDE ORACHE. By bridge, 1988.

* **Cerastium vulgatum** COMMON MOUSE-EAR CHICKWEED. 1987.


**Elymus virginicus** VIRGINIA WILD RYE. South shore, base of willow [obs. 1988]

**Eupatorium rugosum** WHITE SNAKE-ROOT. Throughout, 1988 [obs.]


**Lepidium virginicum** COMMON PEPPERGRASS. 1988.

**Lycopus americanus** CUT-LEAVED WATER HOREHOUND. 1988.

**Lycopus virginicus** VIRGINIA BUGLEWEED. 1986.


**Muhlenbergia frondosa** LEAFY MUHLENBERGIA. 1988.

**Muhlenbergia sylvatica** WOODLAND DROPSEED. 1988.

**Physocarpus opulifolius** NINE-BARK. 1896.

* **Plantago major** COMMON PLANTAIN. 1986.

* **Poa annua** SPEAR GRASS. 1986.


* **Salix alba** WHITE WILLOW. 1988.


**Solidago caesia** BLUE-STEMMED GOLDENROD. 1988.

**Solidago canadensis** var. *scabra* TALL GOLDENROD. 1988.

**Solidago graminifolia** NARROW-LEAVED GOLDENROD. 623386.

VASCULAR PLANTS: WEST END OF THIRD SISTER

**Anemone virginiana** THIMBLE-WEED. 1987.

**Asclepias syriaca** COMMON MILKWEED. 1988 [obs.].

**Aster lateriflorus** STARVED ASTER. In rock cavity, 1988.

**Chelone glabra** TURTLEHEADS. 1988 [obs. in roots of Willow, north end].

**Cystopteris bulbifera** BULBLET BLADDER FERN. “Dolomite rocks facing Brother Island,” 87316.


**Muhlenbergia mexicana** WOOD GRASS. 1988.

**Polygonum aviculare** COMMON KNOTWEED. 1988.


VASCULAR PLANTS: EAST END OF THIRD SISTER

**Eupatorium maculatum** JOE-PYE-WEED. 87317.

**Juncus articulatus** JOINTED RUSH. 1986.

**Juncus tenuis** PATH RUSH. 1986.

LICHENS: EAST END OF THIRD SISTER

**Caloplaca citrina**. On rock, Harris 22886 (NY), Harris 22991 (NY).

**Caloplaca flavovirescens**. North side, on rock, Harris 22937 (NY).

**Diplotomma epipolium**. On rock, Harris 22887 (NY).

**Lecanora umbrosa**. NEW TO NEW YORK STATE, north side, on rock, Harris 22940 (NY).

**Lecidella stigmatea**. North side, on rock, Harris 22936 (NY), Harris 22938 (NY), Harris 16432 (NY).

**Lepraria finkii**. On rock, Harris 22919 (NY).

**Verrucaria sp**. Harris 22892 (NY).

LICHENS: WEST END OF THIRD SISTER

**Buellia punctata**. At base of Salix, Harris 22934 (NY).

**Parmelia sulcata**. On lignum, Harris 16437 (NY).

**Phaeophyscia orbicularis**. At base of Salix, Harris 22935 (NY).

**Physcia adscendens**. At base of Salix, Harris 23943 (NY).

**Verrucaria sp**. North side, Harris 22939 (NY).

LICHENS: CENTRAL AREA

**Caloplaca citrina**. South side, on rock, Harris 22989 (NY).

**Lecidella stigmatea**. South side, on rock, Harris 22890 (NY).

BRYOPHYTES: EAST END OF THIRD SISTER
Amblystegium tenax var. tenax. 2 Nov. 1988, Buck 16431 (BUF, NY), Buck 16433 (BUF, NY).


Brachythecium oxycladon. 2 Nov. 1988, Buck 16434 (BUF, NY).

Brachythecium rutabulum. 2 Nov. 1988, Buck 16430 (BUF, NY).

BRYOPHYTES: WEST END OF THIRD SISTER

Didymodon rigidulus. 2 Nov. 1988 Buck 16438 (BUF, NY).

Leptodictyum trichopodium. 2 Nov. 1988, Buck 16435 (NY).

Mnium cuspidatum. In vug of dolomite boulder.  

Tortula mucronifolia. In small solution vugs in dolomite, 8612338, April 27, 1986 (BUF).
4. **Brother Island**

This island lies just west of the Third Sister and downcurrent from it. The vegetation here is dense and lush, heavily wooded and apparently relatively unaltered. A narrow channel separates this island from the heavily trafficked Third Sister. This channel appears to be deep enough to prevent trespass, although the bottom is clearly visible, and the current here seems the most powerful of all the water channels between the other three islands, mainly because it seems to derive from a deep fracture or joint in the underlying dolostone bedrock. Visually many of the shrubs on the margins of Brother Island appear to be Dogwoods, notably *Cornus stolonifera* or Red-Osier Dogwood. A large Horse Chestnut (*Aesculus hippocastanum*) on Brother Island, faces the Third Sister and supports a lovely crop of dense, parti-colored white flower-clusters in early summer. Large willows may be observed here; perhaps these are Black Willow (*Salix nigra*). This island may provide clues to the aboriginal ecology of various parts of Goat Island and other Islands at the brink of the Falls, although the absence of conifers indicates some disruption in the ecosystem.

![Third Sister, summer 1988. Denuded boulder tops, looking west. Broth Island is the dense wall of vegetation beyond the narrow channel into which these visitors are peering.](image-url)
Botanical Heritage of Islands at the Brink of Niagara Falls

after Kindle & Taylor (1913): stippled areas indicate outcrop exposures of Silurian rocks (SI on the 1913 map) Pleistocene and Recent sedimentary deposits representing "recently abandoned channel floors of Niagara River ... cut while falls retreated 1500 to 2000 feet south of Hubbard Point ... falls passing west end of Goat Island ... (and) slightly later cutting" are also shown in stipple, representing the lesser island areas. (One area on the 1913 map). Note that all the prospect areas, except Stedman's Bluff overlooking Luna Island on Goat Island, occur in these geologic areas and associated habitats. The rarest plants occur and occurred in these areas.

Upper Niagara River
Brink of the Horseshoe, from an engraving, 1872. An example of seepage over dolomite bedrock—the exposed reverbed, once the site of the Horned Bladderwort (*Utrichuaria cornuta*) reported by Nuttall in 1818 (Day, 1888).
An example of how these wet flats have disappeared—note the “fill” over jointed bedrock (19ARC, 1903), Canadian falls margin.

“Previous to 1812, most of the large forest trees north of Bridge Street (New York) had been cut down, but young trees and undergrowth, particularly near the river, grew very thick and close, quite down to the Falls. On the Canadian side, with the exception of a small flat where Barnett’s Museum now stands, the whole flat from Table Rock to the Clifton House, was a swamp, covered chiefly with cedars. Cedars also grew thickly on the declivities below the perpendicular bank on both sides of the river, adding much to the general effect of the scenery” (Porter, 1875). 

---

Botanical Heritage of Islands at the Brink of Niagara Falls
F. THE OLD RIVER MARGIN HABITATS

The flora of recently abandoned river channels: It is possible that the floras of Dufferin Islands and the entire frontage area of the Queen Victoria Park from Dufferin Islands to the present Rainbow Bridge were closely related with a distinctive floristic composition related to that of the old Terrapin Rocks, the Three Sisters, the southeastern extremity of Goat Island, the islands in the American channel and the river front from the eastern boundary of the Reservation to the brink of the Falls. These areas may have been related floristically because of factors of time (the events in the river which created similar substrates), in the kind of substrate (exposed calcareous rock, or such covered with thin soil or gravel), exposure to inundation events at the shoreline and the spray at the Falls and ice-stress in winter.

Note that on the Kindle-Taylor geologic map (1913) there were a series of lowered water level events, not simply one, with younger and younger communities developing outward from older river and glacial deposits in the center of the complex.

Since these geological-hydrological events were caused by fluctuating water levels in the Great Lakes, and in the same floristic region, similar plant communities should be found in many areas of the region.

Along the river the presence of conifers fringing the lower margins of the deciduous forest of the talus slopes above them may also be due to the relative youth of the exposed river bank due to lower Great Lakes water levels and corresponding lowered water levels in the river, and to the effects of ice-scour and sudden inundation in this essentially dry bedrock habitat. This conifer woods seems best developed where a ledge of bedrock has been exposed, such as at the Whirlpool, especially on the Canadian side. Shortness of duration of sunlight, cool moisture from the foaming rapids and long periods of cold in spring due to ice continuing to be brought down the river from Lake Erie upstream also contribute to conditions favoring a conifer element.

Cedar Island, an island in the Queen Victoria Niagara Falls Park in Ontario, destroyed by 1913 by commercial exploitation of the water channel between it and the mainland near the brink of the Horseshoe Falls, was reported to have possessed the following characteristics:

"[It consisted] ... largely of gravely soil, enriched by leaves and silt washed from the river. The Legumes are well represented here. Some beautiful shrubs, and towards autumn, the asters and golden rods decorate the attractive island. Several varieties of St. John's Wort and masses of wild Bergamot [Monarda sp.] cover many spots" (Panton, 1890).

The following catalogue is a representation of the flora of this lost island derived from the literature of the period, and specimens in the Queen Victoria Park School of Horticulture (NFO):

- *Anemone cylindrica* LONG-FRUITED ANEMONE. 1890.
- *Carex lupulina* HOP SEDGE. "Near Cedar Island," Cameron 1892 (NFO).
- *Decodon verticillatus* SWAMP LOOSESTRIFE. 1893.
- *Equisetum variegatum* VARIEGATED SCOURING-RUSH. 1891.
Hieracium scabrum ROUGH HAWKWEED. 1893.
Hypericum canadense CANADIAN ST. JOHN'S-WORT. 1893.
Hypericum kalmianum KALM'S ST. JOHN'S-WORT. “On Cedar island, in the vicinity of the bridge crossing to the mainland on the way to Dufferin Islands” (Panton, 1890).
Monarda fistulosa BERGAMOT. “Very common on Cedar Island, wild” (Panton, 1890).
Physostegia virginiana FALSE DRAGON-HEAD. 1890.
Ranunculus aquatilis var. capillaceus WHITE WATER CROWFOOT. 1891.
Shepherdia canadensis CANADIAN BUFFALO BERRY. “Very common along the paths on the islands, especially Cedar island” (Panton, 1890).
* Vicia sativa VETCH. “There are no doubt many other species of legumes which have escaped the writer's notice as yet. The Bean family is well represented in many parts, but especially in Cedar Island, where its representatives line the beautiful pathways through this sylvan spot” (Panton, 1890).

The recently abandoned channel floors have a particular flora: soils will be relatively immature, possibly with coarse sediments and consequently well drained (Kindle & Taylor, 1913). There will be seepage in places from drainage out of contiguous older glacial moraine or riverine sediments onto the exposed riverbed, such as at the Spring on Goat Island, and the flat land adjacent to the crest of the gorge in the park on the Canadian side, and periodic inundations with fluctuating river levels. There exist many fine nineteenth century drawings and photographs of these habitats showing the Canadian side, especially at the brink of the Horseshoe Falls. There will be ice-scour and water scour at the water's edge due to storm surges. River gravels will build up as on Cedar Island and the islands in the American Channel and support trees—colonizing evergreens on the immature, shallow soils which dry out quickly—especially Arbor Vitae, which appear to be able to tolerate both extremes. Areas of poor drainage may occur, as in what is now Queen Victoria Park in Ontario, where in 1799 “there was still a pond north of Table Rock House with cedar and ash swamps between it and the bluff, [that is, the Niagara Moraine]” (Tiplin, 1988).

But it is the area of exposed riverbed by the brink of the Horseshoe Falls which calls to the imagination certain habitats and their floras, some of which have been eliminated from Goat Island. On the Ontario side there was a “small patch of low lying wet soil, extending from Table Rock to Cedar Island. This is one of the richest areas in the whole park. It abounds with flowers of many varieties. It is largely swampy but shallow. Here can be found forms peculiar to dry areas where such exist and all the varieties found in wet places. There are three Loosestrifes here, and the attractive Lobelia kalmii. On one occasion we gathered twenty species of purple flowers in this comparatively small area which may be well considered an “Eldorado” for botanists” (Panton, 1890).

This description most closely resembles the rock-flora of the remnant of the Terrapin Point Complex as it occurs at the extreme tip of what is now called Terrapin Point: Gentianopsis procera, Gerardia, Lobelia kalmii (see section on Terrapin Point).

It also suggests the grassy mats on the Second Sister, east side. Since most of the purple flowered species are conspicuous in summer and fall, it was probably then that Panton saw his purple flowers.
species of Gerardia, Gentian, of Lobelia and Aster, and species of the mint family.

The last population of Linear-leaved or Four-flowered Loosestrife (*Lysimachia quadriflora*) in New York State occurs in a habitat such as this on Goat Island, as does the more generally distributed Fringed Loosestrife (*Lysimachia ciliata*). The Tufted Loosestrife (*Lysimachia thyrsiflora*) has been reported several times from the wet areas near the Falls (Day, 1888; Panton, 1890; Cameron, 1895).

The second floral component of these recently exposed river channels is the conifer shore-line forests.

As recently as seven hundred years ago, the cataracts existed just north of Goat Island, presenting one continuous crestline (Otis, 1982). The level of water in the river reached up to at least the base of the sedimentary bluff on Goat Island's west end. This was at a time when the forest at this end of the island was a shoreline, not a crestline, as would be the case for the aboriginal crest forests all along the present seven mile length of the Niagara Gorge. Two shorelines were created as the gorge extended southward—one along the shore of the Niagara River above the falls, later to become abandoned as a crestline, the other being created at the base of the gorge and extending south with the lengthening of the gorge.

At the river margin the presence of conifers fringing the lower margins of the deciduous forest typical of the upper talus slopes may be due to the relative youth of the exposed river bank due to lower Great Lakes water levels and corresponding lowered water levels in the river. The effects of ice-scour, sudden inundation followed by periods of dryness and warmth due to shallowness of soil may have been tolerable to these trees, as the deciduous element favored areas of deep sediment (moraine on the upper banks, talus on the lower slopes). Shortness of duration of sunlight, cool moisture from the foaming rapids and long periods of cold in spring due to ice continuing to be brought down the river from Lake Erie upstream also contribute to conditions favoring a conifer element at the extreme base of the gorge.

This scenario is well depicted in the pre-camera paintings, drawings, engravings, etc., made of the cataract and gorge landscapes when these forest communities were still relatively intact (see the Pictorial Tradition and Terrapin Point sections). The two pictures by Cockburn drawn around 1833 discussed in the first of the two chapters just mentioned, suggests that the physiognomy of the crestline and the basal area forest of the talus slope in the gorge were the same, composed of evergreen trees behind which occurred the typical deciduous forests of the region, including the talus slopes above the basal evergreen community. Depictions showing deciduous forest with scattered evergreens perhaps are later modified or replacement mixed forest communities.

As has been stated elsewhere in this manuscript, the crest areas were among the first forests to be cleared along the gorge rim, due to their use as prospect areas.

This scenario should still exist in some areas in the Great Lakes region and can be tested on the rocky shoreline pavements there, provided the natural relationships are truly analogous, including the genesis of bedrock flats areas at lake water-boundaries (from lowered water levels or exposure from isostatic rebound on northern lake rims). This phenomenon may be only related to the hydrology of lakes and major rivers and not, e.g. communities along the Niagara Escarpment.

In the testimonials and old depictions, the evergreen trees may have been White Pine on the drier
areas and gorge crests, such as at Whirlpool Park (see discussion, Crest Woods) and parts of the Three Sisters. Hemlock may have occurred in the spray areas and protected habitats such as Dufferin Islands and the western end of the Second Sister (28 Ann Rep Comm, 1912)—there are still a number of these to be found at the base of the talus slope in the gorge. On rocks in the plunge pool near the cataracts, Arbor Vitae (*Thuja occidentalis*) may have favored the river margins as well, and Red Cedar (*Juniperus virginiana*) above, in the open, successional areas on the southeastern side of Goat Island, and the ridge of slopes and bluffs, as at Wintergreen Flats above Niagara Glen, Ontario today. It is possible that these areas visually contributed a great deal to the original prospect at Niagara. This reconstruction takes into account the illustrated caricatures of Hennepin’s written description of the falls (see series in 16 Ann Rep Comm, 1900).

One interesting characteristic of these plant communities associated with lowered water levels was the development of vegetation mats of various sizes with plant communities composed of species with similar growth form and habit arranging themselves in concentric zones, from minute species in the outer extremities in toward shrubs and young trees in the center. Probably the best expression of these mats and the concentric zonation on them occurs on the east end of the Second Sister. The nuclei around which such mats may originate might be investigated in the exposed riverbed near the eastern ends of the Three Sisters, and the succession studied.

This peculiar zonation may have also occurred and be still occurring on the little islands in the present channels of the American and Horseshoe Falls. When Louis Agassiz (1850) noted seven tree species: Arbor Vitae, Red Cedar, Hemlock, Basswood, Chestnut-Oak, White Pine and Maple, growing on “the little islet (only a few feet in extent)” called Ship Island in the American channel, it is difficult to imagine how these species with their different habitat requirements for light, shade, moisture and good drainage, arranged themselves in such a tight space, if not in some pattern, such as concentric zonation, with the deciduous trees, at least, in the center.

It would be interesting to note how the soil is or was stratified as to depth and sediment size, and whether this could have had an effect on community structure, and whether the soil was developed as a result of processes of succession or of river or glacial deposit.

The nucleus for the development of these mats from nothing may start with a solution cavity or vug in the dolomite river channel. After an accumulation of clam, crayfish, etc. shells, such as those discarded by gulls, and sediment and algae, occasionally a rather large plant establishes itself, such as a willow, or recently Purple Loosestrife (*Lythrum salicaria*). The roots of this plant become “pot-bound” coiling up in the cavity and consequently anchoring itself against the rather swift, if occasional, current. Around these roots then moss, such as species of the pleurocarpous genus *Amblystegium*, establish themselves. Within the moss substrate succession from smaller to larger species begins to take place. Once the mat is established, it increases its area at the margins mainly by the moss community fixed there—if wet margins, then mosses of the acrocarpous genus *Philonotis* may become introduced. As the moss population becomes extensive, the next life-form group extends itself into it outward from the center. The biggest size groups occur at the center, consequently contributing more biomass, creating conditions for the introduction of the next largest life-form group—the ultimate being a tree—presently willow or ash.
In the aboriginal condition, conifer trees may have formed a part of this process, especially the Arbor Vitae, after which several of Niagara's islets have been named.

Numbers of individuals of any species are most numerous in the tiniest, shortest plants in the outer zones, decreasing inwards with increase in species size and height with usually one tree or one shrub at the center.

Not all vegetated mats and islets seem to follow this hypothetical process, however, especially those recently developed in the flats areas on the south side of Goat Island. Brother Island, never accessible to the public, does not seem to show this zonation. Perhaps only mats begun from solution cavities develop this way, as if there were another form of succession.

It is for this reason that if more riverbed is exposed through lower water levels, it is here recommended that lawn-scenes not be established, as they have been on the south side of Goat Island and at Terrapin Point, but that nature be allowed to construct an ecosystem out of this land, as has been and is being done in the southern flats area and elsewhere in the complex.

For further discussion see section on the Second Sister Island.
G. ROCKY BANKS AND BOULDER HABITATS

References were made in the early travel literature to habitats not evident today, or bereft of their original vegetation. DeWitt Clinton noted that “the banks of the river about the falls are lined with white pine and cedar” (Clinton, 1822), two trees nearly exterminated from the Goat Island complex today except for certain reintroductions of White Pine, and that not on the banks (see early photographs in this report).

Porter quoted Hennepin as observing Goat Island in 1678 to be “full of cedar and firr” (16 Ann Rep Comm, 1900)—an observation seconded by Francois Andre Michaux, who emphasized the growth of Arbor Vitae, or White Cedar (Thuja occidentalis) on the island’s borders (Michaux, 1819).

A series of prints made of the prospect from the Canadian shore facing Goat Island said to be based on descriptions made by Hennepin show a conifer element restricted to all the margins of the Niagara River (reprinted in 16 Ann Rep Comm, 1900).

Information on at least the idea of the herbaceous component of the shoreline is only suggested from the plan of Olmsted and Vaux (1887), where they recommend that shoreline ballast on the mainland serve as revetments “for banks of soil in which the dwarf willows, rushes, ferns, irises, flags and other water side plants of the region would be planted ... with a result in view that would differ but little in character from that of the natural, low, rocky shores of the neighboring islands.”

The First of the Three Sisters, and portions of the other two today may demonstrate somewhat the nature of the primeval rocky river-banks of Goat Island, and the boulder-top flora. “Beautiful plants grow among the boulders, the rocks on the banks of the river, such as the gueldar rose, the white cedar, the Rubus odoratus, now flowering in all its loveliness, the lime [Tilia americana], maple, and sumac [Rhus typhina]” (Wied-Neuwied, 1834). It was on the top of a “large rock” on the north slope of Goat Island near Luna Island that George Clinton found the moss Anomodon viticulosus, and around where Leo Lesquereux had found it previously (see section in Clinton’s journal for October 21, 1865).

The absence of Lyre-leaved Rock Cress (Arabis lyrata) on Goat Island, so beautifully displayed on the First Sister, may be due to loss of boulder habitats on Goat Island. Boulder-top communities, to judge from those developed on the Three Sisters, typically support extensive bryophyte (moss and liverwort) communities, lichens, Bristle-leaved Sedge (Carex eburnea), ferns, such as the Maidenhair Spleenwort (Asplenium trichomanes) and Common Polypody (Polypodium virginianum), the last of which is now absent from the Goat Island complex. The Sharp or Blunt-leaved Hepatica, reported by Day (1888) and both now extirpated from Goat Island, thrives on soil-covered boulder tops, as can be seen today at Niagara Glen (Niagara River Gorge, Ontario). A vivid orange color on boulders of the Three Sisters near the water's
Part II: Vegetation

edge, best seen in the winter months, is due to an alga: a species of *Trentepolia*.

Loss of boulder-top habitats seems to have been due to two major factors: removing them for use as a landscape decoration, and using the native rock, in situ, as a bench, or for climbing on top of.

In 1895, “rustic stones for restoring the shore to a natural appearance were brought from Goat Island” for improvement of the shore of the river between Prospect Park and Mill slip (12 Ann Rep Comm, 1896). River-channel rocks, without any vegetation, may be seen today, placed at the lawn corners on Luna Island.

The most severe example of loss of boulder-surface habitat may be seen on the Third Sister Island during the tourist season when busloads of travelers disembark here for a twenty minute or so chance to stretch their legs and take pictures before proceeding with their tour. Boulder tops there are polished surfaces, and the vegetation on the margins is cluttered with lawn weeds.

Third Sister, summer 1988.
Botanical Heritage of Islands at the Brink of Niagara Falls

H. STONE BRIDGE TO THE FIRST SISTER

In the final decade of the nineteenth century, several “rustic stone-arched bridge” constructions, all now gone, were built on the mainland part of the Reservation, such as at Willow Island, including the rustic bridge, the “Bowlder Bridge,” on the west side (12th Report), and the Weir Bridge (13th Report), with accompanying photographs (12, 1896 and 13 Ann Rep Comm, 1897). A “rustic stone-arched bridge and forest coping” was built on the mainland made of “water-worn stones ... collected in the fields in the outskirts of the city,” and another stone arched bridge was built at the outlet of a pond at Port Day in 1896 (13 Ann Rep Comm, 1897). A photograph of a rustic bridge at Port Day, and one of the French Landing Bridge was printed (14 Ann Rep Comm, 1898).

The stone for certain of these bridges derived from various places, some from stone excavated for the nearby hydraulic canals, from stone fences removed, and some from the Goat Island sediments themselves: “many of the boulders brought here in the ice age ... have been collected ... and used in the construction of the handsome stone bridges that have been built on the Reservation, on the main shore opposite Goat Island” (Porter, 1900).

The bridge to the First Sister was designed by Calvert Vaux. Made of river-bed dolomite or limestone, it duplicates the substratum of the Three Sisters, and other old shorelines and riverbed substrates all along the Niagara River from Niagara Falls to Lewiston.

In 1898, when construction of the bridge to the First Sister was begun following plans drawn by Calvert Vaux, the structure was to appear “rustic,” and it “has a dark gray coloring which harmonized with the surroundings .... Although at present rather massive in appearance, when partially overgrown with vines it will be an exceedingly picturesque and graceful object” (15 Ann Rep Comm, 1899). The bridge was made of stones “removed from the retaining wall at 4th Street in the city of Niagara Falls” (Scott & Scott, 1983)—of dolomite or limestone to duplicate the native rock exposures in the bed of the Niagara River and its gorge.

An intention was expressed in 1901 to replace the other two bridges to the Second and Third Sister Islands with similar stone arch bridges (17 Ann Rep Comm, 1901).

Perhaps indicative of times to come, when the masonry dam under the first bridge to Willow Island was destroyed by high water, a reinforced concrete dam replaced it (27 Ann Rep Comm, 1911).

The uneven surfaces of native-stone bridges promotes the establishment of mosses, lichens and other vegetation—a fact approved of by those with the intention to restore and protect the Reservation’s natural richness. The bridge to the First Sister Island, for example, presently supports the following plants: Cystopteris bulbifera BULBLET BLADDER FERN. Parthenocissus vitacea VIRGINIA CREEPER.

* Poa compressa CANADA BLUE-GRASS and other grasses.

Viola sp. VIOLET. East side, stone bridge to First Sister Island.

The vivid red color of the Virginia Creeper comple-

Bridge to the First Sister, summer, 1988. Note the abundant grasses and small herbs which have established themselves on the rock surface (photo: Richard Zander).
ments the bright yellow autumn colors in the rock of the first bridge to the Three Sisters from growth of the lichens: 
*Caloplaca citrina*. First Sister, bridge, on mortar, Harris 22863 (NY), and,  
*Caloplaca flavovirescens*. Bridge to First Sister, Harris 22876 (NY).

In the textured surface of the “water-worn” rock the of the following mosses have become established:  
*Funaria hygrometrica*. Chink in stone bridge, west side, Eckel, April 26, 1987 (BUF).  
*Grimmia alpicola* var. *alpicola*. In depression, with lichens, Eckel, Sept. 29, 1988 (BUF).

Replanting trees and shrubs at the boundaries of the bridge to promote moist shade would encourage the establishment of lichen and moss species. Establishing spectacular native vines such as Climbing Bittersweet (*Celastrus scandens*—male and female plants are needed) is also possible.

Bridge to the First Sister, summer, 1988. Virginia Creeper (*Parthenocissus*) festoons the bridge from above (photo: Al Schotz).
Bridge to the First Sister, summer 1988. The dark patches are moss communities. Crustose lichen populations contribute to the irregular coloring of the rock surface (photo: Richard Zander).

Stippled areas are Northern Hardwoods \((Acer-Betula-Fagus-Tsuga)\). Dominants: Sugar maple \((Acer\, saccharum)\), Yellow birch \((Betula\, allegheniensis)\), Beech \((Fagus\, grandifolia)\), Hemlock \((Tsuga\, canadensis)\). Other components: \(Acer\, pensylvanicum,\, A.\, rubrum,\, A.\, spicatum,\, Fraxinum\, americana,\, Pinus\, strobus,\, Prunus\, serotina,\, Taxus\, canadensis,\, Tilia\, americana,\, Ulmus\, americana.\) (No. 106 in Kuechler, 1964).

Hatched areas are Beech-Maple Forest \((Fagus-Acer)\). Dominants: Sugar maple \((Acer\, saccharum)\), Beech \((Fagus\, grandifolia)\). Other components: \(Carya,\, Fraxinus\, americana,\, Juglans\, nigra,\, Liriodendron\, tulipifera,\, Prunus\, serotina,\, Quercus\, rubra,\, Tilia\, americana,\, Ulmus\, americana,\, U.\, rubra\) (No. 102 in Kuechler, 1964).

101 = Elm-Ash Forest \((Ulmus-Fraxinus)\). Dominants: White ash \((Fraxinum\, pennsylvanica)\), American elm \((Ulmus\, americana)\).

104 = Appalachian Oak Forest \((Quercus)\). Dominants: White oak \((Quercus\, alba)\), Northern red oak \((Q.\, rubra)\).
Extent of continental glacier during the most recent ice age—the Wisconsin. All vegetation perished that grew in the areas indicated for the ice fields. The strsd have since been revegetated from areas south of the ice-front (map rerawn from Forrester, 1976).
General map of the forests surrounding the region.

Vertical lines: Mixed Forest (Mid-latitudes). Broadleaf and Conifer.

Horizontal lines: Broadleaf Forest (Deciduous).

(map generalized from Bartholomew & Son, 1963).

Note the extension of the vegetation south and west of the Great Lakes up the lake plains of Lakes Erie and Ontario in both Canada and the United States. Compare with Rueckler, above.
ORIGINS OF THE FLORA

The Niagara Reservation consists of the margin of a river and a series of islands. These two conditions alone serve to distinguish these natural areas ecologically from those of the surrounding continuous landscape. The original forest, depicted in nineteenth century and earlier pre-photographic engravings and illustrations as growing down to the river and gorge edge, would have had a boundary there. So, too, would its darkening canopy and the modification of environmental conditions within it. Life on the margin would be exposed to sunlight, to weather, to soil changes, soil textures with different nutrients, and to increases in soil moisture and the mechanical effects of the same moisture freezing in winter, fluctuations in water levels, etc. These different physical conditions would have and do create opportunities for distinctive plant communities, with species assemblages differing from those of the forest dominating the enclosing region.

As a general rule, it may be said that the organisms growing on Goat Island—and any of the other islands at the brink of the falls—derive from populations existing or which have existed in the past in the region as a whole. Day (Porter, 16 Ann Rep Comm, 1900) inferred this because no species he was able to observe growing there could not be found elsewhere in the adjacent mainland. This simply means there were no endemic species developed here and nowhere else, or that there were any bizarre elements in the flora only confined to the islands.

It may also be said that whatever broad climatological events affected the region also affected conditions on Goat Island. Whatever the preglacial regional ecosystems were, these were destroyed and the entire area was stripped of its indigenous flora and soil as the last glacier ground over it at the end of the Pleistocene over 12,000 years ago. As plants and animals recolonized the areas south of the northwardly retreating ice front, these species would have made contact with whatever land surface was available in the channel of the post-glacial river we now call the Niagara River. Conditions were sub-arctic near the ice front and became gradually ameliorated as the millennia proceeded. Communities of plants existing south of the glacier, and presently found north of the Niagara region, first pioneered and succeeded one another on the recently exposed land. The Niagara area supported tundra vegetation and isolated patches of spruce forest (Terasmae in Tesmer, 1981). Perhaps 1300 years subsequently, with ameliorating climate, the boreal forest with spruce and jack pine dominants replaced the tundra situation. Topographic stability in western New York, following the various hydrological changes corresponding with the retreat of the glacier, was achieved by around 9000 years B.P. “Residual features such as bogs, kettle holes, now-dry lowland marshy areas, etc., were major features of the landscape that would have influenced distribution of plant communities, animal habitats, and human sites” (Calkin & Miller, 1977).

Forests dominated by spruce and fir continued to colonize the land, and elements of the present eastern deciduous forest, with its beech-maple dominants, succeeded them (Zenkert, 1934). Significant pine elements were present around 9000 years ago and persisted to 6000 years ago, due to drier conditions than exist in the Niagara area today (Terasmae in Tesmer, 1981). From around 5000 years ago to the present the climate was much as it is today, promoting growth of extensive deciduous forest.

Isolated pockets and range extensions of boreal plant species continue to exist throughout glaciated western New York State, down to the southern limits of the glacier in the unglaciated area of Allegany State Park, south of Salamanca in Cattaraugus County. These species do not occur south of the old glacial boundary (Zenkert, 1934). These species continue to persist in areas of relative cold, as in the higher elevations of the Allegheny Plateau in southwestern New York, in cold bogs and along cold springs, and in areas of late snow melt. The water-charged atmosphere cooled by spray from the cataracts and the turmoil of water in the Niagara River gorge, also cold ice floes building up in the gorge from Lake Erie late in the year, together with northern exposures and the restricted angles of sunlight in the gorge, allowed northern trees, such as *Betula papyrifera* (Paper Birch) and *Thuja occidentalis* (Arbor Vitae) to extend down the Niagara Escarpment through Ontario to the north, into the Niagara gorge, which is continuous with that escarpment, and on up to Goat Island at the southern terminus or head of
Part III: The Flora

that gorge. It is to be expected that the historic flora of Goat Island and the Niagara Gorge flora derived from the flora of the north-facing calcareous Niagara Escarpment, of which the seven-mile gorge is a continuation. This interpretation is Zenkert's (1934) based on observations along the Niagara Escarpment, and the presence of northern species in cool, shaded habitats in the Niagara gorge, such as Miterwort (Mitella nuda) and Oak Fern (Gymnocarpium dryopteris). Arbor Vitae, or Northern White Cedar, is commonly found to the north but is quite characteristic of the margins of the Great Lakes, to which many place names testify. It is near the southern margins of its range in our area and tends to persist on bedrock pavements (especially of calcareous rock).

The flora of western New York may be said to represent a transitional zone between the great northern boreal-coniferous and the more southerly deciduous forests of today. This transition expresses itself floristically in a "macromosaic-like arrangement with pure deciduous forest on favorable habitats with good soil, and pure coniferous forest on less favorable habitats with poor soils" (Walter, 1973), although this latter condition is difficult to see in western New York due to a history of logging and agricultural clearing (Zenkert, 1934). Pinus strobus (White Pine) is the conifer species indicative of this transition zone in the Great Lakes, with Tsuga canadensis (Hemlock) elements (Walter, 1973). Transitional forest areas may also be composed of "a few coniferous species (mainly pine) and a few deciduous species" (Walter, 1973). In southeastern forests, Juniperus virginiana (Red Cedar) is indicative of a transition between forest types.

A corridor of Broadleaf Deciduous Forest, reaching from southern Michigan and the Great Lakes region south to Texas, extends up the north and southern boundaries of the Erie and Ontario Lake plain, perhaps following climatically the modifying influence of these lakes. This forest corresponds to Kuechler's Beech-Maple Forest of tall broadleaf deciduous trees (No. 102): Sugar Maple (Acer saccharum) and Beech (Fagus grandifolia) are the dominants, co-dominants include White Ash (Fraxinus americana), Black Walnut (Juglans nigra), Tulip Tree (Liriodendron tulipifera), Black Cherry (Prunus serotina), Northern Red Oak (Quercus rubra), Basswood (Tilia americana), American Elm (Ulmus americana) and Slippery Elm (Ulmus rubra) (Kuechler, 1963), all present on Goat Island. This Beech-Maple Forest zone as mapped by Kuechler extends along the Lake Erie lake plain from Cleveland to Buffalo, north through Grand Island and east to the vicinity of Rochester.

The northern tip of Grand Island and the rest of Niagara County, including Goat Island, however, is covered by the Northern Hardwood (mixed broadleaf and conifer) Forest (No. 106) (Kuechler, 1963). This forest, in New York State, exists south of the lake plain flora with its southern affinities, and continues on east into central New York State. The Beech-Maple Forest corridor inserts itself within the surrounding region of Mixed Broadleaf and Conifer Forest associated with Middle latitudes—the transition forest mentioned above (Bartholomew, 1963). The southern Ontario portion of this corridor is referred to as the Carolinian Floristic Zone, more common south of the border with the United States, and is the only representation of this vegetation type in Canada—rather like Florida and other portions of the Caribbean coast have the only tropical vegetation type in the continental United States, (Kuechler, 1963).

The Mixed Broadleaf and Conifer Forest is Kuechler's Northern Hardwoods Forest (No. 106) of tall, broadleaf deciduous trees with some needle-leaf conifers such as Hemlock (Tsuga canadensis) and White Pine (Pinus strobus). The dominants are Sugar maple, Yellow birch (Betula lutea), Beech and Hemlock. Other components of these forests include Striped Maple (Acer pensylvanicum), Red Maple (A. rubrum), Mountain Maple (A. spicatum), White Ash (Fraxinus americana), White Pine, Black Cherry, Ground Hemlock (Taxus canadensis), Basswood, and American Elm. This forest type extends into New England, across New York State into northern Pennsylvania, and surrounds the northern Great Lakes region to northern Michigan and Wisconsin.

Since Kuechler did not map the northern limits of the forest types existing in the United States as they occur in Canada (Ontario), the areal relationships between the Beech Maple southerly forest and the Northern Hardwoods forests in adjacent Ontario and their relationship with the study area are obscured. Literature probably exists regarding the distribution of forest types in southern Ontario, but time constraints prevented its examination for this report.

The range of each forest vegetation type repre-
sents migration routes for species entering the area from regions north and south of the Great Lakes area of which the vicinity of Niagara Falls is a part. The Broadleaf Forest Corridor, associated with limestone pavements and climate modifications along the lake boundaries represents areas in New York and southern Ontario of plant species rare in the State and Province and with plains affinities.

The history of hydrological relations in areas south of the retreating ice-front are very complex, with lake enlargements and disappearances, impoundments and shifting east-west drainages of the watersheds system to the west (Tesmer, 1981). Exposed bedrock ledges or pavements with shallow soils along old lake and river drainage routes support a distinctive flora contrasting with that of the surrounding region. A coastal plain floristic element in the Great Lakes flora, of which Niagara is a part, has been described by Peattie (1922) and House (1925) wherein species native to areas east of the Appalachian elevations migrated westward and inland along temporarily connected shorelines of the receding glacial lakes. Examples of plants with this association and found or were once found on Goat Island include *Saururus cernuus* (Lizard's Tail), once on Terrapin Point, and *Juncus articulatus* (Jointed Rush), one of the most common of the rushes on Goat Island (Zenker, 1934). Other Coastal Plain taxa may be found in the associated flora of the Niagara River gorge (Eckel, in prep.).

The source of certain species migrating into the Niagara area after the Wisconsin glaciation derived from elevations in the Ozark Mountains in the present Missouri-Arkansas area. These species survived there during the period of glaciation, and recolonized areas to the north as the glaciers retreated. The Bur Oak (*Quercus macrocarpa*), present on Goat Island, and the abundantly represented Black Maple (*Acer nigrum*) are representative of this Ozarkian element, as are Bladdernut (*Staphlea trifoliata*), New Jersey Tea (*Ceanothus americanus*) and Rue Anemone (*Anemonella thalictroides*), present in the Niagara River gorge (Curtis, 1959).

During the thousands of years succeeding the end of the Pleistocene, the warming of the climate has not been uniform. Several times conditions were significantly warmer than at present with the result that elements of floras to the west and south of our region were sustained, although later, as at present, cooler, moister conditions prevailed, favoring a different suite of plant species—those that are presently more typical of western New York and southern Ontario. Gordon (1940) referred to the literature on the subject of a Xerothermic period (Gleason, 1922; Sears, 1932; Transeau, 1935) extending “thousands of years following the disappearance of glacial ice” when there occurred a prolonged period of deficient rainfall, which may have lasted for a couple of centuries.” This period is placed between 1400 and 1200 B.C. “A more severe dry period occurred about 650 A.D. A later period of drought ... reached its worst in the thirteenth century (Huntington, 1924). The effect of such climatic changes ... was to bring about death ... to mesophytes and hydrophytes, favoring the spread of xerophytes from the western prairies and plains” (Gordon, 1940). Openings in the Beech-Maple in western New York forests were dominated by oak and hickory, or oak and native chestnut trees and “prairie species” the survivors of “this migration are found today on shallow soils over limestone ...” and other habitats (Gordon, 1940). Most of the rare species of New York State growing on Goat Island and in the adjacent Niagara River Gorge are at the eastern limits of their ranges. They are more characteristic of lands to the west of us, and most grow and once grew on soil on the barren, wet limestone pavements on the south side of Goat Island (see rare plant section). It is also interesting that here is also where the rarer alien species introductions have presently been found. Artificial and natural openings in the forest and brush covers mimic meadows and pastures which in turn mimic prairie conditions.

Although not explored for the purposes of this study, more detailed examination of regional climatic regimes which reach their eastern limits in western New York State in association with lowland areas along Lakes Erie and Ontario may suggest conditions favoring continuation of biotic characteristics of regions west of Niagara into the Niagara area. The distribution of some western birds may parallel this climatic extension, and some fauna such as the Fox Squirrel (*Sciurus niger*). Limestone may intensify this climatic boundary of, at least, greater warmth for plant species.

An alternative accounting for the existence of Oak-Hickory, Oak-Chestnut openings in the area as well as habitats supporting western plants relies on the existence of calcareous outcroppings with shallow, immature soils or no soils at all, perhaps in addition to warmer temperatures than elsewhere in New
York State. The presence of Oak-Hickory elements in the Niagara forests was observed in the eighteenth century: the country around Niagara “though extremely sandy, is covered with oak, chestnuts, and fine hickory trees, and such parts, as are better watered, bear ... ash and maple-trees” (Liancourt, 1799).

Shallow soils and rocky bedrock pavements occur from New York State, in the area of Lakes Ontario and Erie, west to Michigan and Wisconsin (Tesmer, 1981), well developed along the Niagara Escarpment west to Manitoulin Island and east of Niagara in places along the northern margin of Lake Ontario in the Province of Ontario. In New York State limestone pavements along Lake Ontario into the St. Lawrence Seaway near the city of Watertown have recently been found to support an unusual flora with a plains affinity (H. Faber in New York Times, Sept. 18, 1988).

Exposed limestone has edaphic characteristics which promote dryness and warmth, mainly by characteristic fracturing through which rain is quickly dispersed. The presence of habitats of calcareous exposure with an east-west trend extending to the plains, which is also calcareous as to bedrock and soil derivation, may give a competitive advantage (due to possible adaptations to the physical conditions of this substrate) to calcareous-loving species, and provide avenues of dispersal or migration. This “biological highway” of calcareous substrates, in interaction with xerothermic periods, probably contributes to the intrusion of the western flora this far east.

The occurrence of rare eastern plants with a “western affinity” was thought by Wynne-Edwards (1937) to be “better explained as resulting from their lime-loving nature rather than from differences in their Pleistocene history” (Scoggan, 1978). For discussion of how, after the xerothermic period mentioned above, western prairies were artificially maintained eastward of their typical range at the expense of forest communities due to the hunting activities of early native peoples, see the work of Gleason and Cronquist (1964). This hunting tactic involved setting fire to the countryside to herd native animal populations. Zenkert (1934) furnished additional information on openings or “prairies” in the Erie County portion of the Niagara region, aligned in an east-west direction on thin soils “some ten miles south of the limestone ledge” (the Onondaga escarpment) a portion of which was called the “Buffalo Plains” (Rogers & Zander, 1977).

Examples of the calcareous flora at Goat Island, based on past and present reports, and which are typical of calcareous substrates, include the following (after Zenkert, 1934):

- **Amelanchier sanguinea** ROUND-LEAVED JUNE-BERRY.
- **Anemone cylindrica** LONG-FRUITED ANEMONE.
- **Aquilegia canadensis** WILD COLUMBINE.
- **Arabis canadensis** SICKLE-POD.
- **Asplenium trichomanes** MAIDENHAIR SPLEENWORT.
- **Aureolaria flava** SMOOTH FALSE FOXGLOVE.
- **Carex aurea** GOLDEN-FRUITED SEDGE.
- **Carex eburnea** BRISTLE-LEAVED SEDGE.
- **Carex normalis** LARGER STRAW SEDGE.
- **Carex rosea** ROSE SEDGE.
- **Celastrus scandens** CLIMBING BITTERSWEET.
- **Cornus rugosa** ROUND-LEAVED DOGWOOD.
- **Cystopteris bulbifera** BULBLET BLADDER FERN.
- **Erigeron pulchellus** ROBIN'S PLANTAIN.
- **Hepatica americana** BLUNT-LEAVED HEPATICA.
- **Linaria vulgaris** BUTTER-AND-EGGS.
- **Penstemon hirsutus** HAIRY BEARD-TONGUE.
- **Polypodium vulgare** COMMON POLYPODY.
- **Quercus macrocarpa** BUR OAK.
- **Quercus prinoides var. acuminata** YELLOW OAK.
- **Rhus typhina** STAGHORN SUMAC.
- **Saxifraga virginensis** EARLY SAXIFRAGE.
- **Triosteum perfoliatum** var. aurantiacum ORANGE HORSE GENTIAN.
- **Viburnum rafinesquianum** [var. affine] WESTERN ARROW-WOOD.

Further investigation into other plant groups present in the Niagara area, including the Goat Island complex, may reveal interesting patterns of past floristic conditions. Bryophytes (mosses and liverworts) may be particularly instructive regarding evidence of floristic origins (Sharp, 1939; Crum, 1952, 1972). These and other smaller organisms “have the ability to survive in microhabitats in areas where many vascular plants may have been unable to survive” (Anderson, 1971).

The fact that the Goat Island complex lies along the continuous inland coastline of the Great Lakes
and its feeder streams, rivers and straits may account for the presence of a number of plant species in the Goat Island shoreline flora. Insofar as there is a distinctive Great Lakes floristic region, the Niagara area is a part of it as it shares many similar physical conditions: the area was glaciated, is characterized by calcareous substrates and has thin or no soils, its climate is moderated by the influence of the water masses in the lakes, it is part of a great shoreline corridor of swamp or marsh, or rocky stream-river margins whereby flora and fauna peculiar to these habitats may migrate up or downstream. The only station for Kalm’s St. John’s Wort in New York State was reported from Goat Island stations. This species is characteristic of calcareous soil, “mostly on moist sands along the Great Lakes” (Gleason and Cronquist, 1963). Other species, such as Burning Bush, or Wahoo (Euonymus atropurpureus) may attain the northern limits of their range in the Great Lakes watershed, growing “on river banks and floodplain forests” associated with the lakes in Michigan (Voss, 1985). Goat Island appears to have once supported an extensive population of this species (see species catalogue).

Weedy shore species introduced into the St. Lawrence Seaway have come upstream against the current, probably in association with migratory waterfowl. Flowering Rush (Butomus umbellatus), becoming abundant off the south shore of Goat Island along the Three Sisters and flats islands, is a “handsome European plant, introduced into America in the St. Lawrence valley only about 50 years ago [at the turn of the century and] was first noticed on the Lake Erie Islands [in the western half of that lake] on June 21, 1939. It occurs near the water level on gravelly or muddy shores and by means of its abundant seeds and numerous small basal bulblets, broken off by wave action, has rapidly spread throughout the [Erie] island group” (Core, 1948).

In the present flora, one may assume the dynamics of disspore dispersal is as continuous as it has been for centuries: the wind, the river current, migrating birds and mammals, and new sources, such as associated with vehicles from all over North America that come onto the island. The Tomato (Lycopersicon esculentum) has been established from restaurant refuse behind the Terrapin Point restaurant. The majority of new and alien species, noted in the species catalogue, derive from “garden soils” around root balls of young trees and in horticultural treatments in the islands, and from the establishment and maintenance of extensive lawns. One interesting grass species, Wood Bluegrass (Poa nemoralis) is “archaeological” in the sense it was established probably in the early days of the Reservation “when it was recommended to seed lawns in shady areas” (Dore and McNeill, 1980, see species catalogue). Other odd alien species which have rare or non existent distributions elsewhere in western New York are Chapman’s Blue-grass (Poa chapmaniana), Gamma Grass (Tripsacum dactyloides), and a tiny Chickweed (Cerastium semidecandrum) whose source and mechanism of dispersal might be more difficult to explain, or that the Goat Island complex provides special conditions for their establishment seldom found elsewhere.

It may be assumed that today the best source for the natural introduction of native (or alien) species is from birds—a good justification for developing cover for them on Goat Island throughout the diversity of habitats present. Preparing additional habitats, such as substrates: logs, stone surfaces, and creating topographic irregularity would increase the likelihood of “capturing” species additional to the Goat Island flora, or allowing populations already present to expand.
Goat Island was remarkable a century ago for the great diversity of plant species it was able to sustain (Day, 1910). In the third report of the Commissioners (1887), the Superintendent referred to the interest of scientific societies in the area of the Falls, and reported “it is estimated that more than 1,000 species of flowering plants and ferns are native at the falls, or in their neighborhood.”

It is important, for the purposes of assessing whether Goat Island can naturally sustain again a great, diverse and interesting vegetation, to explore the possible mechanisms which may have contributed to this unusual diversity, and mechanisms that contribute to diversity generally.

If one adopts the generality that the number of species on islands depends upon immigrations and extinction rates, it follows that Goat Island must have had a good deal of immigration of species to it, and a relatively low rate of extinction. Routes of migration to the Island include diaspores floating to it from upriver. Dispersers must come in with aquatic bird populations, such as Mallard ducks or Gulls. They arrive borne on the wind, especially in short jumps, which is one explanation for the high similarity of the native florae on the Canadian (upwind) and American sides (downwind) of the river. With the large, mobile population of visitors to the park areas around the Falls, and to Goat Island, the likelihood of exotic diaspores becoming available for colonization of the area is relatively high.

What the original effects of isolation from animal life were on the islands at the brink of the falls can only be conjectured. Diversity may have been encouraged due to the absence of permanent populations of destructive herbivores on the island, especially during the summer months, and the relative absence of human activity and its associated disturbances. Herbivores, such as rabbits and deer, could on occasion have reached the island in winter on ice bridges. According to Kalm (1770), on hearsay, bears “seeing deer on the island, occasionally try to visit them, but are with much growling compelled to change their course and go over the falls.” Goat Island “is covered with tall trees, and is sometimes full of deer” who, trying to cross the river upstream from Goat Island are swept there by accident, or are swept over the Falls. A rabbit is depicted in a drawing of the Goat Island flora (16 Ann Rep Comm, 1900) although this may have been fanciful, or rabbits may have been introduced when the bridges were built in the nineteenth century. A young road-killed specimen of Eastern Cottontail (Sylvilagus floridanus) was collected from the Island in 1987 and is presently in the collections of the Buffalo Society of Natural Sciences. A group of three raccoons were sighted in recent years at the Three Sisters.

Ice jams at any point or points along the length of the upper river did occur, damming the river's flow such that the beds of whole sections of either channel were exposed and could be crossed. The water is shallow in places in the river channels at the Falls (formerly to 10 feet on average). Goat Island seems to never have supported more than populations of native rodents. Larger mammals came to the Island by misadventure, situations exploited by the native peoples who were attracted to the “number of deer, elk and other animals that tried to cross the stream but which were carried to this islet .... When the natives from the mainland saw a sufficiently large number of animals on the island, they waded across and killed them” (Kalm, 1770).

“It seems almost as though [the fauna of Niagara] could never have resorted, habitually, to Goat Island. The access to it of the elk, the red deer, the bear, the panther, the lynx, the fox, and the wolf, common enough in the neighborhood, must always have been difficult, and their return to the mainland almost impossible. At the present time the quadrupeds inhabiting the island are probably only three, the Black-squirrel, the Red-squirrel, and the ... Chipmunk” (Day, 1901). The Gray Squirrel (Sciurus carolinensis) and its melanistic form are presently frequent on Goat Island. Chipmunks (Tamias striatus) and the entrances to their burrows may be seen today on the shaded northern slopes of the Island. A population of Fox Squirrel (Sciurus niger) has been found for several years on Goat Island (1985-89, Dr. R. Andrle, personal communication). This squirrel is so rare in western New York State that it is frequently reported as absent from the State (Collins, 1981). It might be instructive to observe populations of deer and other herbivores on another large island in the Niagara
River above the falls and maintained as a sanctuary, Navy Island, to see what their habits and effects are. Sixty-four acres and natural conditions on the island were insufficient to sustain animal populations for long. Although Goat Island is said to derive its name from goats being kept on the island (Clinton, 1822), it is instructive that all the other animals introduced in the same or nearly the same year perished in their first winter. It is doubtful that these goats could have lived there long enough to seriously affect the vegetation.

As late as 1810 there was no bridge to Goat Island, for when De Witt Clinton visited the area in that year, he thought it would not be practical to put a State Prison there, as access to and from the island would be too easy: “I saw a man who had potatoes planted on it, and who visited it frequently. Stedman used to ride there on horseback” (Clinton in Campbell, 1849). In fact, the Legislature of New York declined a request for entitlement by Augustus Porter, submitted in 1811 because they intended to erect a State Prison or Arsenal there (Porter, 16 Ann Rep Comm, 1900). In 1819, Howitt noted that Goat Island was until “a short time ago, the secure eyry of a number of Bald Eagles; but the bridge exposed them to the intrusion of travelers, and they have totally deserted it” (Howitt, 1820). The first bridge to the Island was built in 1817 (Porter, 16 Ann Rep Comm, 1900).

According to Walter (1973) “plant species are capable of existing far beyond their natural distribu-
tional areas if they are protected from competition with other species.” He also suggested “the natural limit of distribution of a particular species is reached when, as a result of changing physical environmental factors, its ability to compete, or its competitive power, is so much reduced that it can be ousted by other species.” Species extinction rates within portions of their range then, must be more related to factors of competition with other plant species than with physical parameters. Since so many species appear to have been crowded within the Goat Island complex, some factor must have been involved to lessen the ordinary rate of extinction from competing plant species.

In addition to high numbers of species noted on the complex, the Goat Island vegetation was also noted for its extraordinarily high abundance, or high biomass, or high productivity. One might expect that vigorous growth of plant species would encourage competition between species, with correspondingly higher extinction rates, yet this does not appear to have been the case.

Some factor or factors in the Goat Island complex must have lessened the competitive advantage or power of some species, and increased that of others, so an equilibrium was reached favoring high species diversity and abundance. For example “The slope leading down to Luna Island is covered with small trees so overgrown by vines that one wonders how the trees can grow at all, yet they appear to thrive under the load” (Chamberlin, 1892). Although the “small trees” may, under ordinary circumstances, have been destroyed by the vines competing with them, they appear to have derived competitive power sufficient to keep from being killed, and this perhaps from conditions favoring physiological optima in the species involved.

The relationship of the physical characteristics of the environment to a species’ viability is of secondary importance to the competition for sun, nutrients, etc. with other living elements with the same or similar requirements. If physical requirements are met with to an unusually satisfactory degree on the islands, there will be more vigor on the part of the biota. Since not every species has the same requirements as another, the physical characteristics of the environment on the islands must have been diverse enough to have contributed to the vigor of a variety of species with corresponding power of competition. And yet there must have been competitive checks on all species such that few species dominated the whole area.

Something must have at once lessened extinctions due to competition by more well-adapted species, and still contributed to optimal conditions for vigorous growth and survival of individuals, especially seen in tree species and the native grape. During the January storm of 1889, a Buttonball (Platanus occidentalis) tree was blown down. It was “five feet in diameter, the largest tree upon the reservation” (6 Ann Rep Comm., 1890); “by the rapids, on the American side ... and on Goat Island, grew some of the largest arbor vitae ... I ever saw,—some of them measuring seven feet round” (Howitt, 1820); “in few other places [than Goat Island] does the Wild Grape climb so high or spread so far or swell itself into such tree-like proportions” (Chamberlin, 1892); “on Goat Island ... we were shown a piece of grape-vine about six feet long, which must have averaged six inches in diameter” (G. W. Clinton in Zenkert, 1934).
These sizes may reflect their great age, or the availability of nutrients or moisture or some other factor favoring growth. It is most probable that the effects of competition between plant species was mitigated by the sheer diversity and complexity of microhabitats available on the islands. Disturbance regimes due to high windfall and ice trimming discussed for the island in the central woods and crest vegetation sections above tend to reduce the competitive advantages of typically dominant species, such as trees and typical riverside vegetation lost due to ice-scour, or species over bedrock or thin soil at the water's edge, which are intolerant of periodic inundation and excessive drying.

Factors contributing to stability or ecological equilibrium in plant communities include interspecific competition, dependence of one species on the attributes and presence of another, the occurrence of species “that complement one another either spatially or temporally so that every ecological niche is filled,” “The natural community is thus saturated and invading species can gain no foothold, although they are much more successful if the state of equilibrium is disturbed” (Walter, 1973). It is this disequilibrium that is probably central to the nature of the unusual flora on the islands.

It is most likely that the greatest factors favoring the historic diversity and abundance reported for the Goat Island flora derived primarily from:

a) Topographic diversity. Diversity has been lost due to grading in the establishment of lawnscapes and ease of their mowing, grading for extensive and excessive road and pathways in the Reservation, and modifying natural surface hydrology. Reintroduction of additional substrates and uneven surfaces and boundaries, such as making irregularities in ballasted and rip-rapped areas to diversify force of river current favors the establishment of a diversity of shore-pant communities.

b) High and diverse natural disturbances, such as atmosphere-derived ice, river ice, and high winds. A century-long amelioration in regional climate has produced less cold-stress-related regimens on the Reservation. Establishment of the ice boom at Buffalo-Fort Erie has reduced the incidence of ice-scour. Surging of river volume has been normalized by river-volume control devices. Seriously low volumes in winter with ice removal from the river at the Three Sisters eliminates the disturbance that may have created conditions for establishment of the rare plant communities there. Loss of much of the river volume due to diversion, especially in winter, may again reduce water availability for optimum growth displayed at the turn of the century.

c) Areas experiencing high moisture regimens, particularly in the heavy spray zones. Loss of much of the river volume due to diversion, especially in winter, may again reduce water availability for optimum growth displayed at the turn of the century. The most serious effect may be excessive diversion at the Three Sisters.

d) Isolation from excessive disturbance: by herbivores or through human “clear-cutting” and lawnscaping activities. Catastrophic disturbance is presently only exhibited by maintenance activities.

e) Powerful dispersal (seed, spore) vectors: relatively high winds, abundant migratory wild-fowl, strong river currents. Careful reestablishment of habitat for migratory and other birds will contribute to an increase in incoming diaspore material.

f) Rich source of diaspores from diverse plant communities: in nearby Ontario and areas on the American side near the Niagara River Gorge, in freshwater habitats in the Great Lakes Watershed system open to migrating birds, in rich plant communities in the upper Niagara
Both the State of New York and Province of Ontario and municipalities governing river-side areas should develop policies in their parks favoring species diversity. Without this resource it will become increasingly difficult for species to become naturally introduced into the Goat Island complex.

The numerous recently reported species of plants, such as the mosses *Trichostomum crispulum* and *Weissia hedwigii*, as well as taxa reported new to New York State in similar habitats in the nearby Niagara River gorge: *Didymodon australasiae* new to eastern North America, *Pottia davalliana*, new to New York State, *Desmatodon porteri*, only station for New York, as well as the rare lichens reported for the Reservation by Dr. Harris (see lichen section) show Goat Island and related habitats are still unusual areas for species colonization or persistence. The islands seem naturally quick to accept new species, and reluctant to let them go.

Additional rare plants still in existence on Goat Island and newly introduced (see discussion above and rare plant sections) show that Goat Island still has the intrinsic resources to promote an important flora, if natural processes are allowed to function.
Examination of the involvement of eminent men and women in the natural sciences over the past several centuries at Niagara Falls, before it became state property, is indicative of the scientific promise of natural phenomena offered by one of the most unusual cataract complexes in the world. Other catalogues of visits and research data by prominent individuals to unique geological places in North America in the pursuit of understanding the biological world can probably also be made, such as at Yellowstone National Park, with its interesting algal flora around the hot springs there and its diversity of spectacular habitat, and the extraordinary saline biology of the Great Salt Lake of Utah.

Early workers in North American botany usually began their careers in professions such as the clergy, commerce, law and pharmacy or medicine. People from many walks of life, with various talents and abilities, recognized the need to describe the natural history of their continent, a subject mostly unknown to science. They could see the great opportunities for personal distinction that existed at the time and accepted the discipline required to produce the nation’s first floristic and taxonomic treatments in all aspects of natural history.

In many cases, a person needed only to examine the natural history of his or her own backyard to produce important scientific data, as was the case in the early careers of such botanists as the bryologist William Starling Sullivant, who had the “good fortune to have early established his home in a botanically rich district,” which became the subject for his “Catalogue of Plants, Native, and Naturalized, in the vicinity of Columbus, Ohio”—near his home town of Franklinton (Humphrey, 1961). The eminent New York State botanist John Torrey made his initial publication and public presentation “A Catalogue of Plants growing spontaneously within Thirty miles of New York”—his home town—read before the newly founded New York Lyceum of Natural History (Humphrey, 1961). The bryologist Coe F. Austin collected many herbarium and exsiccat specimens around his home in Closter, New Jersey—even naming a species after this locality: *Fissidens closteri* Aust.

In the absence of well-identified specimen collections and published knowledge about the biota of North America, a certain effort was made by these early American students of natural history to produce drawings of the organisms under observation to aid in identification, such as William Starling Sullivant who made “careful and accurate drawings [of grasses and sedges] designed to be readily helpful to other students of these genera and species” (Humphrey, 1961). Extensive illustrations were also published by Francis Wolle in his books on North American algology—but more so in the case of his grandson, Philip Wolle. The latter, although never publishing data, filled twenty-five “copious notebooks of excellent drawings, with much astute descriptive and critical annotation (now on file at the Smithsonian Institution)” (Conger, 1971). Sullivant was later to publish two volumes of his exquisite bryophyte drawings (Sullivant, 1864, 1874).

Such illustrations and aids to identification contributed much to scientific communication when words alone were insufficient to ensure confidence in identification. To a great extent, these illustrations were an important adjunct to the infancy of the nation’s systematics collections, which are the bases upon which past and future published reports on North American organisms can be interpreted and progress made with some degree of coherence and continuity in understanding.

Individuals who would succeed in making the first fundamental contributions to the systematics and description of North American natural science also spent a great deal of time selflessly identifying or verifying specimens or otherwise encouraging other individuals struggling to become proficient at their chosen specialty. These helpful individuals usually had access to the nation’s first reference herbaria and libraries of botanical literature. Occasionally they dedicated a great portion of their career to providing assistance to those requesting it, as, for example, the great American lichenologist Edward Tuckerman who “aided others continually and much of his labor received no public recognition” (Fink, 1906).

Another important adjunct to the reference herbarium was the assembling and distribution of sets of identified (“authentic”) specimens by which newly collected or investigated material or printed discus-
sions of the organisms in question could be compared. These formal sets of specimens were called “exsiccatae.” A formal exsiccat is a minor herbarium itself, and a kind of publication. A published exsiccat may be understood to have “the features of a published book—uniformity of contents of several [species] examples, serially numbered units (pages, labels) beginning with “1”, title, date and place of issue” (Sayre, 1975). Typically, a mass collection is made from one population of each of the species comprising the numbers of the exsiccat: a collection large enough to generate 25, or 50 or more duplicate specimens of that species. An exsiccat of 25 species with 25 duplicates of each species would require 625 specimens. The labels (variously called tickets or schedae) accompanying each numbered species in the exsiccat includes the scientific name (such as *Fissidens grandifrons*) and is attached to corresponding specimens. In addition, these labels are typed on pages assembled in book form and separate from the specimens. If the author, or editor of such an exsiccat wished, he or she could solicit contributions from the general public, as was done by Coe F. Austin on the back of his booklet accompanying his Musci Appalachiani, Supplement 1, 1878: “... I take this opportunity to cordially invite the co-operation of all American botanists...” to submit specimens to be used in upcoming supplements to the exsiccat. “Liberal allowance will be made and due credit given, for 100 good specimens of any desired moss or hepatica. Except in rare mosses and those difficult to obtain, the specimens should be large and ample.”

They needed to be ample because it was understood that these specimens were to be dissected and analyzed many times in the course of study. The specimens were also to be used in teaching many students of botany for decades, and in some cases, centuries to come.

One of the effects of these “published herbaria” resulted from the convention of including on the labels information about the exact collecting locality of the specimen only when the species was rare, or unusual. Botanists interested in obtaining additional material of that rare species or desirous of acquiring a collection of their own could then visit the listed locality—hence so many collections of the rare moss *Fissidens grandifrons* from Niagara Falls in the following list of bryophytes (mosses) from Goat Island. The fact that “Niagara” occurred on so many collecting labels does not indicate so much how easily the botanist had access to Niagara Falls, on roads, canals and railroads, but rather how unusual the biology of the natural landscape at Niagara Falls was, for it was to that place one could go to find rare species in nature.

“In closing this report, I desire to express my thanks to those botanists whose names appear in the preceding pages, for their kind and hearty cooperation in the investigation of our flora and for their generous contribution of specimens. A continuance of their aid is earnestly solicited” (Charles Peck, New York State Botanist, 1872).
Part III: The Flora

BOTANISTS ON GOAT ISLAND

There were many collectors in and around Goat Island and Niagara Falls in general, many of national significance in one way or another. The curious element of the history of collecting in the latter half of the nineteenth century and the early decades of the twentieth, that is, during the Victorian period in North America, is the degree of interest in the less conspicuous groups of organisms, of mosses, liverworts, algae, fungi, and of molluscs: fresh water or terrestrial snails. Such interest since has seldom strayed from what we call the flowering plants—the most conspicuous of organisms. The clue to this interest may lie in the continuous references of the period to these organisms as “humble” or “lowly forms of life.” Given that nature revealed moral direction, that “in all that is grand and sublime in the works of nature, there resides a power to educate and refine which is of inestimable worth” (1 Ann Rep Comm, 1885), a moral lesson in humility, in the glorification of simple things from which nature or divinity does not withhold its logic and pattern, probably resided in such activities. It is to beliefs like these that we owe the great flowering of interest in the natural world of the nineteenth century, with its remarkable achievements in the sciences. Today, research into the simplest (“most primitive”) organisms provides the basis for some of the Nobel-prize winning achievements in biology of the twentieth century. Natural processes, such as photosynthesis and genetics, seem to reveal themselves most easily in the structurally simplest forms of life.

HISTORY OF COLLECTORS AT NIAGARA

During the great period of botanical exploration of the North American continent in the eighteenth and nineteenth centuries, quite a number of botanists visited the unique natural phenomenon of Niagara Falls, and explored the general vicinity. Many collected and made various notes, some of the more important of which are collected here. Botanical and other references to the natural history of Goat Island before construction of the first bridge there in 1817 were made from observations on the mainland. No herbarium specimens were collected on the Islands before that date; any Niagara area specimens were from the mainland on both sides of the river.

Doubtless specimens exist from the area in some form or other in botanical collections all round the world. Some of the most famous natural historians have traversed the area, and still do, though none have stayed to make a systematic study. Some of the more notable collectors of the flowering plants are listed below, collectors of cryptogamous plants, such as mosses, lichens, etc., under separate chapters.

Niagara attracted botanists, such as Peter Kalm, the distinguished student of Carolus Linnaeus, “the eminent Swedish naturalist and leading botanist of his time (1707-1778), [who] conceived the project that brought the first trained botanist into the Niagara region.” Kalm visited Niagara Falls, which he beheld August 13, 1750 and with which he was suitably impressed. Kalm apparently left no record of botanical activity at the Falls—which is not to say he made no collections. Day (1888) speculated he collected what came to be known as Kalm's Lobelia (Lobelia kalmii) and Kalm's St. John's Wort (Hypericum kalmianum) near Table Rock (Ontario), both species described by Linnaeus and named after their collector, although on what basis Day made such claims is unclear. Both species enjoy the rocky shores and rivers of the Great Lakes region, both have been reported from the vicinity of Table Rock by later collectors and could have been found on the Three Sisters Islands, New York—Kalm's Lobelia even today. Both plants also bloom in August, both, the one with bright blue flowers, the other with yellow, could have conceivably been conspicuous to the roving botanist. Kalm's report of his experiences at Niagara Falls has one botanical reference (tall trees on Goat Island), nor is there any indication he visited Goat Island—there being no bridge there at the time.

Thomas Nuttall (1786-1859) author of the two-volume Genera of the North American Plants, 1818, visited and collected at Niagara Falls, but before construction of the bridge to Goat Island.

Francois Andre Michaux (1770-1855) undertook to describe the forest trees of [eastern] North Amer-
ica, a task begun by his father Andre Michaux, and whose efforts gave a valuable introduction to the nature of the resources of the northern countries developing on that continent. That he visited Niagara Falls is attested to by his published observations of the American Arbor Vitae or Northern White Cedar (Thuja occidentalis): “Goat Island, round which the Niagara divides itself to form the stupendous cataract which is one of the most wonderful spectacles of nature is seen from the banks of the river to be bordered with Arbor Vitae” (Michaux, 1841, Vol. II); and of the Cucumber Tree (Magnolia acuminata): “The most northern point at which I have myself observed the Cucumber tree is on the Niagara River, near the celebrated cataract of that name, in latitude 43 degrees; and I believe it does not exist far beyond this limit” (Michaux, 1841, Vol. 1).

These observations give valuable insight into floristic changes through time, as Arbor Vitae has all but disappeared on Goat Island, and no spontaneous Cucumber trees are presently to be found in the vicinity of the Falls and its gorge.

In 1823 the Scottish botanist David Douglas (1798-1834) visited the United States in order to collect native plants for the Royal Horticultural Society (Zenkert, 1934). Sir William J. Hooker of the Botanical Garden in Glasgow referred, in his Flora Boreali-Americana (1840), to four species Douglas collected near the Falls: Polygala incarnata, Silene stellata, Desmodium bracteosum and Sedum ternatum, (Zenkert, 1923). None of these species have since been observed at the Falls, if they had ever occurred there, yet chroniclers of the Niagara Flora, including the present one, dutifully record his observations. Douglas' specimens are housed at the British Museum and at Cambridge University.

By the Niagara River above the Falls Douglas found the soil was “rich, of black and brown loam,” where there was Ulmus americana “in many places ... scarce” and species of Crataegus. On September 30, he found Astragalus canadensis or A. neglectus, Juniperus virginiana, Carya cordiformis, species of Oak and Violet “at Niagara Falls.”

Douglas noted plants in his diary observed on Goat Island (see section on Douglas’ diary below), and in the Whirlpool area, although in which country is ambiguous. At the Whirlpool he noted an Asplenium species, probably A. trichomanes which is abundant on the rocks there, Polypodium vulgare, also enjoying the boulder-tops, and an Oak “on rocks ... narrow serrated leaves, acorns small & olive shaped” (probably Quercus prinus or Q. prinoides).

In 1862 Leon Provancher (referred to as Abbe by Day) published his Flore Canadienne in two volumes. Provancher, presumably based on his own experiences and collections, reported Hypericum kalmianum on “Rochers au bas de la chute de Niagara,” Vitis labrusca in the vicinity of the Falls, and Plantago media, which has not been detected since, Quercus stellata, Quercus macrocarpa, Carex oerderi, “near the Horse-shoe Fall” (all citations from Day, 1888). His reports refer to plants found on the Canadian side.

Louis Agassiz (1807-1873), more of a naturalist than a botanist, was a leading European scholar in the fields of ichthyology, geology and paleontology before coming to Harvard in 1847, visited Goat Island and Niagara Falls in company with a group of fifteen scholars and students from several academic institutions, including Harvard University, on their way to explore the wilds of Lake Superior. This journey led to his 1850 publication on the natural history of that lake region. At meals, during this expedition, Professor Agassiz would show his comrades prepared diagrams and lectures on the observations he had made...
on the natural environment through which they passed—comparing it with his experience in Europe, and giving us much that is interesting and useful regarding the natural, including botanical, character of Goat Island before it became State property.

The British phytogeographer and son of William J. Hooker, Sir Joseph Dalton Hooker (1817-1911) of Kew Gardens also took an opportunity to visit Niagara Falls. In the company and with the assistance of Dr. Asa Gray, the distinguished American botanist of Harvard University, he identified 50 species of trees and shrubs on Goat Island in 1877, later using this island flora as an example of the species richness of the North American flora in a speech before the Royal Institute of Great Britain, (Turrill 1953). Hooker's authority in plant biogeography, for which he was internationally recognized after investigating the floras of the far-flung colonies of the British Empire of his day, lent weight to his testimonial as to the scientific value of the Goat Island flora. “Sir Joseph Hooker, the noted English Botanist, has said that he found on Goat Island a greater variety of vegetation within a given space than he had found elsewhere in Europe or east of the Sierras in America, and Dr. Asa Gray, the greatest of American Botanists, confirms that statement” (Porter, 1900). This particular generality was to be used by advocates for the establishment of the Niagara Reservation; see section on Hooker.

Asa Gray (1810-1888) visited Niagara Falls in 1831 as a young man after graduating from Fairfield Medical School in that year (Rogers, 1942), and teaching courses at Hamilton College. “With his earnings ... he financed his botanical explorations of the vicinity of Niagara Falls and elsewhere in New York ...” (Humphrey, 1961). Specimens he collected that year were sent to the American botanist John Torrey, with whom Gray was just beginning to correspond. Gray later went on to found the botany department at Harvard. Gray was to develop a close collaboration with Sir Joseph Hooker and make important contributions to the plant-geography of the North American continent. It was while returning from an exploration of the western states that both botanists visited Goat Island in 1877.

Although Gray's collecting labels were generally spare of data (Dr. E. Shaw, personal communication), a habit he passed on to Judge George W. Clinton of Buffalo, New York at the beginning of Clinton's botanical career, it is possible that a search of the Gray Herbarium at Harvard will reveal more collections from Goat Island. A Goat Island specimen of Gray's is reported to be in the New York State herbarium, without date (Hypericum kalmianum, Zenkert, 1934). Note also a specimen of Lysimachia quadriflora reported by House, (1924). Beck (1833) made reference to Gray's activities in western New York (v. Hypericum cistifolium p. 61). The bridges to the islands were in place throughout Gray's botanical career.

The cataracts of Niagara and its associated gorge contributed much to the development of the natural sciences within the towns and villages of western New York, in botany as well as geology, malacology and ornithology. The unusual natural phenomenon of Niagara Falls attracted many local residents to examine its unique character in finer detail.

Botanical specimens (Equisetum variegatum, Populus balsamifera) collected at Niagara by Dr. John A. Kinnicutt (1828), a native and physician of the then village of Buffalo, New York, appeared in John Torrey's 1843 publication on the flora of New York State. Other botanists who contributed Niagara specimens cited by Torrey were a Mr. Cooper, Dr. Casper, Wister Eddy of New York City, Dr. Knieskern, Mr. Macrae, Dr. H. P. Sartwell, Mr. D. Thomas and Mr. Charles Whitlow. Dr. Sartwell (1792-1867) resided at Penn Yan, New York, west of the Finger Lakes region, and corresponded with George W. Clinton, mentioned above. Sartwell's herbarium is presently at the New York Botanical Garden.

George William Clinton (1807-1885), future judge, mayor of Buffalo, first president of the Buffalo Society of Natural Sciences, and son of the Governor of New York State, DeWitt Clinton, visited the Falls in 1826 as a young man of 18 years in the company of scholars who were quite distinguished in their time, or would become so: Prof. Amos Eaton, geologist-naturalist, Dr. James Eights, scientific draftsman, young Asa Fitch, future entomologist, and Dr. Lewis Caleb Beck, among others. This was the Canal Trip: a 700-mile round-trip journey made by scholars by barge from Albany to Buffalo along the Erie Canal (see Barnes, 1988, for details regarding this trip, although he refers erroneously to a George Washington Clinton, son of the governor). This voyage is strongly suggestive of the journey in the not too distant future of Louis Agassiz and his students on their way to Lake Superior, and other scholarly travels. The mem-
bers of Clinton's Canal Trip journey visited Goat Island (Clinton, unpublished diary). It was probably on this trip that Beck found the Niagara Thyme (*Satureja glabella* var. *angustifolia*) he reported from limestone rocks at Niagara Falls (Beck, 1833). Eaton made a few notes in his diary on characteristics of its vegetation, recording the occurrence of Mayapple (*Podophyllum peltatum*) there, populations still to be seen (Clinton, 1826). When later his career took him to Buffalo, he continued his avid botanical activities, collecting plants in western New York and producing the first checklist of vascular plants for that area (Clinton, 1863). Singular reports of species in the Niagara area occurring at the Falls were noted in that publication. The Clinton Herbarium of the Buffalo Museum of Science, the herbarium of the Buffalo Society of Natural Sciences which he helped found in 1888, is the repository of these early specimens. “...No one knew better than he all the herbal and sylvan treasures of Niagara's banks” (Severance, 1911, cited by Zenkert, 1934).

While a member of the New York State Board of Regents from 1852 to 1883, Clinton was “instrumental in establishing botany as a permanent concern of State government” and was responsible for making the position of the State Botanist of New York a permanent one (Mitchell, 1986). Although Clinton's major achievement was as a botanical collector, he labored hard to bring the botanical richness of western New York State to the attention of the nation's leading botanists in diverse fields, in bryology (Leo Lesquereux), in mycology (Charles Peck) and in vascular plants (Asa Gray). The unpublished collecting journal he maintained from 1862 to 1878, in the research library of the Buffalo Society of Natural Sciences, is a mine of natural history information (see transcriptions in this report).

David F. Day, a Buffalo lawyer, worked with Clinton in expanding botanical exploration in western New York and southern Ontario. After Clinton had moved to Albany in 1882, Day produced an updated version of Clinton's earlier list of plants, including numerous citations of those found at Niagara Falls (Day, 1882). In 1885, Goat Island and other islands at the brink of the Falls together with a corresponding stretch of river bank was removed from private ownership and transferred to New York State property, forming a Niagara Reservation or nature preserve. The Commissioners of this new State Park requested Day to produce an inventory of the plants growing in the vicinity of the Cataracts and Gorge. In pursuit of this goal, Day visited habitats of species richness, such as Goat Island, “wet areas above Clifton”), and quiet inlets along the upper Niagara River just above the Falls. He investigated vegetation along the crests of the Niagara gorge from the Falls to Lewiston-Queenston and produced a list published for the State of New York in 1888 (see section on Day).

Perhaps stimulated by the success of efforts to establish an internationally renowned and precedent State Park for the preservation and enjoyment of Niagara's natural resources, and a public park on the Canadian properties adjacent to the Falls and Gorge, coupled with the interest of both administrations in the floristic treasures of these newly protected lands, there was a certain flowering of botanical energies in Niagara county in the last two decades of the nineteenth century. Mr. A. D. Pease of Wilson engaged in a flora of Niagara County in the eighties, and Miss Marion Jessup Wright, and Mr. E. C. Townsend, both of Lockport, in the nineties. All three individuals spent time collecting in areas explored earlier by Day such as DeVeaux College woods, Goat Island, and Niagara Glen (Ontario), or Foster's Flats as it was then known. Their specimens eventually made their way into the collections of the Buffalo Museum of Science.

Mr. Frank W. Johnson, who moved from Chicago to Buffalo around 1915 (Zenkert, 1934), began to direct the Botanical Section of the Buffalo Society of Natural Sciences. One objective of the Section was to revise Day's 1882 publication of the plants growing in the vicinity of Buffalo, and his Catalogue of the Niagara Flora (1888). It is owing to the latter effort that so many voucher specimens exist for plants of the Niagara Falls area made by Mr. Johnson and his associates. When Mr. Johnson left Buffalo in 1928 he sent his herbarium to the New York State herbarium in Albany (NY) “for storage” in addition to providing data to Dr. H. House, then State Botanist and engaged in revising a flora of New York State (Zenkert, 1934). More specimens from Goat Island and Niagara Falls may be sought there.

Mr. Charles A. Zenkert, research associate in Botany in the Buffalo Society of Natural Sciences, car-
ried through on Mr. Johnson’s direction, summarizing floristic data that had been accumulating since Day’s 1882 and 1888 Catalogues, revising the nomenclature, revisiting old botanical haunts, exploring new ones, analyzing and interpreting the data already housed in the Clinton Herbarium of the Buffalo Mu-

**Part III: The Flora**

David Douglas (1798-1834), collected seeds and other plant materials suitable for transplanting, for the Royal Horticultural Society on a one-year trip to the United States in 1823. His collections were later examined by William J. Hooker of the Botanical Garden in Glasgow and published in Hooker’s Flora Boreali-Americana (1840) (Zenkert, 1934).

In his diary (Douglas, 1914), Douglas made note of American horticulture, its gardens, vineyards, orchards, what grew well of an indigenous nature, or by foreign importation. He also searched for new species, unusual habitats of species he did know and clarified problematical taxonomic problems, such as those of our North American Oaks.

Douglas made the following account of Goat Island in his journal, Tuesday, September 30th, 1823:

“It is partly covered with woods of large dimensions; the soil is variable, part rich and part sand and gravel. The sugar maple, *Acer saccharinum*, on the brink of the rocks grew very large; they had all been tapped or bled and still seemed uncommonly vigorous [Acer saccharinum] in our present nomenclature refers to the Silver Maple, which does occur on Goat Island, but nowhere near as commonly as *Acer saccharum*, the true Sugar Maple; it is the Sugar Maple to which Douglas refers here]. There were a few pines of two species, but had no cones. *Botrychium*, two species in shady parts of the wood in decayed leaves; two species of *Orobanche*, in dry places also among leaves. *Trillium* seemed to be plentiful, but the leaves being decayed, I could not get as many as I would like. *Arisaema triphyllum*, *Dracontium* sp., and *Pothos foetidus*: I was not a little surprised to see *Pothos* in a dry place; they had perfected seeds. *Rhus vernix* in conjunction with some species of *Smilax*; and another species of *Rhus* clad the trunks of the large trees. On the south side of the island there is very good limestone and a good kind of gypsum.”

Again, reference is made to the unusual size of the trees, in this case the Sugar Maple, growing on the Island. The pines are no doubt the White Pine, *Pinus strobus*, which still may be seen there, and perhaps *Tsuga canadensis*, which at one time was more abundant than now. Day (1888) reported only one species of *Botrychium* (*B. virginianum*) and no one has reported or collected a second. The *Orobanche*, a genus of parasitic plants, may refer to *Conopholis americana*, Squaw Root, parasitic on Oak roots and, although not reported for Goat Island, colonies may be found at DeVeaux woods, several miles down river where Oak trees there reach a fine development today, and *Epifagus virginiana*, or Beech Drops, parasitic on Beech. Both species occur in the Orobanchaceae. Day did report this latter species from Goat Island when the Beech-tree element was, in Day’s words, abundant. *Monotropa hypopitys*, Pinesap, which is parasitic on conifers was also reported on Goat Island by Day (1883). *Arisaema triphyllum*, Jack-in-the-Pulpit, a spring ephemeral, was probably more conspicuous in Douglas’ time. At the time of year of his visit, he could have seen only its brilliant red seed-heads, since its large leaves would have long disappeared. The species of *Dracontium* was most likely *Arisaema draconitum*. No one has since reported seeing *Pothos* (*Symlocarpus foetidus*) Skunk Cabbage, from the Island, although the presence of seepage can be demonstrated in numerous areas, particularly on the northern margin of the island. In September, all that would have been left of the plant above ground would be its odd and conspicuous fruiting structure. Perhaps he found it in an uncharacteristically dry area because the drainage had been recently altered, otherwise I can think of no other species with which this one could be confused. Today, Skunk Cabbage populations are abundant in Niagara Falls, Ontario, in wet, wooded muck at Dufferin Islands and seepage at the base of the hill overlooking the Horseshoe Falls. No one has reported *Smilax* from the Island, but *S. herbacea* can be found at Scovell’s Knoll where the Ni-
agara River leaves the gorge of the Niagara River at Lewiston, New York, and in woods along the crest of the gorge in Ontario. The only climbing Rhus is Rhus radicans, or Poison Ivy.

Douglas' reference to the south side of the Island indicated the shallowness of the soil cover there then, as now, relative to the north side. The riverbed is quite exposed in this area, as it is in the flats above the Horseshoe Falls, in the south, or Canadian, channel of the Niagara River. The gypsum perhaps refers to the bright white deposits one used to be able to see, interbedded with the dolomite rocks. According to George W. Clinton's diary kept during the Erie Canal Trip of 1826 (see section on collectors), mineral hunters enjoyed breaking away this material and taking it home. Gypsum may still be encountered in little-frequented areas on the Island, such as in the talus at the cliff base where tourists are now not ordinarily allowed to go.

THE DIARY OF SIR JOSEPH DALTON HOOKER

(Unpublished journal, copyright, Royal Botanic Gardens, Kew: Chicago to Niagara Falls, Sept. 19, 1877)

In 1877, Drs. Joseph Dalton Hooker and Asa Gray were returning east after conducting an expedition to study the flora of western North America. Niagara Falls lay on their eastward route and they decided to make a visit. Gray had explored the island some thirty years earlier in 1831 and had noted certain unusual plant species growing there, specimens of which he had sent to John Torrey and others.

According to Hooker's travel and botanical diary, he and Gray started their day, on September 19, 1877 on the Canadian side of the Niagara River. After some remarks upon the Canadian landscape and a comment on the poor quality of wine derived from Vitis labrusca (called Concord and Isabella), and from native grapes of the Eastern United States generally, Hooker crossed the Niagara River and stopped at the Cataract Hotel in Niagara Falls, New York. After having established themselves, they proceeded to Goat Island. Hooker then listed in his diary a number of botanical species that he, in the company of Dr. Gray, encountered on the island. It is an accurate list, as Dr. Gray, who verified his identifications, was the leading expert on the flora of North America, having published on the subject with John Torrey, of New York. He had, in 1848, issued the first edition of his Manual of the Botany of the Northern United States which has remained, with revisions, to the present day, one of the several major manuals of the flora of that region.

The next day, Hooker went back to Canada (the "British side") to enjoy the prospect and visit the Museum there. By the 21st he was well on his way east to Albany.

Less than a year later (April 12, 1878), Hooker gave a lecture to the Royal Institution of Great Britain entitled “The distribution of the North American Flora” (Turrill, 1953). In addition to discussing the flora of the Arctic in the New World and of Canada (as the British North-American flora), Hooker referred to the Great Eastern Forest region of the United States flora. This floristic region, which extends “from the Atlantic to beyond the Mississippi” to the Great Plains, is “noteworthy for the number of kinds especially of deciduous trees and shrubs...even on a very limited area.” “Of these I shall select two examples from my Journal.” One of these was on the Missouri River near St. Louis where “in little more than half an hour, and less than a mile's walk, I saw forty kinds of timber trees ....” “The other example was afforded me by Goat Island, which ... covers less ground than Kew.
Gardens. Here the vegetation was more boreal and less varied than in Missouri; but with Dr. Gray's aid I counted thirty kinds of trees, of which three were oaks and three poplars, together with nearly twenty different shrubs.” “I know of no temperate region of the globe in which any approach to this aggregation of different trees and shrubs could be seen in such limited areas, and perhaps no tropical one could afford a parallel” (Turrill, 1953).

It is this rich eastern and north-eastern flora that inspired Asa Gray's postulation of the close relationship of the East American with East Asiatic floras—especially with that of Japan: two hundred and thirty species are shared and nearly three hundred and fifty were closely related. This correspondence was not true for the floras of the Plains and the Rocky Mountains “and still less, perhaps, in regions farther west.”

Hooker’s celebration of the richness of the flora of Goat Island, as indicative of the richness of the eastern North American forest flora, seems to be the source of an idea repeated over and over again in a variety of diverse publications. “The eminent English botanist, Sir Joseph Hooker, has said that he found upon Goat Island a greater variety of vegetation within a given space than anywhere in Europe, or east of the Sierras, in America; and the first of American botanists, Dr. Asa Gray, has repeated the statement” (Olmsted in Gardner, 1880 and paraphrased by Porter, 1900). Frederick Law Olmsted goes on to say “I have followed the Appalachian chain almost from end to end, and traveled on horseback ... over four thousand miles of the most promising parts of the continent without finding elsewhere the same quality of forest beauty which was once abundant about the falls, and which is still to be observed in those parts of Goat island where the original growth of trees and shrubs has not been disturbed ...” (Gardner, 1880). An echo of Hooker's observations appears in a work of David F. Day's (1901) “It would be very difficult to find within another territory, so restricted in its limits, so great a diversity of trees and shrubs,” backed up here with abundant statistics, however: of the 170 species of trees and shrubs known from western New York, 140 occur on “Goat Island and the immediate vicinity of the river near the Falls.”

Other individuals have also commented on the richness of the flora. One of Agassiz’s scholars on the Lake Superior trip prior to 1850 commented that the “variety of trees and shrubs on these islands is remarkable” (Agassiz, 1850), where followed, by example, a list of the trees growing on one of the tiny islands in the American channel (Ship Island). It was Hooker, however, who attempted to substantiate this impression, if only for his own interest, by producing a catalogue of plants on Goat Island.

The following list comes directly from the diary Hooker kept during his trip to North America, kindly lent as photocopy by Leanore Thompson, Assistant Librarian at the Royal Botanic Gardens, Kew, where Hooker's original diary is archived.

Asa Gray (attribution unknown).
PLANTS AT GOAT ISLAND
[TREES AND SHRUBS]
Abies canadensis [= Tsuga canadensis] [EASTERN HEMLOCK]
Acer saccharum [SUGAR MAPLE]
Alnus [cf. rugosa] [SPECKLED ALDER]
Amelanchier canadensis [CANADIAN SHADBUSH]
Ampelopsis quinquefolia [= Parthenocissus quinquefolia] [VIRGINIA CREEPER]
Betula papyrifera [CANOE BIRCH]
Carpinus [sc. caroliniana] [AMERICAN HORN-BEAM]
Celastrus scandens [CLIMBING BITTERSWEET]
Cornus paniculata [= Cornus racemosa] [PANICLE DOGWOOD]
C. alternifolia [ALTERNATE-LEAVED DOGWOOD]
C. circinata [= Cornus rugosa] [ROUND-LEAVED DOGWOOD]
Euonymus atropurpureus [WAHOO]
Fagus [sc. grandifolia] [BECH]
Fraxinus americana [WHITE ASH]
Juglans nigra [BLACK WALNUT]
Juniperus virginiana [RED CEDAR]
J. communis [JUNIPER]
Lonicera parviflora [= Lonicera dioica] [SMOOTH-LEAVED HONEYSUCKLE]
Morus rubra [RED MULBERRY]
Ostrya [sc. virginiana] [HOP-HORNBEAM]
Pinus strobus [WHITE PINE]
Platanus [sc. occidentalis] [SYCAMORE]
Populus candidans [BA LM OF GILEAD]
P. grandidentata [LARGE-TOOTHED ASPEN]
P. tremuloides [QUAKING ASPEN]
Prunus serotina [BLACK CHERRY]
Pyrus coronaria [WILD CRABAPPLE]
Quercus rubra [= Quercus borealis var. maxima] [RED OAK]
Q. prinus [CHESTNUT OAK]
Q. tinctoria “?” [= Quercus velutina] [BLACK OAK]
Rhus toxicodendron [= Rhus radicans] [POISON IVY]
R. typhina [STAGHORN SUMACH]
Ribes cynosbati [PRICKLY GOOSEBERRY]
Rosa sp. [ROSE]
Rubus odoratus [PURPLE-FLOWERING RASPBERRY]
Rubus strigosus [RED RASPBERRY]
Salix cordata [= Salix rigida] [HEART-LEAVED WILLOW]
Sambucus canadensis [ELDERBERRY]
Shepherdia canadensis [CANADIAN BUFFALOBERRY]
Spiraea opulifolia [= Physocarpus opulifolius] [NINEBARK]
Symphoricarpus racemosus [= Symphoricarpos albus] [SNOWBERRY]
Taxus canadensis [GROUND HEMLOCK]
Thuja occidentalis [ARBOR VITA E]
Tilia americana [BASSWOOD]
Ulmus fulva [= Ulmus rubra] [SLIPPERY ELM]
Vitis riparia [FROST GRAPE]
V. labrusca [FOX GRAPE]
[HERBS]
Acalypha virginica [in this case = Acalypha rhomboidea, see notes in the species catalogue under this species] [THREE-SEEDED MERCURY]
Achillea millefolium [COMMON YARROW]
Agrimonia eupatoria [COMMON AGRIMONY]
Ambrosia artemisiaefolia [COMMON RAGWEED]
Amphicarp a [sc. bracteata] [HOG PEANUT]
Anemone virginiana [THIMBLE-WEED]
Aralia nudicaulis [WILD SARSAPARILLA]
Arctium lappa [GREAT BURDOCK]
Asclepias cornuti [= Asclepias syriaca] [COMMON MILKWEED]
Asparagus officinalis [ASPARAGUS]
Aster cordifolius [HEART-LEAVED ASTER]
A. laevis [SMOOTH ASTER]
A. miser (diffusis) [= Aster lateriflorus] [STARVED ASTER]
A. novae-angliae [NEW ENGLAND ASTER]
A. tradescantii [Aster simplex var. interior] [TALL WHITE ASTER]
A. undulatus [WAY-LEAVED ASTER]
Ampelopsis breviligulata [= Ampelopsis neglecta] [COOPER'S MILK-VETCH]
Chenopodium stramoniifolium [= Chenopodium hybridum] CHECK SYNONYMY
Cnicus muticus [= Cirsium muticum] [SWAMP THISTLE]
Equisetum variegatum [VARIEGATED SCOUR-
ING-RUSH]
Erechtites hieracifolia [PILEWORT]
Erigeron canadensis [= Conyza canadensis]
[HORSEWEED]
E. strigosus [DAISY FLEABANE]
Eupatorium ageratum [= Eupatorium rugosum]
[WHITE SNAKEROOT]
Eupatorium perfoliatum [BONESET]
Eupatorium purpureum [PURPLE JOE-PYE-WEED]
Frangaria vesca [WOOD STRAWBERRY]
Frangaria virginiana [VIRGINIA STRAWBERRY]
Geranium robertianum [HERB ROBERT]
Geum virginianum [=Geum laciniatum] [ROUGH AVENS]
Gnaphalium uliginosum [LOW CUDWEED]
Helenium autumnale [SNEEZEWEED]
Houstonia purpurea var. ciliata [= Houstonia canadensis] [FRINGED HOUSTONIA]
Hypericum perforatum [COMMON ST. JOHN’S-WORT]
Galeopsis tetrahit [HEMP-NETTLE]
Lactuca elongata [= Lactuca canadensis] [WILD LETTUCE]
L. leucophaea [= Lactuca biennis] [TALL BLUE LETTUCE]
Leersia [CUT- or WHITE-GRASS]
Lithospermum officinale [GROMWELL]
Lycopus sinusiusus [= Lycopus americanus] [CUT-LEAVED WATER HOREHOUND]
Monarda fistulosa [WILD BERGAMOT]
Muhlenbergia mexicana [WOOD GRASS]
Nabalus albus [= Prenanthes alba] [LION’S FOOT]
Nepeta cataria [CATNIP]
THE DIARY OF GEORGE WILLIAM CLINTON

(Unpublished journal, copyright, Buffalo Society of Natural Sciences, Buffalo Museum of Science)

The following are several abstracts from Clinton’s journal relating to Goat Island, areas around Niagara Falls and the Niagara River Gorge. Modern nomenclature in square brackets follows the names Clinton used. In many cases, the specimens Clinton reported collecting may be seen today in the botanical collections of the Clinton Herbarium, Buffalo Museum of Science. The Buffalo Society of Natural Sciences named their botanical collections after Clinton because the specimens he collected and purchased form the nucleus of this herbarium.

Additional notes or insertions made by the present writer are placed in square brackets. In many cases the abbreviations used by Clinton as shorthand are spelled out. Series of dots indicate either extensive portions of irrelevant text deleted, or words obscure in Clinton’s handwriting. The question marks, unless in square brackets, are Clinton’s. If a technical name followed by a question mark is then given an exclamation mark, it is because Clinton was later able to confirm his identification.

Suspension Bridge was the name of a small village now incorporated into the City of Niagara Falls, as was DeVeaux, just north of it along the crest of the Niagara Gorge.

“The present Herbarium was not commenced until 1865. In January of that year I visited [Asa] Gray, at Cambridge, and advised with him. I adopted his species sheet and genus wrapper.” [Note: written on a loose sheet in Clinton’s journal.]

GEORGE W. CLINTON’S BOTANICAL JOURNAL 1862-1878

1862
April 29.
On Goat Island, in flower, the Juniper (Juniperus virginiana), Shepherdia, Sanguinaria, Dicentra cucullaria and Dentaria laciniata.

May 17.
List of flowers found since last emendation. Goat Island. Arabis lyrata. Viola sagittata (Sed? Veronica serpyllifolia and V. agrestis? I have searched the station repeatedly since for it, in vain, and think now that it was a mere form of V. cucullata), Shepherdia in young leaf. Both sexes.

June 26.
Niagara Falls. Goat Island. Collected leaves and fruit of Shepherdia canadensis, Geranium robertianum. Below Biddle Stairs, a fern. On the top of the bank, Arabis lyrata in seed and Houstonia ciliolata [Houstonia canadensis] (which last I found also in dry woods on the
Mainland), also *Symphoricarpos racemosus* [S. albus var. albus] just commencing to flower. Descending to the level of Terrapin Bridge, to the left of the path, found *Astragalus Cooperi* [Astragalus neglectus], also a pretty *Lathyrus?* (!) more than 3 teeth to the sheath. On the side hill, an *Anemone*, which may not be the *aconitifolia* (it turned out to be *A. virginiana*). *Lithospermum officinale* a common weed on the Island & about the Falls. Gathered some *Rhus toxicodendron* [Rhus radicans], *Cornus circinata* [Cornus rugosa] here & there on the Island. Walked through the woods over to Gill Creek and back. Found *Hieracium venosum*, *Thaspium aureum* [Thaspium trifoliatum], 1 specimen of *Asclepias quadrifolia*. At the Creek, *Gratiola virginiana* [perhaps *G. neglecta*, the former being excluded from the Niagara Region by Zander and Pierce, 1979] the plants each having its first flower.

July 3 & 4.

Niagara Falls. This side. *Arabis canadensis*, *A. hirsuta*? On the Island, *Anemone cylindrica* or *virginica* (cylindrica’). Near the Ferry landing on the Canadian side, this *Anemone* was very large, and the heads were quite long & very cylindrical, and so they are sometimes, on the [Buffalo] Plains, where, as I afterwards found, it is quite common [see discussion on the Buffalo Plains in the origins of the flora section above].) At & near Table Rock, *Nasturtium officinale, Myriophyllum heterophyllum*, what looks like the leaf of *Parnassia* (it turned out to be *Parnassia caroliniana* [Parnassia glauca] which is also on Goat Island, on the flat near Terrapin bridge, & on Strawberry Island). By the railroad, back of Table Rock, *Linaria vulgaris*. In woods near Suspension Bridge, *Oenothera chrysanthra* [Oenothera biennis], *Galium circinatum* & *lanceolatum*. From Zimmerman’s hedge, *Anemone*.

July 5.

Niagara Falls. About the flat by Terrapin bridge, *Platanthera hyperborea* [Habenaria hyperborea, *Equisetum variegatum*], a bush in seed now, pericarps of last year (proved to be *Hypericum kalmianum*). On the bank on top of the cliff at the Whirlpool, American side, *Melampyrum, Asclepias tuberosa, Arctostaphylos uva-ursi*, in berry, *Vitis* with the leaves much cut. Dr. Van Rennsselaer showed me a tree which he had been told was the cucumber. It is, probably, *Morus rubra*! In the Whirlpool horse yard, 1 specimen of *Pterospora andromeda*, not quite in blossom. On the bank, this side of Devil’s Hole, *Campanula rotundifolia*. Everywhere *Lilium philadelphicum*. Cross-road sides, between Schlosser [old site of Fort Schlosser, American mainland] & the Falls, *Echium vulgare*. On the Island, *Rhus typhina*.

Aug. 1.

Went in 8 A. M. train to Tonawanda. Kept on, in 8 o’clock train to Suspension Bridge, & walked down to the Whirlpool. There found 6 specm. of *Pterospora andromeda*, in seed, *Asclepias verticillata*. Collected also leaves of *Sassafras officinale*, & 1 specimen of a very singular compound flower, *Aster* like, but florets all tubular (= *Liatris cylindracea*.) Near Devil’s Hole, collected *Dipsacus sylvestris*, & a *Helianthus* everywhere. Crossed the Suspension Bridge, & walked to Table Rock. There collected *Lobelia Kalmii, Calamintha glabella* var. *nuttallia* [Satureja glabella var. *angustifolia*], & a pretty *Lycopodium* or (more probably) *Selaginella =S. apus.* Going down to the Ferry, when almost down, by the road, *Polymnia canadensis*. On Goat Island, *Hypericum Kalmianum, Lathyrus palustris*. Collected *Phytolacca decandra* [Phytolacca americana], *Mentha viridis* [Mentha spicata], & one of the *Antennaria*.

Sept. 11.

To Suspension Bridge. Walked to the Whirlpool, thence back to the Falls, foot of Amer'n
Staircase. Goat island, thence up the [Mill] Race & on to La-Salle, thence, by the cars, home. At Cayuga Creek, Dulichium spathaceum, [Dulichium arundinaceum], Nesaea verticillata [Decodon verticillatus]. Between the Falls & that Creek, Melilotus officinalis. At the Dam of the [Mill] Race, Dianthera americana [Justicia americana], Pedicularis lanceolata, Cicuta bulbifera, Siam lineare [Sium suave]. On the Island, Chenopodium hybridum, 2 specimens of Gentiana detonsa (?) [Gentiana procera]. On the right of the path to Terrapin Tower saw a hundred Gentians (G. detonsa) [Gentiana procera]. Collected there Parnassia caroliniana [Parnassia glauca]. On the Island, a Nabalus [Prenanthes]. At the foot of the Ferry Stairs, Helenium autumnale in the very narrow leaves. Wood opposite the Whirlpool, on the western side of the wood, what I thought might be Parietaria (turned out to be dwarfs of Acalypha virginica.) Whirlpool woods. Saw Monotropa hypopithys in seed. Along the bank, 2 ferns, one (of which I found only one root) Allosorus atropurpureus [Pellaea atropurpurea] the other Polypodium vulgare. A compound flower, not tuberous, flowers all tubular (Liatris cylindracea), a willow leaved Aster? (Aster ptarmicoides), a procumbent round leaved Lespedeza, Lespedeza violacea [Lespedeza intermedia] (have collected it before, at Portage & about Buffalo.) Asters & Solidagoes.

Sept. 23.
In springy fields below Table Rock & also on Goat Island near Terrapin Bridge, Gentiana detonsa [Gentiana procera] abundant. Also, below Table Rock, in same situation, Gerardia purpurea? Parnassia caroliniana common. Descending to the Whirlpool, on the Canada side, gathered an Asplenium, an Aspidium? with a very narrow & long frond (=Cystopteris bulbifera) and Camptosorus rhizophyllus.

1863
April 25.
Went by 8 o'clock train to Lewiston, walked to the landing, & then up the River a way. By the path from the river up the bank found a very small leafless shrub, woody, with white flower buds in terminal heads (probably Rhus aromatica). Near the stone house Dr. Scoville once used in flower, Saxifraga virginiensis, Dicentra cucullaria, Claytonia virginica, Ulmus fulva [Ulmus rubra]. On the top of the bank a little beyond the Suspension Bridge, Houstonia [purpurea crossed out] caerulea. Walked to & up the Rail Road and the precipice above it, where water dripped or ran from it, had many icicles. A cold north wind. Went half way down the Devil's Hole, felt there was no use, & so climbed up again. Walked to Whirlpool ... on the bank beyond it, Hepatica triloba [Hepatica americana] abundant. Found also Erythronium americanum. Some ... of Trillium grandiflorum & Cardamine rhomboidea [Cardamine bulbosa]. On Goat Island, Dicentra cucullaria, Sanguinaria canadensis, and Shepherdia. I was a week too early, some of these things were fairly in blossom. Took the 6*20' train at the Falls & got home at 7*20' P.M. Collected also on Goat Island white (?) birch (Betula papyracea), & on the bank, above the Devil's Hole, a poplar (large trees by fence.) Evening at meeting of [Buffalo] Soc. of Nat. Hist. Mr. Reinecke told Mr. [David F.] Day & myself that, a week ago, he found a yellow flower (which he described as well as he could) on this side of the Scajaquada, near the stream, east of Delaware St, & some distance from it. (It turned out to be Caltha palustris.)

June 5th.
With [David F.] Day, took cars to Suspension Bridge, crossed it & walked along the bank to Whirlpool & descended, to the water, and made our way to the st... flat where a stream comes in. Found nothing new. Took some specimens of the Taxus canadensis. Ascended the stream some way leaving it on the left, & then, fought our way up to the top of the bank. Found ... a
wet place on hillside, near the stream, *Equisetum variegatum* & collected a *Carex*. High up on the hill, *Aphylla uniflora* [*Orobanche uniflora*] (4 specm-) and a *Cypripedium* which may be *parviflorum* (!) but is probably a very small flowered *pubescens*. On the top of the bank, a number of Sassafras bushes in full flower, all staminate. A little beyond this rock platform at the foot of the Whirlpool, a smallish, hairy *Arabis* (= *A. hirsuta*). Took a road which led us to the main road to Queenston, & went to Brock's Monument. In the dry gravelly soil around it, a low small yellow flowered crucifer abundant, looking like a *Lepidium* (It is *Alyssium calycinum* [*A. alyssoides*]). Crossed the Suspension Bridge & down to Lewiston. The only thing I could find ... the white bush mentioned April 25 (p. 6) is a *Rhus*, perhaps the *aromatica*. Cut by Scovill's old place to the railroad. *Ranunculus scleratus* very abundant. Picked a few specimens of *Houstonia caerulea*. In the pond in the groove between R. R. & river bank, noticed *Ranunculus purshii* [*Ranunculus gmelinii*, excluded from the Niagara Frontier Region by Zander and Pierce, 1979]. On the top of the bank, on both sides of the River, a *Vicia*, which I think must be *V. americana*, abundant & beautiful. Made for the Whirlpool House & so along the bank to the tree of *Morus rubra*, which was in full fruit and a male. The *Astrastaphylos* has cheated me again, though we found a few flowers, which are very small. Found also, near the bank, a *Cerastium arvense* probably *oblongifolium* [crossed out] and a very handsome variety of *Senecio aureus*. Picked up by the roadside *Hesperis matronalis*? a garden scape. Walked on to the Falls, and arrived there 20 minutes before the starting of the 6*20* train which took us back to Buffalo.

June 8.

2*2' [*?] P. M. train to Niagara Falls. Took a few specimens of *Carex clintonii*? [*C. Oederi* [written above]] from below American Staircase, not dioicous & a *Carex* from above the Staircase where *Hypericum kalmianum* is abundant. On Goat Island the little flat above the bridge looked in vain for *C. Oederi*. but collld. two. Also [*Agrostis* crossed out] *Poa pratensis*. None of the Carices in condition. Collected 2 specs of *Carya alba* from the 3 trees near the [depot?].

June 24.

Took 8 A. M. train to Suspension Bridge, crossed & walked down to Whirlpool. On the way, in a little pool, found *Alopecurus geniculatus* ? [*Alopecurus aequalis*] stems rooting in the mud, also, *Fragaria vesca*, an Oatlike grass, gathered, I think before (= *Danthonia spicata*, written above). Descending to the Whirlpool, collected a *Cystopteris bulbifera*, a small grass, & on the beach at the bottom, a *Panicum*. Ascended the little stream to the place where Day & I collected a *Carex* and collected some of it, then climbed up the slide just below it, and found *Bromus mollis* [crossed out] *kalminii* and 1 specimen of *Calystegia spithamea* [*Convolutus spithamaeus*]. On top of the bank before coming to Point View [Whirlpool Point] collected *Hieracium venosum*, 2 specimens of *Platanthera hookeri* [*Habenaria hookeri* & *Pyrola chlorantha* [*Pyrola virens*]. Along the top of the cliff, beyond the point, *Scutellaria parvula* abundant. Collected some *Carices* & a number of grasses at various points, particularly on a wooded, lower plateau 1/2 mile below the Point. Also *Asclepias quadrifolia*. On the edge of a wheatfield, this side of descent to Foster's Flat. *Triticum repens* [*Agropyron repens*] abundant, & also at Niagara Falls. In descending to Foster's Flat, gathered an *Arabis*, and, along the path near the bottom, two grasses, one of them found 1/2—6* high, also *Hydrophyllum canadense*. Endeavored to return by keeping outer edge of the woods, & came out on a road, which led me to the Great Western R. R. on which I walked to the Bridge, & crossed & walked up to the Falls. At the foot of American Stairs, below it, on the old steamboat dock, & in the talus above, collected 3 *Carices*, including 2 states or forms of *C. Oederi* & *Lolium temulentum*. 
Took the 6*14’ ... train for Buffalo ...

July 5.
Walked to Whirlpool with George, got 2 or 3 specimens of Pterospora, some specimens of Rhus aromatica, Bromus kalmii, 2 or 3 grasses, Asplenium trichomanes, Pyrola rotundifolia, Silene antirrhina. At foot of American Staircase, Carices, a grass, and Typha angustifolia. On Goat Island, Carices. Collected also the bitter Carya, White Ash, and Ironwood (Ostrya).

Friday, Sept. 11.
Went by 8 A.M. train to Lewiston. On the bank of the River collected Aster ericoides. Walked to the Suspension Bridge in a cultivated field, on the right in the road & on the Bank of the River, Abutilon avicennae [Abutilon theophrasti] abundant, crossed & went to Brock’s Monument. The Alyssum gone but put some dead stalks in my pocket, hoping there might be a seed or two in them. The Monument gate-keeper asked me if I knew the Lobelia (L. inflata of course, written above), I said yes!. He said he had the asthma & it was recommended to him & showed me some Verbascum blattaria & asked if that was it. I told him no! But that it was a very common plant, & if I found it in going to the bridge I’d leave it at the bridge toll-house, for him which I did. He told me that the gravel around the monument had been drawn in part from the first village above, & in part from below. I inquired about this, partly because I wished to trace the origin of the Alyssum, & partly because I had found & collected from the side of the gravelly road near the Monument, a small grass (+ Viifia vaginiflora) [Sporobolus vaginiflorus] very much resembling the smaller Sporobolis (T...) of the Lake Shore. In descendency to the Bridge found the Senecio vulgaris, of an unusual aspect, & so took some of it, to try Dick, our canary, with it, unless it should turn out something different (which it did not, written later). Recrossed the Bridge & walked to the Station house, & in going thither, noticed the Houstonia caerulea still flowering, & picked 1 specm. of a tufted grass. Took the 12*30' train to Suspension Bridge, & walked to the Red Mulberry Tree near the Bank of the River, found several younger trees of the species in the wood near it, so that there is probably a male among them, took some of the lobed leaves. On a rock in the wood found the Camptosorus, & on rocks near the bank, Allosorus atropurpureus [Pellaea atropurpurea] and Asplenium trichomanes, kept along the bank to the Whirlpool House, & found, in one place, in a slight, gravelly (?) depression in the edge of the bank the same grass I found near the Monument, or one very much like it. Collected also 1 specm. of Gerardia tenuifolia with white flowers, Andropogon scoparius & A. furcatus [Andropogon gerardii] (noticed Sorghum nutans [Sorghastrum nutans] Arctostaphylos uva-ursi in fruit, Aster ptarmicoides, Liatris cylindracea. Descended about 1/2 way to the River, & in the right of the path, planted a few roots & scattered spores of the Scolopendrium, also planted a few roots of it on the talus just below the American Staircase at the Falls. In reascending found & took a Strawberry with a runner 2-3 feet long. In the wood by the Whirlpool, collected Zizia integrerima [Taenidia integrerima], Desmodium nudiflorum & Pyrola rotundifolia in seed. Saw Gerardia flava [Aureolaria flava]. Walked back to the Falls. Between the Bridge & the Falls, following the railroad, took 1 Solidago, 1 Aster, & Lespedeza violacea [Lespedeza intermedia], exuberantly in flower. At the Falls, near the Grove [Prospect Park], found & took one plant of Sinapis alba? (= probably S. nigra [Brassica nigra]) Small leaved & very smooth. Also a low Euphorbia, on a suspicion that it might be E. peplus, though it is probably, only the helioscopia. Went to foot of American Staircase & searched diligently for Carex Clintonii, but in vain, found long dead culms of this year, c... with the plant in full seed, culms which had shed all their seeds & may be what Dr. Dewey took for stamine spikes. On Goat Isld., in the flat by Terrapin Bridge, collected a few seeds of Astragalus Cooperi [A. neglectus] and one Plantago, in the hope that it would turn out P. rugelii (it did not, written in), and, on the Island, 1 specm. of P. major.
Part III: The Flora

Took the 6*20' P.M. train for home.

1864
May 9.
2 beautiful big poplars, before E. Grey's house, on Ellicott St., just flowering. Must get specm. Mr. Sweeney wishes to go to Tonawanda to get what he calls “the Adder's tongue” for his garden, & I promised to go with him. Can it be Erythronium? 2 P.M. took train to Suspension Bridge. Cut across lots to the Whirlpool Woods, & took 3 or 4 specm. of a poplar at head of 1st gully. In the wood, found Oryzopsis asperifolia (culm leafy below, but awn long & dead leaves larger than ...) in full flower, its leaves, as yet, shorter than the culm. Took a little Saxifraga virg. & Cardamine purpurea [Cardamine douglasii]. Walked up to Goat Island, & collected Dentaria laciniata & Dicentra canadensis, and, by the River side, above the Bridge, a willow or two, Betula papyracea, Shepherdia. A very pretty little Carex (= C. aurea) coming forward on the rocks there.

May 12.
Before Breakfast stroll. Could not get at Mr. Grey's poplars in Ellicott St. [Buffalo]. Took a specimen of Acer saccharinum from tree in N.W. corner of Washington & Mohawk St., and one of Populus balsamifera from N. E. corner of Huron & Michigan Sts. Chatted with [David F.] Day. He says Populus balsamifera is on head of Squaw Island.

Went by 9 A. M. train to Lewiston. On the bank of the River found the shrub mentioned Ap. 25, 1863 (p.6 ante) in flower, & is Rhus aromatica. Upon the rocks some after passing the road beyond old Scoville place, found, just coming into flower a Turritis [Arabis], which does not look to me like the glabra. Found it also in continuation of the same hollow after crossing the rail-road (+ T. stricta) [Arabis drummondii]. Picked up a Carex & divers other things, including Ostrya in flower, & Betula papyracea (populifolia crossed out) beautifully in flower. In the middle of the pond, on right of R. R., some ways before reaching the tunnel, a patch of yellow flowers. My chest being sore with a cold, I did not dare to wade, but think it was Ranunculus Purshii [Ranunculus gmelini, excluded from the Niagara Frontier Region by Zander and Pierce, 1979], having noticed it there last year. Walked up the R. R. & ascended the Bank just north of St. Xavier's College, kept the road till opposite the Whirlpool Woods. On the bank beyond the Whirlpool House found a very little of Arctostaphylos in flower, & a beautiful flower it is, a white ball constricted at the mouth, & the neck & mouth pink (Rhus aromatica ... in the edge of the wood by the bank). Walked to the Falls. On the Island collected some Equisetum variegatum in fruit or nearly so, & found a few specimens of Dicentra cucullaria in seed. Took the 6*20 train at the Falls. It rained some after & all the way up. Had a delightful day ....

July 7.
The Panicum collected yesterday has slightly softly hairy sheathes, but is, most probably, P. latifolium. What can I do with the grasses without a microscope?

The Triticum [Agropyron], the one spike I examined, has uniformly 3-flowered spikelets 2d. Are the leaves flat? now involute.

P.M., 2*15', went to Niag. Falls. Down by Ferry Stairs, Triticum caninum? [Agropyron trachycaulum var. unilaterale] [Cinna]?... caespitosa, an Agrostis, Carex Oederi [Carex viridula]. Collected beautiful specm. of Carex aurea, a handfull, found they were over-ripe.

Aug. 22.
2*15' P.M. [train] ran down to Goat Island, to collect *Hypericum kalmianum*, & found it, as I anticipated, in seed. On the American side of the Island, by the river, & above the Bridge found all out of season *Carex eburnea*.

Sept. 12.
Took 2 P.M. train to Suspension Bridge. Walked back to the Falls & on my way, stopped at John J. Bush's (the old Buchanan Place. W. B. .. & Florence absent, at the east, & Mr. Wm...? Ford in possession) reclaimed the packet of paper left there July 21, with plants collected at Devil's Hole. In it leaves of an *Uvularia*, which, at the time, I thought might be *U. perfoliata*. About 1/2 way down the Americn. stair, & then took path under the cliff, descended, went to & ascended the cliff below the stairs & so entered the stairway & up. Collected some *Gentiana detonsa* var. *[Gentiana procera]*, walked to Cataract Hotel & chatted a little while [...] Scattered some seed of *Alyssum calycinum* [A. *alyssoides*] on the sides of the road by the Judge Porter place, in the Cataract Hotel side, & also, some distance up, on the river side of the road running by the river. Observed *Abutilon avicennae* [Abutilon *theophrasti*], as a weed in a garden. Collected two or three weeds. Home by the 6*15' train.

1865
June 1.
Took 9 A.M. train to Lewiston. Walked back, in the track, to the rocky grove. Collected there *Turritis stricta* [Arabis *drummondii*], in capital condition, noticed a *Cornus circinata* [Cornus *rugosa*], & took a specm. for Dr. Wright. Also *Avena striata* [Schizachne *purpurascens*], the *Rubus* noticed yesterday, which seems quite common (*R. canadensis* [Rubus *flagellaris*]), took a *Climacium americanum* [moss] (I want to find, hereabouts, the one Peck writes is rare) *Selaginella rupestris*.

Ascended the hill to the abandoned track of a railroad, & followed that as far as St. Xavier's College where it crosses a ravine, with a spring running into it, under a cliff, found beautiful specm of *Arabis hirsuta*, and, on the wet rock, bulging masses of a nice dark green moss, with no sign of fructification: afterward noticed the same on the wet precipice below the American Staircase [probably the moss *Didymodon tophaceus*, which grows there in darkish masses along with *Hymenostylium recurvirostrum*].

In the old field below St. X's College took one specimen of *Vicia americana*? (it looked green) and *Antennaria plantaginifolia*. At the Coll., took the highway and left it for the Whirlpool Woods, at the 2nd or 3rd line of fence below Deveaux College. Near the bank, going along, noticed *Avena striata* [Schizachne *purpurascens*] & a very few puny plants of *Arabis hirsuta*. Also took two species of a broad, short leaved *Carex*, quite small, must look at it.

In the yard of the house at the Whirlpool, *Polygala Senega*, abundant & fine, just flowering. *Carex eburnea* is common all along the bank of the River, in the woods.
Part III: The Flora


On the outside of the cliff, utterly inaccessible, seen in one instance, gloriously in flower, *Lonicera parviflora, v. douglasi* [Lonicera dioica var. glaucescens].

Descended the American Staircase to the top of the talus, & walked down on it a little way, & found, in the wet rock, a pretty, small fruited moss, and a small (*Reboullia*) *Marchantia* [liverwort] which, I think, cannot be *M. polymorpha = Preissia commutata [P. quadrata]*.

Went on Goat Island, up the American side, to the rocky flat by the River. Took, from a stump, a small lead colored fungus in the gills, & a larger one, perhaps the same and one or two mosses collected before. On the naked pasture on the head of the Island, an umbellifer, probably *Carum carui*. Met Sam. Burnok & wife, Mr. Haywood & wife, & a third couple, who have been picnicking, & they took me to Luna Island & we there finished their lemonade, cake & sandwiches. Home by 6*20’ train.

June 10.

By 9 A. M. train to Suspension Bridge, walked down to R. R. nearly to opposite the Devil's Hole, & then, in a deep rock cutting, collected some mosses. *Rosa blanda* in flower. Descended, at the Devil's Hole. Collected some mosses & *Carex platyphylla & C. plantaginea*, the latter over ripe. Walked along the bank to the Whirlpool, & along the chasm above, through Niagara City, & along the R. R. to the American Ferry Staircase. Went half way down, & walked under the cliff to the American Fall, & down to the front of the Staircase ..., except below the staircase, *Carex Oederii* [Carex viridula] ... same as usual, & what if it be *C. granularis*, looks green to me. Up the staircase to the top of the talus, & down along the top of it, where springs trickle down. Collected more *Preissia commutata* [liverwort; *P. quadrata*] & also, not in fruit, a green leaved plant growing on the rock in the water (*Fissidens grandifrons*). Over to Goat Island and collected *Barbula tortuosa* var. [Tortella tortuosa, a moss]. Home by the 6* train. The day has been very pleasant.

Sat. June 17.

By 6* A. M. train to Tonawanda. Explored wood ... by the Lockport RR, 2 or 3 mosses & a *Pyrola*, whether *chloranthus* [Pyrola virens] or a var. of *rotundifolia*? it grew among the pines (The stem is angular, almost quadrangular, and, at least in some instances, twisted). By the 9* train to the Falls, & crossed by the Ferry * called on John .. Bush, after exploring from the Ferry up under the cliff, for mosses. On his grounds saw a brilliant, beelike, but, apparently stingless insect, gregarious, ...?, entering & issuing from holes in the soil (caught one & brought it home in my box). Retd. to Amn side, after visiting Table Rock, Goat Island, walked up to Sawmill on the River, H....!

July 18.

Whirlpool woods. Could not find *Hypnum abietinum* [moss] (very likely it came from the Devil's Hole). Found, inside the enclosure, 7 specm. of *Pterospora*, in seed. At the Ferry Stairs, wet rocks at top of talus, collected *Fissidens grandifrons*, and a before uncollected (by me) moss, very delicate. Goat Island, searched it opposite to Luna Island & some way up, for *Potamogeton niagarensis* in vain. Near the Terrapin Tower, collected some *Hypericum kalmianum*.
July 23.
Sunday. My wife & daughter being at the Falls, I went down in the A. M. and ret'd by 5 P. M. train.

Noticed, by the Cataract House, above it & between the race & the river, Atriplex hastata [Atriplex patula var. hastata]. Think I noticed it there last year. On Goat Island, American side, above the Bridge, Dianthus armeria abundant & nearly accessible, will be in good condition in 2-4 weeks hence. Fissidens grandifrons [moss] is abundant on the wet rocks above, as well as below, the American Staircase, above the talus. Took some of it, & of the Hypnum [moss] which grows with it [probably Cratoneuron filicinum].

July 26.
Took 9* A.M. train to the Falls, where my wife is staying. Descending to the Whirlpool, turned off at the top of the talus, and, to ... it up along some rocks, under the guidance of the Keeper of the Whirlpool grounds, reached rock wetted by springs. The little, delicate moss, which grows near the American Staircase, in similar situations was abundant. Noticed no other except a Bryum (?) [moss] in old fruit. Descended to the river bank & picked up a little of 2 or 3 small mosses, one very small, like a Hypnum, growing on stones. Found the same in Goat island, near the cascade. Gathered, in the ... a few more specimens of Hypericum Kalmianum.

Gerardia flava [Aureolaria flava] has been in flower for some time, G. quercifolia [also Aureolaria flava] has not commenced flowering.

Aug. 8.
By 12* 20' train to Niagara Falls. Followed top of talus a longish way down below American Staircase, nothing new. On wet wettish rocks, at & above top of talus, everywhere here & on Goat Island, below Biddle Staircase, Preissia commutata [liverwort; P. quadrata], now past fruit, abundant. Near the water, a good way below the Staircase, on a large rock, a small moss in fruit, which may be new, not before collected by me [Gymnostomum crossed out]. Fissidens grandifrons does not extend far below the Staircase, nor have I found it on Goat Isl. Colld. some Lobelia Kalmii, & a birch in fruit, probably Betula papyracea [Betula papyracea]. Descended Biddle Staircase. Gymnostomum curvirostrum [Hymenostylium recurvirostrum; moss] everywhere common on wet rocks. On the talus, directly below the Cave of the Winds shanty, Hypericum kalmianum in flower & in ...purpurs.... On the other side took 4 or 5 specimens of Dianthera americana (Justicia americana).

Aug. 15.
By 12* 20' to the Falls, collected the [Quercus] near Terrapin Tower, stamens 3, also Dianthera [Justicia & Betula papyracea, whither we have the alba v. populifolia [Betula populifolia] (1866 answer, we have not! written in). On Goat Island, a little above, or opposite the head of Luna Isd, in wet [sand?], the water having retreated, a Potamogeton. Above the Amn. Staircase, a small Eupatorium, like aegeratoides [E. rugosum] but leaves small & short peti-oled.

Sept. 7.
12* 20' train to the Falls. Pursued the foot of the talus, below American Stairs to nearly where the Hydraulic Canal runs over the cliff—then to the ... where on a high rock, I collected the moss Mr. Peck ... Collected very little besides mosses, & few of these. Home by the 6* train.
Along the talus, collected *Nabalus [Prenanthes]*, *Muhlenbergia* (probably *capitata*) but heads more open than usual. In the little inclosure, opposite the R. R. depot, the common redblossomed *Amaranthus* growing spontaneously.

Sept. 23.
By invn. of Wm.[A. Thompson?] with [the Buffalonians?], took the 9 A. M. train to the Falls, & there met “the British capitalists” crossed at the Ferry & took first train on Erie & Niagara River, at the Clifton Station, backed 1/2 mile up & then went down to Niagara, where the ... gave the ... of that City & ourselves a nice lunch at Mr. Moffats's [...] Tavern. Walked down to the River and then taken back to Clifton by the train. Recrossed River at Ferry, and made one (unsuccessful) grab, near American Falls for *Anomodon viticulosus* [a moss]. Home by 11* P. M. special train.

Sept. 27.
By 9* A. M. train to Suspension Bridge, went down the old road to the Maid of the Mist Landing & along the water up a good way to not far below the Fall made by the Hydraulic Canal, then scrambled to & returned a good way on the top of the talus, & there down it &
back to the top of the bank. On the talus found one white *Gentiana Andrewsii*. Walked up to Goat Island down the Biddle Stairs & searched near the Middle & the British Falls for [the moss] *Anomodon viticulosus*, then to the American Staircase & did the same at the American Fall. Then took a short walk in the wood, & then home by the 6* P. M. train. Collected some mosses, probably nothing new.

Oct. 18.
Before Breakfast, recd. letter from Dr. Lesquereux, giving the precise station of *Anomodon viticulosus* on Goat Island. Went to Suspension Bridge by 9 A. M. train, mossed at Devil's Hole. Turned up to the Falls & to Goat island and examined the station, but, alas! no *Anomodon vit's* there! The Station was on Goat Island, on a rock, about halfway down the path leading from the Carriage way to the Bridge to Luna Island, not the Hog's Back path, but the one above it. There's no rock there. Perhaps the path has been changed since Dr. L. was there.

Oct. 21.
Went to the Falls, collected *Orthotrichum anomalum* [moss], for Dr. Lesquereux, from trees in the park opposite the Ferry House, also another lighter colored one also. From first tree, what Mr. [James?] thinks is *Leskea nervosa* [moss]. Crossed the Ferry, & explored up to the Horseshoe Fall, under the cliff, looking specially for *Trichostomum rigidulum* [*Didymodon rigidulus*; moss]. Found, on the wet talus, close to the Fall, a sterile moss? which may be it (=A singular Conferva). Recrossed, & walked down the river & took some more *Didymodon rubellus* [*Bryoerythrophyllum recurvirostrum*; moss]. Ascended the Stairs, went to Goat island, and, commencing at the end of the Bridge, explored the bank all the way down to opposite the middle of the island above Luna Island. Found no rock till I got there—a ridge of the bank, & there, quite close to the bank, was a large rock, in the earth on top of which was an *Anomodon* which I am confident is not *A. obtusifolius* (it turned out to be *A. viticulosus*.) At the foot of the Cascade, in the water, growing on the rock, ... *Fissidens grandifrons*. Home by the 6* P. M. train. [Note: In Webster's New International Dictionary, 2nd Edition, the confer-voids are defined as “a group [of algae] comprising the larger hairlike and mosslike fresh water kinds”. This “singular Conferva” of Clinton's was probably one of these.]

Nov. 10.
To the Falls by 9* A.M. train, crossed & walked up, along the River, nearly to the Horseshoe, looking for *Trichostomum rigidulum* [*Didymodon rigidulus*; moss], am afraid I did not find it. Icicles hanging from the cliffs. Back to Goat Island, where I spent the rest of the day looking for *Dicranum montanum* & *Hypnum sprucei*, am afraid that I found neither. Home by the 6* P.M. train.

Nov. 21.
Mossed at Devil's Hole, in Whirlpool Wood, and in Grove by the American Staircase [now Prospect Point]

Nov. 29.
12:34 P.M. to Niagara Falls, to see if *Fissidens grandifrons* showing any signs of fruiting, it doesn't. On Goat Island, *Euonymus atropurpureus* in fruit, very pretty, searched the whole of the wooded part of the Island. About this date, received a package from Dr. Martindale.

1866
April 21.
Niagara Falls, by 12*20‘ train, to see W. Pettibone, who had told me that there was a plant on
Goat Island, a tea from the roots & seeds of which, drunk as you would any tea, had relieved him very much in his kidney complaint, gravel. Went over the Island with him, he looking in vain for it. He describes it as a low bush, with a very small, pearshaped, white hard seed. It occurring to me that it was, most probably, *Lithospermum officinale*, I looked it up & dug up a root with a dead stalk & he thought it to be the plant, though, the seed being gone, he could not tell certainly. Said the root looked & smelt like it. The channel between the Island & the first Sister being dry, I walked over & explored it. *Hypnum nudum* [moss] abundant. Collected an *Orthotrichum* [moss] on Goat Island. Also in the Grove opposite the Ferry House, from a tree, *O. anomalum* with calyptra.

May 12.
Went to Goat Island with Mr. Forbes & a party of young ladies from the Buffalo Fem... Sem.... & passed the day there, botanizing &c., until about 3 P.M., then to G.W. Holley's, where .... entertained the party, & thence to the railroad station & home. On the Island, the girls found a few specimens of the green petalled *Tillium*, which seems to be *T. grandiflorum*. I found *Fegatella conica* [*Conocephalum conicum*; liverwort] capitally in fruit.
“In December, 1886, the writer [David F. Day], in answer to the request of the Commissioners of the State Reservation at Niagara, promised to prepare for their use a catalogue of the plants growing upon the reservation and its vicinity.” And so, during the growing season of 1887, David F. Day reviewed his botanical observations of twenty years and “devoted such leisure as was at his command” to work in the field. The usefulness of such a catalogue to a commission established by the New York State Legislature to restore the natural scenery of the area of Niagara Falls would be great, both to understanding the flora in the broader, but still limited, context of the flora of the Niagara River Gorge and upper river shoreline on the Canadian side, but specifically of areas within the bounds of the Reservation of 1887. Such a catalogue would be important to the work of the “landscape gardeners” employed by Thomas V. Welch during his tenure as Superintendent of Works. It would be useful to scientists studying botany who would visit the area and assess its botanical character. The catalogue was originally published in the 4th annual report of the Commissioners (1888).

David Fisher Day (1829-1900) was a lawyer, closely associated with the young Buffalo Society of Natural Sciences established in Buffalo in 1861, serving several times as its President. He was a colleague with George W. Clinton in law and in botany, and was, with Clinton, a founding member of the B.S.N.S. Committee on Botany. This Committee was dedicated to botanical exploration of the then unknown region around Buffalo, and to developing a research herbarium for the new society. For a while Day was President of the Section on Botany for the American Association for the Advancement of Science (Lang, no date).

“... strangely enough, without any agreement or knowledge of the purpose of the other, we [Clinton and Day] met in a piece of wood in the southeastern portion of the city [of Buffalo]. Each of us had already collected something; and after comparing what we had found, we spent the remainder of the day together, returning to the city at nightfall. Thereafter for several years our journeys together were very frequent,” (Day, 1896). Day’s personal collection of plants went to the Buffalo Botanical Garden herbarium, and were later transferred to the Clinton Herbarium when the Gardens ceased to exist. Day and Clinton botanized together and had friendly arguments over correct identifications of field collections (Clinton’s unpublished botanical journal). In 1882 and 1883, Day published The Plants of Buffalo and Its Vicinity as a bulletin of the new society of natural history, including not only vascular plants, but also the little-known flora of mosses, liverworts, lichens, algae, and fungi—“The fact is entitled to notice that now, probably for the first time in America, a local catalogue is published in which the plants of all the classes in the vegetable kingdom are included” (Day, 1882). Quite a few diverse species in these inconspicuous groups from Niagara Falls were reported in that publication.

The collections of Judge Clinton, who corresponded widely with the foremost botanists of his time, were duly reported in this publication, as were those of Miss Mary Wilson, who also corresponded with distinguished scientists, and Charles Peck, who was to become the foremost American student of mycology (study of fungi) of his day—a botanist of the New York State Museum overseeing the flora of
Part III: The Flora

New York State. Peck supervised and corrected the lists of mosses and liverworts for the catalogue, based on Clinton's collections, and authored the section on fungi, many of which were also based on Clinton's local collections. Professor David S. Kellicott of the State Normal School of Buffalo did the first and only provisional treatment of the alga flora, which the Society was to revise and reissue later. This is the Kellicott who contributed the report of the rare *Wolffia columbiana* Karst in the "Niagara River above the Falls" of Day's (1888) Niagara Flora.

When the Reservation was established in 1885, it was natural that the Commissioners turn to Day for a botanical catalogue, as he was considered to be the expert on the local flora. Motivated perhaps in a similar way to produce a list of plants occurring in the new Queen Victoria Niagara Falls Park, two Canadian workers authored valuable catalogues of plants found in these areas. In 1890, Prof. J. Hoyes Panton produced a list of plants occurring in the vicinity of the Horseshoe or Canadian Falls, and in 1895, Roderick Cameron, Gardener for the Park, published a list for the "park and its outlying territories." His list of species is exhaustive and his intent may have been to follow, to some extent, the format of Day's *Plants of Buffalo and Vicinity* (1883). Day's flora was unusual in its time for describing not only the vascular flora but also the hepatic, moss, alga and fungal floras as well. Cameron's list of mosses is remarkably trustworthy as he reports nothing that cannot be currently discovered in the area to the present day (Eckel, unpublished data). Another important aspect of Cameron's efforts was his mounting voucher specimens of the plants he reported in an herbarium to be kept in the Park Superintendent's Office, organized by family in cases, specimens of which exist today in the herbarium of the Queen Victoria Park School of Horticulture (NFO).

Many small populations of species were probably overlooked by Day in the one year he engaged in the Niagara Flora, as he himself acknowledged, as when he reported a species common in western New York, as Moonseed (*Menispernum canadensis*) was then, but "doubtless overlooked" by himself at the falls, or species typical of certain habitats he knew to be on Goat Island, for example, which were "not yet seen by us, but may be confidently looked for (*Ludwigia palustris*)." He attempted to compensate for the brevity of his examination by including species in the catalogue that occurred elsewhere in the Niagara River, but which he had not been able to observe at the Falls in the time allotted, such as the Water Lilies (*Nuphar* and *Nymphaea* species), which were "some distance above the Falls."

Day began his catalogue with a historical review, confining himself to certain major botanical works available to him, beginning with the botanist Peter Kalm, student of Carolus Linnaeus of Sweden whose notes of his visit at Niagara in 1750, though copious in many respects, are surprisingly empty of botanical observations. The possibility of Table Rock being the type locality for *Lobelia kalmii* and *Hypericum kalmianum*, though very probable, cannot be substantiated with specimens or manuscript. John Torrey, the author of the first flora of New York State (1843) may never have visited the Falls himself. Day indicated he had use of "the MS. journals of the Hon. George W. Clinton," the Flore Canadienne of Abbe Provancher, the Catalogue of Canadian Plants of John Macoun, and the Canadian Filicineae of Macoun and Burgess, of London, Ontario.

Occasionally a reference is made to Mr. Day himself "introducing" taxa onto the Reservation, although I have not been able to find an official reference to him doing so. It is primarily Charles Zenkert, a later botanist at the Buffalo Museum of Science, who attributed these introductions to Day (Zenkert, 1934). Weedy introductions are indicated in Day's list in small capitals, other species are designated as intentional introductions into the flora of the Reservation, some native, some exotic, perhaps in keeping with the Olmsted and Vaux plan (1887) for revegetating or restoring the native flora of the Reservation:

*R*Draba verna*. WHITLOW GRASS. "Intro-


Day’s 1888 catalogue listed 285 native species, 50 alien, and 8 varieties* on Goat Island of the 909 species, 758 of which were native, and 151 alien reported for the study area of his catalogue. Hooker noted 47 species of trees and shrubs and 68 of herbs, or 115 species altogether on his one day on Goat Island. In a later report by Day (1901) he noted that 140 of the 170 species of trees and shrubs then known from western New York State occurred on Goat Island “and the immediate vicinity of the river near the Falls.”

[Note: varieties in the Day catalogue are noted above only if additional to the typical variety; single varieties given without the typical variety are counted as a species): 335 species and 8 varieties.]

In this limited area of approximately two square miles of vegetated land along the Niagara Gorge and some way along the upper river above the cataracts, Day found around seventy percent of the catalogued species published previously in 1882 for the Niagara Frontier Region as a whole. The Niagara Frontier Region is the area of a circle with a fifty mile radius with its center at Buffalo, New York—an area of 7,850 square miles. This percentage still holds between the flora of land in the vicinity of the Falls and that of the Niagara Frontier Region (Eckel, 1987). This extraordinary diversity is the equivalent to that of a county flora.

Although Day tabulated his numbers of species and such, he made no statistical comparison to his regional flora in substantiating claims to the unusual variety of species at Niagara. Nor did he extend claims by contemporary botanists to the extraordinary diversity of the Goat Island flora, an area of seventy or so acres, to the matching diversity in the gorge environment, of which Goat Island was and is only a part. Yet he left behind sufficient data so that such a comparison could eventually be made.

Roderick Cameron, chief gardener for the Queen Victoria Niagara Falls Park in Ontario, also made a flora of his park and its “outlying territories,” although, probably as a park employee, confining his efforts to the Canadian side of the river. His 1894 publication tallied “105 families, comprising 417 genera and 915 species” (cited in Dow, 1921). A subsequent republication of his list was “a more complete list than that in the ninth report [of 1894], but not exhaustive, since only such plants as had been mounted and were actually on evidence in the herbarium were included. The whole number consisted of ‘107 families, comprising 487 genera and 1,101 species” (Dow, 1921, citing Cameron, 1895). Note should be made that Cameron’s catalogue included quite a number of mosses, liverworts and other plant groups, rather like Day’s 1882, 1883 publications for the vicinity of Buffalo, which accounts to some extent for the difference in the figures. Cameron’s efforts reconfirm accounts of the great plant diversity in the gorge environment of which the Goat Island complex is a part.
VOUCHER SPECIMENS

Voucher specimens support statements made regarding the presence of species in the study area. They provide a lasting record of species occurrence, and preserve biological data regarding the contemporary flora on Goat Island, and the flora of the floristic region of which Goat Island is a part.

Living plants were collected in the field and arranged in a standard field press, or, in the case of bryophytes and lichens, in field collecting envelopes. Data pertaining to locality, date of collection, collector and other relevant information was recorded at that time. Plants were identified in the field, in the herbarium before drying, or after desiccation depending on access to technical equipment (microscopes, etc.), degree of difficulty of determination, time available, presence of reference material, and like variables.

Plants were identified and processed into herbarium specimens at the Clinton Herbarium (BUF) of the Buffalo Museum of Science, Buffalo, New York. This institution provided space, the consultation of its curator, access to bibliographic and herbarium reference materials and dissecting equipment, and provided all the archive-quality paper materials used in preparing permanent specimens. The Museum also provided computer facilities. Specimens collected by myself or others on Goat Island in previous years, which had not been identified or processed, were dealt with at this time.

Field collections of vascular plants were transferred to papers, blotters and cardboards for desiccation in the herbarium drying cabinet, allowing one week for this process, and for killing insects and other organisms that may have been included with the collection. Each specimen was then mounted on its own standard size, acid-free paper herbarium sheet using polyethylene glues and/or linen tape, allowing the specimen to be removed for future examination, and a label prepared. A herbarium number was assigned each specimen, and was stamped on the sheet, together with a stamp indicating the specimen data was entered into the database-cataloguing system of the Clinton Herbarium.

Labels were generated using the database computer software (DBASE III Plus (r)) employed by the Clinton Herbarium in cataloguing its own herbarium specimens. This software is one of the standard commercial packages used by many North American herbaria. Available computer hardware used was an IBM PC system with data stored on removable 10-megabyte Iomega Corp. "Bernoulli" cartridges.

Data was entered using the following field structure:
- Herbarium Number
- Accession Number
- Division (Anthophyta, Bryophyta, Lichenophyta, Pteridophyta, etc.)
- Family (Asteraceae, Caprifoliaceae, etc.)
- Genus and species (*Phascum cuspidatum*)
- Authority (Schreber)
- Synonymy
- Country (USA)
- State (New York)
- County (Niagara)
- Township (City Niagara Falls)
- Locality 1 (Goat Island on the Niagara River, etc.)
- Locality 2
- Locality 3
- Locality 4
- Collector's Name
- Collector's Number
- Collecting Date
- Date in Code
- Code

Specimen data can be searched on any of these fields or combination of fields.

Labels were made of archival quality acid-free paper, provided by the Museum, and were generated using a commercial macroprocessor (SuperKey (r)), thus customizing the database software to print data entered in the field structure outlined above in a label format. Labels were printed and glued to the corre-
sponding specimen sheet.

Data at this time was entered for analysis into the word-processor files on the investigator's portable microcomputer (a Sharp PC-7000).

Finished herbarium specimens were then alphabetized first by family, then by genus, then by species and filed into the botanical collections in the herbarium's steel Lane cases.

Notices of species listed as rare or extinct from the flora of New York State, but discovered in the study area were routinely sent to Dr. Richard Mitchell, New York State Botanist, Albany, New York, and Dr. Steven Clemants, New York State Heritage Program, DelMar, New York.

All primary specimens were deposited in the Clinton Herbarium, where they form part of that institution's research collections. They may be examined by the interested public by appointment with the Curator of Botany, Dr. Richard Zander, during the Museum's regular operating hours.

Eventually, all computerized specimen data from this study, together with that of specimens in the Clinton Herbarium, will be given 24-hour public access by modem through the Museum's TAXACOM online service.

I would like to acknowledge the assistance of Dr. Richard Zander, Curator of the Clinton Herbarium, Dr. Richard Mitchell, New York State Botanist, Albany and Dr. Charles Sheviak, Curator of the New York State Herbarium in determining or verifying certain botanical specimens. Drs. Zander and Mitchell provided helpful assistance in the field during the course of this study. Dr. Zander also kindly permitted me access to his unidentified, unprocessed bryophyte collections made at the base of Goat Island in the 1970's, and provided valuable computer-related advice.

HISTORICAL BOTANICAL SPECIMENS

Taking into account historical reports, botanical specimens probably exist from the area of Niagara Falls, American side, in several herbaria in Europe, notably at the Royal Horticultural Gardens at Kew, England. Asa Gray, in his youth, visited the Falls and probably collected there, as did John Torrey, and others, but their collecting data is poor with respect to locality, or has not been published, or is filed in herbaria such as the Gray Herbarium at Harvard University or the New York Botanical Garden in the Bronx and thus difficult to retrieve in the time allotted for this study. Zenkert (1934) lamented the apparent inattention to reports of Niagara plants by Linnaeus' student Peter Kalm, who visited Niagara in 1750, but whose corresponding specimens apparently lack locality data, and whose journal is lacking in references to the Niagara flora. These specimens, in whatever form they may exist, if they do at all, are not accounted for here.

The primary source for historic specimens of vascular plants were those curated at the Clinton Herbarium, Buffalo Museum of Science. Since the founding of the Buffalo Society of Natural Sciences, which operates the Museum, in 1861, various members of that society have collected and published their discoveries on the Niagara flora as one of the most interesting floristic localities in western New York State and adjacent Ontario (the Niagara Frontier Region). With the kind assistance of Dr. Harold Robinson, Curator of Bryophytes, historic specimens of mosses were searched for at the National Herbarium, Smithsonian Institution, Washington, D.C. Dr. William Buck, curator of bryophytes, generously assisted in the search for mosses and hepatics at the New York Botanical Garden, Dr. Richard Harris, also of the New York Botanical Garden, kindly determined and annotated the Clinton Herbarium's historic specimens of lichens from Goat Island, and the areas around Niagara Falls.

In the Clinton Herbarium, Buffalo, approximately 20,000 vascular plant, 3,600 bryophyte, 2,500 mycological and phycological specimens were searched for collections made on Goat Island. Each Goat Island specimen as it was found was removed from its herbarium case and its label information typed into the herbarium database according to the procedure outlined above in the section above on voucher specimens. The specimen sheet was stamped, indicating its data had been entered, the specimen was reidentified (except for myco- and phycological material), and the specimen was returned to its herbarium case. Specimens found at the other institutions mentioned above, were pulled from their collections and sent on loan to the Clinton Herbarium, where they were reidentified, typed into the specimen databases and word-
Data from historic herbarium sheets was added to floristic data compiled in the field, and from published reports.

Dr. Asa Gray exerted a powerful influence on the botanists of his day. George W. Clinton, whose collections from the latter half of the nineteenth century constitute the nucleus of the present Clinton Herbarium, consulted with Gray regarding the manner of curating his own herbarium, as Clinton notes in the very first lines of his collecting notebook. Unfortunately, Gray seemed more interested in plant taxonomy and general plant distribution, rather than the precise localities from which his specimens derived, and referred to collecting localities only in general terms on the labels of his own collections at the Gray Herbarium, Harvard University. Clinton, and probably other botanists of the period, also frequently did not cite locality data on the labels accompanying collections, hence many of Clinton’s specimens cite only the name of the plant on the sheet, and the printed label with the words: “Ex Coll. G. W. Clinton, Buffalo, New York.” Publications, such as Peck’s first checklist of the bryophytes of New York State, cite Clinton collections from Goat Island, Devil’s Hole, Whirlpool Woods, and elsewhere along the gorge of the Niagara River, but Clinton’s specimens themselves do not necessarily include these localities. Apparently Peck knew their provenance from correspondence with Clinton, or through some other communication. Specimens of Clinton’s existing in the National Herbarium, or the New York Botanical Garden that probably derive from Goat Island or the Niagara Gorge were not pulled for inclusion in this report because of the ambiguity of information on their provenance.

The designation “Niagara Falls,” which does occur on Clinton’s labels, and the labels of other collectors, is also ambiguous as to whether the reference is to localities in New York State or the Province of Ontario, or the city of Niagara Falls, New York, much less demonstrative of exact sites at the Falls, such as Goat Island and the Three Sisters, to which some Niagara Falls citations must refer. Clinton, according to his journal, liked to collect by the “American Staircase,” an area now called Prospect Point. I have not been able to determine if Prospect Point was a named used before 1885, that is, before the establishment of the Reservation.

**BOTANICAL TYPE LOCALITIES AT NIAGARA FALLS** (including Goat Island)

Botanical types are specimens that stabilize the usage of scientific names. Types are specimens selected from field collections by specialists in certain plant groups to give a physical basis for the description of a new species or variety, and thus govern the meaning of the name the species will go by. The published description of a new species is therefore less important than the type specimen on which the name is based. These specimens, called type specimens, are then carefully kept in herbaria, usually at museums or universities, for future reference, in case there should be some doubt of the identity of plants called, in future collecting, by the new name.

Frequently the original population, or an ancestor of the original population from which the type was selected, still exists. The locality in which that population exists is called the type locality.

Due to the frequency with which collectors visited Niagara Falls over the past several centuries, many specimens were collected that later became type specimens, and the localities from which the specimens derived therefore their type localities.

Day (1888) reported the visit to Niagara of Linnaeus’ student Peter Kalm and speculated that Table Rock (Ontario) was the type locality of *Hypericum kalmianum* and *Lobelia kalmii*. Apparently Kalm made no mention of the place where he collected the plants he brought back to Sweden with him, and which Linnaeus described and named after him (Zenkert, 1934).

It is beyond the scope of this paper to investigate the extensive history of geological research conducted by early and later paleontologists and stratigraphers, such as Sir Charles Lyell of England, and James Hall, Geologist for New York State, in the latter half of the nineteenth century. Stratigraphers, however, use rock strata with characteristic assemblages of minerals and fossils to establish sequences of geologic events in geologic time. Individual rock strata used in this way may be given technical names (Rochester Shale, DeCew Dolostone, Gasport Formation, Eramosa Dolostone, and so on), and type locali-
ties are the exposures from which the description of the designated rock layer was taken. One such stratum is for the Goat Island Dolostone, with type locality designated as “Goat Island at the brink of Niagara Falls” (Howell and Sanford, 1947, see also Zenger, 1965). For discussion and description of these strata in the Niagara Gorge, see Tesmer, 1981.

It is highly probable that fossil types may also occur at Niagara Falls, including Goat Island. The following is a list of some botanical types from Goat Island or the immediate vicinity.

VASCULAR PLANTS

Satureja glabella var. angustifolia (Torr.) Svenson.

One of the syntypes of this variety described by Torrey (1843) (as Micromeria) was collected on Goat Island, the other on Table Rock (Ontario).

BRYOPHYTES

Grimmia hookeri Drumm. Type: On a stone near the falls of Niagara in Upper Canada. [exsiccat: printed label in from the Torrey Herbarium (NY)]. Now referred to Ptychomitrium incurvum (Schwaegr.) Spruce.

Didymodon diversifolius Austin—No. 115. Musci Appalachiani by Coe F. Austin, 1870 Hab. ... near Newville, Herkimer County, New York (1868). Also about Niagara Falls, S. T. Olney. Now referred to Didymodon tophaceus.

Fungi

Peziza hesperidea C. & P. Goat Island is the type locality, published by Clinton and Peck (“Among fallen leaves. Goat Island, where it was first found. Clinton,” Peck, 1873).


Thelephora willeyi Clinton (“Goat Island.”) [Correspondence at BUF demonstrates this is the type material of what is now referred to as Stereum diaphanum]

ALGAE

Scytonema cataractae H. C. Wood: “This species grows abundantly in Niagara River on the rocks below the great cataract,” H. C. Wood (Kellicott in Day, 1883). Niagara Falls is the type locality for this species (Wood, H.C. Prodromus Proceed-

ings of the American Philosophical Society Vol. XI, 1871.)


TYPE LOCALITIES OF THE MOLLUSCAN FAUNA

Planorbis bicarinatus Say *1817-19. Nich. enc. Am. ed. pl. 1, fig. 4). “Found only in the gravel on Goat Island” (Letson, 1901). Miss Letson may be suggesting Goat Island is the type locality for this species.

Pyrgulopsis letsoni (Walker). (= Amnicola letsoni Walker). Goat Island gravels, type locality (Letson). “First found by Miss Letson in Post Pliocene deposits on Goat Island in 1901. It has been found since then living in various localities in the Great Lakes region ....” (Robertson & Blakeslee, 1949)

Goniobasis niagarensis Lea. (Goniobasis livescens niagarensis (Lea.)). “A small carinated variety found in Niagara River near the cataract and as a fossil in the Goat Island gravels.” Goniobasis livescens niagarensis is now treated as an extinct subspecies (presently recognized in Oxytrema, v. Calkin & Brett, 1978). Goat Island is probably the type locality for this mollusc.
Most visitors to the Falls are not aware how much algae, the “seaweeds,” contribute to the experience and appreciation of the natural environment at Niagara.

“[At the Whirlpool rapids] strangely enough, not only does the water look like the waves of the ocean beating upon the land in a storm, but there is almost a sea smell in the air, although the water is really fresh. A green seaweed-like growth covers the rocks, and perhaps the smell may proceed from that; in any case, it is distinctly noticeable” (Alec-Tweedie, 1913).

Certainly the more conspicuous species of algae cover the shallow waters around the Three Sisters in blooms, one corresponding to early spring, for example, and contribute to the green color on the bark of trees. They add to the fragrances and colors that enhance the excitement and interest of being in the cataract environment.

Over the years, loss of atmospheric moisture from decreased river levels, the cutting of the central and peripheral (slope) forests and consequent aggravation of desiccating factors present in the natural environment will have contributed to loss of species diversity and abundance among hygrophytic vegetation, of which the algal flora is certainly characteristic.

The Niagara algae have not been studied in detail by anyone, to my knowledge, but it might prove an interesting subject. Clinton, hunting a particular moss in the wet conditions on the talus slopes near the Horseshoe Falls, returned home with what turned out to be “a singular Conferva,” or moss-like filamentous alga (Oct. 21, 1865, Clinton’s Journal). Clinton did not appear to have studied this group otherwise.

In the Clinton Correspondence at the Buffalo Museum of Science, there is a letter to George Clinton from the New England naturalist John L. Russell (March 2, 1870). Clinton had, apparently, sent him specimens of algae from Niagara Falls. Russell wrote:

“You are doubtless aware that any determination of our native freshwater alga must be in many instances nothing more than surmises and approximations as we have so few authentic specimens of the European. But we can satisfy ourselves of the genera, become acquainted with their structure, and their varying forms are just as attractive as if one knew their synonymy! Your specimens I think are

“A. Cladophora! Unioiodes Kutzing or perhaps setiformis Kutzing  B. Cladophora! brachyclados Migne., with traces of Clad; fracta Dillwyn C. Cladophora! glomerata, the yellowish one, with Cladoph. fracta Dillwyn, the dark green one. D. Chroolepus Kutzing! aureus! Kutzing, the var. glomeratus Kutz. Species Algarum.

“The Cladophoras are branched Conferva: they make an immense genus, and require an immense Genius to understand them; of such I consider Fred. Traug. Kutzing!

“The Confervacea, especially when dry, become so altered that it is better to study them fresh, and the next best, is to mount them immediately in Chloride of Calcium between slips of talc. I should be most thankful for any more which may occur on the wet rocks or in the Cataract: the limestone formation of Niagara affords plants quite distinct from ours, which grow upon granite & metamorphic rocks, so everything is of interest to the Eastern or New England botanist.”

In the treatment of the cryptogam flora of the vicinity of Buffalo (Day, 1883), Prof. David S.
Kellicott of the State Normal School of Buffalo authored the algae section. He, “unfortunately, ... has not been able to give to their study more than a small portion of this time, and that only during the last few seasons” (Day, 1882). Day hoped that a revised list of the Algae of Buffalo will be issued by the Society at some future time. Kellicott had been more interested in the entomological collections of the young Buffalo Society of Natural Sciences, and published several papers in its Bulletin series. He was “foremost among Buffalo microscopists in the study of freshwater protozoa and prominent in all microscopical activities of the Society” (Robertson, 1938).

In Kellicott's publication, following his nomenclature, the following stations appear:

**Arthrosiphon alatus** Rabenh. “On dripping rocks under Biddle stair-case, Niagara Falls,” Harvey.

**Chroococcus rufescens** Naeg. Niagara Falls, Wolle.

**Chroolepus aureum** Kuetz. [probably now Trentepohlia aurea (L.) Martius] Niagara Falls.

**Cladophora canalicularis** Roth. Three Sisters Islands, Niagara Falls, Wolle.

**Diplocolon heppii** Naeg. Niagara Falls, Wolle.


**G. janthina** Naeg. Cliffs, Niagara Falls, Wolle.

**G. aeruginosa** Kuetz. Niagara Falls.


**Nostoc commune** Vauch. Niagara Falls, Oct. 28, 1882. “Abundant on moist ground, rocks, etc. Our plant agrees well with Rabenhorst's description except in the distance between the cells:—ours having the cells not loosely, but closely connected, H. C. Wood points out the same variation.”

**Scytonema cataractae** H. C. Wood. “This species grows abundantly in Niagara River on the rocks below the great cataract,” H. C. Wood.

**Scytonema chrysochlorum** Kuetz. Shaded rocks, Niagara Falls, Wolle.


**Symphysisiphon increustans** Kuetz. On rocks exposed to the spray of Niagara Falls, Wolle.

**Symphysisiphon contarenii** Kuetz. In same situations with the last, Wolle.


**Zonotrichia mollis** H. C. Wood. Cave of the Winds, Niagara Falls, H. C. Wood.


The above reference to a collector named Harvey under *Arthrosiphon alatus* Raben. (“On dripping rocks under Biddle-stair-case, Niagara Falls,” Harvey) is to William Henry Harvey, Professor at Trinity College, University of Dublin, the author, in 1858, of “Nereis Boreali-Americana. III. Chlorospermeae” [Smithsonian Contributions to Knowledge 10(2):1-140]. Many of Prof. Harvey's specimens of the Chlorospermeae, or Green Algae, “were personally collected by myself [i.e. Harvey] in 1850, when traveling in America” although he notes observing living (vidi vivam) material of *Arthrosiphon* (as *Petalonema*) at the base of Goat Island in 1849 (Harvey, 1858). “When at Niagara Falls in the autumn of 1849, I collected on the rocks under the Biddle Stairs specimens of a large decumbent Scytonema. ...” Harvey declined to name it because of deficiencies in the described species in Kuetzing's treatment of that genus.

In 1872, H. C. Wood published “A contribution to the history of the fresh-water algae of North America” [Smithsonian Contribution to Knowledge 19. 241:1-262]. Wood made collections of algae at Niagara Falls, at the base of Goat Island around and behind what is today known as the Bridal Veil Falls. It is probably because Harvey and Wood worked at the Falls and published their Niagara collections that Francis Wolle was attracted later to the same locality.
Niagara Falls is the type locality for *Scytonema cataractae* H. C. Wood (Wood, 1871) “in flumine Niagara prope cataractam” where it “grows abundantly in Niagara River on the rocks below the great cataract.” The Cave of the Winds is the type locality for two species of Zonotrichia: *Z. mollis* and *Z. parcezonata* (Wood, 1872).

The Clinton Herbarium owns a soft green paper folder containing several green loose sheets on which are mounted specimens of algae. This comprises an exsiccat of freshwater species issued by Francis Wolle and entitled “Fresh Water Algae of the United States.” Although not issued formally, that is, not having the features of a published book in the sense of Sayre (1975), for the purposes of convenience these collections are here referred to as an exsiccat. One of the earlier curators of the Museum’s botanical collections indicated on the back of this volume that the Buffalo Society received these collections on February 20, 1877.

Most of the numbers in this algae exsiccat cite no locality from which the specimen was collected, giving only typical substrates in which the species grows, such as warm or cold springs or ponds, wet ground, submerged stones, rocks, pools, greenhouse walls, casks of water, and elsewhere. A few do cite localities: Colorado is mentioned once (no. 90), a station in Bethlehem, Pennsylvania (12), two from Buffalo, New York (nos. 11, 51), one deriving from variously Pennsylvania, New York and Colorado (no. 13), and one, perhaps a type specimen, from a locality called “Glen Onoko” (no. 2). It is rather striking how many specimens in this segment of the exsiccat state that derive from Niagara Falls, one, in fact, is indicated as from the Three Sisters Islands (no. 88; see list below).

Included in this volume of specimens is an unpublished, handwritten letter by Rev. Wolle to Miss Mary S. Wilson of Buffalo, New York, dated March 28, 1877. Miss Wilson was a research associate of the early Buffalo Society of Natural Sciences, later becoming Curator of Botany of that Society, and contributed the checklist of lichen species then known for western New York State and adjacent Ontario (Day, 1883; see lichen section). Miss Wilson, for a time, showed an interest in algae, having donated a number of species of marine algae to the New York State Museum in 1874 (Peck, 1874, see bryophyte section). In Kellicott’s list of the algae around Buf-
distribution and exchange of his grandfather’s and his own collected materials” (Conger, 1971). Such collections probably included representatives of other organisms, such as bryophytes.

The specimens from Niagara Falls in Francis Wolle’s exsiccat may have derived from collections made by Mary Wilson, but it could easily be assumed he collected them himself, as there are many specimens of bryophytes of which Wolle himself said they were collected at the Falls (see section under bryophytes). Wolle seems to have known of George Clinton, for he wrote in his letter to Miss Wilson: “Judge Clinton, in his recent [lectum? lecture?] tells of the ‘lumpers and splitters’ among botanists. M. M. The ... (the late) commenced, or rather proposed a new arrangement upon the ‘Lumpin’ plan. Boract ... [?] his successor advocates the plan, but I cannot reconcile my mind to it, although in part it certainly is very good.” And for Mary Wilson, some advice from the Moravian Seminary for Young Ladies: “Permit me to say don’t be discouraged in your desire to acquire knowledge of the algae of the country. A very little here, and a little there will in the course of time accumulate. I never set out to know much, but to try to enjoy the little that comes in my way. [signed] Truly and respectfully, Francis Wolle.”

Wolle assisted in the determination of several specimens of algae for Kellicott, which appear in the Buffalo checklist, and appears to have contributed records from western New York and adjacent Ontario.

Reverend Wolle’s herbarium is at the Field Museum of Natural History, Chicago, Illinois (Sayre, 1975) and the herbarium of the Academy of Natural Sciences of Philadelphia, holding Wolle’s herbarium and types, with further material at the Clinton Herbarium (BUF), the herbarium of the California Academy of Sciences (CAS), and elsewhere. His correspondence is at FH, G, GH, and NY, while manuscripts, correspondence and drawings are at the Philadelphia Academy. Additional material relevant to Niagara Falls may be sought at these institutions.

NIAGARA SPECIMENS IN WOLLE’S EXSICCAT:
“Fresh Water Algae of the United States”

No. [...] Cladophora glomerata (L.) Kuentz. Hab. Niagara, 1876, Francis Wolle.
No. 60. Scytonema Hagetschweileri Rab. Hab. Niagara, Francis Wolle.
No. 88. Cladophora canaliculata Roth Hab. Three Sisters Islands, Niagara, Francis Wolle.
No. 91. Diplocolon Heppii Hab. Rocks Niagara, Aug. 1876, Francis Wolle.

Smith (1933), in his treatment of the genus Scytonema for the United States mentioned that “the only American records of [the] occurrence of Scytonema alatum (Berk.) Borzi are from limestone cliffs at Niagara Falls and in Minnesota” (see Harvey, 1858). Porphyrosiphon notarisii (Menegh.) Juentz. “has been collected in Florida, South Carolina, and at Niagara Falls. The record for the last named station is, however, open to question,” Smith (1933) citing Wolle (1887). “The single species of the genus, Diplocolon heppii Naeg., was first collected in this country on the limestone cliffs at Niagara Falls (Wolle, 1877), where it grew as a blackish-brown stratum of considerable extent” (Smith, 1933). Actinocylcus niagarae H. L. Smith was found in Lake Erie: the epithe-
and are not too turbid. Rocks and boulders in the faster flowing regions of the stream are the best habitats for red algae.” “... the great majority [of fresh water algae: Rhodophyceae] ... are rather closely restricted to the well aerated waters of rapids, falls, and mill dams in cold rapidly flowing streams” (Smith, 1933). The high-energy open environments at Niagara Falls should prove a fine subject of study for this group (see also Lin & Blum, 1977; Damann, 1979).

One specimen of Bangia has been recently found on the dolomite ballast stones at the head of Goat Island: *Bangia atropurpurea* (Roth.) Ag. Niagara Falls, on limestone rocks in upper decameter of Niagara River at southernmost tip of Goat Island, R. Zander & P. Eckel & 4740, July 8, 1979 (BUF).

An abundance of a terrestrial alga of the genus *Trentepohlia* (probably *T. aurea* (L.) Martius] may be noted growing on rocks in the Three Sisters, being conspicuous on rocks below the bridges, as a reddish-orange cast on the calcareous boulders especially in the cool wet autumn and spring, turning brown in the warm, dry weather of summer. It looks and feels like felt, being velvety to the touch. This is an aerial species of algae noticeable throughout the Niagara River Gorge in cool, shady places. It was reported from Niagara Falls in 1883 by Kellicott (in Day, 1883) (as *Chroolepus aureum*). This distinctive alga can be seen throughout the Niagara River Gorge, and is frequent on boulders at the base of Goat Island.

I would like to acknowledge the assistance of Dr. Harold Robinson, curator of bryophytes, Smithsonian Institution, in certain aspects of this report.

**THE FUNGAL FLORA**

Charles Peck was New York State Botanist from 1883 to 1915, largely through the influence of Governor DeWitt Clinton's son George W. Clinton, a member of the State Board of Regents (Both, 1984). Peck began to specialize in the study of fungi after 1868, although he was responsible for other plant groups as well (see section on bryology). Peck eventually became the leading North American authority on fungi describing “some 2,000 new species, at least half of which have stood the test of time, and he monographed over 40 genera or sections of genera as they occur in New York State” (Both 1984).

George Clinton collaborated with Peck as Clinton explored western New York, and they published new species and interesting reports together (e.g. Peck, 1873). Clinton enjoyed collecting on Goat Island and the Three Sisters, throughout the Niagara Gorge and all of the secluded Islands in the Niagara River, and so it is not surprising that many of his collections were derived from these special areas (Clinton, unpubl. diary). Goat Island, for example, was the type locality for *Peziza hesperidea* published by Clinton and Peck (“Among fallen leaves. Goat Island, where it was first found. Clinton,” Peck, 1873), *Puccinia clintonii* Peck (“Leaves of Pedicularis. Goat Island. Clinton. October, Peck, 1875), and *Thelephora willeyi* Clinton (“Goat Island”).

In his journal, George Clinton first mentioned collecting fungi on Goat Island on June 1, 1865, where “from a stump, a small lead colored fungus in the gills, & a larger one, perhaps the same.” Peck published a report of *Polyporus ferruginosus* Fr., a fungus that Clinton found on “prostrate trunks of trees” at Niagara Falls (Peck, 1873).

In a relatively undisturbed natural condition with a diversity of habitats, as Goat Island was in the latter half of the nineteenth century, there would be a variety of organisms of all kinds and a diversity of associated and dependent or related fungal organisms. Many fungi, for example such as parasitic vascular plants as Squaw-root, *Conopholis americana*, which grow on oaks, are host-specific, occurring in association with only one species host, or hosts in a single genus or family of plants. Other specific organic substrates, such as animal remains, support particular fungus species, such as Clinton's 1869 specimen from Goat Island of *Oidium equina* Pers., growing “On a decaying horn” and perhaps indicative of carriage use on the Island. Presumably this fungus was more frequently seen in the horse and buggy era (cf. an accompanying specimen from Machias, New York, growing on the “decaying hoofs of horses”).

Such historic mycological specimens frequently yield otherwise unobtainable floristic data, because the plant hosts were often noted on the specimen label. The fungus species listed below, for example, with their plant hosts, have been tabulated from George W. Clinton's mycological collections at the Clinton Herbarium (BUF):
FUNGUS [Scientific name] AND ITS HOST [English and Scientific Name]
Aecidium allenii – BUFFALOBERRY Shepherdia canadensis (Second Sister)
Aecidium ranunculacearum – BANEBERRY Actaea sp.
Depazea cruenta – GREAT SOLOMON’S SEAL Polygonatum biflorum
Diatrype betulina – BIRCH Betula sp.
Microsphaeria peckii – ELDERBERRY Sambucus canadensis
Phyllactinia guttata – BITTERSWEET Celastrus scandens
Peyotyctis vulgaris – PRICKLY GOOSEBERRY Ribes cynosbati
Prothemia sp. – ARBOR VITAE Thuja occidentalis
Puccinia violarum – DOWNY YELLOW VIOLET Viola pubescens
Puccinia clintonii – COMMON LOUSEWORT Pedicularis canadensis
Roestelia lacerata – SHADBUSH Amelanchier sp. (Three Sisters)
Roestelia cornuta – SHADBUSH Amelanchier sp.
Vermicularia dermatium – SWEET CICELY Osmorhiza claytonii
Vermicularia lilicbearum – WILD LEEK Allium tricoccum

It is somewhat unfortunate that Charles Peck's contribution to the 1883 publication of the “Plants of Buffalo and Vicinity” by David F. Day dealt primarily with systematics and no plant localities were given, although most, if not all were based on collections made in western New York by George Clinton. Duplicates of the specimens on which Peck made his reports will be in the State Herbarium, Albany, and localities may be noted from their specimen labels.

Maintenance policies throughout the past century which favor the removal of stumps, brush, diseased tree and shrub material and other non-living organic substrates has and will continue to impoverish the fungal flora on Goat Island and throughout the Reservation. Such substrates also promote the establishment of seedlings of many kinds of forest species, perhaps all of them, particularly ferns (note the fern flora from Goat Island has been eliminated). Mosses also favor rotted stumps and logs.

One interesting observation based on recent collections is the occurrence of so many edible species. The fungus flora of Goat Island could form the basis for an interesting interpretive program on Goat Island coupled with a change in maintenance policy toward enriching the flora.

Even reinstution of horse and carriage service onto the islands would provide additional substrates for fungus species to colonize, with the additional benefit of the enrichment of impoverished oils.

Fungi: Historical Specimens in the Clinton Herbarium
Not determined
Aecidium allenii Clinton

Aecidium allenii Clinton
Goat Island (the middle Sister), on Shepherdia canadensis [specimen included]. Ex Coll. G. W. Clinton, Buffalo, N.Y. June 28, 1870 (BUF).
Aecidium ranunculacearum DC.
Goat Island, “probably Ae. cimicifugatum Schw.,” on Actaea [handwriting G. W. Clinton], July 4, 1871 (BUF).

Aecidium ranunculacearum DC.
Goat Island, a. on Actaea [specimen included], b. Thalictrum cornutum [specimen included]. Ex Coll. G. W. Clinton, Buffalo, N.Y. July 4, 1871 (BUF).

Agaricus atrocaeruleus Fr.

Agaricus atrocaeruleus Fr.
Goat Island. Ex Coll. G. W. Clinton, Buffalo, N.Y. Nov. 2, 1875 (BUF).

Agaricus bombycinus Schaeff.


Agaricus phalloides Fr.

Agaricus silvaticus Schaeff.

Cladosporium lignicolum Cd.

Corticium oakesii B. et C.

Coryneum clavaesporum Peck

Cyripora sp.

Depaea cruenta Fr.

Diatrype betulina Peck
Goat Island [on Betula]. Ex Coll. G. W. Clinton, Buffalo, N.Y. April 1871 (BUF).

Diatrype disciformis Fr.
Goat Island. Ex Coll. G. W. Clinton, Buffalo, N.Y. April 24, 1870 (BUF).

Geaster saccatus Fr.

Helminthosporium episphaericum C. et P.

Hemiacyria rubrifloris Pers.

Hydnium septentrionale Fr.
Goat Island. Ex Coll. G. W. Clinton April 24, 1870 (BUF).

Hypocrea gelatinosa Fr.

[Hypocrea gelatinosa] Fr.
Goat Island, [no name given, but on a sheet with other collections of this name] 20, April 18 (BUF).

Hypocrea patella C. et P.
Goat Island, [two specimens, one March 14, the other April 18 ?]. Ex Coll. G. W. Clinton, Buffalo, N.Y.
Hypoxylon atropurpureum Fr.

Hypoxylon atropurpureum Fr.

Lenzites sepiaria Fr.

Leucostoma persoonii (Nitsche) Togashi
Second Sister, west end, in oak maple forest, on dead Prunus, Buck, 16366 Nov. 2, 1988 (BUF).

Melanconium bicolor Nees
Goat Island, on Sambucus canadensis, Ex Coll. G. W. Clinton, Buffalo, N.Y. Nov. 1874 (BUF).

Nectria cinnabarina Tode

Oidium equina Pers.

Oidium fulvum Lk.
Goat Island, Ex Coll. G. W. Clinton, Buffalo, N.Y. Nov. 1873 (BUF).

Oidium megalosporum B. et C.
Goat Island, Ex Coll. G. W. Clinton, Buffalo, N.Y. Nov. 1871 (BUF).

Paxillus atrotomentosus Fr.
Goat Island, Ex Coll. G. W. Clinton, Buffalo, N.Y. April 20, 1870 (BUF).

Peziza citrina Batsch.
Goat Island, Ex Coll. G. W. Clinton Jan, 1870 (BUF).

Peziza citrina Batsch.
Goat Island, No. 56. “This little beauty, found only in one stick, on Goat I” (BUF).

Peziza coccinea Jacq.
Goat Island [three specimens from here], a: April 1870, b: April 1871, c: June 28, 1871, Ex Coll. G. W. Clinton, Buffalo, N.Y. April 1870 (BUF).

Peziza hesperidea P. et C.
Goat Island, Ex Coll. G. W. Clinton, Buffalo, N.Y. June 28, 1871 (BUF). [Possible type specimen; possible lectotype]

Peziza tiliae Peck
Goat Island, Ex Coll. G. W. Clinton, Buffalo, N.Y. Nov. 26, 1871 (BUF).

Phyllactinia guttata Lev.

Podosporum rigidum Schw.
Goat Island, Ex Coll. G. W. Clinton, Buffalo, N.Y. Dec. 18, 1877 (BUF).

Polyactis vulgaris Link. “?”

Polyporus abietinus Fr.
Goat Island. (Luna I.) [handwriting G. W. Clinton] July 4, 1874 (BUF).

Puccinia clintonii Peck

Puccinia clintonii Peck

Puccinia clintonii Peck
Goat Island, On Pedicularis canadensis, Ex Coll. G. W. Clinton, Buffalo, N.Y. Nov. 4, 1874 (BUF).

Puccinia clintonii Peck
There is a Puccinia clintonii Peck type specimen also, as the Aecidium allenii specimen cited above, curated in the Arthur Herbarium of Purdue University. The packet reads “On Pedicularis canadensis. Goat Island, Niagara, N. Y. G. W.
Clinton. Oct.” which would indicate that the specimen collected on October 9, 1875 noted above is perhaps the holotype specimen for the species, and the specimen at Purdue is an isotype (or they are all isotypes). I am grateful to Nick Harby of Purdue University Herbaria for digital images of the packets of these specimens and drawing them to my attention.

**Puccinia violarum** Lk.
Goat Island, [specimen enclosed], on *Viola pubescens*. “The yellowish dots are *Trichobasis violarum* Berk. but are only the early state of the *Puccinia*” Peck. Ex Coll. G. W. Clinton, Buffalo, N.Y. July 4, 1871 Aug. 12, 1875 (BUF).

**Roestelia cornuta** Tul.
Goat Island, on *Amelanchier* [specimen enclosed] Ex Coll. G. W. Clinton, Buffalo, N.Y., Sept. 7, 1871 (BUF).

**Roestelia lacerata** Tul. fide Peck.
One of the Sister Is., Niagara Falls, on *Amelanchier*, Ex Coll. G. W. Clinton, Buffalo, N.Y., June 28, 1871 (BUF).

**Septoria scrophulariae** Peck
Goat Island. Ex Coll. G. W. Clinton, Buffalo, N.Y. Nov. 4 (BUF).


**Sphaeria doliolum** Fr.

**Sphaeria ovina** Pers.
Goat Island, Ex Coll. G. W. Clinton, Buffalo, N.Y. Oct. 9, 1875 (BUF).

**Stereum albo-badium** Frieson

**Stictis versicolor** Fr.
Goat Island. Ex Coll. G. W. Clinton, Buffalo, N.Y., Nov. 9, 1875 (BUF).

**Thelephora willeyi** Clinton
Goat Island, “near *T. Swertia*, but upper surface not rough [...]” (BUF). [Corr. with Stanley Smith enclosed]. Ex Coll. G. W. Clinton, Buffalo, N.Y. Sept., 1870 (BUF). [Correspondence at BUF demonstrates this is the type material of what is now referred to as *Stereum diaphanum*]

**Tremella albida** Hud.

**Tremella aurantia** Schw.

**Tubulina cylindrica** Bull.
Goat Island. Ex Coll. G. W. Clinton, Buffalo, N.Y. July 5, 1875 (BUF).

**Uncinula circinata** C. et P.
Goat Island, Sugar Maple, on *Acer saccharinum* [= *Acer saccharum* of the nineteenth century] [handwriting G. W. Clinton] (BUF).

**Ustilago erythronii** Clinton
Goat Is. “Prof. Wm. G. Farlow (letter No. 234, Mar. 15, 1878) says this is *Ustilago Ornitho-gali* (S.&K.) Magnus, and that Prof. Fischer de Wald-
Vermicularia dermatium Fr.
Goat Island, on Osmorhiza brevistylis (= Osmorhiza claytonii) [handwriting G. W. Clinton] Nov. 4 [1877] (BUF).

Vermicularia liliacearum Schw.

Xylaria digitata Grev.

MODERN COLLECTIONS
Curated in both the Clinton Herbarium, Buffalo Museum of Science (BUF) and the New York Botanical Garden (NY)
Bisporella citrina (Batsch:Fries) Korf & Carpenter
Goat Island, north slope, on rotten log, 1 Nov 1988, Buck 16294 (BUF, NY).

Cladobotryum varium Nees ex Duby
Second Sister, west end, on Trametes versicolor, 2 Nov 1988, Buck 16367A (NY).

Coprinus comatus (Muell. ex Fr.) S. F. Gray.
SHAGGY MANE.
Goat Island, north side, wooded slope, Eckel Nov. 1, 1988. [Specimen rotted before processing.]

Coryne dubia (Persoon) S. F. Gray
Goat Island, north slope, on rotten log, 1 Nov 1988, Buck 16288 (NY).

Flammulina velutipes (Curts ex Fries) Singer
WINTER MUSHROOM.
Goat Island, north slope, on tree trunk, 1 Nov 1988, Buck 16310 (BUF, NY); stump, northern wooded slopes of the island, sticky smooth chestnut brown to orange to yellowish caps, velvety stipe base, Eckel with R. Zander, Nov. 1, 1988 (BUF); stump by east entrance to the restaurant by Terrapin Point, old Acer saccharum stump, sticky smooth chestnut brown to orange to yellowish caps, velvety stipe base, Eckel ver. E. Both, Oct. 28, 1988 (BUF).

Goat Island, rocky base of island near American Falls, rotted wood by entrance to the elevator, sticky smooth chestnut brown to orange to yellowish caps, velvety stipe base, Eckel w. R. Zander, Nov. 1, 1988 (BUF).

Ganoderma applanatum (Persoon) Patouillard
Goat Island, north slope, on dead tree, 1 Nov 1988, Buck 16314 (BUF, NY).

Gibellula pulchra (Saccardo) Cavara
Goat Island, north slope, on dead spider, 1 Nov. 1988, Buck 16307 (NY).

Hymenoscyphus calyculus (Sowerby:Fries) Phillips
Second Sister, west end, on dead wood, 2 Nov 1988, Buck 16374 (NY).

Hysterium angustatum Albertini & Schweinitz
Luna Island, on stump, 1 Nov. 1988, Buck, 16322 (BUF, NY).

Lactarius sp.
Second of the Three Sisters Islands, west end, specimen uniformly brownish orange, Eckel det. E. Both, Oct. 28, 1988 (BUF).

Lecanidion atratum (Hedwig ex Fries) Endlicher
Goat Island, north slope, on rotten log, 1 Nov. 1988, Buck 16290 (BUF, NY).

Lepista glaucocana
Goat Island, central woods, soil, toward east end, white to buff to tan all over, Eckel det. E. Both, Nov. 2, 1988 (BUF).

Marasmius sp.

Pholiota sp.

Pleurotus ostreatus (Jacquin ex Fr.) Kummer

Polyporus squamosus Mich. ex Fries
Goat Island, in shaded Acer saccharum-Fraxinus americana mixed woodland, on old stump, Eckel 8704001, Sept. 9, 1984 (BUF); base of cliff, west end, on old log, Eckel 881101, Nov. 1, 1988 (BUF). Polyporus squamosus is a common and conspicuous fungus to be seen in the area collected and throughout the Niagara River Gorge and surrounding woodlands.

Polyporus sulphureus (Bull.) Fr. SULPHUR POLYPORE, CHICKEN MUSHROOM.
Goat Island, south end in split trunk of living Fraxinus americana, brilliant yellow, Eckel Oct. 28,
1988 (BUF).

**Scolecosporiella typhae** (Dudemans) Petrak
Second Sister, east end, on dead leaves of *Typha angustifolia*, 2 Nov 1988, Buck 16397 (NY).

**Trametes** sp.

**Trametes versicolor** (Linnaeus:Fries) Pilat
Second Sister, west end, on stump, 1 Nov. 1988, Buck 16367 (BUF, NY).

**Ustulina deusta** (Hoffman:Fries) Petrak
Goat Island, north slope, on dead tree, 1 Nov. 1988, Buck 16296 (NY).

The assistance of Ernst Both of the Buffalo Museum of Science in certain determinations is gratefully acknowledged. Dr. William R. Buck also generously collected fungi on Goat Island and acknowledgement is made to Dr. Clark Rogerson of the New York Botanical Garden, who has determined certain of these specimens.
THE LICHEN FLORA

Various classes of organisms are sensitive to factors in their environment: soil algae, being hygrophytic, require a high degree of moisture to flourish, and fungi, being saprophytic for the most part, require an abundance of decaying organic matter, such as exists in an old woodland. Lichens, organisms composed of a symbiotic relationship between an alga and a fungus, can tolerate extremes of drying but exhibit unusual sensitivity to air pollution, particularly sulfur dioxide. Although coal-fired furnaces probably much decimated the lichen population in the Goat Island complex in the past several decades, recent air pollution abatement controls should contribute much to expansion of the lichen flora on Goat Island (see pollution discussion, this manuscript).

Hale (1967) citing studies by Rydzak (1955) indicated that “low humidity and higher temperatures of cities alone can explain the loss of lichens. Desiccation and lack of dew formation are characteristic of the urban microclimate, and lichens are subjected to abnormally rapid wetting and drying cycles.” Elevated desiccation regimes due to forest depletion on Goat Island with its high wind factor may have contributed to loss of species diversity there. “The continual destruction of native trees in cities and replanting with lichen-free nursery stock effectively reduce the supply of vegetative propagules”; ... where old herbarium records of showy fruticose and foliose lichens made before the primary forests were cut down simply cannot be duplicated in secondary or regenerated forests. Atmospheric pollution is not a factor here at all nor could desiccation account for the loss” (Hale, 1967). Although showy lichen species were not evident on Goat Island specimens, still, the effect would be the same on more inconspicuous species (see discussion by Harris in this account).

LICHENS: HISTORIC ACCOUNTS

The following list of lichen specimens from Goat Island and the Three Sisters derives from nineteenth century collections in the Clinton Herbarium. These have been most recently revised by Dr. Richard C. Harris of the New York Botanical Garden, together with other specimens collected at localities such as Devil's Hole, Niagara Falls, and Whirlpool Woods.

In 1883, under the editorship of David F. Day, the Buffalo Society of Natural Sciences published its second installment of “The Plants of Buffalo and Vicinity” (Day, 1883). The lichens were treated in this edition. Miss Mary L. Wilson prepared the lichen reports based primarily on her own and George Clinton's collections. Not much is known of Wilson's work or activities outside of her contributions to this bulletin.

Day introduced Miss Wilson as follows:

“Early in the history of the Society, the investigation of our Lichens was generously undertaken by Miss Mary L. Wilson, then of our city, now of Haverhill, Mass. The success which attended her efforts in this difficult and neglected field is demonstrated by the very valuable collections of plants of that order, constituting a part of the Herbarium. Miss Wilson has now enhanced the value of her labors by preparing with her own hand the list of the Lichens of Buffalo which makes a part of the Catalogue” (Day, 1882).

There is an envelope in the Clinton Herbarium addressed to her at 78 Niagara Street, Buffalo, apparently her residence before she moved to Massachusetts.

Among the species listed in Miss Wilson's catalogue of lichens growing in the vicinity of Buffalo, Theloschistes chrysophthalmus L. was reported from Niagara Falls, as were Physcia ciliaris Ach. var. angustata Tuck., Placodium rupestre (Scop.) Nyl., Lecanora hagenii Ach., and Staurothele drummondii Tuck. The Lecanora specimen was reported earlier by Peck (1873) as new to New York State. No place names were given for any other species except two from Wyoming County, New York, two from Lime Lake in Cattaraugus County and one from Williamsville in Erie County. All of the other 193 species were presumably of sufficient general distribution as not to warrant reporting their localities. Again, this is indirect evidence of the unusual biological nature of the environs of Niagara Falls.

Miss Wilson communicated with various natural historians, such as the American phycologist Francis Wolle to whom she sent specimens of algae and from whom she received algal collections (see section on phycology). Miss Wilson had involved herself much with the newly formed Buffalo Society of Natural
Sciences of 1861 of which she was a member. Prior to 1880, she assisted in developing a field club associated with the Society. Subsequently she involved herself with curation of the initial conchological collections of the Society when its collections were housed at the Young Men's Association Building, Main Street, Buffalo (Robertson & Blakeslee, 1948). She worked actively to expand the Society's conchological representations by collection and exchange until they included about 6,000 species “or about one-quarter of the known kinds” (Robertson & Barcellona, 1939). Other botanical interests were to follow, so that by 1873, she had become the custodian of the Society's botany collections, her research interests tending toward cryptogams. Miss Wilson communicated with European botanists, from whom she received named specimens of European lichens to assist her in understanding the American flora (R. Harris, pers. comm.). As indicated on the notations of the labels listed below, she sought the assistance of the eminent North American lichenologist Edward Tuckerman (1817-1886) in the verification and determination of some of her specimens.

Tuckerman was the first to write comprehensive treatises on the American lichen flora (Fink, 1906). He was “to lichenology what Asa Gray was to the study of our seed-plants.” But Tuckerman also “aided others continually and much of his labor received no public recognition,” such as the attention he afforded Wilson and her specimens from western New York State. The Buffalo Museum of Science, where the collections and archives of the Buffalo Society of Natural Sciences are kept, is presently organizing its collections and archives of the Buffalo Society of Natural Sciences of 1861 of which she was a member. Prior to 1880, she assisted in developing a field club associated with the Society. Subsequently she involved herself with curation of the initial conchological collections of the Society when its collections were housed at the Young Men's Association Building, Main Street, Buffalo (Robertson & Blakeslee, 1948). She worked actively to expand the Society's conchological representations by collection and exchange until they included about 6,000 species “or about one-quarter of the known kinds” (Robertson & Barcellona, 1939). Other botanical interests were to follow, so that by 1873, she had become the custodian of the Society's botany collections, her research interests tending toward cryptogams. Miss Wilson communicated with European botanists, from whom she received named specimens of European lichens to assist her in understanding the American flora (R. Harris, pers. comm.). As indicated on the notations of the labels listed below, she sought the assistance of the eminent North American lichenologist Edward Tuckerman (1817-1886) in the verification and determination of some of her specimens.

Tuckerman was the first to write comprehensive treatises on the American lichen flora (Fink, 1906). He was “to lichenology what Asa Gray was to the study of our seed-plants.” But Tuckerman also “aided others continually and much of his labor received no public recognition,” such as the attention he afforded Wilson and her specimens from western New York State. The Buffalo Museum of Science, where the collections and archives of the Buffalo Society of Natural Sciences are kept, is presently organizing its archive collections, but so far there is little representation of her activities there. While examining the lichen books in the research library of the Museum, I was pleased to discover a copy of Tuckerman's Genera Lichenum (1872) with the following autographed dedication: “Miss Mary L. Wilson with the regards of the author.”* This volume also bears notations in Wilson's handwriting. Inserted into a page of this book is a copy of Tuckerman's obituary and his photograph.

The first line of Tuckerman's volume indicated something of his attitude toward those who sent him specimens:

“This is a final report to the friendly correspondents of the author on the specimens which, for many years, they have sent to him for determination. And such determination implying a certain arrangement, the book is further a report upon what, after much labour, has commended itself to him as the best-ascertained, systematic disposition of the Lichens.”

In Tuckerman's later publication, the Synopsis of 1882, he cited specimens sent him by Wilson: Buellia dialyta (Nyl.) Tuck., Buellia schaereri DeNot., Lecanora verrucosa (Ach.) Laur. var. mutabilis Th.Fr., Physcia ciliaris (L.) DC., and Rinodina milliaria Tuck., Biaora decipiens, from Niagara Falls, a calcareous-loving lichen “more common westward, “was submitted, and two specimens of Graphis from Florida (G. leucopepla Tuckerm. and G. scoleclitis Tuck.)

Henry Willey (1824-1907) was a student of Tuckerman's, and helped verify or identify most of Wilson's determinations listed below. Willey was also a correspondent with George Clinton, who collaborated with Wilson in respect to determining Clinton's lichen collections, and, he also exchanged letters with Charles Peck, certain of whose New York State specimens Willey identified (Peck, 1874). In 1873 Clinton published a new species of fungi and named it after Willey, “a most active and enthusiastic lichenist,” (Thelephora willeyi, Clinton in Peck, 1873). Upon his death, Willey's 10,000-specimen herbarium was sold to the Smithsonian Institution (Jennings, 1914; Fink, 1914), and it is perhaps there that additional collections from Niagara Falls and the Niagara Reservation may be sought.

Clinton named several new mycological species after Mary Wilson: Puccinia Mariae-Wilsoni Clinton (Peck, 1872), Diderma Mariae-Wilsoni Clinton in Peck (1873). Peck named Aecidium Mariae-Wilsoni after her (Peck, 1870). The new species Phoma Mariae Clinton in Peck (1875), was dedicated to Miss Mary L. Wilson, as was perhaps Sphaeropsis Wilsoni Clinton in the same issue, Hendersonia Mariae Clinton and Septoria Wilsoni Clinton. See also Russula Mariae Peck (1872), and Pestalozzia Mariae Clinton in Peck (1874).

Charles Peck had published lichen records Wilson had collected from western New York, primarily Buffalo, for example, in the Report on the State Museum of 1870 (23 lichens), 1872 (eight species of lichens), 1873 (eight species of lichens). In 1873-1874, Wilson donated thirty-five species of marine algae to the New York State Museum (Peck, 1874), for which she probably had paid a visit to the seaside...
away from her Buffalo home. In 1874-1875, she donated two specimens of lichens to the New York State Herbarium (Peck, 1875), nothing in the year 1875 (Peck, 1876), [none in 29-34 annual reports, [1876] 1878-1881. Her specimens of *Lecidea russellii* Tuck., *Gyalecta cupularis* Schae., and *Stereocaulon condensatum* Hoffm. were reported from Niagara Falls, and *Physcia ciliaris* var. *angustata* Tuck. from Goat Island (Peck, 1870).

**LICHENS: HISTORIC**

Catalogue of Lichen Specimens from the Clinton Herbarium

I acknowledge the assistance of Dr. Richard Harris, New York Botanical Garden, for reidentifying these historic specimens, bringing the nomenclature up to date.

**Anaptychia setifera** Raes.

**Anaptychia setifera** Raes.

**Anaptychia setifera** Raes.

**Dermatocarpon miniatum** (L.) Mann

**Dermatocarpon miniatum** (L.) Mann

**Dermatocarpon miniatum** (L.) Mann
Goat Island, opposite the First Sister [First det. may be handwriting of Henry Willey] [Det. Richard C. Harris, 1986.] [perhaps handwriting G.W.Clinton] Nov. 5 (BUF).

**Dermatocarpon miniatum** (L.) Mann

**Caloplaca flavorubescens** (Hudson) Laundon
Goat Island. “12” “Took it, I suppose, partly because I was in despair, & partly because the tree was Ash.” [Clinton’s handwriting] [Det. Richard C. Harris, 1988] Nov. 5 (BUF).

**Gyalecta jenensis** (Batsch) Zahlbr.

**Lecidea russula** Ach.
Goat Island. “12” “Took it, I suppose, partly because I was in despair, & partly because the tree was Ash.” [Clinton’s handwriting] [Det. Richard C. Harris, 1988] Nov. 5 (BUF).

**Leptogium lichenoides** (L.) Zahlbr.

**Mycobilimbia sabuletorum** (Schreber) Hafellner

**Pannaria rubiginosa** (Ach.) Bory

**Teloschistes chrysophthalmus** (L.) Th. Fr.

**Verrucaria calcinsiana** Servit

**LICHENS: RECENT COLLECTIONS**

Catalogue of recent Lichen Specimens from the New York Botanical Garden

The following specimens are representative of the current lichen flora of the Goat Island complex and are the result of collections by Dr. Richard Harris of the New York Botanical Garden (NY), whose aid
was enlisted for this project. His summary of collections is appended to this list. These collections were made in the first two days of November, 1988.

**Arthonia lapadicola** (Taylor) Branth & Rostrup
North side Goat Island, on slope near water just E of Luna Is. bridge, on rock, Harris 22855 (NY) NEW TO NEW YORK STATE.

**Bacidia epixanthoides** (Nyl.) Lettau
First Sister west, on *Mnium thomsonii*, Harris 16341 (NY) NEW TO NEW YORK STATE.

**Bacidia granosa** (Tuck.) Zahlbr.
Goat Island, north side, on bank near water, on rock, Harris 16297 (NY).
First Sister, west end, on rock, Harris 16348 (NY); west end, on rock, Harris 22837 (NY); north side, on rock, Harris 22867 (NY), Harris 22869 (NY), Harris 22872 (NY), Harris 22874 (NY), Harris 22877 (NY).
Second Sister, west end in central woods, on rock, Harris 22895 (NY); west end, on rock, Harris 22903 (NY), Harris 22924 (NY); east end, on rock, Harris 22931 (NY).

**Bacidia inundata** (Fr.) Koerber
Goat Island, western half central forest, on small rock, Harris 22836 (NY).

**Bacidia sp.**
Goat Island, north side, on flat rock partially in water, Harris 22837 (NY).
Second Sister, east end, limestone flat, on rock, Harris 22898 (NY).
Luna Island, on rock, Harris 16326 (NY), Harris 16327 (NY), Harris 16328 (NY).

**Bacidia sp.**
Goat Island, north side, at base of *Populus*, Harris 22831, Harris 22841 (NY).

**Bacidia sp.**
First Sister, east end, on *Anomodon attenuatus*, Harris 16413 (NY); east end, on lignum, Harris 16416 (NY).
Second Sister, west end, on lignum, Harris 16375 (NY).

**Bacidia sp.**
Goat Island, north side, on lignum, Harris 22822 (NY); north side, on exposed roots of *Acer*, Harris 22826 (NY); north side, on lignum and old *Hypoxylon*, Harris 22828 (NY); north side, on old *Hypoxylon*, Harris 16921 (NY).

**Bacidia sp.**
Second Sister, west end, on decorticate stump, Harris 22893 (NY).

**Buellia punctata** (Hoffm.) Massal.
Goat Island, north side near Luna Island bridge, at 1 m on *Robinia*, Harris 22835 (NY); near Luna Island bridge, at base of *Robinia*, Harris 22850 (NY).
Second Sister, west end, at base of *Tilia*, Harris 22885 (NY), Harris 16389 (NY); east end, Harris 16400 (NY).
Third Sister, west end, at base of *Salix*, Harris 22934 (NY).

**Caloplaca cerina** (Ehrh. ex Hedwig) Th. Fr.
Luna Island, on bark, Harris 16333 (NY).

**Caloplaca cirrochroa** (Ach.) Th. Fr.
First Sister, east end, on rock, Harris 22917 (NY) NEW TO NEW YORK STATE.

**Caloplaca citrina** (Hoffm.) Th. Fr.
First Sister, east end, on mortar, Harris 22863 (NY); west end, on rock, Harris 22866 (NY).
Third Sister, east end, on rock, Harris 22886 (NY); middle, south side, on rock, Harris 22989 (NY); east end, on rock, Harris 22991 (NY).

**Caloplaca feracissima** Magn.
Goat Island, north side, retaining wall at river's edge, Harris 22856 (NY); north side, on rock, Harris 16299 (NY).
First Sister, east end, highest point, on rock, Harris 22916 (NY); east end, limestone flat, on rock, Harris 22929 (NY).

**Caloplaca flavovirescens** (Wulfen) Dalla Torre & Sarnt.
Bridge to First Sister, Harris 22876 (NY).
First Sister, west end, on rock, Harris 16417 (NY). Second Sister, west end, large boulder on south side, Harris 22912 (NY).
Third Sister, east end, north side, on rock, Harris 22937 (NY).

**Caloplaca sp.**
Second Sister, east end, limestone flat, on rock, Harris 22896 (NY), Harris 22906 (NY), Harris 22914 (NY).

**Caloplaca sp.**
Second Sister, west end, on ridge, south side, on rock, Harris 22888 (NY).

**Caloplaca sp.**
First Sister, west end, on rock, Harris 22870 (NY).

**Candelaria concolor** (Dickson) B. Stein
Second Sister, west end, on *Quercus*, Harris 16387...
Botanical Heritage of Islands at the Brink of Niagara Falls

Candelariella aurella (Hoffm.) Zahlbr.
Goat Island, N end of bridge to Luna Island, on rock, Harris 22859 (NY).
First Sister, east end, on rock, Harris 23028 (NY).
Second Sister, east end, limestone flat, on rock, Harris 22898 (NY); Harris 22900 (NY); east end, on rock, Harris 16409 (NY).
Candelariella efflorescens Harris & Buck
Second Sister, west end, on Salix, Harris 16377 (NY).

Cladonia humilis (With.) Laundon—bourgeanic acid strain.
Second Sister, west end, on rotten log, Harris 16383 (NY).

Collema tenax (Sw.) Ach.
Base of Goat Island, on soil, Harris 16357 (NY).

Diplotomma epipolium (Ach.) Arn.
Third Sister, east end, on rock, Harris 22887 (NY).

Endocarpon pusillum Hedwig
Goat Island, north side, on rock, Harris 22832 (NY).
Goat Island, central woods, west side, near parking lot, on rock, Harris 22947 (NY).
First Sister, west end, on rock, Harris 22868 (NY); Harris 22877 (NY); Harris 22878 (NY); Harris 22879 (NY).
First Sister, east end, highest point, on rock, Harris 22916 (NY); west end, on rock, Harris 16336 (NY); west end, on rock, Harris 16420 (NY); west end, on rock, Harris 16425 (NY).
Second Sister, west end, in woods, on rock, Harris 22895 (NY); west end, on rock, Harris 22942 (NY); east end, on rock, Harris 22938 (NY); east end, on rock, Harris 16432 (NY).

Lecania perproxima (Nyl.) Zahlbr.
Second Sister, east end, on rock, Harris 22904 (NY) NEW TO NEW YORK STATE.

Lecanora dispersa (Pers.) Sommerf.
Goat Island, north side, retaining wall at river's edge, Harris 22860 (NY).
Luna Island, on rock, Harris 22858 (NY).
First Sister, west end, on rock, Harris 22868 (NY); east end, highest point, on rock, Harris 22916 (NY).
Second Sister, east end, limestone flat, on rock, Harris 22900 (NY); east end, limestone flat, on rock near water, Harris 22908 (NY); west end, on rock, Harris 22902 (NY).
Caloplaca feracissima Magn.
Goat Island, north side, retaining wall at river's edge, Harris 22856 (NY); north side, on rock, Harris 16299 (NY).
Candelariella aurella (Hoffm.) Zahlbr.
Goat Island, N end of bridge to Luna Island, on rock, Harris 22859 (NY).
Endocarpon pusillum Hedwig
Goat Island, north side, on rock, Harris 22832 (NY); central woods, west side, near parking lot, on rock, Harris 22947 (NY).
Lecanora dispersa (Pers.) Sommerf.
Goat Island, north side, retaining wall at river's edge, on rock, Harris 22860 (NY).

Lecanora umbrosa Degel.
Third Sister, east end, north side, on rock, Harris 22940 (NY) NEW TO NEW YORK STATE.

Lecidella stigmatea (Ach.) Hertel & Leuckert
Second Sister, west end, south side, on big boulder, Harris 22901 (NY).
Third Sister, middle, south side, on rock, Harris 22890 (NY); east end, north side, on rock, Harris 22936 (NY); east end, north side, on rock, Harris 22938 (NY); east end, on rock, Harris 16432 (NY).

Lepraria finkii (B. de Lesd. in Hue) R. C. Harris
Goat Island, north side, at base of Betula, Harris 22819 (NY); north side, at base of Tilia, at river's edge, Harris 22821 (NY); north side near pedestrian bridge, on rock, Harris 22825 (NY); north side, at base of dead Ulmus, Harris 22829 (NY); north side, on rock, Harris 16305 (NY).
Luna Island, at base of Ulmus, Harris 22842 (NY); on Quercus root over water, Harris 22847 (NY).
First Sister, west end, on rock, Harris 22875 (NY), Harris 22875 (NY).

Lepraria lesdainii (Hue) R. C. Harris
Second Sister, west end, in overhang of breakwater on north side, Harris 22927 (NY).

Leptogium juniperinum Tuck.
First Sister, west end, in rock crevice, Harris 16346 (NY) NEW TO NEW YORK STATE.

Leptogium tenuissimum (Dickson) Fr.
Second Sister, west end, on soil among mosses, Harris 16381 (NY).

Mycobilimbia sabuletorum (Schreber) Hafellner
Goat Island, north side, rock at river's edge, Harris 22845 (NY); north side, on rock, Harris 16302 (NY), Harris 16312 (NY).
First Sister, east end, on rock, Harris 22930 (NY);
west end, on moss, Harris 16339 (NY), Harris 16422 (NY); west end, on rock, Harris 16428 (NY).
Second Sister, west end, on rock, Harris 16393 (NY), Harris 22910 (NY), west end, on moss, Harris 22915 (NY).

P. sulcata Taylor
Goat Island, north side, on Fraxinus at river's edge, Harris 22834 (NY).

P. orbicularis (Necker) Moberg
Goat Island, edge of west parking lot, on Acer, Harris 22816 (NY).
Along road, south side of west end of Goat Island, on bark, Harris 22820 (NY).
Luna Island, on dead Ulmus, Harris 22843 (NY); on Ostrya, Harris 22851 (NY); on rock, Harris 22861 (NY).
First Sister, east end, highest point, Harris 22916 (NY).
Second Sister, west end, south side, on rock, Harris 22899 (NY); east end, on rock, Harris 22905 (NY).
Third Sister, at base of Salix, Harris 22935 (NY).

P. rubropulchra (Degel.) Moberg
Second Sister, east end, on bark, Harris 16387 (NY).

P. adscendens (Fr.) H. Oliver
Goat Island, edge of west parking lot, on Acer, Harris 22816 (NY).
Second Sister, east face of stone block at river's edge, Harris 22897 (NY).
Third Sister, west end, at base of Salix, Harris 23943 (NY).

P. millegrana Degel.
Goat Island, parking area for Three Sisters, on bark, Harris 23941 (NY).
Second Sister, west end, on Salix, Harris 16392 (NY).

Protoblastenia rupestris (Scop.) Stainer
Base of Goat Island, on rock, Harris 22884 (NY).
Luna Island, on rock, Harris 16324 (NY).
Terrapin Point, on rock, Harris 16443 (NY).

Pyrenocollema strontianensis (Swinscow) R. C. Harris
Luna Island, on rock, Harris 16317 (NY)

Sarcogyne regularis Koerber
First Sister, shore rock, Harris 22921 (NY).

Verrucaria muralis Ach.
Goat Island, north side, near water, on rock, Harris 22824 (NY); north side, small rocks in clay bank, Harris 22849 (NY); north side, on rock, Harris 16036 (NY), Harris 16303 (NY).
Base of Goat Island, on rock, Harris 22880 (NY), Harris 22883 (NY).
Terrapin Point, on rock, Harris 16443 (NY).
First Sister, west end, on rock, Harris 22871 (NY); east end, along shore, on rock, Harris 23925 (NY).
Second Sister, west end, on rock, Harris 23907 (NY); east end, limestone flat, on rock, Harris 23944 (NY).

Verrucaria sp.
Goat Island, north side, on small rock in clay bank, woodland taxon, Harris 22838 (NY); Harris 22846 (NY); Harris 22848 (NY).
Goat Island, central woods, western half, on small rock, Harris 22854 (NY).
Goat Island, north side, on small rock, woodland taxon, Harris 16308 (NY), Harris 16313 (NY).

Verrucaria sp.
Luna Island, Harris 22852 (NY).
First Sister, west end, Harris 22869 (NY), Harris 22871 (NY), Harris 22879 (NY).
First Sister, east end, Harris 22918 (NY); east end, on shore, Harris 22920 (NY).
Second Sister, east end, Harris 22923 (NY).
Third Sister, west end, north side, Harris 22939 (NY); east end, Harris 22892 (NY).

Verrucaria sp.
Base of Goat Island, Harris 16352 (NY).
First Sister, east end, Harris 22928 (NY).

Verrucaria sp.
Base of Goat Island, Harris 22881 (NY), Harris 22882 (NY).
Second Sister, east end, limestone flat, Harris 22914 (NY).

Verrucaria sp.
Goat Island, central woods, western half near parking lot, on small rock, Harris 22857 (NY).

**Verrucaria** sp.
Goat Island, central woods, western half, near parking lot, on small rock, Harris 22844 (NY).

**Verrucaria** sp.
Goat Island, north side, near Luna bridge, near water, Harris 22830 (NY).

**Verrucaria** sp.
Goat Island, north side, near Luna bridge, near water, Harris 22823 (NY).

**Xanthoria fallax** (Hepp) Arn.
Luna Island, on dead Ulmus, Harris 22843a (NY).

**Phaeophyscia orbicularis** (Necker) Moberg.
Goat Island, western half central woods, on *Fraxinus*, Harris 22817 (NY), Harris 22818 (NY).

* A poem is inscribed in Miss Wilson's handwriting on a back page of her autographed copy of Tuckerman's *Genera Lichenum* mentioned above, and which indicates something of her general attitude:

> What shortens time for me?
> Activity!
> What lengthens every tense?
> Indolence!
> What plunges in arrears?
> Waiting & fears!
> Whence profits spring?
> Short wavering!
> What brings dessert?
> Yourself assert!

—Goethe

**NOTES ON THE LICHENS OF GOAT ISLAND, NIAGARA FALLS**
by Richard C. Harris, New York Botanical Garden, Bronx, NY 10458-5126


As part of a botanical survey by Patricia Eckel of Goat Island and the adjoining Three Sisters and Luna islands, at Niagara Falls, New York, Bill Buck and I spent two days in November 1988 collecting the lichens. We are grateful to Ms Eckel for affording us the opportunity. A total of 187 collections yielded 56 species of lichens. The only other collections from Goat Island were made in 1870 and 1871 by George W. Clinton and Mary L. Wilson. They collected ten species of which only two are still present. A complete list of the lichens will be published elsewhere by Ms Eckel.

The status of the lichens on Goat Island today is rather enigmatic. My best guess is that the present expression of the flora results from the effects of pollution and destruction of the original vegetation offset by the buffering nature of the limestone rocks which are extensively exposed. The survivors are often not in the best condition and are frequently covered with foreign algae, which I interpret as a sign of too much shade. Foliose and fruticose species are not common, especially on trees. A startling exception is *Phaeophyscia orbicularis* (Necker) Moberg, which plasters most of the trees in the open, both native and recently planted introductions alike. This species is otherwise very rare in northern New York with the bulk of its United States distribution west of the Mississippi, and it is common in Europe. *Phaeophyscia rubropul-
chra (Degel.) Moberg, which one would expect to be common, is represented by only a single collection. There are a couple possible explanations, differing tolerance to drought and pollution or some sort of founder effect whereby P. orbicularis got established first and now maintains dominance by a vast number of asexual propagules effectively excluding other Phaeophyscias.

On rock the situation is somewhat different as P. adiastola (Essl.) Essl. is also well represented but neither attains any extensive cover on this substrate. The normally weedy Parmelia sulcata Taylor was collected only twice and then only in very moist exposed habitats. Xanthoria fallax (Hepp) Arn., which often occurs with Phaeophyscia and Physcia, was also rare on exposed trees. Also odd, only a single Cladonia, C. humilis (With.) Laundon, was found and it was growing on wood, which is an unusual substrate for this species which usually occurs on clay soil in old fields. Two foliose species collected in the 1870's, Anaptychia setifera Raes. and Teloschistes chrysophthalmus (L.) Th. Fr., are recorded otherwise in New York only from Long Island, perhaps attesting to the originally very “oceanic” character of the immediate falls area. Both are now extinct in New York State. The majority of the lichens surviving grow directly on the lime rock, on or among mosses on rock or on rotting wood. They would perhaps be protected from pollution by the neutralizing effects of the lime or from drought by water retained by the rotting wood. The most common species on rock are Bacidia granosa (Tuck.) Zahlbr., Candellariella aurella (Hoffm.) Zahlbr., Endocarpon pusillum Hedwig, Lecanora dispersa (Pers.) Sommerf., Mycobilimbia sabuletorum (Schreber) Hafellner and Verrucaria muralis Ach. The Mycobilimbia is one of the two species collected in both the 1870's and 1980's. A variety of Caloplaca and Verrucaria species, some not yet identified, are also common. Lepraria finkii (B. de Lesd. in Hue) R. C. Harris, a pollution-tolerant species (it survives in Manhattan), is common on rock and tree bases. Buellia punctata (Hoffm.) Massal. is the only frequent bark crust. Another anomalous feature is that the genus Micarea is absent and its niche on rotten wood is occupied by several possibly undescribed species of Bacidia s. lat. Since most lichens require relatively high light and humidity levels, it is not surprising that Luna Island and the Three Sisters have the most diversity while the central woodland on Goat Island itself has the lowest. It may well be that the lichens of Goat Island have been mainly crustose since the 1870's as George Clinton notes on an herbarium packet including Caloplaca flavorubescens (Hudson) Laundon and Lecidea russula Ach. (neither found in 1988): “Took it, I suppose, partly because I was in despair, & partly because the tree was Ash,” which I take to mean he was not finding many conspicuous lichens. I have no information on current pollution levels around Niagara Falls, but assuming they have dropped in recent years, lichen diversity could be maintained or perhaps increased by keeping open areas, especially on the Three Sisters, but turning some of the lawn into an old field situation, which would provide habitat for Cladonias, by reintroducing Thuja, which is a good substrate for many lichens, and by leaving more fallen trees.

I maintain a checklist of the lichens of New York State based on specimens seen. The only collection so far of Gyalecta jenensis (Batsch) Zahlbr. was made by Clinton on Goat Island in 1870. In our 1988 Goat Island collections, six species are additions to the State list: Arthonia lapadicola (Taylor) Branth & Rostrup, Bacidia epixanthoides (Nyl.) Lettau, Caloplaca cirrochroa (Ach.) Th. Fr., Lecania perproxima (Nyl.) Zahlbr., Leptogium juniperinum Tuck. and Pyrenocollema strontanensis (Swinscow) R. C. Harris.

Goat Island and its associated islands and, I presume, the entire Niagara Gorge are undoubtedly important refugia for a community of lichens very similar to those found in similar lime-rich areas of Ontario and Michigan. Although it is clear some of the members are already extinct in New York, I hope that measures will be taken to retain what is left.
THE MOSS AND HEPATIC FLORA

It is surprising how many specialists in the field of bryology (the study of mosses and liverworts) actually visited Niagara Falls and Goat Island over the past century or so. George Clinton collected systematically in the area mainly with the view to discovering new or unusual species.

The extensive representation of the pleurocarpous species in the genus Amblystegium and weedy species in Brachythecium in recent collections on Goat Island probably relates to the large expanses of lawns where grass is mown down to six inches or less, allowing for more sunlight than would occur naturally, and less competition for these mosses. Recent collections of the weedy acrocarpous species of Barbula unguiculata, Ceratodon purpureus, Pottia truncata, Phascum cuspidatum are present mainly in disturbed or gravelly soil by roadsides and at the bases of trees in lawn areas—the first two species are colonizing the open dolomite flats on the south side of Goat Island.

The old collection of Dicranum montanum mentioned below was and is associated with the trunks of trees, especially old, dead or dying trunks. Since all woody material is and has been scrupulously removed from the Goat Island woods and slope areas, the habitat for this moss and many other similar organisms is absent. Depletion of species of fungi and lichens is also due to loss of rotting wood material.

The presently described bryophyte flora of the Goat Island complex is an extension of the rich and consequently includes little that cannot be found there. The number of species and genera in the family Pottiaceae (Aloina, Barbula, Bryoerythrophyllum, Didymodon, Hymenostylium, Hyophila, Phascum, Pottia, Tortella, Tortula, Trichostomum and Weissia), the highest of any family represented on Goat Island and the lower gorge, is indicative of the alkaline seepages and substrates (dolomite and limestone) exposed or shallowly covered in that area, and for which these species have an affinity. In addition, species of the family Pottiaceae have an unusual ability to tolerate cycles of drying and rewetting, which is typical of non porous limestone environments. Many of these taxa are rare in New York State.

Many mosses from the nineteenth century were collected at the base of Goat Island “ad Niagareae fluminis rupeis humidas” or “ad rupeis irriguas” or “irroratas” after the climb down the Biddle Stairs. Wet rocks supported moss communities in the spray zones of the Horseshoe and American Falls. There also the lime-charged seepage at the top of the talus slope where the early paths were provided, supported, then as today, dense, soaking populations of Hymenostylium recurvirostrum and other typical mosses found in the gorge only in these areas (see discussion below).

The station of Fissidens grandifrons, of which two still persist on Goat Island and in the sites referred to a century ago at the Hermit’s Cascade and The Spring, seemed to fascinate visitors to Goat Island with an interest in mosses, as can be seen from the number of collections cited below. In 1874, Peck published another New York station at Chittenango Falls found by Judge Clinton, “at present ... our most eastern known station of this interesting ... moss.” The presently taxonomically uncertain moss Didymodon luridus was also found at Chittenango Falls “as at Niagara Falls we here find this rare moss associated with Fissidens grandifrons (Peck, 1874).

In the Goat Island complex, the greatest species diversity occurs on the west end of the First Sister (23 mosses, three liverworts) followed by the west end of the Second Sister (19 mosses, two liverworts) and the east end of the Second Sister (12 moss species). The base of Goat Island has 21 moss species and one liverwort. The highest number of taxa in the complex corresponds with areas of little access (base of Goat Island) or areas which are not frequented by visitors and administration.

The distribution of mosses may be significant in the interpretation of phytogeographic, paleoecological and geologic history, since they demonstrate slower rates of evolution than vascular plants (Miller, 1980; Birks, 1982; Fife, 1985). Rare and relictual species may contribute new information in a floristic phenomenon already rich in indicators of past floristic migrations, etc.

Certain mosses are significant in pioneer stages of succession on exposed dolomite river-bed in solution or excavation cavities filled with sand, gravel, bits of shells and organic debris, algae. Mosses in these habitats compete with certain grasses and the young
rosettes of *Lythrum salicaria*, or, in some cases, the establishment of these larger plants may precede that of mosses, which may colonize their roots.

Nomenclature follows Crum and Anderson (1982) except in the case of *Hymenostylium recurvirostrum* (Hedw.) Dix. which is referred to as *Gymnostomum recurvirostrum* Hedw. by Crum and Anderson (1982). The taxonomic position of *Didymodon luridus* is in doubt, and these names may turn out to be *Didymodon tophaceus* or *D. rigidulus*, both common on the Niagara dolomite and limestones, if rare in New York State (Crum & Anderson, 1982).

I would like to express my gratitude to Dr. William Buck, New York Botanical Garden for field collections and identifications undertaken for this report, and to Dr. Richard H. Zander, Buffalo Museum of Science, who collected extensively in the 1970's in the Niagara River Gorge, and kindly allowed his specimens to be a part of this survey. I am also grateful to Richard Zander, a specialist in the genus *Didymodon*, for examining the Drummond exsiccat and sharing his determinations with me.

**BRYOPHYTES: HISTORICAL DISCUSSION**

Thomas Drummond (1780-1835) collected at Niagara Falls and most likely on Goat Island in 1818 (Peck, 1866). Drummond found *Didymodon luridus* at the Falls, and Clinton found it in October, 1865 “on a dry rock near the shore, one-eighth to one-quarter of a mile below the American staircase” (Peck, 1866). If Drummond did collect there in 1818, it was before his expedition of 1825-1827 with Captain Franklin, R.N., through British North America during which he served as assistant naturalist to the expedition. The route took him through New York to Ontario and west in an attempt to find the northwest passage between the Atlantic and Pacific, (Sayre, 1971). Drummond issued an exsiccat of moss specimens from the western part of the continent, the Musci Americani, issued, according to the label, in 1828.

Although it is doubtless that Drummond collected at Niagara, it is unfortunate that some of the specimens he distributed in his Musci Americani do not derive from the Falls, or he mixed specimens from the western states with those from the east. The primary example is No. 120 of the exsiccat, issued as *Didymodon trifarius*. This is a mixed collection including *D. rigidulus* var. *rigidulus*, and a variety of *D. rigidulus* found only in the western states (var. *iemadophilus*). *Didymodon fallax* and *D. tophaceus* also occur in this collection. These also occur at the Falls, but they are common in the Rocky Mountains as well. Perhaps there was a certain confusion at the beginning of Drummond’s collecting program and his specimens or notes were not cared for in the beginning as were his later collections.

The first checklist of the mosses of New York State was produced by Charles Peck, in 1866, at the suggestion of his political mentor, George Clinton of Buffalo (see discussion regarding Peck in the mycological section). Clinton contributed records of bryophyte species from western New York State, also including bryophytes from the area of Niagara Falls and maintained a correspondence with Peck regarding moss studies from 1865 to 1879—some 400 letters from which are archived in the research library of the Buffalo Museum of Science (Both, 1984).

William Starling Sullivant (1803-1873) graduated in engineering from Yale, but turned to the study of the natural sciences, particularly botany, and to bryology, then not yet systematically explored or studied in the United States. His first bryological effort was the exsiccat of specimens entitled the Musci Allegheniensis* (around 50 copies, Sayre, 1971), based on collections made with Asa Gray. The first printing had beige labels, the second printing of 100 copies, had blue labels. Sullivant was beginning to elucidate bryology in North America in the publications of the American Academy of Science, and in editions of Gray’s Manual of Botany. He collaborated with Leo Lesquereux in issuing the Musci Boreali-Americani** in two editions (1857 & 1866). His specimens are at Harvard (Humphrey, 1961).

Leo Lesquereux (1806-1889) was Swiss born. He came to America in 1847 after having established his reputation based on a study of peat, which is a habitat heavily occupied by bryophytes (chiefly the moss *Sphagnum*). In the United States he collected bryophytes and other plants in the eastern United States, some of which were employed in his exsiccat, with Sullivant, the Musci Boreali-Americani. A specimen of *Thuidium abietinum* collected “in insula Goat Island dicta juxta cataractam Niagarae” was distributed in that exsiccat (No. 413, Ed. 2), as was *Tortella tor*.
tuosa (No. 97b, Ed. 1; No. 137, Ed. 2).

When Sullivant had died while developing a manual of the mosses of North America, Asa Gray encouraged Lesquereux to complete it, which he did, in collaboration with Thomas Potts James, then working on mosses at Harvard (Humphrey, 1961). Lesquereux and James's 1884 Manual was the first book published dealing with the moss flora of the continent to that time. References are made to collections from all over the United States and Mexico, including those made at Niagara Falls (Bryum cyclophyllum ("On stones wet by spray, at Niagara Falls (G. W. Clinton)")), Hypnum irriguum var. irriguum, Hypnum revolvens var. intermedium, etc.).

It is in an earlier publication in 1866 by Charles H. Peck that we learn of Lesquereux's researches on Goat Island itself, where four species are represented from his collections there, and another four from the area of Niagara Falls. According to Peck, Lesquereux made collections throughout New York State, including Goat Island. Dicranaum montanum was collected on the Island by Lesquereux, as was Anomodon viticulosus, Abietinella abietina (as Hypnum abietinum), Tortella tortuosa (as Barbula tortuosa), and Rhytidium rugosum (as Hypnum rugosum). He also found Orthotrichum anomalum and Bryum turbinatum at Niagara Falls (Peck, 1866). Lesquereux corresponded with George Clinton regarding mosses, and some of his letters are preserved in the archives of the Buffalo Museum of Science. Lesquereux assisted Peck in the compilation of the first checklist of the mosses of New York State.

Louis Agassiz, as noted elsewhere in this text, passed through Goat Island with students and scholars from Harvard on their way to Lake Superior, prior to 1850. Perhaps it was on this expedition that Agassiz collected enough of the moss Orthotrichum anomalum to contribute to both editions of Sullivant and Lesquereux's Musci Boreali-Americani (No. 119, Ed.1; No. 177, Ed. 2).

Thomas Potts James (1803-1882) published papers on North American mosses and liverworts before a manual existed for their identification in North America. He was able to study bryology at Harvard University, and there produced a number of early publications based on the study of bryophytes collected in geological surveys in western North America. He is most noted for his collaboration with Lesquereux on the Manual of North American Mosses, the first of its kind, which was published in 1884, two years after James' death (Humphrey, 1961).

T. P. James had previously collected on Goat Island, publishing some of his discoveries (Proc. Amer. Phil. Soc.), noted by Peck (1866). For example he found Encalypta streptocarpa Hedw. at Niagara Falls, and Amblystegiella jungrannoiodes (as Hypnum sprucei) on Goat Island itself (cited in Day, 1883). Other specimens of James' from Niagara may be sought at the Farlow Cryptogamic Herbarium, Harvard University (FH) and the Herbarium of the Academy of Natural Sciences of Philadelphia (PH).

Eugene A. Rau, of Bethlehem, Pennsylvania, home town also of Francis Wolle, the algologist and collector of mosses (see section on phycology and specimens listed below) did research in bryology, which contributed to Lesquereux and James' Mosses of North America (1884). Rau and A. B. Hervey published a catalogue of North American Mosses in 1880. His herbarium was purchased by the New York Botanical Garden in 1928, and specimens from Niagara are included in it. Mr. Rau collected at Niagara Falls (see Fissidens grandifrons below).

Charles Reid Barnes (1858-1910), professor of botany at the University of Wisconsin, later at Chicago, and editor of the Botanical Gazette (Sayre, 1975), published Analytic Keys to the Genera and Species of North American Mosses in 1897 (1896, Sayre, 1975) since such a key was not provided by Lesquereux and James' North American flora. The moss genus Barnesia is named after him. Other specimens of his from Niagara may be sought in the herbaria at NY, F, PC and Y. See Anon, 1910; Cowles, 1910; Howe, 1910; Humphrey, 1961.

In 1886 the annual meeting of the American Association for the Advancement of Science (AAAS) was held in Buffalo, N.Y.—an event referred to by Superintendent Welch (3 Ann Rep Comm, 1888). A retinue of this group visited the Reservation and “discussed the geological features of Niagara, in convention.” A review of the excursion-list which Welch scrupulously developed each year of the Reservation's existence revealed a notation for August 21, “Buffalo, N.Y., Scientists, 3 Cars, ca. 180 people.” During the course of examining the labels of bryophyte specimens at the New York Botanical Garden, a series of labels from Niagara were noted (see below), quite a number of them collected on the same
day, or the next—August 21 or 22, 1886. It is curious that specimens collected by Barnes (see list) were collected on Goat Island on August 21, 1886, the same day and place as some of Rau’s. It seemed at first that both these men sent their collections to Elizabeth Gertrude Britton, a bryologist associated with the New York Botanical Garden, to verify, except that some labels include her name or initials as collector, along with the letters AAAS, for August 21. It then became apparent these specimens were collected by the participants in the AAAS foray of 1886—Charles Barnes, Eugene Rau and Elizabeth Britton.

The fifteenth meeting of the AAAS was sponsored by the young Buffalo Society of Natural Sciences (BSNS) in August, 1866. Founded in 1848, the AAAS had been suspending its national meetings during the Civil War since its 1860 meeting in Rhode Island “because of sectional strife” between members with southern or northern affinities. The BSNS again hosted the annual meeting of the AAAS on August 23, 1876 and a field trip to Niagara Falls was probable as the citizens of that town were thanked for their “magnificent hospitality” (Robertson, 1938). Foreign scientists participated in that meeting, due to the coincidence of the Centennial Exposition in Pennsylvania in the same year. It is probable that specimens collected from Goat Island made their way to herbaria overseas.

The thirty-fifth AAAS meeting, sponsored again by the BSNS, held its field trip to Goat Island in the second year of the Reservation's existence—when the bryologists mentioned above made their collections. The final AAAS meeting sponsored by the BSNS was held in 1896, August 24-28 with an excursion to Niagara Falls “because of sectional strife” between members with southern or northern affinities. The BSNS again hosted the annual meeting of the AAAS on August 23, 1876 and a field trip to Niagara Falls was probable as the citizens of that town were thanked for their “magnificent hospitality” (Robertson, 1938). Foreign scientists participated in that meeting, due to the coincidence of the Centennial Exposition in Pennsylvania in the same year. It is probable that specimens collected from Goat Island made their way to herbaria overseas.

After the death of Sullivant “no outstanding mus-

George Clinton began to mention mosses on his day trips to Niagara in his journal on June 1, 1865. He began this document in 1862. On the first of June, 1865, near the DeVeaux section of the Niagara River Gorge, he found “on the wet rock, bulging masses of a nice dark green moss ... afterward noticed the same on the wet precipice below the American Staircase.” Today, only occurring on the vertical dolomite faces of the gorge, including the Goat Island bluffs, these same dark green masses are seen to be primarily composed of the mosses Hymenostylium recurvirostrum and secondarily Didymodon tophaceus. In shale seepage further downstream in the gorge, Cratoneuron filicinum mats replace the previous two species. These mosses remove during photosynthesis “carbon dioxide from water charged with soluble calcium bicarbonate [resulting in] precipitation of insoluble calcium carbonate (Crum & Anderson, 1981) producing a soft, porous kind of stony material which frequently breaks off and falls to the talus below, where they are found by people who marvel at the calcified leafy stem-structures of the mosses in the texture of the rock. Some call these stony masses Didymodontoliths. These mosses and their tufa bases are typical of calcareous seeps and waterfalls all over North America, including the deserts of Arizona and New Mexico.

On the same day, Clinton again found “a pretty, small fruited moss, and [Preissia quadrata]” near the American Staircase. On Goat Island he found “one or two mosses collected before.” On June 10, he collected Barbula tortuosa var. (Tortella tortuosa now restricted to one place on the First of the Three Sisters Islands.) On July 26, he “picked up a little of 2 or 3 small mosses, one very small, like a Hypnum, growing on stones. Found the same on Goat Island, near the cascade. On August 8, “On wettest rocks, at and above top of talus, everywhere here & on Goat Island, below Biddle Staircase, Preissia commutata [= P. quadrata], now past fruit, abundant. Near the water, a good way below the Staircase, on a large rock, a small moss in fruit, which may be new, not before collected by me [Gymnostomum crossed out]. Fissidens grandifrons does not extend far below the Staircase, nor have I found it on Goat Island... Descended the Biddle Staircase. Gymnostomum curvirostrum everywhere, common on wet rocks...” Preissia commutata [P. quadrata] still occurs in the place mentioned; the Gymnostomum curvirostrum is the Hymenostylium recurvirostrum mentioned above; Fissidens grandifrons may be found today on the north shore of Goat Island, and between Goat Island and the First Sister Island in ledges under falling water.

It was about this time of the year that Clinton became interested in collecting Anomodon viticulosus on Goat Island, where earlier Lesquereux had collected it (Peck, 1866). Clinton had apparently found this species already at “Various localities about Niagara Falls” (Peck, 1866). On September 27, he “walked up to Goat Island down the Bidell Stairs & searched near the Middle & the British Falls for Anomodon viticulosus, then to the American Staircase & did the same at the American Fall.” He must have written about it to Lesquereux, for on October 18, 1865, “Before breakfast, redc. letter from Dr. Lesquereux, giving the precise station of Anomodon viticulosus on Goat Island.” He searched for it that day, “examined the station, but, alas! no Anomodon vitis there! The station was on Goat Island, on a rock, about halfway down the path leading from the Carriage way to the Bridge to Luna Island, not the Hog’s Back path, but the one above it. There’s no rock there. Perhaps the path has been changed since Dr. L. was there.” Clinton’s correspondence with Lesquereux included the exchange of specimens, for Clinton refers to having collected Orthotrichum cupulatum for him “from trees in the park opposite the Ferry House.” Happily, on October 21, he “went to Goat Island, and, commencing at the end of the Bridge, explored the bank all the way down to opposite the middle of the island above Luna Island. Found no rock till I got there—a ridge of the bank, and there, quite close to the bank, was a large rock, in the earth on top of which was an Anomodon which I am confident is not A. obtusifolius (it turned out to be A.
viticulosus). At the foot of the Cascade, in the water, growing on the rock ... *Fissidens grandifrons.*” In 1866, on April 21, with a Mr. Pettibone, Clinton returned to Goat Island and “the channel between the Island & the First Sister being dry, I walked over & explored it. *Hypnum nudum* [Leskea polycarpa] abundant. Collected an *Orthotrichum* on Goat Island.” On May 12, he found the liverwort *Fegatella conica* (= *Conocephalum conicum*) capitally “in fruit.”

In 1882, the Buffalo Society of Natural Sciences, Buffalo, New York, published the first part of *The Plants of Buffalo and Vicinity* by David F. Day and listing the vascular flora. One year later the second part was issued containing treatments of the rather inconspicuous and less well known organisms: mosses, liverworts, lichens, fungi and algae—an ambitious undertaking which has been and still is seldom duplicated in floras and other botanical surveys. Day (1882) indicated the following regarding authorship:

“Grateful acknowledgments are made to Mr. Charles H. Peck, of Albany, N.Y., the State Botanist, for his kindness in supervising and correcting our lists of Musci, Hepaticae and Fungi—originally prepared by Judge Clinton, by whom all the species were detected, except as otherwise stated.”

Among numerous references in the 1883 publication were species found at the American Staircase (area below Prospect Point), Devil's Hole, Whirlpool Woods, Foster's Flats, and other localities in the Niagara River Gorge. The following bryophytes were reported from Goat Island:

Musci:

*Bryoerythrophyllum recurvirostrum* (Hedw.) Chen (as *Barbula rubella* Roth. Goat Is., Niagara River.


*Fissidens grandifrons* Brid. Goat Is., at the Cascade.


Hepaticae:

*Conocephalum conicum* (L.) Lindb. (as *Fegatella conica* Corda.) Goat Is., Niagara Falls.

On a more recent note, Dr. Ruth Schornherst Breen made collections at Niagara Falls when she was studying for her doctorate at the University of Michigan. Dr. Breen was President of the American Bryological and Lichenological Society and a Fellow of the American Association for the Advancement of Science. She wrote a manual of the moss flora of Florida in 1963.

Specimens of mosses collected at Goat Island and Niagara Falls seen at the Smithsonian Institution, Washington D.C. (US) derive from the herbarium of Charles Mohr of Mobile, Alabama, a collector of the late 19th century who worked in Mexico, Europe and the United States. His collections were donated to the National Herbarium in 1901. Among his specimens were several from Niagara Falls, some collected by Lesquereux, and in his company (v. *Dicranum montanum*, July 1866) and some by Francis Wolle (1817-1893, some of whose phycological specimens from the Falls are reported—see phycological section). Labels by Wolle specifically cite Goat Island as the collecting locality.

Specimens from the New York Botanical Garden are indicated as (NY), from the Clinton Herbarium, Buffalo Museum of Science as (BUF), from the United States National Herbarium Smithsonian Institution as (US).
BRYOPHYTES—HISTORICAL SPECIMENS

[Aloina rigida (Hedw. ex Schultz) Kindb. gives the locality “Niagara” for a station of distribution for this species treated by Mrs. Ethelda J. Craig (Grout, 1936). This specimen could not be found at the New York Botanical Garden or the National Herbarium.]

Anomodon viticulosus (Hedw.) Hook. & Tayl.
Hab. Trunks of trees in Upper Canada; and about the Falls of Niagara. Musci Americani. Thomas Drummond. 1828 Torrey Herbarium (NY). [A specimen by George Clinton has not been found—see discussion above.]

Barbula unguiculata Hedw.

Barbula unguiculata Hedw.
Niagara Falls leg. C. F. Austin, July 18, 1874 Ex Herb. Eugene A. Rau, Bethlehem, Pa. (NY).

Brachythecium rutabulum var. densum BSG

Bryoerythrophyllum recurvirostrum (Hedw.) Chen
(As Didymodon rubellus var.) Niagara Falls, N.Y. July 18th, 1874 North American Mosses From the Herbarium of Coe Finch Austin (NY).

Bryum sp.

Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Scherb.

Bryum turbinatum (Hedw.) Turn.
No. 190. Hab. ad rupeis irrortatas Niagareae cataractae; etiam in scaturiginosis Minnesotae. [Sullivant & Lesquereux, Musci Bor.-Amer. ed. 2]

Dicranum montanum Hedw.

Dicranum montanum Hedw.
No. 55. Hab. in trunci emortuis prope Niagareae cataractam. Sullivant & Lesquereux, Musci Bor.-Americani, ed. 1. (NY). [it grows on dead [tree] trunks near the cataract of Niagara] (NY)

Dicranum montanum Hedw.
No. 71. Hab. in trunci emortuis prope Niagareae cataractam; etiam per montes Novaeboracenses sat frequens. Sullivant & Lesquereux, Musci Bor.-Amer. ed. 2 (NY). [it grows on dead tree trunks near the falls of Niagara; also it is quite frequent throughout the mountains of New York]

Dicranum montanum Hedw.

Didymodon fallax (Hedw.) Zand.
(As Barbula fallax) with Didymodon trifarius No. 120, Falls of Niagara, Drummond. [Didymodon fallax has been isolated from the collection of Didymodon trifarious and made into a separate specimen, from the William Mitten herbarium, now at NY. R. Zander has examined this collection and determined it to be D. rigidulus var. icmadophilus, a variety from western North America.]

Didymodon fallax (Hedw.) Zand. var. reflexus (Brid.) Zand.
(As Tortula recurvifolia) No. 496. Hab. ... Watkin's Glen and Niagara Falls, New York ... Musci Appalachiani Supplement 1. Coe F. Austin 1878. Didymodon luridus Hornsch. var. cuspidatus Schimp. This species was noted from Niagara Falls, citing specimens of Drummond's and Clinton, by
Lesquereux and James (1884).

**Didymodon luridus** Hornsch.

**Didymodon luridus** Hornsch.
Niagara Falls Ex Coll. Geo. W. Clinton Herbarium Dr. E. C. Howe purchased 1902 (NY).

**Didymodon luridus** Hornsch.

**Didymodon luridus** Hornsch.
Niagara Falls Coll. Francis Wolle 1873. Herbarium Coe Finch Austin Purchased by Columbia College, 1885-1887 (NY).

**Didymodon luridus** Hornsch.

**Didymodon rigidaulus** Hedw.

**Didymodon rigidaulus** Hedw.
(As *Trichostomum rigidaulus*) No. 102. Hab. ad Niagarae fluminis rupes humidas. Musci Bor.-Amer. [sive] Specimina Exiscicata Muscorum in Americae Rebuspubliccis Foederatis detectorum conjunctis studiis W. S. Sullivant et L. Lesquereux MDCCLXVI Presentation copy to H. W. Ravenel Purchased from his estate by L. M. Underwood, 1892 New York Botanical Garden Underwood Collection, 1914. [there is also a duplicate from Columbia University, ex Herb. N. B. Ward, 1896 (NY).]

**Didymodon rigidaulus** Hedw.
(As *Trichostomum rigidaulus*) No. 150. Hab. Niagraae fluminis rupes humidas. Sullivant & Lesquereux, Musci Bor.-Amer. ed. 2 (NY).

**Didymodon tophaceus** (Brid.) Lisa

**Didymodon tophaceus** (Brid.) Lisa
Slate rocks, under the Horseshoe Falls at Niagara, N.Y. July 25th, 1927. Brother Leon [?].

**Didymodon tophaceus** (Brid.) Lisa
Niagara Falls. G. W. Clinton, 1865 [leg.] Herbarium of Coe Finch Austin Purchased by Columbia College, 1885-1887 (NY).

**Didymodon tophaceus** (Brid.) Lisa
Niagara Falls. N.Y., S. T. Olney [leg.] Herbarium of Coe Finch Austin Purchased by Columbia College, 1885-1887 (NY).

**Didymodon tophaceus** (Brid.) Lisa
(As *Trichostomum tophaceum* var.) Niagara Falls. N.Y. July 18th, 1874. [leg.] C.F.A. Herbarium of Coe Finch Austin Purchased by Columbia College, 1885-1887 (NY).

**Didymodon trifarius** Swartz
No. 120. Hab. About the Falls of Niagara Drummond, Musci Americani. 1828. New York Botanical Garden. [Another collection of this species is stated as from the Rocky Mountains, also no. 120 in Drummond's exsiccat, cf. Crum & Anderson, 1981. Richard Zander has redetermined this specimen as *Didymodon rigidulus var. rigidulus*. A duplicate specimen is in the William Mitten herbarium, now at NY. Another “duplicate” of No. 120, from the Mitten herbarium was redetermined as *D. tophaceus*, fide Zander.] A specimen from the Mitten Herbarium labelled as *Didymodon trifarius* var. from North America, “on rocks and trunks of trees,” No. 7, Nr. 138 has been re-determined as *D. rigidulus* var. *rigidulus* by Zander, for this study.

**Fissidens grandifrons** Brid.
Niagara Falls, New York Ex Coll. G. W. Clinton, Buffalo, N.Y. [in Clinton's handwriting] Herbarium of Dr. E. C. Howe, Purchased 1902 (NY). [Another specimen by Clinton is at New York from the herbarium of Dr. O. R. Willis, presented 1903, but without locality.]

**Fissidens grandifrons** Brid.
**Fissidens grandifrons** Brid.
Wet rocks, Niagara Falls. 1874. C.F.A. Herbarium of Coe Finch Austin Purchased by Columbia College, 1880-1885 (NY).

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.

**Fissidens grandifrons** Brid.
No. 186. Hab. ad Niagarae catafactam in rupibus irratoris. Musci Alleghaniensis. W. S. Sullivant, 1845, This copy of the work was presented by W. S. Sullivant to C. W. Short, M.D. with whose collections it came into the possession of the Philadelphia Academy of Science. It was purchased from the Academy by L. M. Underwood in November 1891. Underwood Collection, 1914 (NY).

**Funaria** sp.
Luna Island, Niagara Falls, Aug. 21, 1886 [Eugene A. Rau collected a variety of mosses at Niagara on this date] (NY).

**Funaria americana** L.

**Grimmia hookeri** [Drummond as] nov. sp.,
No. 61. caulibus caespitosis brevibus, folis linearibus obtusiisculis valde crispatis, seta elongata flexuosa, capsula elliptica laevi, operculo longe rostrato recto, calyptra campanulata stricta basi multifida. Hab. On a stone near the falls of Niagara in Upper Canada: rare. Musci Americani. Thomas Drummond. 1828. From the Torrey Herbarium (NY). Crum and Anderson (1981) cite Ontario (Niagara Falls) as one locality for *Ptychomitrium incurvum*, p. 670. Ketchledge, 1980, reports the distribution of this moss as occurring in the ex-
In the extreme southeastern portion of the State, around New York City, Crum and Anderson (1981) cite stations in New York west to Michigan, Iowa, Kansas, the Gulf States and Texas. Ontario is the only province in Canada in which this species occurs (Ireland, et al., 1980) -probably at Niagara. There is little reason to suppose this didn’t come from Niagara, although on the Canadian side. It is unlikely Drummond collected this in the Rockies!

**Grimmia pilifera** P.-Beauv.
(As **Grimmia pennsylvanica**) No. 56. Hab. Near the Falls of Niagara; upon rocks. Musci Americani. Thomas Drummond. 1828. From the Torrey Herbarium (NY).

**Hymenostylium recurvirostrum** (Hedw.) Dix.
(As **Gymnostomum recurvirostrum**) No. 25. Hab.—Falls of Niagara Musci Americani. Thomas Drummond. 1828. Torrey Herbarium (NY).

**Hymenostylium recurvirostrum** (Hedw.) Dix.

**Hymenostylium recurvirostrum** (Hedw.) Dix.

**Hymenostylium recurvirostrum** (Hedw.) Dix.

**Hymenostylium recurvirostrum** (Hedw.) Dix.

**Hymenostylium recurvirostrum** (Hedw.) Dix.

**Hymenostylium recurvirostrum** (Hedw.) Dix.

**Hymenostylium recurvirostrum** (Hedw.) Dix.
(As **Gymnostomum recurvirostrum**) Locus: Niagara Falls Ex Coll. G. W. Clinton Herbarium of Dr. E. C. Howe, now at the New York Botanical Garden [a duplicate exists from the herbarium of Charles H. Peck]

**Hymenostylium recurvirostrum** (Hedw.) Dix.

**Hymenostylium recurvirostrum** (Hedw.) Dix.

**Hymenostylium recurvirostrum** (Hedw.) Dix.
(As **Gymnostomum recurvirostrum**). Niagara, on limestone. Ruth Schornherst Ann Arbor, Michigan July 17, 1937 Herbarium Florida State University now at New York Botanical Garden.

**Hymenostylium recurvirostrum** (Hedw.) Dix.
(As **Gymnostomum rupestre**) Niagara Falls legit G. W. Clinton “Two things: one is Seligeria (removed), the other as named” Examined for North American Flora Det. by A. Le Roy Andrews Herb. Dr. E. C. Howe (NY).

**Hymenostylium recurvirostrum** (Hedw.) Dix.
(As **Gymnostomum rupestre** fide Lesq. & James.

**Hymenostylium recurvirostrum** (Hedw.) Dix.
(As *Gymnostomum rupestre*) Hab. On ground towards 3 Sister Islands, Niagara Falls. Aug. 21, 1886 [Coll. E. A. Rau—cf. other collections with this date] North American Mosses Herb. Eugene A. Rau, Bethlehem, Pa. [Duplicates of this collection are in the herbarium of Coe Finch Austin, and the herbarium of what was to become Columbia University, both now at NY. This species usually grows on rock, not soil, and is indirect evidence for thin soil and bedrock exposure on the southeast end of Goat Island.] A specimen of *H. recurvirostrum* was collected at the Biddle Stairs, “on damp rocks at Niagara Falls below Biddle's Stair, Goat Island, Sept. 1853” on a label in a specimen from the Chapman Collection, which at one time was in the Torrey Herbarium, another in the Columbia University Herbarium and now at the New York Botanical Garden. The collector is not mentioned—perhaps Chapman? [H. recurvirostrum, as *G. curvirostrum* is noted as “very abundant at Niagara Falls” by Lesquereux and James, 1884; no variety is mentioned.]

**Hyophila involuta** (Hook.) Jaeg. & Sauerb.

**Orthotrichum anomalum** Hedw.

**Orthotrichum anomalum** Hedw.
Hab. Niagara Falls—Clinton. “trees above Falls / Clinton” North American Mosses. Eugene A. Rau, Bethlehem, Pa. (NY) [several collections of this species exist, made by George Clinton, but no localities were given: one presented to the New York Botanical Garden (NY) in the Herbarium of Dr. O. R. Willis (presented 1903), and another from the Princeton Herbarium (deposited 1945).]

**Orthotrichum anomalum** Hedw.

**Orthotrichum anomalum** Hedw.

**Orthotrichum anomalum** Hedw.

**Philonotis fontana** (Hedw.) Brid.
(As *Bartramia fontana* var. *falcata*) Niagara Falls, 1873. Rev. F. Wolle Herbarium of Coe Finch Austin Purchased by Columbia College, 1885-1887 (NY).

**Platydictya minutissimum** (Sull. & Lesq. ex Sull.) Crum
(As *Amblystegium minutissimum*) Niagara Falls, N.Y. July 18, 1874 [perhaps Coe F. Austin, as several other collections were made by him on that day, cf. *Barbula unguiculata*, *Bryoerythrophyllum recurvirostrum*, *Didymodon curvirostrum*, *D. tophaceus*]

**Pterogonium trichomitrion** Hedw.
No. 78. Hab. Trunks of trees in Upper Canada; about the Falls of Niagara. Musci Americani. Thomas Drummond. 1828. Torrey Herbarium (NY)

**Rhytidium rugosum** (Hedw.) Kindb.

**Thuidium abietinum** (Hedw.) BSG
Niagara Falls. Rev. Francis Wolle 1873. Herbarium
Part IV: The Species

of Coe Finch Austin Purchased by Columbia College, 1885-1887 (NY).

**Thuidium abietinum** (Hedw.) BSG

(As *Hypnum abietinum*) No. 413. Hab. in sylvis Lacus Superioris (cl. Agassiz comm.) etiam in insula Goat Island dicta juxta cataractam Niagarae. Sullivant & Lesquereux, Musci Boreali-Americani ed 2. Ex Herb Leo Lesquereux, Columbus, Ohio (NY).

**Thuidium abietinum** (Hedw.) BSG


**Thuidium abietinum** (Hedw.) BSG


**Thuidium abietinum** (Hedw.) BSG


**Thuidium pygmaeum** BSG


**Tortella fragilis** (Drumm.) Limpr.

(As *Barbula fragilis*) Table Rock, Niagara Falls [perhaps Canada?] Herbarium of Coe Finch Austin Purchased by Columbia College, 1885-1887 (NY).

**Tortella fragilis** (Drumm.) Limpr.


**Tortella fragilis** (Drumm.) Limpr.


**Tortella humilis** (Hedw.) Jenn.


**Tortella tortuosa** (Hedw.) Limpr.

(As *Barbula tortuosa*) Niagara Falls. G. W. Clinton, Coll. Herbarium Dr. E. C. Howe (NY). [Another specimen of Clinton's was distributed to Princeton University Herbarium by Charles H. Peck of Albany. Another was collected on Goat Island by Clinton in June, 1865—in the herbarium of Coe Finch Austin.]

**Tortella tortuosa** (Hedw.) Limpr.


**Tortella tortuosa** (Hedw.) Limpr.


**Tortella tortuosa** (Hedw.) Limpr.

(As *Barbula tortuosa*) Niagara Falls. Reverend F. Wolle, 1873. Herbarium Coe Finch Austin (NY).

**Tortella tortuosa** (Hedw.) Limpr.


**Tortula mucronifolia** Schwaegr.

(As *Barbula mucronifolia*) Niagara Falls leg. Rev. F. Wolle, 1873. Herbarium of Coe Finch Austin Purchased by Columbia College, 1885-1887 (NY).

**Tortula mucronifolia** Schwaegr.

(As *Barbula mucronifolia*) Niagara Falls leg. Rev. F. Wolle, 1873. Herbarium of Coe Finch Austin Purchased by Columbia College, 1885-1887 (NY).

**Tortula mucronifolia** Schwaegr.


**Tortula mucronifolia** Schwaegr. (As *Barbula mucronifolia*) Hab. banks of Luna Island, Niagara
Botanical Heritage of Islands at the Brink of Niagara Falls

Eugene A. Rau, Bethlehem, Pa.


** Musci Boreali-Americani, Sive Specimina Exsiccata Muscorum in Americae Respublincis Foederatis Detectorum, Conjunctis Studiis W. S. Sullivant Et L. Lesquereux. Columbus Ohioensium, 1857 (Sayre, 1971). [Trichostomum articles, see below]

MOSSES: RECENT RECORDS

**Amblystegium fluviatile** (Hedw.) BSG
Goat Island, southwestern shore just above Three Sisters Island, edge root mat of *Cornus stolonifera*, with *Philonotis marchica*, 28686, June 9, 1986 (BUF).
Second Sister, east end, 2 Nov. 1988, Buck 16395 (BUF, NY).

**Amblystegium riparium** (Hedw.) BSG
Goat Island, extensive mat on wet soil by river edge, southeast end in mats, Eckel, June 3, 1987 (BUF).
Second Sister, west end, tree roots, wet in high water, Oct. 29, 1988 (BUF).

**Amblystegium serpens** (Hedw.) BSG.
Goat Island, soaking soil by rushing water, low area, calcareous substrate, NF11, May 5, 1984 (BUF); north slope, 1 Nov. 1988, W.Buck 162 (BUF, NY), 16298 (BUF, NY), Buck 16309 (BUF, NY).

**Amblystegium serpens** var. *juratzkanum* (Schimp.) Rau & Herv.
Base of Goat Island, spray area of Horseshoe Falls, near river, thin soil over rocks, base of falls, with *Fissidens crístatus*, Zander 3475b, Oct. 28, 1979 (BUF).

**Amblystegium tenax** (Hedw.) C. Jens. var. *tenax*
Goat Island, north slope, 1 Nov. 1988, Buck 16285 (BUF, NY); north slope, west end on brickwork, Eckel, May 20, 1988 (BUF); just west of the Three Sisters, wet base of *Cornus stolonifera* island, with *Lythrum*, Eckel, June 4, 1988 (BUF), Sept. 9, 1984 (BUF).
Base of Goat Island, 1 Nov. 1988, Buck 16356 (BUF, NY).
Terrapin Point, 2 Nov. 1988, Buck 16440 (NY).
Luna Island, 1 Nov. 1988, Buck 16318 (BUF, NY), Buck 16332 (BUF, NY).
First Sister, west end, 2 Nov. 1988, Buck 16421 (BUF, NY), 16427 (BUF, NY).
Second Sister, west end, tree roots, wet in high water, Oct. 29, 1988 (BUF); west end, 2 Nov. 1988, Buck 16382 (NY); east end, 2 Nov. 1988, Buck 16398 (BUF, NY), Buck 16403 (BUF, NY), Buck 16406 (BUF, NY).
Third Sister, west end, 2 Nov. 1988, Buck 16436 (BUF, NY); east end, 2 Nov. 1988, Buck 16431 (BUF, NY), Buck 16433 (BUF, NY).

**Amblystegium trichopodium** (Schultz) Hartm.
(As *Leptodictyum trichopodium* (Schultz) Warnst.)
Third Sister, west end, 2 Nov. 1988, Buck 16435 (NY).

**Amblystegium varium** (Hedw.) Lindb.
Goat Island, just west of the Three Sisters, wet base of *Cornus stolonifera* island, with *Lythrum*, Eckel, June 4, 1988 (BUF).

**Anomodon attenuatus** (Hedw.) Hueb.
Goat Island, north slope, 1 Nov. 1988, Buck 16295 (BUF, NY).
First Sister, west end, P.M. Eckel, 880723, July 8, 1987 (BUF); 2 Nov. 1988, Buck 16429 (BUF, NY).

**Anomodon rostratus** (Hedw.) Schimp.
First Sister, west end, P. M. Eckel, 880726, July 8, 1987 (BUF); 1 Nov. 1988, Buck 16335 (BUF, NY).

**Barbula unguiculata** Hedw.
Goat Island, dolomite ballast, SE end, Eckel, 880721, June 4, 1988 (BUF); north slope, facing Luna Island, Eckel, May 2, 1988 (BUF); west parking lot,
lawn and wood margin, Eckel & Eckel, 880719, April 23, 1988 (BUF); SW shore, river's edge, shaded thicket, Eckel & Eckel, 880721, July 8, 1986 (BUF); behind restaurant, base of tree, with *Pottia truncata* and *Phascum cuspidatum*, Oct. 29, 1988 (BUF); weedy bank facing the Three Sisters, Eckel, Sept. 9, 1984 (BUF).


*Barbula unguiculata* fo. *apiculata*
Goat Island, north slope, west end on brickwork, Eckel, May 20, 1988 (BUF).

*Brachythecium oxycladon* (Brid.) Jaeg.
First Sister, west end, 1 Nov. 1988, Buck 16334 (BUF, NY); east end, 2 Nov. 1988, Buck 16415 (NY).  
Second Sister, west end, 2 Nov. 1988, Buck 16385 (BUF, NY); east end 2 Nov. 1988, Buck 16399 (BUF, NY), Buck 16412 (BUF, NY).  
Third Sister, east end, 2 Nov. 1988, Buck 16434 (BUF, NY).

*Brachythecium rivulare* BSG.
Goat Island, dolomite flats above the Horseshoe Falls, Eckel, July 5, 1988 (BUF).

*Brachythecium rutabulum* (Hedw.) BSG
Goat Island, margin of woods, edge of west parking lot. With *Mnium cuspidatum*, 8705226, Aug. 18, 1986 (BUF); wooded slope, north end, west of vehicular bridge, Eckel, 880708, April 20, 1988 (BUF).  
Terrapin Point, 2 Nov. 1988, Buck 16444 (BUF, NY).  
Luna Island, 1 Nov. 1988, Buck 16321 (BUF, NY).  
Third Sister, east end, 2 Nov. 1988, Buck 16430 (BUF, NY).

*Brachythecium salebrosum* (Web. & Mohr) BSG
Goat Island, dolomite flats above the Horseshoe Falls (autoicous), Eckel, July 5, 1988 (BUF).

*Bryoerythrophyllum recurvostrum* (Hedw.) Chen
First Sister, west end, on dolomite boulders with *Fissidens taxifolius, Weisia controversa, Carex eburnea.* 87312, Sept. 12, 1986 (BUF); 2 Nov. 1988, Buck 16423 (NY); east end, 2 Nov. 1988, Buck 16414 (BUF, NY).

*Bryum argenteum* Hedw.
Goat Island, dolomite ballast, SW end, Eckel, 880723, June 4, 2988 (BUF); May 22, 1988 (BUF).


*Bryum caespiticium* Hedw.
Luna Island, 1 Nov. 1988, Buck 16325 (BUF, NY).

*Bryum cyclophyllum* (Schwaegr.) BSG
Crum and Anderson (1981) cite a reference by Lesquereux and James (1884) to a collection of this species made by George Clinton from “stones wet by spray, at Niagara Falls.” A specimen that Crum and Anderson found in the herbarium of the University of Colorado filed under the name *Bryum clintonii* Aust. from Buffalo, New York, was found by them to be *Bryum cyclophyllum*.

*Bryum capillare* Hedw. var. *flaccidum* (Brid.) BSG.  
(As *Bryum flaccidum* Brid.) Terrapin Point, 2 Nov. 1988, Buck 16441 (BUF, NY).  
Luna Island, 1 Nov. 1988, Buck 16316 (BUF, NY), Buck 16320 (BUF, NY).  
First Sister, west end, 2 Nov. 1988, Buck 16418 (BUF, NY).

*Bryum lisae* De Not. var. *cuspidatum* (BSG) Marg.  
Goat Island, north slope, 1 Nov. 1988, Buck 16300 (NY).  

*Bryum pseudotriquetrum* (Hedw.) Gaertn. Meyer & Scherb.
Goat Island, north side in moist protected cove just west of the vehicular bridge, in dolomite strata in seepage, with *Fissidens grandifrons* 86121702 Sept. 12, 1986 (BUF).  
Calliergonella cuspidata (Hedw.) Loeske
Base of Goat Island, 1 Nov. 1988, Buck 16353 (BUF, NY), 16358 (NY).  
Terrapin Point, 2 Nov. 1988, Buck 16445 (BUF, NY).  
Campylium chrysophyllum (Brid.) J. Lange
Base of Goat Island, 1 Nov. 1988, Buck 16360 (BUF, NY); just outside spray area of Horseshoe Falls, boulder, thin soil, with *Hyophila involuta, Drepanocladus aduncus*, Zander 3482, Oct. 28, 1970 (BUF).  
Second Sister, east end, 2 Nov. 1988, Buck 16396 (BUF, NY).

*Campylium stellatum* (Hedw.) C. Jens.
Botanical Heritage of Islands at the Brink of Niagara Falls

Base of Goat Island, 1 Nov. 1988, Buck 16362 (BUF, NY).

**Ceratodon purpureus** (Hedw.) Brid.

Goat Island, lawn by west end parking lot, Eckel & Eckel, April 23, 1988 (BUF); lawn, base of *Acer rubrum*, just E of pedestrian bridge, Oct. 28, 1988 (BUF); dolomite ballast, southeast end, Eckel, May 22, 1988 (BUF); north slope, facing Luna Island, Eckel, May 2, 1988 (BUF).

Base of Goat Island, spray zone of American Falls, talus, midslope, pathside, thin soil, Zander 3452a, Oct. 28, 1979 (BUF); spray area of American Falls, talus, crevices, rock piles along path. Zander 3450a, Oct. 28, 1979 (BUF); just outside spray area of Horseshoe Falls, on rubble, talus slope, Zander 3491a, Oct. 28, 1979 (BUF); just outside spray area of Horseshoe Falls, talus slope, dripping area, rocks, Zander 3493, Oct. 28, 1979 (BUF).

First Sister west end, on rotten log, 2 Nov. 1988, Buck 16372 (BUF, NY).

**Dicranella heteromalla** (Hedw.) Schimp.

Second Sister, west end, 2 Nov. 1988, Buck 16368 (BUF, NY).

**Dicranella varia** (Hedw.) Schimp.

1979 (BUF).
Terrapin Point, 2 Nov. 1988, Buck 16446 (BUF, NY).

**Fissidens bryoides** Hedw.

**Fissidens cristatus** Wils. ex Mitt.
Base of Goat Island, spray zone of Horseshoe Falls, near river, thin soil over rocks, base of falls, with Amblystegium serpens var. juratzkanum, Zander 3475a, Oct. 28, 1979 (BUF).

First Sister, west end, 880724, July 8, 1987 (BUF); (as Fissidens dubius P. -Beauv.) 1 Nov. 1988, Buck 16343A (BUF, NY).

Second Sister, west end, tree roots, wet in high water, Oct. 29, 1988 (BUF)

**Fissidens grandifrons** Brid.
Goat Island, north side in moist protected cove just west of the vehicular bridge, in dolomite strata in seepage, with Bryum pseudotriquetrum, 86121702 Sept. 12, 1986 (BUF); June 4, 1986 (BUF).
Base of Goat Island, spray area of American Falls, talus, thin soil, crevices of rock, Zander 3444b, Oct. 28, 1979 (BUF); just outside spray area of Horseshoe Falls, on rubble, talus slope, Zander 3478, Oct. 28, 1979 (BUF). Peck (187...) reported Chittenango Falls as “our most eastern known station of this interesting ... moss,” Niagara Falls perhaps at the time being the only other station in New York State.

**Fissidens taxifolius** Hedw.
Goat Island, south side, wooded slopes just N of bridge to First Sister Island, on soil, Eckel, Sept. 30, 1988 (BUF); north slope, 1 Nov. 1988, Buck 16286 (NY).
Luna Island, 1 Nov. 1988, Buck 16323 (BUF, NY).

**Funaria hygrometrica** Hedw.
Goat Island, dolomite ballast, SE end, Eckel, 880722, June 4, 1988 (BUF); May 22, 1988 (BUF); north slope facing Luna Island, Eckel, May 2, 1988 (BUF).
Goat Island, chink in stone bridge to the First Sister Island, Eckel, April 26, 1987 (BUF).
Luna Island, 1 Nov. 1988, Buck 16330 (NY).
First Sister, west end, 880725, July 8, 1987 (BUF).

**Grimmia alpicola** Hedw. var. alpicola
Goat Island, south side, wooded slopes just N of bridge to First Sister Island, on boulder, Eckel, Sept. 30, 1988 (BUF).
Bridge from Goat Island to the First Sister, in depression, with lichens, Eckel, Sept. 29, 1988 (BUF).
Luna Island (as Schistidium alpicola (Hedw.) Limpr.) 1 Nov. 1988, Buck 16319 (NY).
Second Sister, east end (as Schistidium alpicola (Hedw.) Limpr.?)]2 Nov. 1988, Buck 16411 (NY).

**Homomallium adnatum** (Hedw.) Broth.
First Sister, west end, 1 Nov. 1988, Buck 16342 (NY).
Second Sister, west end, on glacial erratic, 2 Nov. 1988, Buck 16364 (BUF, NY)

**Hymenostylium recurvirostrum** (Hedw.) Dix.
Base of Goat Island, 1 Nov. 1988, Buck 16354 (BUF, NY); just outside spray area of Horseshoe Falls, boulder, thin soil, midslope. With Tortella fragilis, Hyophila involuta, Trichostomum crispulum, Zander, 3444d Oct. 28, 1979 (BUF); just outside spray area of Horseshoe Falls, on rubble, talus slope, Zander 3491b, Oct. 28, 1979 (BUF); spray zone of American Falls, talus, thin soil, crevices of rock, Zander 3444a, Oct. 28, 1979 (BUF); just outside spray area of Horseshoe Falls, vertical rock face of gorge, with Preissia quadrata, Zander 3492a, Oct. 28, 1979 (BUF); spray area of Horseshoe Falls, near river, soil under boulder, Zander 3478, Oct. 28, 1979 (BUF).

Luna Island, 1 Nov. 1988, Buck 16331 (NY).

**Hyophila involuta** (Hook.) Jaeg. & Sauerb.
Luna Island, 1 Nov. 1988, Buck 16331 (NY).

**Hedwigia ciliata** (Hedw.) P.-Beauv.
Second Sister, west end, on glacial erratic, 2 Nov. 1988, Buck 16380 (NY).

**Hypnum lindbergii** Mitt.
Second Sister, east end, thin soil over dolomite flats, open area with Salix, Cornus, Betula, Lythrum, Carices, P.M. Eckel 86121701, Sept. 12, 1986 (BUF); east end, 2 Nov. 1988, Buck 16404 (BUF, NY); west end, 2 Nov. 1988, Buck 16379 (BUF),
Hypnum pallescens (Hedw.) P.-Beauv.
Second Sister, west end, on trunk of Salix, 2 Nov. 1988, Buck 16388 (BUF, NY).

Leskea polycarpa Hedw.
First Sister, west end, 2 Nov. 1988, Buck 16419 (BUF, NY).

Mnium affine var. ciliare C. M.
Goat Island, margin of woods, edge of west parking lot, with Brachythecium rutabulum, 8705227, Aug. 18, 1986 (BUF); SW shoreline, flats east of the Horseshoe Falls, wet hummock, roots of Cornus, Eckel 880716, June 3, 1987 (BUF).

Mnium cuspidatum Hedw.
First Sister, west end, 880720, July 8, 1987 (BUF); 1 Nov. 1988, Buck 16338 (NY).

Orthotrichum anomalum Hedw.
Goat Island, south side, wooded slopes just N of bridge to First Sister Island, on boulder, Eckel, Sept. 30, 1988 (BUF); north slope, 1 Nov. 1988, Buck 16301 (BUF, NY).

Orthotrichum pusillum Sw.
Goat Island, south slope, base of maple, 1 Nov. 1988, Buck 16293 (NY).

Phascum cuspidatum Hedw.

Philonotis marchica (Hedw.) Bridel
Goat Island, southwest shore just above the Three Sisters, with Amblystegium fluviatile, wet root masses of Cornus stolonifera, Lythrum salicaria, inundated, 216686, June 9, 1986 (BUF).

Terrapin Point, 2 Nov. 1988, Buck 16439 (BUF, NY)

Second Sister, east end, 2 Nov. 1988, Buck 16394 (NY).

Philonotis muhlenbergii (Schwaegr.) Brid.

Second Sister, west end, tree roots, wet in high water, Oct. 29, 1988 (BUF).

Some doubt exists as to whether this species is distinct from Philonotis marchica, as noted by Crum and Anderson (1981). The specimens reported here key to P. muhlenbergii with the key given by those authors. I thank Dr. Richard Zander for verifying this identification, with the same qualifications.

Plagiothecium cavitum (Brid.) Iwats.
Second Sister, west end, 2 Nov. 1988, Buck 16370 (NY), Buck 16376 (BUF, NY).

Plagiothecium denticulatum (Hedw.) BSG

First Sister, west end, 2 Nov. 1988, Buck 16424 (BUF, NY).

Platygryium repens (Brid.) BSG.
Second Sister, west end, on rotten log, 2 Nov. 1988, Buck 16369 (BUF, NY).

Pohlia wahlenbergii (Web. & Mohr) Andr.
Goat Island, lawn margin, west parking lot, Eckel, Eyebright, Sept. 30, 1988 (BUF); north slope, 1 Nov. 1988, Buck 16301 (BUF, NY).

Second Sister, east end, 2 Nov. 1988, Buck 16410 (BUF, NY).

Pottia truncata var. truncata (Hedw.) Fuernmr. ex BSG
Goat Island, behind restaurant, base of tree, with Phascum cuspidatum, Barbula uinguiculata, Oct. 29, 1988 (BUF); eastern meadow, base of Betula papyrifera, Nov. 10, 1988 (BUF).

Taxiphyllum deplanatum (Bruch & Schimp. ex Sull.) Fleisch.
First Sister west end, 1 Nov. 1988, Buck 16345 (BUF, NY); 2 Nov. 1988, Buck 16426 (BUF, NY).

Thelia hirtella (Hedw.) Sull.
Part IV: The Species

First Sister, west end, 880727, July 8, 1987 (BUF).

**Thuidium delicatulum** (Hedw.) BSG var. delicatulum

Second Sister, west end, tree roots, wet in high water, Oct. 29, 1988 (BUF); west end, 2 Nov. 1988, Buck 16373 (BUF, NY).

**Thuidium pygmaeum** BSG.

Goat Island, central woods on smooth cobble, shade, with *Fissidens bryoides*, Eckel, Sept. 9, 1984 (BUF).

Note also a specimen of this species collected earlier in this century by A. T. Beals also “on small limestone pebbles” in the historical catalogue.

**Thuidium recognitum** (Hedw.) Lindb.

First Sister, west end, dolomite boulder top, west end, 8712251 April 26, 1987 (BUF); 1 Nov. 1988, Buck, 16345A (BUF, NY).

**Timmia megapolitana** Hedw. var. megapolitana

First Sister, west end, 880719, July 8, 1987 (BUF).

**Tortella fragilis** (Drumm.) Limpr.

Base of Goat Island, just outside spray area of Horseshoe Falls, boulder, thin soil, midslope, with *Hyophila involuta*, *Hymenostylium recurvirostrum*, *Trichostomum crispulum*, Zander 3484a, Oct. 28, 1979 (BUF). NEW STATE RECORD, PREVIOUSLY FOUND IN USA IN SW FIDE STONE-BURNER, ARKANSAS BOWERS???

**Tortella humilis** (Hedw.) Jenn.

First Sister west end, 1 Nov. 1988, Buck 16347 (NY).

**Tortella tortuosa** (Hedw.) Limpr.

First Sister west end, 880728, July 8, 1987 (BUF).

Leo Lesquereux collected this species on Goat Island, and Clinton indicated it was “common about Niagara Falls” (Peck, 1866). These plants are not common in these localities today.

**Tortula mucronifolia** Schwaegr.

Luna Island, 1 Nov. 1988, Buck 16329 (BUF, NY). First Sister, east end, 880708, July 8, 1988 (BUF).

Third Sister, west end, 880718, July 8, 1987 (BUF).

**Timmia megapolitana** Hedw. var. megapolitana

First Sister, west end, 880719, July 8, 1987 (BUF).

**Weisia controversa** Hedw.

Luna Island, 1 Nov. 1988, Buck 16315 (BUF, NY)

First Sister, no exact location, 1 Nov. 1988, Buck 16340 (BUF, NY); west end, small population, dolomite boulder, with *Tortula mucronifolia*, synoicous, 8706070, 1986.

**Weissia hedwigii** Crum

Lawn by west parking lot, Eckel & Eckel, April 23, 1988 (BUF) This is the second locality for this species in New York State (Eckel, 1987; Eckel & Eckel, 1988).

BRYOPHYTES: HEPATICS (LIVERWORTS) HISTORICAL SPECIMENS

**Preissia quadrata** (Scop.) Nees


**Reboulia hemisphaerica** (L.) Raddi


**Reboulia hemisphaerica** (L.) Raddi


BRYOPHYTES: HEPATICS (LIVERWORTS) NON-HISTORICAL SPECIMENS

**Cconocephalum conicum** (L.) Dumort.

First Sister, west end, 1 Nov. 1988, Buck 16337 (BUF, NY).

Second Sister, west end, north side rocks, river margins [obs. 1988, Eckel].

**Lophocolea minor** Nees

First Sister, west end, 1 Nov. 1988, Buck 16344 (BUF, NY).

Second Sister, west end, on rotten log, 2 Nov. 1988, Buck 16386 (BUF, NY).

**Preissia quadrata** (Scop.) Nees

Base of Goat Island, spray zone of Horseshoe Falls,
near river, underside of large boulder, Zander 3467, Oct. 28, 1979 (BUF); just outside spray area of Horseshoe Falls, vertical rock face of gorge, with *Hymenostylium recurvirostum*, Zander 3492b, Oct. 28, 1979 (BUF).

First Sister, west end, 1 Nov. 1988, Buck 16349 (BUF, NY).
VASCULAR FLORA OF GOAT ISLAND

The nomenclature of this list follows that of Gleason and Cronquist (1963) and is identical with the regional checklist for the Niagara Frontier, that of Zander and Pierce (1979), who also utilized Gleason and Cronquist's nomenclature. Although a new checklist with considerably revised nomenclature has recently been issued through the New York State Museum (Mitchell, 1986), the names used in the present work match those used by Gleason and Cronquist simply due to time constraints.

In this list, the designations BUF and NYS represent specimens deposited in the herbaria of the Buffalo Museum of Science, Buffalo, New York, and the New York State Herbarium, Albany, New York, respectively. The first indication of collection date and place refers to Goat Island. Other areas, such as Luna Island or the Three Sisters are given as such. The species at the base of Goat Island, of the flats area above the Horseshoe Falls and Terrapin Point are included among the Goat Island taxa.

Only the most conspicuous horticultural species or alien species significant in terms of the flora of the area, e.g. as weeds, etc., are listed below. Numerous other trees, such as various conifers and small trees of the rose family, for example, exist in the Goat Island complex as well, as do various Yews, Larices, etc., planted against buildings and in open areas, which are not included here.

In Day's contribution to the Fourth Annual Report of the Commissioners of the State Reservation at Niagara for the year 1887 (Catalogue of the Niagara Flora, published in 1888), he stated, with respect to this group that he "has no doubt that further investigations, made in the vicinity of the Falls, will considerably increase the number of species here recorded. In the more difficult genera of the Cyperaceae (Sedges) and Gramineae (Grasses) demanding always in a large degree the skill of the specialist, there must be omissions, more or less numerous and important.” Sufficient study by specialists has been made and published since 1888 that it is with confidence that quite a few additions have been made of species in these families, based on recent collections in the study area. It is presumed that these populations also existed in place at the initiation of the Reservation.

Doubtless, more species do occur in the Goat Island complex than are listed here, but they should not be sufficient to significantly alter the statistics and inferences that may be derived from the following list of species. Seeds are continually coming into the complex from upriver, driven by the wind, accompanying bird migrations, brought by tourists—on their vehicles and in the remains of their lunches, and springing from the restaurant midden. Ornamentals will continue to be planted and exotic seeds brought in with garden soils, and so on. Some populations are sufficiently reduced in areal extent that it is possible they were overlooked (e.g. *Teucrium canadense* on the Three Sisters), and in some groups, such as the graminoids, they may have been overlooked because the plants were indistinguishable in the field from species already collected. Some few plants listed here as extirpated may reside in the soil seed bank, and may not have been expressed in the 1988 growing season.

Taxa in square brackets ([ ]) are excluded from the flora of the Goat Island Complex.
R= Rare in western New York State
* = Alien
P = native taxa protected by New York State law
E = endangered taxa in western New York
# = Native
RNY = Rare in New York State (sec. Mitchell, 1986).
[ Abies balsamea (L.) Mill. BALSAM FIR. One hundred young trees of this species were added to the nursery on Goat Island in 1891 (8 Ann Rep Comm, 1892), as were two hundred the following year (9 Ann Rep Comm, 1893). There are no reports of this species growing naturally on Goat Island, and none were observed growing there today. ]


Acalypha virginica as understood at present represents a species characteristic more of areas to the south and west of the Niagara Frontier Region. This name occurs “chiefly” in place of Acalypha rhomboidea in the seventh edition of Gray's manual (Fernald, 1970), and was probably the species meant by Hooker and Gray (Hooker's American Journal).


Twenty five maple (Acer) trees in 1886, and seven in 1889 were blown down in winter storms (6 Ann Rep Comm, 1889). Three maples were blown down in the storm of January 13, 1890 (7 Ann Rep Comm, 1891). In 1890, 636 young maple trees were removed from “the thicket” on Goat Island for the Goat Island nursery (7 Ann Rep Comm, 1891); one hundred and thirteen of these were later removed in 1893 and planted in the eastern meadow (10 Ann Rep Comm, 1894). The following year, 113 were planted there (11 Ann Rep Comm, 1895). A maple was reported growing on Ship Island, in the American channel (Agassiz, 1850). “The timber [ on Goat Island ] is chiefly of the ordinary hard-wood trees, Beach [ sic ] and Maple predominating” (Chamberlin, 1892). Lady Theodora Guest in 1895 observed Maple trees bordering paths on the Three Sister Islands (Guest, 1895).


There are trees of some maturity above Terrapin Point which contribute heavily to infestations on the south slope just east, or upriver, of Terrapin Point. “Abundant at the brink of Niagara Falls, but already reported thence by Day as self-seeded from stock planted in Prospect Park” (Zenkert, 1934).


* Acer platanoides L. NORWAY MAPLE. Young tree, SW shoreline, 1987. Several trees of var. schwedleri Nichols., have been planted, obs. in lawns on the north-central side, 1988. In the area of the old spring on the north slope of Goat Island an extensive colony of these trees was planted long ago.


Mature populations are reduced to a few trees. A group has been re-planted at the west end of the island and one or two occur in the northern weedy-thickets by the ballasted eastern end.

Day's 1888 report (as Acer dasycarpum, the White Maple) does not list this species on Goat Island, but he does report it later (Day, 1901).


Day called this species Acer saccharinum Wang (Sugar Maple) in accordance with the nomenclature of his day.

In 1828 the Scottish botanist David Douglas noted in his diary that this species (as Acer saccharinum) “on the brink of the rocks grew very large; they had all been tapped or bled and still seemed uncommonly vigorous.”

George Clinton collected specimens of Cytispora,
Part IV: The Species

Nectria, Uncinula and Agaricus bombycinus (fungi), from Sugar Maple trees, the latter from the “decaying side of a living” tree of this species [ as Acer saccharinum ] Aug. 17, 1874 (BUF). This is the official tree of New York State (Mitchell, 1986).


# Actaea alba (L.) Mill. WHITE BANEBERRY. Day, 1888.

# Actaea rubra (Ait.) Willd. RED BANEBERRY. Day, 1888.


# Agropyron repens (L.) Beauv. QUACK-GRASS. Flats above the Horseshoe Falls, 1988.


* var. major (Gaud.) Farw. REDTOP. Crest woods, 1988. Flats above the Horseshoe Falls, 1988; Second Sister, east end, 1988; west end, 1988.


George Clinton collected the fungus Vernicularia liiacearum from a plant of this species on September 25, late 1800's (BUF).


Reported by the Superintendent in the second report of the Commissioners in 1886. Alders occurred on the smaller islands in the American Channel in 1968 (The American Falls International Board, 1971)


# Amphicarpa bracteata (L.) Fern. HOG PEANUT. Sept. 19, 1877 (J. D. Hooker's American Journal). Only the generic name is given by Hooker, but this is the only species of the genus occurring in the Niagara Frontier Region.

# Anacharis canadensis (Michx.) Rich. WATER WEED. First Sister, west, 1986.

# Amelanchier arborea (Michx.f.) Fern. TREE SHADBUSH. Second Sister, west end, 1987.

# Amelanchier canadensis (L.) Medic. CANADIAN SHADBUSH. Sept. 19, 1877 (J. D. Hooker's American Journal). (As both var. botryapium) and var. oblongifolia and therefore at least two trees , Day, 1888. 1988.

# Anagallis arvensis L. SCARLET PIMPERNEL. Weedy margin on vehicular bridge, 1986.


# Anemone cylindrica Gray LONG-FRUITED
Botanical Heritage of Islands at the Brink of Niagara Falls


# Anemone quinquefolia L. WOOD ANEMONE. Day, 1888.


var. alba. Day, 1888.


# Arabis canadensis L. SICKLE-POD. Day, 1888.

# Arabis laevigata (Muhl.) Poir. SMOOTH ROCK CRESS. Second Sister, west end, 1986.


Grows on soil-covered boulder tops. If these were removed, so would this species diminish, as perhaps accounts for the loss of this species in the Goat Island flora.


A species of Arctium BURDOCK was observed on the ballast, 1988 and on the First Sister, east end [obs. 1988]; Luna Island, north side, 1988.

# Arctium lappa L. GREAT BURDOCK. Sept. 19, 1877 (J. D. Hooker’s American Journal). Day, 1888. Individuals of this large plant are regularly found in disturbed areas throughout the island, 1988.

# Arctium minus Schk. COMMON BURDOCK. Ballast, 1985. This and the preceding species may be found along all paths and borders. Second Sister, west side, 1988.


* Arctium minus Schk. COMMON BURDOCK. Ballast, 1985. This and the preceding species may be found along all paths and borders. Second Sister, west side, 1988.


In 1823 the Scottish botanist David Douglas noted in his diary that this species (as Arum triphyllum) grew on Goat Island. It grows in “rich low woods in mucky soil” (Zenkert, 1934).

# Arisaeira dracontium L. GREEN DRAGON. This species (listed as Dracontium sp.) was reported in 1823 by Douglas from Goat Island. It grows in rich alluvial soils along streambanks.


# Asarum canadense L. WILD GINGER. Prinz von Wied-Neuwied (1843) mentioned this species (as Asarabaca) growing with Mayapple (Podophyllum peltatum) and other plants on the forest floor on Goat Island. I have accepted this report, as this species grows throughout the Niagara gorge and in woodlands nearby on the mainland.

# Asclepias exaltata L. POKE MILKWEED. Day, 1888.


# Asclepias syriaca L. COMMON MILKWEED. (As Asclepias cornutii) Sept. 19, 1877 (J. D. Hooker’s American Journal). Day, 1888. Ballast [


# Aster cordifolius L. HEART-LEAVED ASTER. Sept. 19, 1877 (J. D. Hooker's American Journal).

# Aster divaricatus L. WHITE WOOD ASTER. Day, 1888.


# Aster laevis L. SMOOTH ASTER. Sept. 19, 1877 (J. D. Hooker's American Journal).


# Aster macrophyllus L. LARGE-LEAVED ASTER. Day, 1888.


# Aster sagittifolius Willd. ARROW-LEAVED ASTER. Day, 1888.


var. interior (Wieg.) Cronq. Southwestern thickets, 1987. The Aster tradescantii L. TRADESCANT'S ASTER of Sept. 19, 1877 (J. D. Hooker's American Journal) and Day, 1888, are here placed with Aster simplex var. interior following Britton and Brown, 1952. These last authors indicate the range of this variety begins in western New York and proceeds westward.


R# Astragalus canadensis L. CANADIAN MILK-VETCH. 1885. A. D. Pease (BUF).

R# Astragalus neglectus (T.&G.) Sheld. COOPER'S MILK-VETCH. (As A. cooperi) “Descending to the level of Terrapin Bridge, to the left of the path, June 26, 1862; “in the flat by Terrapin Bridge” Friday, Sept. 11, 1863; “By the [ Terrapin ] Tower,” July 7, 1864, (Clinton Journal). (As Astragalus cooperi) Sept. 19, 1877 (J. D. Hooker's American Journal). Day, 1888.


var. hastata of Br. & Br. HALBERD-LEAVED ORACHE. Northern thickets, top of slope, 1988. Narrow-leaved forms keying to var. littoralis of Br. & Br. (SEASIDE ORACHE in Zander & Pierce, 1979) may fall within the scope of var. patula, as var. littoralis is a “strictly maritime diploid species” (Voss, 1985).

# Aureolaria flava (L.) Farw. SMOOTH FALSE FOXGLOVE. Day, 1888.


Barberry (Berberis) plants were reported for Goat Island by the Superintendent in the report of the Commissioners in 1886. Referred to as a “wild plant,” the barberry on Goat Island “especially illustrates the tendency of certain plants [ sc. horticultural ] to keep away from cultivation. By far the finest specimen on the island hangs so far below the Luna Island stair-landing that it is unsafe to try to gather the rich clusters of scarlet berries, while a bush on the roadway that has been planted and given some cultivation is far less vigorous and seldom bears more than one or two berries on a single stem.” Chamberlin, 1892.
In 1909 the Superintendent planted this horticultural species on Luna Island and elsewhere in the Reservation as a substitute for an iron railing at the river margin—this shrub keeping people away from the dangerous banks by reason of its thorns, and stabilizing the bank (26 Ann Rep Comm, 1926). Native alternatives might include the raspberries, and perhaps Nine-bark (*Physocarpus opulifolius*), which forms dense thickets at the west end of the Second Sister.


In 1870, on September 28, George Clinton wrote in his collecting diary: “On Goat Island, American side [i.e. the north side], a little above the Spring & between the road & the river [the channel of the American Falls], noticed one thrifty bush of *Berberis vulgaris*. It was never planted there.” Five birches were reported blown down in the winter storm of 1889 (report of the Superintendent, 6 Ann Rep Comm, 1890).

*Betula alba* may be the species reported for Goat Island by the Superintendent in the second report of the Commissioners, 1886, where he refers to a White Birch. It is not reported by Day, 1888. It would probably have been included under *Betula pendula* in this catalogue. At any rate, the tree referred to as White Birch may indicate an alien species, although there exist two native white birches which might have been indicated in the Superintendent's report. This reference has not been used in the present tabulations because of its ambiguity.


*Betula populifolia* Marsh. GRAY BIRCH. Second Sister, far west end, 1988. Separated from *B. pendula* by tight white bark, short fruiting aments, no ciliations on the bract margins.

*Botrychium virginianum* (L.) Sw. RATTLE-SNAKE FERN. Day, 1888. David Douglas reported two species of this fern on Goat Island in 1823 growing “in shady parts of the wood in decayed leaves.”

*Brachyelytrum erectum* (Schreb.) Beauv. BEARDED SHORT-HUSK. Zenkert, 1934.


*Bromus inermis* Leyss. HUNGARIAN BROME GRASS. Seepage, southwestern thickets, 1986. Abundant all along the crest, west end, along the fence.

*fo. aristatus* (Schur) Fern. BROME-GRASS. First Sister, east end, 1987.


*Calamagrostis canadensis* (Michx.) Beauv. BLUEJOINT GRASS. Day, 1888. Flats above the Horseshoe Falls, 1988. Second Sister, east end...
Part IV: The Species


P# Campanula rotundifolia L. HAREBELL. Day, 1888. Day indicated that the Harebell had disappeared from Goat Island “Within a little while” “undoubtedly due to careless flower-gatherers, who have plucked and pulled without stint or reason” (Day, 1888).


[ Cardamine hirsuta L. BITTER CRESS. Day, 1888.] Excluded.


# Carex granularis Willd. MEADOW SEDGE. First Sister, east end, 1988; west end, 1987. The Carex viridula (as C. oederi) of Provancher “near the Horse-shoe Fall” on the Canadian side (Flore Canadienne), Day, 1888, may be this species, as might be Clinton’s references to this plant.


# Carex laxiculmis Schw. SPREADING SEDGE. Day, 1888.


var. blanda First Sister, west end, 1988.

RNY#Carex molesta Mackenzie TROUBLESOME SEDGE. First Sister, east end, 1988.


# Carex pedunculata Muhl. LONG-STALKED SEDGE. First Sister, west end, 1988.


RA#Carex retroflexa Muhl. REFLEXED SEDGE. Day, 1888.


# Carex stricta Lam. TUSSOCK SEDGE. “Shallow water,” Aug. 10, 1918, Frank W. Johnson (BUF).

# Carex vulpinoidea Michx. FOXTAIL SEDGE. First Sister, west end.


* Carum carui L. CARAWAY. “On the naked pas-
ture on the head of the Island, an umbellifer, probably *Carum carvi*,” June 1, 1865 (Clinton's Journal). Day, 1888.

A hickory (*Carya*) species is reported for Goat Island by the Superintendent in the second report of the Commissioners in 1886. Two hickories in 1886, and one in 1889 were blown down in winter storms (report of the Superintendent, 6 Ann.Rep. Comm., 1890).


# *Carya tomentosa* (Poir.) Nutt. MOCKERNUT HICKORY. Day, 1888.

[ *Castanea dentata* (Marsh.) Borkh. CHESTNUT. To date, no reports for this species have been made, and no evidence has been found for its occurrence on Goat Island, even though before the chestnut blight it formed an element in local forests where it was “rather common” and grew on “morainic slopes and ridges, also in sandy soil in the wooded tracts along Lakes Erie and Ontario,” Zenkert, 1934. Hooker and Gray made no note of its occurrence on the island in 1877, but Day (1901) reported its presence in the Niagara flora. ]

[* Castanea mollissima* Blume CHINESE CHESTNUT. Behind the old maintenance building in the loop of the vehicular bridge road, central island, in horticultural context, with Juglans regia (obs. 2001, det. R. H. Zander).


Correction (2002), these trees are actually Quercus muhlenbergii Engelm. (= Q. prinoides var. acuminata (Michx.) Gl.). The tree facing the Three Sisters is now gone but young sprouts occur on the First of the Three Sisters from its acorns.]

R# *Catalpa bignonioides* Walt. CATALPA. 1988. By pedestrian bridge, by the maintenance sheds, on the south side of the island by the entrance to the Three Sisters, around the restaurant near Terrapin Point.


P# *Celastrus scandens* L. CLIMBING BITTERSWEET. Sept. 19, 1877 (J. D. Hooker's American Journal). Day, 1888. Base of Goat Island, 1988. Reported for Goat Island by the Superintendent in the second report of the Commissioners in 1886 and noted as growing “in great abundance.” The Bittersweet grows on Goat Island “as though this were their chosen home of all the earth .... The largest Bittersweet clusters hang far over the western bank, growing in very indifferent soil...” (Chamberlin, 1892). Cuttings of Bittersweet were planted in the Goat Island nursery in 1900 (17 Ann Rep Comm, 1901). George Clinton collected a specimen of *Phyllactinia guttata* (fungi) from a plant of this species on October 13, 1870's.


Part IV: The Species

R* Cerastium viscosum L. CLAMMY MOUSE-EAR CHICKWEED. Day, 1888.
* Cercis canadensis L. REDBUD. Green Island, three trees planted, SW grove, 1988.
R* Chenopodium urbicum L. NETTLE-LEAVED GOOSEFOOT. Green (Bath) Island, Day, 1883 (problematical). Day may have reidentified a Clinton specimen of Chenopodium murale L. from Green, or Bath Island as Chenopodium urbicum L. for his 1888 publication. If he did, he made no annotation on the specimen in the Clinton Herbarium.
* Cichorium intybus L. CHICORY. Throughout Goat Island lawn margins, top of north slope, 1988. A species of Thistle (Cirsium) was observed on the Second Sister, west end, 1988, and on the ballast of Goat Island, east end, 1988; on Luna Island, 1988.
# Cirsium muticum Michx. SWAMP THISTLE. Sept. 19, 1877 (J. D. Hooker's American Journal).
# Cicuta maculata L. WATER HEMLOCK. Day, 1888.
* Claytonia virginica L. NARROW-LEAVED SPRING BEAUTY. Day, 1888.
# Comandra umbellata (L.) Nutt. BASTARD TOAD FLAX. Day, 1888.
# Convolvulus arvensis L. FIELD BINDWEED. 1887.
The Dogwoods (Cornus) of Goat Island are referred to by the Superintendent in the second report of the Commissioners in 1886.
# Cornus anomum Mill. SILKY CORNEL. Day, 1888.
The “Wild Apple” reported for Goat Island by the Superintendent in the report of the Commissioners in 1886 may refer to Hawthorns [Crabapples], *Crataegus*, or to Pyrus (Puer or Apple) trees (*Pyrus coronaria*, native and not reported for the islands, or *P. communis, P. malus*, both horticultural. Sixty hawthorns were planted in the Goat Island nursery in 1892—perhaps from the native populations on the island (9 Ann Rep Comm, 1893).


* Crataegus phaenopyrum* Medic. WASHINGTON HAWTHORN. Planted throughout the island by roadsides and buildings, 1988. This species is native to the south-central areas of the eastern states.

* Cryptotaenia canadensis* (L.) DC. HONEYWORT. Day, 1888.


* Cynoglossum officinale* L. HOUND’S TONGUE. Day, 1888. This weedy species is frequent on the American side in the Niagara River gorge on the gorge crest and the top of the talus slope.


* Cyperus odoratus* L. FRAGRANT CYPERUS. Zenkert, 1934.


* Daucus carota* L. QUEEN ANNE’S LACE. This species is frequent along paths and road margins throughout the Goat Island complex [obs. 1988].

P# Dennstaedtia punctilobula* (L.) Bernh. HAY-SCENTED FERN. Base of Goat Island, here and there toward the Horseshoe Falls, 1988.

Part IV: The Species


R# Deschampsia caespitosa (L.) Beauv. TUFTED HAIR GRASS. Day, 1888.


One or the other of the next two species is abundant at the base of Goat Island, 1988.

RNY, R* Diplotaxis muralis (L.) DC. SAND ROCKET. Woods, 1987. An occurrence of this or the following on Luna Island by the brink [obs. 1988].


# Dirca palustris L. LEATHERWOOD. Reported for the Goat Island woods by the Superintendent in his 1886 published report to the New York State Legislature. Rich deciduous or mixed woods.


P# Dryopteris marginalis (L.) Gray MARGINAL SHIELD FERN. Day, 1888.


# Elymus virginicus L. VIRGINIA WILD RYE. Third Sister, willow base, south side river’s edge [obs. 1988].

# Epipagus virginiana (L.) Bart. VIRGINIA BEECHDROPS. “Not common,” Day, 1888. There are very few beeches on Goat Island on which this parasitic plant might live; this may be due in part to the calcareous soils. There was only one tree seen that did not have its base mown, which would prevent this plant from establishing itself. David Douglas in his diary in 1823 reported two species of Orobanche “in dry places ... among leaves.”


R# Epilobium glandulosum Lehm. WILLOW-HERB. Terrapin Point, 1986.


# Equisetum variegatum Schleich. VARIEGATED SCOURING-RUSH. “About the flat by Terrapin bridge,” July 5, 1862; May 12, 1864 (Clinton Journal). Sept. 19, 1877 (J. D. Hooker’s American
Botanical Heritage of Islands at the Brink of Niagara Falls


# Erigeron philadelphicus L. PHILADELPHIA FLEABANE. Rocky area by Horseshoe Falls; in thickets along the south end of the island, 1986. Second Sister, east end, 1987.


* Eucommia ulmoides Oliver, HARDY RUBBER TREE. One of the collection of exotic trees behind the stone maintenance building at the foot of the vehicular bridge. After a decade of trying to identify this large, mature tree, which has never flowered or fruited during that time, and which has no distinguishing characteristics of an ordinary nature, its identity was discovered by chance at the Missouri Botanical Garden, where a similar tree was located. Among the unusual characteristics of the species is the fact that it is the only lac-tiferous, specifically rubber-producing tree of the north temperate zone (it derives from China where it is rare in the wild). It has no known taxonomic relationship with any other tree group, although currently placed in the Cornales. It is the only member in its family, the Eucommiaceae. Its exotic nature was appreciated many years ago when it was planted on Goat Island and is probably the same age as the two alien nut-trees (Chesnut and Walnut). Another old example of this species occurs adjacent to the central woods near the road that cuts through it, on the north boundary.

Twelve *Euonymus* shrubs were planted on the denuded southern slopes of Goat Island in 1892 (8 Ann Rep Comm, 1892). Sixty *Euonymus* shrubs were transplanted from the Goat Island “thicket” to the Goat Island nursery in 1891 (8 Ann Rep Comm, 1892). Another 204 *Euonymus* were put in the nursery in the next year (9 Ann Comm Rep, 1893).


Reported by the Superintendent (as Burning Bush) in the second report of the Commissioners in 1886. The “Waahoo ... grow as though this were their chosen home of all the earth ... and ... is best content where left entirely to itself” (Chamberlin, 1892). The sixty *Euonymus* shrubs removed from the Goat Island “thicket” and planted in the Goat Island nursery in 1891 (8 Ann Rep Comm, 1892) were native and abundant, and were probably this species, as were perhaps the 216 other *Euonymus* plants mentioned.

Mitchell (1986) in his recent checklist of the plants of New York State reports this species as a “rare introduction” in New York State, and Fernald (1950) indicated that it is “cultivated and somewhat naturalized northeastward” of its natural range. Mitchell has since informed me this species is not now considered rare in New York (personal communication. House (1924) reported this species as “Infrequent or rare from Oneida and Schuyler counties westward and southward. Increasingly common toward the southwest.” This species grows more in regions south and west of the Niagara region, reaching the eastern borders of the Great Plains (Fernald, 1950), for example, in Michigan it grows in several counties on “river banks and floodplain forests” (Voss, 1985). In southern Ontario below the boreal forests of the central and northern portions of the province, that is, in the Deciduous Forest Region (Carolinian Zone), the shrub is native with populations extending from five stations near the Niagara River west to the St. Claire River region of London-Detroit (34 populations reported) (Soper & Heimberger, 1982). The habitat reported is “low places, particularly in thickets along streams, in rich alluvial soil; also in damp sandy or rocky woods.” Zenkert (1934) indicated *Euonymus atropurpureus* was somewhat rare in western New York where it...
can be “abundant and sometimes in dense thickets.” Zenkert goes on to say Indians on the Cattaraugus Indian Reservation had collected roots, etc., of this shrub with “whole thickets being destroyed in this manner.”

_Euonymus americana_ L., STRAWBERRY-BUSH, is native to western New York State in low woods and is rare in the state, being a southern species reaching its northern limits in the state. It is not reported for Ontario by Soper and Heimberger (1982), and no publication seen so far reports its existence at Niagara Falls. The existence of specimens from Goat Island of _Euonymus atropurpureus_, together with various reports of it noted above, and the reported density of populations on the Island in 1892 lends overwhelming evidence for a native enclave of this species in this part of New York State. This idea is consistent with other evidence for species more common south and west of the Niagara area extending across southern Ontario in the Deciduous Forests along the north shore of Lake Erie, and along the limestone habitats of the Niagara Escarpment.

_Euonymus europaeus_ L. SPINDLE-TREE. “Apparently naturalized on Goat Island, Niagara Falls (Johnson), but possibly planted,” Zenkert, 1934.


* Festuca elatior_ L. MEADOW FESCUE. Day, 1888.


* Floerkea proserpinacoides_ Willd. FALSE MERTAID. Day, 1888. Floerkea uligonosa_ Muhl. is an earlier name.

Although not very common any more in our immediate area, in 1862 Judge Clinton found it in Buffalo, at what he called the Elk Street wood [nearly destroyed by 1866]. He “met therein David F. Day. He had just found a Floerkea uligonosa. (I afterwards found it in the hollow at the right, after crossing, from Buffalo, the Lake Shore R. R. bridge over the Buffalo Creek .... Indeed, it is quite common in damp woods and river bottoms)” (from an unpublished mss. in Zenkert, 1934).

* Forsythia suspensa_ Vahl. FORSYTHIA. Planted
by entrance to pedestrian bridge, border of thicket, north slope, 1988.


When the Goat Island nursery was established in 1890 (7 Ann Rep Comm, 1891), 130 young Ash (Fraxinus) trees were transplanted there “from the thicket on Goat Island.” In 1893, seventy-six of these were removed and planted in the eastern meadow (10 Ann Rep Comm, 1894), the following year 76 more were planted (11 Ann Rep Comm, 1895).

Chamberlin (1892) mentioned that at the time of writing the Goat Island forest was predominantly Beech and Maple, with an “occasional” Ash. This is quite unlike present conditions where Ash is the second most dominant tree in the central woods.

Seedlings of Ash are more abundant in 1988 throughout the area than any other tree species.


# **Fraxinus nigra** Marsh. BLACK ASH. Day, 1888.

Day, 1901.

One tree of this species was blown down in the winter storm of 1889 (report of the Superintendent, 6 Ann.Rep. Comm., 1890).

The disappearance of this species may relate to its disappearance in western New York State as a whole. “The black ash, once very abundant in swamps and there outnumbering all other species combined, seems to have fared worst .... The progressive drying-out of the land is mainly responsible for its marked decrease. Seedlings of the black ash do not compete successfully under drier conditions with those of the white (American) elm and those of the red and silver maples., with the result that these have become the prevailing trees in low ground” (E. J. Hill in Zenkert, 1934). The dryer conditions referred to by Hall relate to the general deforestation of the region. Loss of moisture on Goat Island may be due to island deforestation and water diversion.


The variety *bifida* (Boenn.) Lej. & Court. occurs in the Niagara Frontier Region (Zander & Pierce, 1979).


One Bedstraw (*Galium*) species was observed on the First Sister, west end, but was not in identifiable condition, another occurred by the entrance to the maintenance facility, in wooded area, 1988.

# **Galium aparine** L. CLEAVERS. Day, 1888.

# **Galium asprellum** Michx. ROUGH BEDSTRAW. Day, 1888.


# **Galium obtusum** Bigel. BLUNT-LEAVED MARSH BEDSTRAW. Thickets, south side, 1986.


# **Gaylussacia baccata** (Wang.) Koch BLACK HUCKLEBERRY. Day, 1888.


On the talus at Niagara, “in moist spots, here and there a sharp eye may detect many flowered tufts
Part IV: The Species

of the beautiful fringed Gentian, strange to European eyes” (Olmsted, 1880, citing Robinson, 1875).

Lady Theodora Guest, in 1895 noticed a “Pink Crane's Bill” (Geranium) growing on the Three Sister Islands.


# Gnaphalium uliginosum L. LOW CUDWEED. Sept. 19, 1877 (J. D. Hooker's American Journal).

P# Habenaria hyperborea (L.) R.Br. TALL LEAFY GREEN ORCHID. (As Platanthera) “About the flat by Terrapin bridge,” July 5, 1862 (Clinton Journal). “Near the Horse-shoe Fall,” Day, 1888.


* Hedera helix L. ENGLISH IVY. Luna Island, dense, choking masses all margins of the island, 1988.


# Helianthus strumosus L. PALE-LEAVED SUNFLOWER. Day, 1888.


# Heracleum lanatum Michx. DOWNY COW PARSNIP. Day, 1888.


* Geum laciniatum Murr. ROUGH AVENS. (All reports use the earlier name G. virginianum L., which is now applied to a different species of Geum formerly known as G. flavum). Sept. 19, 1877 (J. D. Hooker's American Journal). Day, 1888. Zenkert, 1934.


# Hieracium venosum L. RATTLESNAKE-WEED. Day, 1888.

* Houstonia canadensis Willd. FRINGED HOUSTONIA. Torrey, 1843. June 26, 1862, “On top of the bank” [ the west-facing crest, as it occurs elsewhere on the crest of the Niagara River Gorge ], (Clinton Journal). (As Houstonia purpurea var.


# Hydrophyllum virginianum L. VIRGINIA WATERLEAF. Day, 1888. Populations of this plant may be found along the crest of the Niagara Gorge, eastern side, and DeVeaux College woods.

RNY, R# Hypericum kalmianum L. KALM’S ST. JOHN’S WORT. Torrey, 1843. “About the flat by Terrapin bridge,” July 5, 1862; Aug. 1, 1862; Aug. 22, 1864; “Near the Terrapin Tower, July 18, 1865; July 26, 1865; “On the talus directly below the Cave of the Winds shanty ...” Aug. 8, 1865 (Clinton Journal). Clinton, 1864. Day, 1883. “Goat Island. First Sister, east end, 1892 (BUF).”

This is the only known locality for the species in New York State. Mitchell reported it as possibly extirpated from New York State (1886). Zenkert (1934) reported it as “not observed at the Falls in recent years.” Parts of the base of Goat Island and the islands in the American channel of the Niagara River at the falls were not made available for examination during the course of this study—it is conceivable this plant may still be found in these areas.

There are reports for this species from the Canadian side, on the talus: “Rochers au bas de la chute de Niagara “ Provancher (Fl. Canad. p. 104), Day, 1888.


# Impatiens pallida Nutt. PALE TOUCH-ME-NOT. Day, 1888. This species is frequent in the Niagara River Gorge.

* Inula helenium L. ELECAMPANE. Day, 1888.


One walnut tree (Juglans) was reported blown down in 1886 during winter storms.


According to the second report of the Commissioners to the State Legislature in 1886 [for 1885] is the mention made by the Superintendent that this tree predominated among the natural woods in “The area at the head of the reservation” by the old Port Day pier, just east of the boundary line of the reservation on the mainland. Lady Theodora Guest in 1895 noticed Black Walnut trees on the Three Sisters.

This species is among the trees being replanted on Goat Island and seems a good choice.

* Juglans regia L. PERSIAN or ENGLISH WALNUT. Very mature tree behind old maintenance building in loop of the vehicular bridge road, mown area amid some native trees. Planted a long time ago. Coll. 2001 (BUF).


# Juncus brachycephalus (Engelm.) Buch. SHORT-HEADED RUSH. Clinton (late 1800’s), Zenkert, 1934.

# Juncus bufonius L. TOAD RUSH. Goat Island,


# Juncus effusus var. solutus Fern. & Wieg. COMMON RUSH. Second Sister, east end, few, 1988.


# Juniperus communis L. LOW JUNIPER [COMMON JUNIPER]. Goat Island, George Engelmann (GEH at MO) August 1840; Goat Island, April 29, 1862 (Clinton Journal). Sept. 19, 1877 (J. D. Hooker's American Journal). Day, 1888. This is the Common Juniper referred to in the Goat Island woods by the Superintendent in the second report of the Commissioners, 1886. There are the remains of a Juniper shrub visible on Luna Island, 1988.


The Superintendent of the Reservation indicated “The red cedars are dying out of late years” in the second report of the Commissioners of 1886. Perhaps this published concern for these trees accounts for the fine grove of this species in the eastern meadow. Eleven red cedars were blown down in the winter storm of 1889 (report of the Superintendent, 6 Ann.Rep. Comm., 1890), and two January 13, 1890 (7 Ann Rep Comm, 1891). Nine red cedars were planted on the denuded southern banks of Goat Island in 1891 (8 Ann Rep Comm, 1892). In 1892, eighty-three red cedar were added to the Goat Island nursery (9 Ann Rep Comm, 1893). A Red Cedar was noted growing on Ship Island in the American channel (Agassiz, 1850).

Chamberlin (1892) observed on Goat Island “near the paths many small Cedars, white and red ...” in the woods.

R# Justicia americana (L.) Vahl WATER-WILLOW. “Shallow water,” Charles A. Zenkert, 1924 (BUF). “Near brink of Falls,” Charles A. Zenkert, 1928 (BUF). “Shallow water of Niagara River, on limestone, off Goat Island, just above the Falls, where rather abundant,” Zenkert, 1934. Populations of this lovely river plant (not a Willow at all) were to be found at Dufferin Islands until a few years ago.

[ Larix sp. Several species of Larch of maturity occur throughout Goat Island, growing in open stations where they have been planted—no attempt has been made to identify these as they are obviously introduced, and do not appear to be spreading. In 1891, one hundred “Scotch larch” trees were procured for the Goat Island nursery (perhaps Larix decidua) (8 Ann Rep Comm, 1892). In 1893, thirty-six larches were planted in the eastern meadow, taken from the nursery (10 Ann Rep Comm, 1894), and the following year, 36 more (11 Ann Rep Comm, 1895).

# Larix decidua Mill. EUROPEAN LARCH. Central wood's edge, northeast side facing entrance to pedestrian bridge, with Eucommia ulmoides, near Picea stichensis, apparently even-aged with these horticultural trees. Native to the Alps and Carpathian Mountains of eastern Europe.

# Lathyrum palustris var. myrtifolius (Muhl.) Gray MYRTLE-LEAVED VETCHLING. On June 26, 1862, Clinton found “a pretty Lathyrum” “in the flat by Terrapin Bridge.” Later that year, on August 1, 1862, he found L. palustris in the same locality as Hypericum kalmianum, presumably at Terrapin Point (Clinton Journal). Day, 1888.

# Lactuca biennis (Moench) Fern. TALL BLUE LETTUCE. (As Lactuca leucophaea) Sept. 19, 1877 (J. D. Hooker's American Journal).

# Lactuca canadensis L. WILD LETTUCE. (As Lactuca elongata) Sept. 19, 1877 (J. D. Hooker’s American Journal).

A species of Leersia was noted for Goat Island on Sept. 19, 1877 (J. D. Hooker's American Journal).

# Leersia oryzae (L.) Sw. RICE CUT-GRASS. First Sister, west end, 1888.

# Leersia virginica Willd. WHITE GRASS. Day, 1888.

# Lemna minor L. LESSER DUCKWEED. “South-
Reported for Goat Island (as Spicebark) by the Superintendent in the report of the Commissioners in 1886.


Reported for Goat Island (as Spicebark) by the Superintendent in the report of the Commissioners in 1886.


Reported for Goat Island by the Superintendent in the report of the Commissioners in 1886. Chamberlin (1892) mentioned that at the time of writing, the Goat Island forest was predominantly Beech and Maple, with an “occasional” Tulip-tree. Present planting policy includes extensive planting of this species on the Island.


* Lithospermum officinale L. COMMON GROMWELL. “A common weed on the Island & about the Falls,” June 26, 1862; “by the [Terrapin] Tower & along the bank ...” June 7, 1864; April 21, 1866; “... W. Pettibone, ... told me that there was a plant on Goat Isld., a tea from the roots & seeds of which, drunk as you would any tea, had relieved him very much in his kidney complaint, gravel. Went over the Island with him, he looking in vain for it. He describes it as a low bush, with a very small, pearshaped, white hard seed. It occurring to me that it was, most probably, Lithospermum officinale, I looked it up & dug up a root with a dead stalk & he thought it to be the plant, though, the seed being gone, he could not tell certainly. Said the root looked & smelt like it. (Clinton Journal). Goat Island, D. F. Day, July 19, 1863 (BUF). Sept. 19, 1877 (J. D. Hooker's American Journal). Day, 1888. Zenkert, 1934. First Sister, east end [obs. 1988]. Second Sister, west end [obs. 1988]. Found throughout the thicketed areas of Goat Island, 1988.


Populations of Honeysuckle (Lonicera) on Goat Island were reported by the Superintendent in the second report of the Commissioners in 1886. One kind is referred to by the Superintendent as a “creeping plant” or vine, although which species this may refer to is conjectural. It is doubtful the reference is to Lonicera japonica. On Goat Island “a red honeysuckle [has] there climbed to the very top of an arborvitae situated on a promontory...” Baxter, 1855. Honeysuckle may have referred to a variety of plants, such as species of Rhododendron and Aquilegia canadensis (Fernald, 1970), neither of which could have “climbed to the top” of anything.


* Lonicera japonica Thumb. JAPANESE HONEY-SUCKLE. Terrapin Point, 1986.

and west end, abundant [obs. 1988]. Second Sister, west end [obs. 1988].


RNY, R# **Lysimachia quadriflora** Sims. LINEAR-LEAVED LOOSESTRIFE, PRAIRIE MONEYWORT. Second Sister, east end, on edge of soil mat east end, July 14, 1987


# **Meianthemum canadense** Desf. FALSE LILY-OF-THE VALLEY. First Sister, east end, 1987.


P# **Matteuccia struthiopteris** (L.) Todaro OS-TRICH FERN. Day, 1888.


# **Melampyrum lineare** Desr. var. **americanum** (Michx.) Beauverd AMERICAN COW-WHEAT. Day, 1888.


# **Menispermum canadense** L. MOONSEED. Central woods, 1986.


# **Mitchella repens** L. PARTRIDGEBERRY. Day, 1888.

# **Mitella diphylla** L. MITERWORT. Day, 1888.


# **Monotropa hypopitys** L. PINESAP. Day, 1883. Perhaps indicative of old evergreens on the island, as this species is parasitic or symbiotic with them. “An undetermined species [of **Morus**] has been planted on Luna Island” Day, 1888. Lady Theodora Guest in 1895 observed Mulberry trees bordering “little rocky paths” on the Three Sister Islands.


All trees, seedlings and saplings of the Mulberry ob-
served were of White Mulberry, this in spite of the fact that in almost every case the berries of these plants developed from white to deep purple. The leaf characters conformed in every instance to that of Morus alba. The weedy character of these plants is also diagnostic.


# Muhlenbergia frondosa (Poir.) Fern. LEAFY MUHLENBERGIA.


# Muhlenbergia glomerata (Willd.) Trin. SATIN GRASS. On moist rocks, Goat Island, G. Engelmann, August 1860 (MO).


This species may be found in the springy areas of Goat Island by the eastern end of the First Sister.

# Myriophyllum spicatum var. exalbescens (Fern.) Jeps. SPIKED WATER-MILFOIL. Flats above the Horse-shoe Falls, 1988.


A rare escape in New York State (Mitchell, 1986), several plants of this species occur in the central woods where they contrast badly with the native spring ephemerals. Several large patches of this plant are planted at the woods margins.


# Oryzopsis asperifolia Michx. MOUNTAIN-RICE. Day, 1888.

# Oryzopsis racemosa (Sm.) Ricker BLACK-FRUITED MOUNTAIN RICE. “rocky soil,” 1921. Zenkert, 1934.

# Osmorhiza claytonii (Michx.) Clarke HAIRY SWEET CICELY. Day, 1888.

George Clinton collected a specimen of Vermicularia dermatium (fungi) from a plant of this species (as O. brevistyris) on November 4, 1870's


# Osmunda regalis var. spectabilis (Willd.) Gray ROYAL FERN. “Not common,” Day, 1888.


This is the Ironwood reported for the Goat Island woods in the Superintendent's report in the second report of the Commissioners, published in 1886. Two Ironwoods in 1886, and three in 1889 were blown down during winter storms (report of the Superintendent, 6 Ann.Rep Comm., 1890). In 1890, twelve young Ironwood trees were removed from “the thicket” on Goat Island and planted in the nursery on Goat Island (7 Ann Rep Comm, 1891).


# Panax quinquefolium L. GINSENG. “Rare,” Day, 1888.

Commercially exploited in New York State; “native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated)—sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present” (Mitchell, 1986).
Part IV: The Species


# Panicum lanuginosum Ell.


var. septentrionale Fern. NORTHERN WOOLY PANIC-GRASS. Second Sister, 1986.

# Parnassia glauca Raf. GRASS OF PARNASSUS.


“Within a little while ... the Grass of Parnassus [as Parnassia caroliniana L.] ... is fast going. This is undoubtedly due to careless flower-gatherers,” Day, 1888.

The Virginia Creeper (Parthenocissus) species were noted as abundant for Goat Island by the Superintendent in the report of the Commissioners in 1886. On the denuded southern shore of Goat Island, 440 Virginia creeper plants were planted in 1891 (8 Ann Rep Comm, 1982). Certain species were available through commercial nurseries before 1900, and cuttings were made of native vines for the Goat Island nursery (17 Ann Rep Comm, 1901).


* Parthenocissus tricuspidata Planch. JAPANESE or BOSTON IVY. On stone pedestrian bridge between Goat and Green Islands, 1988.

Six plants of Ampelopsis vilchii were planted on Green Island around the cottage used as the offices of the Commissioners in 1893 (10 Ann Rep Comm, 1894), and eighteen more the following year. This is an earlier name for Parthenocissus tricuspidata.


Twelve plants of Ampelopsis royalli (A. roylei, Hort.) were planted on Bath Island by the office of the Commissioners (10 Ann Rep Comm, 1984). Bailey (1924) indicates this is a large-leaved form of Parthenocissus vitacea, seen by him as a variety of P. quinquefolia.

# Pedicularis canadensis L. COMMON LOUSE-WORT. Day, 1888.

George Clinton collected Puccinia clintonii (fungi) on an individual of this species growing on the island (Nov. 4, 1874, BUF).

PRE#Pellaea glabella Mett. SMOOTH CLIFF-BRAKE. Up until 1934, the only species of Pellaea reported for western New York State was P. atropurpurea (L.) Link, or PURPLE CLIFF BRAKE (Zenkert, 1934). Subsequently, our material from the Niagara River Gorge has been reidentified by Stanley J. Smith, Curator of Botany of the New York State Museum, and later by Richard H. Zander, Curator of the Clinton Herbarium (BUF) to be P. glabella according to the characters detailed by Mitchell & Sheviak, 1981. The present writer has reviewed the relevant specimens at BUF and concurs with the changes in identification. Day's reference to P. atropurpurea (“Formerly on Goat Island and the Three Sisters. Not lately seen by us. Probably extinctated,” Day, 1888) has been referred in this paper to Pellaea glabella.

One specimen collected by George Clinton and hence dating prior to 1885, with no locality given (Herb. No. 35310) is Pellaea glabella by most characters, except it has very long stalks on its lower pinnae. It probably derives from the Niagara River gorge, as no other station for the genus occurs in western New York, or was reported from the Niagara Frontier Region before 1934 (Zenkert, 1934). Day (1910) mentioned two species of Pellaea growing in the vicinity of Niagara Falls: P. gracilis and P. atropurpurea.

* Penstemon digitalis Nutt. FOXGLOVE PEN-
This species grows in several areas along the crest of the Niagara River gorge on both sides of the river.

*Phalaris arundinacea* L. REED CANARY-GRASS. Juse east of the vehicular bridge, low, moist area, 1987.


*Phleum pratense* L. TIMOTHY. Day, 1888.


*Phryma leptostachya* L. LOPSEED. Day, 1888.


*Picea abies* Karst. NORWAY SPRUCE. By elevator, Cave of the Winds, 1988; and several other places around the island. The use of this species by maintenance staff on Goat Island goes back to 1890 when the Superintendent Thomas Welch procured seventy-five trees for the nursery established on Goat Island in that year (7 Ann Rep Comm, 1891). In 1891, one hundred more were procured for the nursery (8 Ann Rep Comm, 1892). A number of Norway spruce planted along the riverway failed in 1891 (8 Ann Rep Comm, 1982).


Two species of pine (*Pinus*) were noted growing on Goat Island in 1828 in the diary of David Douglas: one no doubt the White Pine, the other perhaps our hemlock (see note under *Tsuga* below).

Wied-Neuwied (1843) mentioned portions of the islands in the channel of the falls “are covered with pines, some green, others in a decayed state ... the pines being frequently broken and snapped and here and there piled up in the water,” and that “The shores of [Goat Island] are shaded by old pines and very large white cedars...” Lady Theodora Guest in 1895 reported a tree “Balsam” bordering the paths on the Three Sisters—she was surely referring to our Hemlock, as the Balsam Fir (*Abies balsamea*) is rare and not reported for the Goat Island complex -although a tree of that species is reported recently to occur in Niagara Glen in the Niagara River gorge (Hamilton, 1943). Ms. Guest may have seen transplanted Balsam Firs of
the hundred planted in the Goat Island nursery in 1891 (8 Ann Rep Comm, 1892). Frederick Law Olmsted (1880) quoted Robinson (1895) that at the falls “the high cliffs are crested with woods ...” and the talus below is “also beautifully clothed with wood to the river's edge, often so far below that you sometimes look from the upper brink down on the top of tall pines that seem diminished in size.”

Extensive exotic conifer trees were purchased by the first Superintendent of the Reservation. A screen of evergreens were planted on Goat Island in 1900 to hide the lumberyard from the drive (17 Ann Rep Comm, 1901).

# *Picea sitchensis* (Bong.) Carr. SITKA SPRUCE. Several old trees amid White Pine on Goat Island to the right facing the pedestrian bridge. This tree is native to the Pacific Coast of the United States and Canada as far north as southern Alaska. It should do well on Goat Island in the spray zone of the cataracts as in its native habitat this tree is greatly dependent on the dense fog banks associated with the nearby ocean.

---

[ *Pinus mugo* Turra SWISS MOUNTAIN PINE. One hundred young trees of “mountain pine” were procured for the Goat Island nursery in 1891 (8 Ann Rep Comm, 1892). One modern horticultural reference consulted indicates *Pinus mugo* Turra is called Swiss Mountain Pine—an earlier technical name being *Pinus montana* Mill., Mountain Pine (Bailey, 1924). Later in the 8th report, ten Mugho dwarf pines were reported purchased and planted on Bath Island and elsewhere on the Reservation. ]

* Pinus nigra* Arnold AUSTRIAN PINE. Several trees planted in lawns on the west end, 1988, and east meadow.

In 1891, one hundred young trees of this species were procured for the Goat Island nursery (8 Ann Rep Comm, 1892).


“The banks of the river about the falls are lined with white pine and cedar” (Clinton, 1822). White Pine was reported growing on Ship Island in the American channel (Agassiz, 1850).

Reported for Goat Island by the Superintendent in the report of the Commissioners in 1886. Seven trees of this species were blown down in the storm of 1889 (6 Ann Rep Comm, 1890); one pine fell January 13, 1890 (7 Ann Rep Comm, 1891). One hundred young trees of this species were planted in the Goat Island nursery in 1891 (8 Ann Rep Comm, 1892). Since all of the thousand other conifer trees put into the nursery in that year were non-native, nursery stock, perhaps the source of these young pines was not from the Reservation, nor the two hundred planted in 1892 (9 Ann Rep Comm, 1893).

Two trees of this species are established on Goat Island to the right of the pedestrian bridge adjacent to the Sitka Spruces that also grow on the elevation overlooking the bridge.

* Pinus sylvestris *L. SCOTCH PINE [ SCOTCH FIR ]. Eastern end, 1988. Two hundred trees of this species (as Scotch fir) were procured for the Goat Island nursery in 1891 (8 Ann Rep Comm, 1892).

---

[ *Platanus occidentalis* L. SYCAMORE. Sept. 19, 1877 (J. D. Hooker's American Journal). Day, 1888. By the pedestrian bridge, and by the bluffs overlooking Luna Island, 1988. These trees are not the hybrid (*P. acerifolia*) since the fruits are...
mostly one to a pedicle. Several trees on Green Island, 1988. This is probably the tree referred to Goat Island by the Superintendent in the report of the Commissioners in 1886 under the name “Buttonball.” It is probably not Cephalanthus, or Buttonbush, because this is more of a shrub, and noone has reported its occurrence otherwise on the Island. During the January storm of 1889, a Buttonball tree was blown down. It was “five feet in diameter, the largest tree upon the reservation” (report of the Superintendent, 6 Ann Rep Comm, 1890). This was probably the “Monarch of the Isle” mentioned by Porter (16 Ann Rep Comm, 1900—with drawing), a section of which was kept in the Niagara Falls Public Library. Its growth rings indicated it was 400 years old.


Note that these small plants could be easily confused with the next one and must be dissected for confident identification. It is probable that some of the material referred to by sight identification in this report is actually P. chapmaniana.

RNY, R* Poa chapmaniana Scribn. CHAPMAN’S BLUE-GRASS. First Sister, west end, on boulder, 1888.

Second collection made in western New York State. Special search might disclose additional populations in the Goat Island complex.


Second report for western New York. This is a “sparsely introduced species [in Ontario] found mainly in long-settled towns and old resort areas where at one time it was recommended to seed lawns in shady areas. It does not survive mowing, but it has escaped to survive in adjoining woodland…” (Dore and McNeill 1980). It is probably found throughout the Goat Island complex.


* Poa pratensis L. KENTUCKY BLUE-GRASS. “On Goat Island the little flat above the bridge,” June 8, 1862 (Clinton’s Journal). Day, 1888.


On Goat Island “the Podophyllum peltatum was in flower,” (Clinton, 1826). On Goat Island “we were refreshed, during our walk, with wild fruits ... mandrakes which resemble our largest gooseberries, with a very thick rind. They are the fruit produced by the plant called the may-apple” (Gurney, 1841). Prinz von Wied-Neuwied mentions this plant growing on Goat Island in 1843, and Lady Theodora Guest observed in 1895 its occurrence on the Three Sisters Islands.


An unidentified species of Polygonatum was noted on Goat Island Sept. 19, 1877 (J. D. Hooker’s American Journal).

R# Polygonatum biflorum (Walt.) Ell. GREAT SOLOMON’S SEAL. Day, 1888.

On November 2, 1870's, George Clinton found a specimen of the fungus Depaeza cruenta on a plant of this species.

# Polygonatum pubescens (Willd.) Pursh. SMALL SOLOMON’S SEAL. First Sister, east end.

R* Polygonum achoreum Blake HOMELESS KNOTWEED. Disturbed area beside path before the Three Sisters Island, 1986.


P# Polygodium vulgare L. var. virginianum (L.) Eat. COMMON POLYPODY. Day, “Goat Island.

The variety on the Island seems to be the var. pyramidalis Bunge, or BOLLE’S POPLAR, due to the long plume-like habit of the trees in the eastern meadow, rather than the typical broad-topped trees growing in the vicinity of Niagara Falls generally.


* Populus candelans Ait. BALM OF GILIAD. Sept. 19, 1877 (J. D. Hooker's American Journal). “Roadsides and along streams and in old fields. Sometimes regarded as a native of the western states or Canada and supposed to be naturalized in New York State. Appearing however as if indigenous along the shores of Lake Ontario. Common in cultivation,” House, 1924. Many regard this species as a hybrid, with synonymy reported as Populus X jackii Sarg., P. X gileadensis Rouleau and P. balsamifera X deltoides. Populus balsamifera does occur in the Niagara River gorge.


The Aspens, one or the other of the next two species, were reported for Goat Island by the Superintendent in the report of the Commissioners in 1886.


* Portulaca oleracea L. COMMON PURSLANE. Southeastern thickets, 1988; lawn, eastern meadow.

“Goat Island, searched it opposite to Luna Island & some way up, for Potamogeton niagaraensis in vain, July 18, 1865; “On Goat Island, a little above, or opposite the head of Luna Island, in wet [ sand? ], the water having retreated, a Potamogeton,” August 15, 1865 (Clinton’s Journal).

While processing unsorted specimens of George Clinton’s at the Clinton Herbarium (BUF), a specimen of Potamogeton was found “From lower edge of Goat Island, opposite Luna Island,” which is probably the collection referred to in Clinton’s diary entry above. It is a specimen of Potamogeton alpinus.


# Potentilla canadensis L. DWARF CINQUEFOIL. Day, 1888.


Reports of the Sour Cherry (Prunus cerasus) are probably this species.

* Prunus cerasus L. SOUR CHERRY. “Spontaneous on Goat Island.” Day, 1888. As this species seldom escapes from cultivation, it is doubtful this species occurred spontaneously on the island. It is frequently confused with Prunus avium.

* Prunus insititia L. BULLACE, DAMSON PLUM.

*Prunus persica* (L.) Batsch PEACH. “Spontaneous on Goat Island,” Day, 1888.

#Prunus serotina* Ehrh. BLACK CHERRY. Sept. 19, 1877 (J. D. Hooker's American Journal). “attaining ... a wonderful development,” Day, 1901. Several old trees noted at different stations throughout the island, 1988.

Reported for Goat Island by the Superintendent in the report of the Commissioners in 1886. The Superintendent also mentions a “white cherry,” whose technical name I cannot find.


Sixty of these little trees were added to the Goat Island nursery in 1892, presumably from the Goat Island populations (9 Ann Rep Comm, 1893).


#Pyrola elliptica* Nutt. ELLIPTIC-LEAVED PYROLA. Day, 1888.

*Pyrus communis* L. COMMON PEAR. Spontaneous on Goat Island,” Day, 1888.

#Pyrus coronaria* L. WILD CRABAPPLE. Sept. 19, 1877 (J. D. Hooker's American Journal). Day (1901) reports this species “Near the gorge of the river, on either side, but not upon the island ....”


White Oak is reported in the Goat Island woods by the Superintendent in the second report of the Commissioners in 1886. The January storm of 1889 blew down a white oak (6 Ann Rep Comm, 1890), and another on January 13, 1890 (7 Ann Rep Comm, 1891).

#Quercus borealis* var. maxima (Marsh.) Ashe. NORTHERN RED OAK. 1984. First Sister, east end, 1986. Second Sister, west end, several, 1988 [obs.]. Being planted in the east end and other places.

Red Oak is reported for the Goat Island woods by the Superintendent in the second report of the Commissioners in 1886.


*Quercus palustris* Muenchh. PIN OAK. Several trees of this species have been planted throughout the island in upland situations, unlike the moist to wet habitat it prefers naturally. Little attempt has been made to distinguish this tree from *Q. coccinea* for the purposes of this study: it appears that wherever they occur on the island, they have been planted. The asterisk is given here as natural occurrences are not apparent on the Reservation.


The “Chestnut-oak” of Agassiz (1850) reported for Ship Island was perhaps not dolomite boulders, 1986. 

#Quercus prinus* Willd. Day, 1888. of this list. *Quercus prinus* does occur in the Niagara Frontier Region, and exists in the Niagara River Gorge flora (Eckel, in prep.). Note, however, Provancher's report of *Q. prinus* for Niagara Falls (Day, 1888).


R#Ranunculus hispidus* Michx. HISPID BUTTERCUP. Goat Island, north end just east of Vehicle bridge in low moist area. In danger of mowing and will become extirpated in the next few years for this reason, 1987.

#Ranunculus recurvatus* Poir. HOOKED BUT-


# Rhus aromatica Ait. FRAGRANT SUMAC. Shrubby slopes overlooking Luna Island, 1988.

Occurring in abundance in the Great Plains where, in South Dakota, it is called Skunkbush.


This is probably the “Ivy,” the “creeping plant” on Goat Island reported by the Superintendent in the second report of the Commissioners in 1886 growing “in great abundance.” The policy has been, in both Canadian and American parks, to remove this vine from the trunks of trees. Bits of viny “holdfasts” may occasionally be seen on trunks of trees in cleared areas where the public walks, etc. Unfortunately the similar but harmless and interesting Virginia Creeper is also being removed.

In 1828 David Douglas noted that on Goat Island a “species of Rhus clad the trunks of the large trees.


Probably this is the species reported by the Superintendent in the second report of the Commissioners in 1886 that was “spreading in groves over the eastern end of the island [and ] should be removed.” Others do not seem to share the Superintendent’s opinion: “Beautiful plants grow among the boulders [in the Goat Island complex], the rocks on the banks of the river, such as the guelder rose, the white cedar ... and sumach” (Wied-Neuwied, 1834). “Goat Island is a luxuriant spot. The shumach [sic] trees with their red bunches of hairy berries, were at this time adorning it,” Gurney, 1841. “the Sumachs, which form a grove on the southeast of [Goat Island] that is striking at any season, do not wait for frost, and produce reds and yellows that are fairly flaming,” Chamberlin, 1892. In 1895 Lady Theodora Guest noted “On Goat Island is a considerable growth of sumach.” “Many of the sumachs, which are rapidly overrunning the upper end of Goat Island, should also be removed, and the meadow suitably planted,” the Superintendent (6 ann rep Comm, 1890). The sumachs finally went in 1982 (9 Ann Rep Comm, 1893), a “large number of sumachs which were spreading rapidly over the upper end of Goat Island have been removed. Clumps in various places have not been disturbed.” “A large number of the sumacs that were rapidly spreading over the upper end of Goat Island have been removed” (17 Ann Rep Comm, 1901). The destroyed shrubs were then placed over the “timber docking and cribwork” on the south side of the island, together with brush collected “in the thicket on Goat Island” in order to restore the “natural appearance of the shore.”

# Rhus vernix L. POISON SUMAC. In 1828 the Scottish botanist David Douglas noted in his diary the occurrence of this species on Goat Island. Characteristic of wooded swamps and bogs, and growing at Dufferin Islands, where it was reported as “particularly abundant in several wet places” by Hamilton, 1943.

“... We were refreshed, during our walk, with wild fruits ... small prickly gooseberries” (Gurney,
Botanical Heritage of Islands at the Brink of Niagara Falls

The presence of Wild Currants and Gooseberries, both of the genus *Ribes*, is reported for Goat Island by the Superintendent in the second report of the Commissioners in 1886.


George Clinton collected a specimen of *Polyactis vulgaris* Link. (fungi) from a shrub of this species (Nov, 1871, BUF).


* Robinia pseudacacia* L. BLACK LOCUST. “Several trees planted on the SE end ... vigorous escape,” 1986. The island is ringed with this species at the crests or top of slopes on the western and southern parts of the island. Four small trees of this species have been planted at the end of the ballast, southeast end [obs. 1988]. Base of Goat Island, 1988. One tree was planted with Gleditsia and Sophora at the eastern lawn verge of the large western parking lot, 2006.

A species of the genus *Rosa* was reported for Goat Island on Sept. 19, 1877 (J. D. Hooker's American Journal).

# *Rosa iblanda* Ait. SMOOTH ROSE. Day, 1888.

# *Rosa carolina* L. DWARF ROSE. Day, 1888.

* *Rosa eglanteria* L. SWEETBRIAR. Green Island, Day, 1888.

* *Rosa rugosa* Thunb. RUGOSE ROSE. North- and southeastern thickets, 1988.

R* # *Rosa virginiana* Mill. PASTURE ROSE. Crest woods. 1887.

In 1841, on Goat Island, “we were refreshed, during our walk, with wild fruits—raspberries ...” (Gurney, 1841). Raspberries, referring to the genus *Rubus*, were reported for Goat Island by the Superintendent in the report of the Commissioners in 1886. The dry, tasteless fruits of the Purple-flowering raspberry have not been considered worth eating.

# *Rubus flagellaris* Willd. NORTHERN DEWBERRY. Day, 1888.


“Among the boulders, the rocks on the banks of the river ... Rubus odoratus, now flowering in all its loveliness,” Wied-Neuwied, 1843.


# *Sagittaria latifolia* Willd. BROAD-LEAVED ARROWHEAD. First Sister, west end, Aug. 30, 1987. Willow beds were reported destroyed in winter storms of 1886 (six willows), and in 1889 (two willows “along the riverbank,” presumably on the mainland part of the reservation. Four young “osier” trees were transplanted “from the thicket on Goat Island” to the newly established Goat Island nursery in 1890 (7 Ann Rep Comm, 1891). Willow beds were again planted on the south shore in 1900 (17 Ann Rep Comm, 1901).

In 1891 “700 cuttings of yellow willow, 110 cuttings of weeping willow, 1,900 cuttings of dwarf willow” were planted on the denuded banks of the southern shoreline of Goat Island (8 Ann Rep Com, 1982). Willows were again planted on the south shore in 1900 (17 Ann Rep Comm, 1901). Willow beds were reported growing on the smaller islands in the American channel (American Falls
Part IV: The Species

International Board, 1971). Several young trees are starting on the ballast at the eastern end of the island, 1988.


* Salix alba var. vitellina Stokes. Several trees in the eastern meadow; leaves glabrous above, glabrate below (silky hairs toward the leaf base), yellow twigs, tenacious, 1988. This is supposedly a hybrid between S. alba and S. fragilis. Southeastern thickets, 1987.

# Salix amygdaloides PEACH-LEAVED WILLOW. First Sister, west end, 1988.


The Crack Willow on the Second Sister is a hybrid with the White Willow: it displays all the typical characters of Crack Willow, but the branchlets and branches are pubescent. Soper and Heimbarger (1982) report that “much of the material collected in Ontario represents hybrids between S. alba and S. fragilis.”


Reported for Goat Island by the Superintendent in the report of the Commissioners in 1886.


Day (1888) predicted the loss of this species due to “careless flower-gatherers.”

If care is not taken, a noxious weed of this family, Celandine (Chelidonium majus) could easily be imported onto the island complex. This species is infesting native woodlands on the Ontario side of the river, and the American mainland. A vigorous population occurs on the slopes on the mainland overlooking the eastern end of Goat Island.


This species or the following or both were reported by the Superintendent in the second report of the Commissioners in 1886. George Clinton collected a specimen of Microsphaeria peckii (a fungus) from a shrub of this species (Nov. 1874, BUF).

# Sambucus pubens Michx. RED-BERRIED

# Sanicula canadensis L. SHORT-STYLED SNAKEROOT. Sept. 19, 1877 (J. D. Hooker's American Journal).

# Sanicula marilandica L. BLACK SNAKEROOT. Day, 1888.


# Satureja glabella var. angustifolia (Torr.) Svenson LOW CALAMINT. (As Micromeria) “Goat Island,” Torrey, 1843, who referred to this plant as the NIAGARA THYME. Beck (1833) also reported this plant from Niagara Falls, then the easternmost margin of its range.


Several stations of this plant occur throughout the Niagara River gorge and shores of the lower river.

A species of Scirpus occurs on the little dolomite flat on the north side of Goat Island near Luna Island.

# Scirpus acutus Muhl. ex Bigel. WESTERN BULRUSH. Shallow water, Goat Island, Frank W. Johnson (BUF).


# Scirpus lineatus Michx. REDDISH BULRUSH. “East side ... in wet places near the River,” Day, 1888.


R# Scutellaria parvula Michx. SMALL SKULLCAP. Day, 1883.


# Senecio aureus L. GOLDEN GROUNDSEL. Day, 1888.


# Sisyrinchium graminoides Bickn. STOUT BLUE-EYED GRASS. First Sister, west end, 1988.

R# Sisyrinchium montanum Greene MOUNTAIN BLUE-EYED GRASS. Flats above the Horseshoe Falls, 1986.


Part IV: The Species


# Smilax sp. CATBRIER, CARRIONFLOWER, GREENBRIAR. One species grew together with Poison Sumac (*Rhus vernix*) on Goat Island in 1828, according to David Douglas.

*Smilax herbacea* L. may be found in several stations along the Niagara River gorge.


# Solidago arguta* Ait. CUT-LEAVED GOLDENROD. (Also as Solidago muenlenbergii) Sept. 19, 1877 (J. D. Hooker's American Journal).

# Solidago bicolor* L. SILVERROD. Day, 1888.


*Sophora japonica* L. JAPANESE PAGODA-TREE. One tree of this species was planted with Robbia and Gleditsia in the lawn on the eastern verge of the large western parking lot, 2005. There are probably one or two additional trees of this species planted within the Reservation.

# Spartina pectinata* Link SLOUGH-GRASS. (As *Spartina cynosuroides*) Sept. 19, 1877 (J. D. Hooker's American Journal).


# Streptopus roseus* Michx. TWISTED-STALK. Day, 1888.


* var. laevigatus Blake GARDEN SNOWBERRY. Southern thickets, 1988. This variety appears to predominate in the island complex.


Reported by the Superintendent as present on Goat Island in the second report of the Commissioners in 1886. Although a species native to the south of us, its presence on Goat Island was due to planting. It appears to have been occasionally planted at the entrances to the bridges.

# Symplolarus foetidus (L.) Nutt.) SKUNK CABBAGE. Reported by Douglas in 1828 (as Pothos foetidus) for Goat Island where he “was not a little surprised to see Pothos in a dry place; they had perfected seeds.” This species grows at Dufferin Islands and the wet base of Clifton Hill in Niagara Falls, Ontario in cool, wet, shaded muck.

* Syringa vulgaris L. LILAC. “Apparently spontaneous in one spot on Goat Island” Day, 1883. Frequent around the maintenance buildings near the vehicular bridge, dense and escaped all along the top of the southwestern slopes. Abundant in thickets, north side, 1888. Reported for Goat Island by the Superintendent in the second report of the Commissioners in 1886. “Fifty-eight purple lilacs, twenty-four white lilacs” were planted on the south banks of Goat Island in 1981 (8 Ann Rep Comm, 1982).

* Taraxacum laeavigatum (Willd.) DC. RED-SEEDED DANDELION. Zenkert, 1934.


This species is evident throughout the Goat Island complex, 1988. Lady Theodora Guest noted the occurrence of “the inevitable Dandelion” on the Three Sisters in 1895.

# Taxus canadensis Marsh. GROUND HEMLOCK. Sept. 19, 1877 (J. D. Hooker's American Journal). Day, 1888. Reported for Goat Island by the Superintendent in the second report of the Commissioners in 1886. Chamberlin (1892) observed many “prostrate Yew-bushes ... near the paths,” in Goat Island’s woods.

# Taxus cuspidata Sieb. & Zucc. JAPANESE YEW. An old, massive planting of this Asian species has been established on the eastern boundary of Green Island where it obscures the upstream prospect of the northern portion of the Niagara River where it divides around Goat Island. It also obscures the plinth of a bust of Jacob Schoellkopf erected in this place, which is bustless and buried within the bushes.


George Clinton collected a specimen of Aecidium ranunculacearum (fungi) from a plant of this species (July 4, 1871, BUF).


* Thuja occidentalis L. ARBOR VITAE, WHITE CEDAR. Sept. 19, 1877 (J. D. Hooker's American Journal). “The most abundant of the evergreens
Part IV: The Species

growing near the Falls,” Day, 1888. Second Sister, west end, single tree, boulder top by bridge to Third Sister Island [obs. 1988]. Eliminated from Goat Island, 1988. Only a few individuals may be seen today growing with bonsai-like effect from the tops of one or two boulders in the channels between the Three Sisters Islands. How to account for the loss of these trees is problematical. A fine clump of these trees grows at the base of Goat Island along the path to the Cave of the Winds.

François André Michaux, in the 1819, English version of his North American Sylva states “Goat Island, round which the Niagara divides itself to form the ... cataract ... is seen from the banks of the river to be bordered with Arbor Vitae” (Zenkert, 1934). “By the rapids, on the American side ... and on Goat Island, grew some of the largest arbor vitae ... I ever saw,—some of them measuring seven feet round” (Howitt, 1820). Prinz von Wied-Neuwied (1843) observed “the shores of [Goat Island] are shaded by old pines and very large white cedars such as we should in vain look for in Europe ....” Luna Island “is closely overgrown with white cedar ... the tall, thick, whitish trunks of which, with their stiff, extended boughs, scarcely leave space for the shrubs that grow between them, in which the cedar bird (Bombycilla cedrorum) builds its nest. The northern chatterer or silk tail ... is likewise found here in small companies during the winter .... Beautiful plants grow among the boulders, the rocks on the banks of the river, such as ... the white cedar ....”

“The banks of the river about the falls are lined with white pine and cedar” (Clinton, 1922). Agassiz noted this tree growing on Ship Island in the American channel (Agassiz, 1850). “A day on Goat Island! Would that no stormy ocean separated us from the groves of arbor vitae and forests of maple, which overhang the rapids and clothe the steeps! ... A splendid vine, from which I plucked delicious grapes, and a red honeysuckle have there climbed to the very top of an arborvitae situated on a promontory...” Baxter, 1855.

Reported by the Superintendent for Goat Island in the second report of the Commissioners in 1886 (as White Cedar). Eight white cedars were blown down in the winter storm of 1889 (report of the Superintendent, 6 Ann Rep Comm, 1890). Two of these trees fell in the winter storm of January 13, 1890 (7 Ann Rep Comm, 1891). Seventy-five White Cedar “have also been procured” for the Goat Island nursery established in 1890, and it is interesting that, of the 1,122 young trees transplanted from the “thicket on Goat Island,” none of these were young White Cedars (7 Ann Rep Comm, 1891). In 1891, fifty Siberian arbor vitae were planted on the Reservation after purchase, and perhaps the seventy-five White Cedars put in the nursery the year before were exotics as well (8 Ann Rep Comm, 1892). The next year, two hundred Arbor Vitae were added to the nursery (9 Ann Rep Comm, 1893).

Chamberlin (1892) observed on Goat Island “near the paths many small Cedars, white and red ...” in the woods.

George Clinton collected two specimens of Pros- themium sp. (a fungus) on a tree of this species (July 4, 1874 BUF), one on the “west side above the Three Sisters”.


This tree is generally found throughout the wooded areas of the island. Second Sister, west end, by aluvial area, 1988 [obs.]

Ten trees of this species were blown down in winter storms in 1889 (report of the Superintendent, 6 Ann Rep Comm, 1890); eleven in the January 13 storm in 1890 (7 Ann Rep Comm, 1891). When the Goat Island nursery was established in 1890, ninety-one young trees of this species were transplanted there “from the thicket on Goat Island” (7 Ann Rep Comm, 1891). In 1893, fifty-five basswoods from the nursery were planted in the eastern meadow, (10 Ann Rep Comm, 1894), the following year fifty-five more were planted (11 Ann Rep Comm, 1895).

Tilia sp. “Day (Day, 1888) notes that on Goat Island
... a basswood was to be found seemingly quite distinct from *T. americana*, readily distinguished by its bark which is as white as that of the white ash." Zenkert, 1934. At the end of the 1888 report by Day is the note "The unnamed species of *Tilia*, herein referred to seems to be only a variety of *Tilia americana*, L., July 26, 1888." This report by Day may have referred to an example of *Tilia heterophylla*, WHITE BASSWOOD, which is rare in New York State.

* *Tilia cordata* Mill. SMALL-LEAVED LINDEN. 1888. This species, or a horticultural variety close to it, is extensively planted throughout the island.

* *Tragopogon porrifolius* L. SALSIFY. 1987.

* *Tragopogon pratensis* L. GOAT'S-BEARD. 1987.


David Douglas noted in 1823 that on Goat Island "Trillium seemed to be plentiful, but the leaves being decayed, I could not get as many as I would like." On September 30th this spring ephemeral would have been decayed indeed!


On May 12, 1866, George Clinton recorded that "a party of young ladies" from a Buffalo school "found a few specimens of the green petalled *Trillium*, which seems to be *T. grandiflorum*." Day (1888) predicted the extermination of *Trillium* plants on Goat Island due to "careless flower-gatherers."


Linnaeus originally described this species in the genus *Pinus* (Sp. Pl. ed 2, 1421, 1763, as did DuRoi (as *Pinus americana*) in 1771, and Marshall (as *Pinus Abies-americanus*) in 1785 (House, 1924), hence David Douglas' reference to two pines on Goat Island in 1828 surely related to this tree.

Agassiz (1850) reported this tree growing on Ship Island in the American channel. Reported for Goat Island by the Superintendent in the report of the Commissioners in 1886. One of these trees was blown down in the winter storm of 1889 (6 Ann Rep Comm, 1890), and another January 13, 1890 (7 Ann Rep Comm, 1891). Chamberlin (1892) observed this tree in the Goat Island woods "near the paths many ... Hemlock[s]." In 1892, two hundred young trees were planted in the Goat Island nursery, and were probably purchased (9 Ann Rep Comm, 1893). Day (1901) recommended this tree for reforestation of Goat Island.

A bank of these trees may be seen on the north side of the central woodland facing the maintenance shed. They appear planted. Several young, presumably escaped trees may be seen in the ‘road island’ formed by three intersecting roads just to the north of this bank of trees. It appears that this species would do well if part of a restoration plan.


* *Typha angustifolia* L. NARROW-LEAVED CATTAIL. First Sister, west end, 1986. Second Sister, east end, 1985.

A specimen of *Scolecosporiella typhae* (fungi) was collected from the dead leaves of this plant by W. R. Buck, Nov. 2, 1988 (NY).

* *Typha latifolia* L. BROAD-LEAVED CAT-TAIL. First Sister, west end, 1988. Second Sister, west end, alluvium, 1988 [obs.]

Elms (*Ulmus*) were reported for Goat Island by the Superintendent in the report of the Commissioners
in 1886. Three elms were blown down in the January storm of 1889 (6 Ann Rep Comm, 1890). Five elms were blown down in the storm of January 13, 1890 (7 Ann Rep Comm, 1891), two of these being three feet in diameter. Fifteen young elm trees were transplanted “from the thicket on Goat Island” to the Goat Island nursery established in 1890 (7 Ann Rep Comm 1891). Thirteen of these were taken from the nursery and planted in the eastern meadow in 1893 (10 Ann Rep Comm, 1894), the following year, thirteen more were planted there (11 Ann Rep Comm, 1895).

Elms were reported growing on the smaller islands in the American channel in 1968 (American Falls International Board, 1971).


It is interesting that Hooker and Gray did not note this species growing on Goat Island in 1877 when they made their catalogue of its trees, shrubs and herbs. Perhaps this indicates it was not a conspicuous member of the forest.


A modern synonym for * Verbena obtusifolia * noted by J. D. Hooker in his American Journal for Goat Island has not been found as of this writing. It may be * Verbena hastata var. oblongifolia * Nutt., a probable hybrid between the two species below (House, 1924).


# Veronica peregrina * var. xalapensis * (Kinth) St. John & Warren. PURSLANE SPEEDWELL. Goat Island, along paths, 1986.


Thirty-six “snow-ball” trees were planted on the denuded southern shore of Goat Island in 1891 (8 Ann Rep Comm, 1892); these may have been the ornamental shrub * Viburnum opulus * L. var. sterile —the species or variety with the rounded inflorescence, with all the flowers large, rather than just on the periphery of the flower cluster. However, it is more likely the snow ball tree was the native shrub * Viburnum opulus * var. americanum, and the plants were transplanted from the populations on Goat Island.

This is the first report for this species in western New York.

* **Viburnum opulus** L. var. *opulus* GUELDER ROSE. “Large trees in meadow, east end.” 1986. Green Island, SW river margin, 1988. Wied-Neuwied (1834) mentioned the “geuldar rose” [sic] growing along the river banks, and probably meant to the native High-bush Cranberry, or *V. opulus* var. *americana* Ait. I have not yet found a reference to the native shrub growing on the islands.

# **Viburnum rafinesquianum** Schultes. RAFINESQUE VIBURNUM. Day, 1888.

# **Vicia americana** Muhl. AMERICAN VETCH. Day, 1888.

# **Vicia caroliniana** Walt. CAROLINA VETCH. Day, 1888.


# **Viola blanda** Willd. SWEET WHITE VIOLET. Day, 1888.


# **Viola conspersa** Reichenb. AMERICAN DOG VIOLET. Day, 1888.

# **Viola cucullata** Ait. MARSH BLUE VIOLET. Clinton though he found *Viola sagittata* on Goat Island, but decided “it was a mere form of *V. cucullata*,” May 17, 1862 (Clinton Journal). Day, 1888. “Abounds,” Day, 1901.


# **Viola papilionacea** Pursh. MEADOW VIOLET. First Sister, west end, 1988.

# **Viola pubescens** Ait. DOWNY YELLOW VIOLET. “Abounds,” Day, 1901.

A specimen of *Puccinia violarum* (fungi) was collected from a plant of this species (July 4, 1871, Aug. 12, 1875, BUF).


Regarding grape (*Vitis*), “on Goat Island ... we were shown a piece of a grapevine about six feet long, which must have averaged six inches in diameter,” (Clinton, 1826).

The “wild grape-vines” are reported as abundant on Goat Island by the Superintendent in the report of the Commissioners in 1886. “In few other places [ than Goat Island ] does the Wild Grape climb so high or spread so far or swell itself into such tree-like proportions. Nowhere, especially on the American side and in the vicinity of Luna Island, is the visitor out of sight of these rampant vines. The slope leading down to Luna Island is covered with small trees so overgrown by vines that one wonders how the trees can grow at all, yet they appear to thrive under the load” (Chamberlin, 1892).

# **Vitis aestivalis** Michx. SUMMER GRAPE. (as var. *aestivalis*) Goat Island, George Engelmann Aug. 17, 1879 (MO); (as var. *aestivalis*) small island in the Niagara rapids, George Engelmann August 1840 (MO); Day, 1888. Zenkert, 1934. Wooded crest, 1988.

* **Vitis labrusca** L. FOX GRAPE. Sept. 19, 1877 (J. D. Hooker’s American Journal).


# **Waldsteinia fragarioides** (Michx.) Tratt. BARREN STRAWBERRY. Day, 1888.

# **Zizia aurea** (L.) Koch GOLDEN ALEXANDERS. Zenkert, 1934.
SUMMARY OF THE RARE PLANTS OF THE GOAT ISLAND COMPLEX

Day, in his 1888 catalogue of the plants growing at Niagara, stated that “the flora of Goat Island presents few plants which may be called uncommon in Western New York. For the rarer plants, included in the Catalogue, other localities must be visited.” If certain of these plants were not rare in western New York in Day’s time, they had become so by the time of Zenkert’s 1934 flora of the Niagara Frontier Region, and others have become so by the present day. Several of the state-wide rarities listed below fall into the category of graminoid species that Day acknowledged he did not study exhaustively. Nor did Day concentrate exclusively on the Goat Island flora, but spent the year 1887 producing a flora of the vicinity of the cataracts including the seven-mile gorge of the Niagara River and collecting-haunts along the gorge rim, a decision that probably caused him to overlook the more conspicuous rarities listed below.

Day did recognize that “some of the rarest plants of western New York and Ontario grow in the neighborhood of Niagara river, but not within the confines of the Reservation” (Day, 1888), some of these being Fragrant Sumac (*Rhus aromatica*) found recently to occur on Goat Island, Upland White Aster (*Aster ptarmicoides*), Four-leaved Milkweed (*Asclepias quadrifolia*) and Red Mulberry (*Morus rubra*) in addition to several ferns, Walking Fern (*Camptosorus rhyzophyllus*) and Maidenhair Spleenwort (*Asplenium trichomanes*), again, recently found on the First Sister Island. Some plants of the gorge today, occurring on the New York Heritage list of rarities, and some bryophytes (mosses) rare in the State are given in the appendix at the end of this section. Again, Goat Island is only one component in the natural phenomenon of Niagara -its rarities are a response to the unusual natural conditions presented throughout the Niagara River in the vicinity of the cataracts and the gorge. The western boundary of Goat Island is, in fact, the head of the gorge and is structurally continuous with it. Other plants that are rare in New York State extend down the length of the Niagara gorge.

Both weedy species, alien and native, and rare plants grow where there is unusual opportunity, for example, by reason of recent human disturbance of the typical growing conditions in the region (typical of weeds), or natural disturbance through time, that is, where natural disturbance is characteristic of the environment, and was in effect when the (rare) species first became introduced. Alien species whose establishment is unusual (rare) are also indicative of an unusual environment, and so these are included with the rare list.

“... Marie-Victorin (1938) pointed out that several western plants, when grown in limestone beds at the Montreal Botanical Garden, increased their area and thrrove vigorously until finally crowded out by weeds.
Several botanists, including Griggs (1934, 1940), had already noted that weeds are often found in the same habitat as rare plants. Species of both groups are adapted to survive on such typical rare-plant habitats as unstable sea-cliffs and river-gravels, but would be eliminated if the erosion cycle were able to reach a stage permitting establishment of the normal forest-flora of the region. The rare plants share the sun-loving character of weeds. The limestone cliffs, because of their splintered and angular type of weathering (with formation of extensive talus slopes at the base), will still bar conquest by the forest for an indefinite period” (Scoggan, 1978).

A population of Fox Squirrel (Sciurus niger) has been observed for several years on Goat Island (1985-89, Dr. R. Andrle, personal communication). This squirrel, abundant in the central and west-central United States is so rare in western New York State that it is frequently reported as absent from the State (Collins, 1981). The Island has an abundance of native nut trees, and people are frequently seen feeding the squirrels at the entrance to the Three Sisters.

See the species catalogue for more information regarding each species listed below.

The following lists of rare plant species include:
1. Native species, native vascular plants and mosses, on Goat Island listed by the New York Natural Heritage Program as rare in New York State:
   a) eight native taxa, vascular or flowering plants.
   b) seven native taxa, mosses.
Native species of lichens, not yet part of a heritage program:
   c) eight native taxa, lichens.
   a) six native rarities (all noted as heritage rarities below).
   b) ten alien taxa.
Total rarities in New York State reported for the Goat Island complex: 16.
3. Alien and native vascular plant (flowering) species reported as rare in western New York State (within a fifty-mile circumference of Buffalo, New York; Zander & Pierce, 1979).
   a) thirteen native species
   b) nineteen alien species
Total rarities in western New York reported for the Goat Island complex: 32.
Note: a single species may appear on each of the three lists for rare according to the DEC Heritage program, the New York State checklist and the checklist for western New York (the Niagara Frontier Region).

1. Native Species: New York Natural Heritage Program

a) Vascular Plants

The language interpreting the codes G4 G5 S1 T3 etc. and the code itself is quoted verbatim from the New York Natural Heritage Program Rare Plant Status Report: Spring 1988, ed. by S. E. Clemants (1988).

Carex garberi Fern. ELK SEDGE. G4 G5 S1 T3. Apparently secure throughout its range (but possibly rare in parts) or (may be rare in certain areas). Critically imperiled in New York State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological factors. The species is threatened with endangerment in New York. The third priority list: native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than
one rarity is present.  
First Sister, east end on dolomite flat, 1988.  
Special thanks is here made to Dr. William Crins, currently at the New York State Museum for assistance in determining certain of these species in this difficult group. George Clinton wrote in his collecting diary that on May 9, 1864, he collected Carex aurea on Goat Island. I have found no other references to this plant found there. It so closely resembles C. garberi, which grows there today, that it is that species which may be assumed grew on the Island in Clinton’s day. Also his references to Carex viridula might more likely be C. granularis, also acknowledged by Clinton in an entry for June 10, 1865. Clinton seems to have done rather well identifying grass-like plants with only a hand-lens, for on July 7 of that year he lamented having no microscope.

Carex molesta Mack. TROUBLESOME SEDGE.  
G4 S1. Apparently secure throughout its range (but possibly rare in parts). Critically imperiled in New York State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological factors.

First Sister, east end, 1988.  
Chelone glabra var. dilata Fern. & Wieg. TURTLE-HEAD. G5T? SH R. Demonstrably secure throughout its range (however it may be rare in certain areas). Threatened (the species is threatened with endangerment in New York). No extant sites known in New York State but it may be rediscovered. Rare. Recorded 15 times or fewer in the state (or up to 20 times with known cases of extirpation).

Second Sister, west end, 1986.  
Epilobium glandulosum Lehm. WILLOW-HERB. G5T? SH. Demonstrably secure throughout its range (however it may be rare in certain areas). Threatened (the species is threatened with endangerment in New York). No extant sites known in New York State but it may be rediscovered. Rare. Recorded 15 times or fewer in the state (or up to 20 times with known cases of extirpation).

Terrapin Point, 1986.  
Gentiana procera Holm FRINGED GENTIAN. G5 S1 E3 P. Demonstrably secure throughout its range (however it may be rare in certain areas). Critically imperiled in New York State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological factors. Endangered (the species is in danger of extirpation from New York). The third priority list: native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present. The plant is on the Protected Native Plants list and protected by New York State law.

Lysimachia quadriflora Sims FOUR-FLOWERED LOOSESTRIFE. G5? SH E3. Demonstrably secure throughout its range (however it may be rare in certain areas), ?. No extant sites known in New York State but it may be rediscovered. Endangered (the species is in danger of extirpation from New York). The third priority list: native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.

Second Sister, east end, on edge of soil mat east end, July 14, 1987.  
Physocarpus opulifolius var. intermedius (Rydb.) Robins. NINEBARK, G5T?, S1, R Demonstrably secure throughout its range (however it may be rare in certain areas). Rare. Recorded 15 times or fewer in the state (or up to 20 times with known cases of extirpation). Critically imperiled in New York State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological factors.

First of the Three Sisters Islands, west end, 1988; Second of the Three Sisters Islands, west end, 1985 [probably throughout the Three Sisters and Niagara River Gorge].

Veronica peregrina ssp. salapensis (Kunth) Pennell PURSLANE SPEEDWELL. G5T5 SH, R. Demonstrably secure throughout its range (however it may be rare in certain areas). No extant sites known in New York State but it may be rediscovered. Rare. Recorded 15 times or fewer in the state (or up to 20 times with known cases of extir-
Botanical Heritage of Islands at the Brink of Niagara Falls

Goat Island, along paths, near the Three Sisters, 1986.

Heritage vascular plants extirpated from Goat Island

**Hypericum kalmianum** L. KALM’S ST. JOHN’S WORT. G4 SX X3.

Apparenty secure throughout its range (but possibly rare in parts). Apparently extirpated from New York State. Extirpated (the species is probably extirpated from New York). The third priority list: native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present. The plant is on the Protected Native Plants list and protected by New York State law.

(As *P. atrapurpurea*) “Formerly on Goat Island and the Three Sisters. Not lately seen by us. Probably extirpated,” Day, 1888. For discussion, see the species catalogue.

**Potamogeton alpinus** Balbis var. tenuifolius (Raf.) Ogden ALPINE PONDWEED. G5 S1 R. Demonstrably secure throughout its range (however it may be rare in certain areas). Critically imperiled in New York State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological factors. Rare. Recorded 15 times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.


**Satureja glabella** (Michx.) Briquet var. angustifolia (Torr.) Svenson LOW CALAMINT (As *Calamintha arkansana*) G5 SH E3. Demonstrably secure throughout its range (however it may be rare in certain areas). No extant sites known in New York State but it may be rediscovered. Endangered (the species is in danger of extirpation from New York). The third priority list: native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.

“Goat Island,” Torrey, 1843. See species catalogue.

b) Bryophytes (Liverworts, Mosses)

Data on rarity in New York State is derived from Clemants & Ketchledge (in press), except for the last two on this list which are new reports for the State.
Acknowledgement is made to Drs. Richard H. Zander and William R. Buck for permission to use their bryophyte data here.

**Didymodon rigidulus** Hedw. G4 G5 S3
Third of the Three Sisters, west end, 2 Nov. 1988, W. R. Buck, 16438 (BUF, NY).
Apparently secure throughout its range (but possibly rare in parts); demonstrably secure throughout its range (however, it may be rare in certain areas).

**Didymodon tophaceus** (Brid.) Lisa G5 S3
Demonstrably secure throughout its range (however, it may be rare in certain areas).
Goat Island, dolomite ballast, SE end, Eckel, 880722, June 4, 1988 (BUF).

**Didymodon**

**Hyophila involuta** (Hook.) Jaeq. & Sauerb. G5 S1
Demonstrably secure throughout its range (however, it may be rare in certain areas). Critically imperiled in New York State because of extreme rarity (5 or fewer sites).
Goat Island, base, just outside spray area of Horse-shoe Falls, wet hummock, roots of *Cornus*, Eckel, 880718, June 3, 1987 (BUF); Second Sister, west end.

**Orthotrichum pusillum** Mitt. G5 SH
Demonstrably secure throughout its range (however, it may be rare in certain areas). No extant sites known (verified within the past 15 years) in New York State but it may be rediscovered.

**Philonotis muhlenbergii** (Schwegr.) Brid. GUQ SH
Status unknown: a question exists concerning the taxonomy of the species. No extant sites known (verified within the past 15 years) in New York State but it may be rediscovered.
Goat Island, SW shoreline, flats east of the Horse-shoe Falls, wet hummock, roots of *Cornus*, Eckel, 880718, June 3, 1987 (BUF); Second Sister, west end.

**Thuidium pygmaeum** BSG.
Demonstrably secure throughout its range (however, it may be rare in certain areas). Critically imperiled in New York State because of extreme rarity (5 or fewer sites).
Central woods on smooth cobble, shade, Eckel, Sept. 9, 1984 (BUF).

**Trichostomum crispulum** Bruch in F. A. Muell.
Base of Goat Island, just outside spray area of Horse-shoe Falls, boulder, thin soil, midslope, with *Hyophila involuta*, *Hymenostylium recurvirostrum*, *Tortella fragilis*, Zander, 3484a, Oct. 28, 1979 (BUF). NEW STATE RECORD.

**Weissia hedwigii** Crum
Second locality in New York State, unknown in the state outside of one other area in Niagara County (Eckel, 1987; Eckel & Eckel, 1988).

**c) Lichens**

No New York State Heritage list has yet been developed for rare lichens in New York State. It is probable, if there were such a list, the following species would be included in it.

Collections made by Dr. Richard Harris, New York Botanical Garden on Goat Island, the Three Sisters and Luna Island have produced the following records for seven species, one in a previously unrecorded genus for the State, all previously unknown to the lichen flora of New York State. He has collected several which might prove to be new to science (i.e., new species, Harris, personal communication).

**Arthonia lapadicola** (Taylor) Branth & Rostrup
New to New York State.
N side Goat Island, on slope near water just E of Luna Is. bridge, on rock, R.H. Harris, 22855 (NY).

**Bacidia epixanthoides** (Nyl.) Lettau
New to New York State.
First Sister west, on *Mnium thomsonii*, R.H. Harris, 16341 (NY)

**Caloplaca cirrochroa** (Ach.) Th. Fr.
New to New York State.
Botanical Heritage of Islands at the Brink of Niagara Falls

First Sister, east end, on rock, R.H. Harris, 22917 (NY)

**Lecania perproxima** (Nyl.) Zahlbr.
New to New York State.

Second Sister, east end, on rock, R.H. Harris, 22904 (NY).

**Lecanora umbrosa** Degel.
New to New York State.

Third Sister, east end, north side, on rock, R.H. Harris, 22940 (NY).

**Leptogium juniperinum** Tuck.
New to New York State.

First Sister, west end, in rock crevice, R.H. Harris, 16346 (NY).

**Pyrenocollema strontianensis** (Swinscow) R. C. Harris
Genus and Species New to New York State.

Luna Island, on rock, R.H. Harris, 16317 (NY).

**Teloschistes chrysophthalmus** (L.) Th. Fr.
“The only inland New York record,” 1870.


**EXTANT SPECIES:**

**NATIVE:**

**RNY, Carex garberi** Fern. **GARBER’S SEDGE.**
Reported by Mitchell (1986) as “threatened with endangerment in New York State” and as “native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.”

First Sister, east end on dolomite flat, 1988.

**RNY, Chelone glabra** L. **var. dilatata** Fern. & Wieg. **TURTLEHEAD.**
Second Sister, west end, 1986.

**RNY, PRE Gentiana procera** Holm **SMALLER FRINGED GENTIAN.**
Reported by Mitchell (1986) as “endangered (the species is in danger of extirpation from New York State)” and as “native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.”

Goat Island, along paths, near the Three Sisters, 1986.

**RNY, Physocarpus opulifolius** var. **intermedius, NINEBARK.**

**RNY, Veronica peregrina** L. **var. xalapensis** (Kinth) St. John & Warren **PURSLANE SPEEDWELL.**
Goat Island, along paths, near the Three Sisters, 1986.

**ALIEN:**


**RNY, * Cerastium semidecandrum** L. **SMALL MOUSE-EARED CHICKWEED.** Second Sister, east end, 96122611. First Report for the Niagara Frontier Region.


**RNY, * Lycopersicon esculentum** Mill. **TOMATO.**
New York State.

EXTIRPATED FROM THE GOAT ISLAND COMPLEX:

NATIVE:
RNY, # Hypericum kalmianum L. KALM'S ST. JOHN'S WORT. [see citations above].
RNY, # Panax quinquefolium L. GINSENG.
“Rare,” Day, 1888.
Commercially exploited in New York State, “native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.” (Mitchell, 1986).
R# Pellaea glabella Mett. SMOOTH CLIFF BRAKE.
Reported by Mitchell (1986) as rare in New York State, recorded 15 times or fewer in the State (or up to 20 times with known cases of extirpation). Endangered (the species is in danger of extirpation from New York State). The third priority list: native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.”

ALIEN:
Reported by Mitchell (1986) as a rare introduction in New York State.

3. Alien and native species reported as rare in western New York State
(to fifty miles east of Buffalo, New York; Zander & Pierce, 1979).

EXTANT SPECIES:

NATIVE:
R# Carex garberi Fern. GARBER'S SEDGE. First Sister, east end on dolomite flat, 1988.
R# Carex molesta Mackenzie TROUBLESOME SEDGE. First Sister, east end, 1988.
R# Chelone glabra L. var. dilatata Fern. & Wieg. TURTLEHEAD. Second Sister, west end, 1986.
R# Epilobium glandulosum WILLOW-HERB. Terrapin Point, 1986. First report for western New
York State.


Lysimachia quadriflora Sims. LINEAR-LEAVED LOOSESTRIFE, PRAIRIE MONEYWORT. Second Sister, east end, on edge of soil mat, east end, July 14, 1987.


R# Ranunculus hispidus Michx. Low, moist area north side just east of vehicular bridge—will soon be extirpated by mowing, 1988.


ALIEN:


Cerastium semidecandrum L. SMALL MOUSE-EARED CHICKWEED. Second Sister, east end, 96122611.

First Report for Western New York State.


Polygonum achoreum Blake HOMELESS KNOTWEED. Area facing the Three Sisters, 8609112.


First report for Western New York State.
EXTIRPATED FROM THE GOAT ISLAND COMPLEX:

NATIVE:

R# *Aster undulatus* L. WAVY-LEAVED ASTER. Sept. 19, 1877 (J.D. Hooker's American Journal).

R# *Astragalus canadensis* L. CANADIAN MILK-VETCH. 1885, A. D. Pease (BUF).


R# *Carex viridula* Michx. GREEN SEDGE. (As C. oederi) “near the Horse-shoe Fall” Provancher (Flore Canadienne), Day, 1888.

R# *Castilleja coccinea* (L.) Spreng. PAINTED CUP. Day, 1901.

R# *Celtis occidentalis* L. HACKBERRY. Midst of the central woodlands, 1986. Probably planted or an escape.

Reported for Goat Island by the Superintendent in the report of the Commissioners in 1886. I am assuming that Nettletree, used in this report, indicated this species. The Superintendent indicated, however, that his Nettletree was a shrub. Day also uses Nettletree to refer to *Celtis occidentalis*, which he indicates is “rather common between Queenston and Niagara” on the Canadian shore, based on a report by John Macoun.

R# *Corylus americana* Walt. AMERICAN HAZELNUT. Day, 1883.


R# *Deschampsia caespitosa* (L.) Beauv. TUFTED HAIR GRASS. Day, 1888.


R# *Hieracium gronovii* L. Hairy HAWKWEED. Day, 1888.


This is the only known locality for the species in New York State. Zenkert (1934) reported it as “not observed at the Falls in recent years.”

R# *Justicia americana*. (L.) Vahl WATER-WILLOW. “... shallow water of Niagara River, on limestone, off Goat Island, just above the Falls, where rather abundant,” Zenkert, 1934.


R# *Polygonatum biflorum* (Walt.) Ell. GREAT SOLOMON’S SEAL. Day, 1888.

R# *Potamogeton alpinus* Balbis var. tenuifolius (Raf.) Ogden ALPINE PONDWEED. “From lower edge of Goat Island, opposite Luna Island—growing on mud,” Clinton [probably Aug. 15, 1865—see species catalogue]. “Rapids of the Niagara River, near Bath Island,” Zenkert, 1934.

R# *Scutellaria parvula* Michx. SMALL SKULL-CAP. Day, 1883.

R# *Solidago ulmifolia* Muhl. ELM-LEAVED GOLDENROD. Day, 1888.

R# *Stachys aspera* Michx. ROUGH HEDGE-NETTLE. Day, 1888.

ALIEN:


R* *Populus candicans* Ait. BALM OF GILIAD. Sept. 19, 1877 (J. D. Hooker's American Journal).

R* *Cerastium viscosum* L. CLAMMY MOUSE-EAR CHICKWEED. Day, 1888.

R* *Chenopodium urbicum* L. NETTLE-LEAVED GOOSEFOOT. Bath Island, Day, 1883 (problematical). Day may have reidentified a Clinton specimen of *Chenopodium murale* L. from Green, or Bath Island as *Chenopodium urbicum* L. for his 1888 publication. If he did, he made no annotation on the specimen in the Clinton Herbarium.

R* [*#]Collinsia verna* Nutt. BLUE-EYED MARY.


ADDENDUM

The following are additional stations of Heritage rare plants in and along the Niagara River Gorge, of which the flora of Goat Island is a part. Protection of the Goat Island flora will require the protection of the larger flora of the Niagara Gorge and adjacent areas. This list does not include lichens or fungi.

VASCULAR PLANTS:

Aster azureus Lindl. SKY-BLUE ASTER (As Aster ooolentangiensis) G5, SH, E3 Demonstrably secure throughout its range (however, it may be rare in certain areas). No extant sites known in New York State but it may be rediscovered. Endangered (the species is in danger of extirpation from New York). The third priority list: native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.

Liatris cylindracea Michx. CYLINDRIC BLAZING STAR. G5, SH, E3. Demonstrably secure throughout its range (however, it may be rare in certain areas). No extant sites known in New York State but it may be rediscovered. Endangered (the species is in danger of extirpation from New York). The third priority list: native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.

Pellaea glabella Mett. SMOOTH CLIFF BRAKE. G5 S1 T3 P. Demonstrably secure throughout its range (however, it may be rare in certain areas). Critically imperiled in New York State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological factors. Endangered (the species is threatened with endangerment in New York). The third priority list: native plants known to have occurred in New York State five times or fewer (up to nine historical sites where some are known to be extirpated); sites harboring these species should be preserved if possible, especially in cases where more than one rarity is present.

BRYOPHYTES:

Note: several rare species of these plants have been noted for the Niagara Gorge generally or on the Canadian side specifically both recently and his-
torically: *Ptychomitrium incurvum*, *Aloina rigida*, *Grimmia pilifera* and most recently *Eucladium verticillatum* which has not yet been found in New York State. Since these organisms are so minute and it takes a specialist to collect and identify these plants with certainty, it is quite possible these Heritage rare species may yet be discovered or rediscovered. Also, the taxonomic status of plants historically reported as *Didymodon trifarius* and *D. luridus* collected from the Goat Island area and the vicinity of Niagara Falls, and which are rare taxa in North America, is yet to be settled.

*Bryum cyclophyllum* (Schwaegr.) BSG. G5 SH. Demonstrably secure throughout its range (however, it may be rare in certain areas). No extant sites known (verified within the past 15 years) in New York State but it may be rediscovered. See discussion in the bryophyte species catalogue. Judge George Clinton found this moss “on stones wet by spray, at Niagara Falls,” reported by Lesquereux and James (1884).

*Bryum turbinatum* (Hedw.) Turn. G5 SH?. Demonstrably secure throughout its range (however, it may be rare in certain areas). No extant sites known (verified within the past 15 years) in New York State but it may be rediscovered. Part of Sullivant and Lesquereux’s collection No. 190 of their Musci Boreali-Americani exsiccat (1856) was collected on wet rocks at Niagara Falls (see bryophyte section this manuscript).

*Desmatodon porteri* James ex Austin: only location reported for New York State (Ketchledge, 1980; Eckel, 1987)

*Didymodon australasiae* var. *umbrosus*, bryophyte, only location for New York State and for North America outside of New Mexico, Mexico and California (Eckel, 1986).

*Didymodon rigidulus* Hedw. G4 G5 S3 Apparently secure throughout its range (but possibly rare in parts); demonstrably secure throughout its range (however, it may be rare in certain areas). Rare in New York State (usually 21-100 extant sites).

*Didymodon tophaceus* (Br.) Lisa G5 S3 Demonstrably secure throughout its range (however, it may be rare in certain areas). Rare in New York State (usually 21-100 extant sites).

*Hyophila involuta* (Hook.) Jaeq. & Sauerb. G5 S1 Demonstrably secure throughout its range (however, it may be rare in certain areas). Critically imperiled in New York State because of extreme rarity (5 or fewer sites).

*Platydictya minutissimum* (Sull. & Lesq. ex Sull.) Crum G4 S3? Apparently secure throughout its range (but possibly rare in parts); Rare in New York State (usually 21-100 extant sites). A specimen of this plant was collected at Niagara Falls, New York in 1874 by Coe F. Austin (see bryophyte section).

*Pottia davalliana* (Sm. ex Drake) C. Jens. One of the few localities in the State (Eckel, 1987). NEW TO THE NEW YORK STATE FLORA.

*Seligeria campylopoda* Kindb. ex Macoun & Kindb. Apparently or demonstrably secure throughout its range but possibly rare in parts or in certain areas. Imperiled in New York State because of rarity (6-20 sites); rare in New York State (usually 21-100 extant sites) ? [sic].

*Seligeria recurvata* (Hedw.) BSG. Apparently or demonstrably secure throughout its range but possibly rare in parts or in certain areas. Imperiled in New York State because of rarity (6-20 sites); rare in New York State (usually 21-100 extant sites).
WEEDS

As early as 1850 Louis Agassiz noted the alien component of the vegetation in North America when he reported on his journey across Massachusetts and New York State to Buffalo that all the plants “growing on the roadsides are exotics, as are also all the cultivated plants and grasses. Everywhere in the track of the white man we find European plants; the native weeds have disappeared before him like the Indian. Even along the railroads we find few indigenous species. For example, on the railroad between Boston and Salem, although the ground is uncultivated, all the plants along the track and in the ditches are foreign” (Agassiz, 1850).

Agassiz’s “native weeds” would be pioneering, colonizing and opportunistic species taking advantage of recent disturbance, such as clearings, river margins, etc.—habitats that in the aboriginal forest were relatively uncommon. Such native “weeds” in the Goat Island complex today include shrubs such as Staghorn Sumac, and the Paniced and Red Osier Dogwoods, and many species in the Composite or Daisy family, Thistles, Goldenrods and Asters, and especially White Snakeroot (Eupatorium rugosum) on the Three Sisters. These herbs must have once been abundant on the upper end of Goat Island, which had been cleared and was undergoing stages of succession. Sumac, in fact, grew in great clonal thickets.

Goat Island’s weed flora became significant with the apparent first major disturbance event in its history—the clearing of extensive portions of its eastern boundary in the eighteenth century. With every disturbance of the original ecosystem by the addition of a road, a lawn, parkage or grading throughout the two centuries by two administrations, would come increased area in which species associated with disturbance could displace native vegetation. Many exotic species from Eurasia (honesuckles), South America (Galinsoga), west and southwestern United States (Black Locust) are opportunistic species, much as our native Asters and Goldenrods.

These kinds of plants would disappear over the years if the native ecosystem was not suppressed by intensive maintenance practices such as mowing, spreading of herbicides, soil disturbance by grading, thinning and otherwise disrupting native conditions on the islands.

Weeds do not exist in nature. This is a word representing a value judgment, even if reference is made to a “biology” of weeds in reference to their opportunistic life strategies and their place in the earliest stages of succession in an ecosystem. A weed is commonly defined as any plant growing where someone does not want it to grow. A botanist who cherishes the native flora for scientific reasons will consider exotic species as weeds, while a horticulturist, intending to impose a designed landscape over the native one will consider any plant, native or exotic, a weed if not planted intentionally. A weed is considered by agriculturists to be species in financial competition with food and other crop species for the nutrients, sunlight, space and handling of the harvest.

In terms of a historically and scientifically significant natural ecosystem such as the Goat Island flora is and has been, “weed” shall be used here to represent any species of plant inappropriately growing in the flora of the Goat Island complex, and, by extension, in the Niagara Reservation as a whole. “Appropriate” means, any species not contributing to the historic and scientific value of the property, for which it was purchased from its private owners and maintained for over a century at great expense, and for which it has been placed on the list of Historic National Landmarks by the United States Department of the Interior.

Classes of weeds in the Complex

1) Any species not native to the area of western New York and the eastern end of southern Ontario (the Niagara Frontier Region). This includes any and all exotic ornamental species.

In the past century horticultural species were added to the aboriginal flora of the Goat Island complex to beautify, or because they were available in nurseries on the mainland, or because maintenance personnel knew how to maintain them. These include
the established thickets of Japanese Barberry (*Berberis thunbergii*) in 1909 on Luna Island and elsewhere (see species catalogue). Today, there are dense infestations of old shrub plantings—of Lilac (*Syringa vulgaris*) on the tops of the southern banks, of an alien species of Dogwood (*Cornus sanguinea*), Wayfaring Tree and Guelder Rose (*Viburnum lantana* and *V. opulus* var. *opulus*), and *Acanthopanax cf. sieboldianus* on the top of the northern slope of Goat Island. The Buckthorn (*Rhamnus cathartica*) and Tartarian or Eurasian Honeysuckles and Privet (*Ligustrum vulgare*) form extensive thickets on the island margins.

Thomas Welch, first Superintendent of the Niagara Reservation, noted non-indigenous plant taxa growing in the Goat Island forest in the 1880's: barberry, coralberry, lilac and weeping willow. These plants were either placed there by the Porters during the previous decades or they may represent escapes from the mainland areas in New York and Ontario into disturbed areas in the complex. *Berberis vulgaris* (Barberry) was reported on the Island by Day (1888), but the only *Symphoricarpos* species noted by him in the Niagara area was the native one (*Coralberry is an ornamental member of this group*). Lilac was considered capable of escaping into the wild, as was weeping willow. The big exotic willows seen today, White and Crack Willows and their hybrids (*Salix alba* and *S. fragilis*) are extremely old—as their ability to stabilize riverbanks and affect drainage to some extent was early recognized.

There is another aspect of the term “weed” that makes it synonymous with the term “disease.” Many diseases are caused by an organism invading the body of another organism with the result that the invaded body is weakened or dies. Some of the most disastrous of these diseases are caused when a foreign organism is introduced into that of an organism which has evolved in a different region, and against which it has evolved no defense. Entire species can be wiped out with profound regional ecological consequences such as the present virtual extinction of the American Chestnut (*Castanea dentata*) from the Asiatic fungus *Endothia parasitica*, and the withering of populations of American Elm (*Ulmus americana*) from the fungus *Cerastomella ulmi* and an introduced bark-beetle *Scolytus multistriatus*. Both trees are important components of native American forests.

Another biological invader which has caused ecological havoc is the economic disruption of the Great Lakes fishing industry by introduction of the predatory and parasitic sea lamprey (*Petromyzon marinus*). It has been said that the Niagara River is not a river but a strait. More than a simple distinction, the fact that the Niagara is a strait means it has a fundamental connection between two great bodies of water—it is an avenue between them, and so serves a different biological role than a river with its land-bound source, or head. The Niagara strait connects the lake ecology of Lake Erie with that of Ontario. The hundred and sixty or so feet of the cataract at Niagara Falls had been an effective ecological barrier to certain organisms originating downstream in the Atlantic Ocean, or escaping from trans-ocean freight unloaded at Montreal or other port connections in the lower St. Lawrence Seaway (Elton, 1958). Apparently, with the navigational bypass in 1829 with the opening of the Welland Ship Canal, the lamprey proceeded into the upper lakes with the result that “in ten years after the lamprey invasion began to take effect, the numbers of lake trout (*Salvelinus namaycush*) taken in the American waters of Lake Huron and Lake Michigan fell from 8,600,000 lb. to only 26,000 lb.” with additional depletion of burbot, suckers and lake whitefish (Elton, 1958).

Although species may be destroyed by direct attacks on their physical integrity, as in the examples cited above, another way species may be attacked is as they are out competed for the resources (sunlight, soil nutrients, moisture) on which they depend for survival, or if their young cannot become established and the species is in existence only as long as the parents survive. Normal or natural plant communities are heterogeneous associations of a diversity of plant species and other organisms and the destructive processes of competition are a natural component of these communities, which are always changing. Species rich plant communities in the Goat Island complex include those on the island margins in wet soil, the deep central forested area, limestone pavement covered with shallow patches of soil, etc. The species diversity, due to the heterogeneity of habitat on the islands, was historically, and is, quite high—the area was noted for this characteristic among botanists and those that appreciated natural environments in the nineteenth century.

Exotic organisms, however, can be introduced into a diverse plant community which are so aggres-
sive that they out compete every other plant organism in the community, with the resulting degradation of the community structure and extirpation of species diversity within the community. Communities overrun by what may be seen as essentially disease organisms are said to present monocultures of the invading species and become ecologically barren.

The plants that the word weed implies in this case are those that tend to form monocultures: that is areas totally dominated by a species to the exclusion of the establishment of anything else. One of the advantages noxious weeds have is their ability to establish themselves before other species can. They either germinate quicker, produce more seed, keep photosynthetic leaves active throughout the winter or possess some other physiological advantage over the assemblage of species they ultimately replace.

Naturally, in high energy environments such as the cataracts at Niagara Falls and the Niagara River gorge, there is a great deal of natural disturbance by the direct energy of water, or indirectly by collapsing or spalling/sapping of the bedrock. It is this disturbance that contributed and contributes to the unusual community characteristics noted historically in these areas. Exotic monoculture species thrive on disturbance, for they establish themselves more quickly than native species that had evolved within the checks and balances provided by other species with which they had been environmentally associated for centuries or millennia.

Consequently, in the patchy, discontinuous floral assemblages throughout the gorge and the islands and river margins in the vicinity of the cataracts, there are large areas of complex native tree, shrub and herbaceous assemblages reflecting centuries of community development in place. Interspersed with these are areas composed almost entirely of exotic tree species, which have seeded themselves from plantings along the urban streets along the gorge rim above: primarily Norway Maple (*Acer platanoides*) and, on the Canadian side by the Maid-of-the-Mist landing, Sycamore Maple (*Acer pseudoplatanus*). Another Maple species spreading rapidly throughout the gorge is Box Elder (also known as Manitoba Maple, *Acer negundo*). These species are probably so successful because their tolerances are close to that of the climax Maple for the region: Sugar Maple (*Acer saccharum*). There is no reason to suppose that the native maple will ever replace the exotic maples once they have dominated the areas in which they have become established.

Another serious monoculture-forming species is the shrub Tartarian Honeysuckle (*Lonicera tartarica*), although other species of *Lonicera* have also become noxious, such as *Lonicera morrowii*, or Morrow's Honeysuckle. The planting of Tartarian honeysuckle has had disastrous consequences in one area of the Niagara Gorge north of Whirlpool State Park where picnic tables and stairs have been built. It was probably planted there decades ago. Species diversity here has dropped substantially, compared to similar areas above and below this station.

Ours is not the only area under siege by these species. Symptoms of deterioration of Illinois prairie lands are indicated by “infestations of European Buckthorn (*Rhamnus catharticus*) Tartarian honeysuckle (*Lonicera tartarica*) and garlic mustard (*Alliaria officinalis*). These aliens create thickets so dense, green up so early in spring, and hang on so late in fall, that they often drive out everything else. An especially sad (and common) landscape features forlorn, aristocratic old oaks in an unbroken sea of buckthorn—the understory kept so dark by the dense, alien shrubbery that not one young oak, not one spring trillium, not one native grass can be found ....” “In some places you can explore the preserves only by crawling for long stretches on bare dirt under the dead, thorny lower branches of buckthorn.” In the Illinois area just mentioned, controlled burns killed “most of the buckthorn and Tartarian honeysuckle” (Packard, 1988).

For example, along the gorge crest is a scientifically and historically interesting suite of species. A *Lonicera*-dominated monoculture is what is replacing this community. Some examples of species existing and known from the crest habitat and which cannot compete with the Honeysuckle are given below.

**MONOCULTURE:**
*Lonicera tartarica*

**DIVERSE CULTURE:**

**TREES**
Amelanchier sp.
Betula papyrifera
Ostrya virginiana
Quercus borealis
Tilia americana
Pinus strobus

Shrubs
Cornus rugosum
Diervilla lonicera
Ribes sp.

Rosa blanda

HERBS
Pterospora andromeda
Comandra umbellata
Smilacina racemosa
Smilacina stellata

2) A second component of the definition of weed used here, then, is: any exotic species tending to form a monoculture in the plant community in which it has become established.

The second major disturbance regime on Goat Island, other than the one produced by the river, is generated by intensive maintenance practices where the natural order of plant succession and spontaneous species establishment is suppressed by activities such as mowing, weeding, the application of herbicides and sowing of purchased seed. Such practices favor permanent weed populations and artificial monocultures of a few species of grass bearing no relationship to the native ecosystem.

In Woodland communities, the herbaceous crucifer Garlic Mustard (Alliaria officinalis) overwhelsm the complex spring ephemeral assemblages and persists to compete with subsequently emerging native woodland species. In a “Natural Regeneration” area maintained by the park on the Canadian side, this early, quick growing weed may be seen to overtop Jack-in-the-Pulpit (Arisaema triphyllum), Trillium (Trillium spp.), Toothwort (Dentaria laciniata), the False Solomon’s Seal (Smilacina spp.), Adder's Tongue (Erythronium spp.). Since Garlic Mustard is non-mycorrhizal, and plants of the lily family, which dominate the spring flora, are richly mycorrhizal, not only is the diversity of the conspicuous subaerial flora threatened by this plant, but there may exist a serious threat to the integrity of the microscopic soil flora which contributes to the vigor and success of the entire plant community.

In the same Canadian woodland noted above, one entire sector of the regenerating woods was composed of Celandine (Chelidonium majus) in the herb layer. Although Celandine has not yet been established on Goat Island, it does occur on the adjacent mainland on a wooded slope continually stripped of its native vine cover—another reason the development of vines should not be suppressed.

On the woods borders and areas where thickets are developing several shrubs, including Tartarian Honeysuckle, the following species were established and are continuing to increase their area: Buckthorn (Rhamnus cathartica), Wayfaring Tree (Viburnum lantana) and Privet (Ligustrum vulgar). Some of these, such as Lilac (Syringa vulgaris), have spread clonally. Another species to watch is Acanthopanax (Acanthopanax sieboldian). None of these invasive species has any relevance to the historical and scientific value of the Niagara Reservation, and their presence in fact degrades that value.

The recent establishment of Daffodil (Narcissus pseudo-narcissus) on Goat Island has caused the escape of this plant into the central woods where its conspicuous presence conflicts with the appearance of the native wildflower flora there. Care must be taken that Star-of-Bethlehem (Ornithogallum umbellatum or O. nutans) which has been established and is spreading vigorously on the mainland in an old homestead by the bridge to Goat Island not be introduced into the Goat Island flora.

In must also be born in mind that a process of climatic warming has been developing since the weather began to be monitored in the latter half of the nineteenth century. Since one of the principal reasons species are limited in their range is due to seasonal temperature restrictions on some aspect of their physiology, it stands to reason than certain species marginally intolerant of the length of growing season or the extent of frost typical of our area would not be able to reproduce themselves here, although individuals, once horticulturally established, survive the winter season and attain great maturity. These species might produce viable seed each year, but these cannot germinate because of unsuitable temperature regimes. As climate ameliorates, as it appears to have been doing throughout the twentieth century, there will probably come critical climatic moments when vari-
ous species will be able to establish themselves without intervention. A blanket of seeds, once shed and resident in the seed bank, and previously without an instance of germination due to climatic suppression, germinate when amelioration reaches a stage where germination becomes possible. A succession of ensuing warmer years, or warmth plus additional moisture or dryness or some such meteorological combination would ensure the survival of the seedlings. With apparent suddenness, a species once unknown to have established surviving offspring appears to have “exploded” into the flora.

The problem with planting exotics which do not appear to be spreading, such as Honey Locust (Gleditsia triacanthos) and Catalpa (Catalpa bignonioides) is that they do produce seeds in quantity every year. Presumably their seeds do not set for climatic reasons. No evidence for their spread into the flora has appeared until recently. In the Niagara River gorge both Black Locust (Robinia pseudoacacia) and both of the species just named have been found to have established themselves in the basal forest of the gorge. Young Black Locust seedlings and saplings have been recently found on the flats area on the south side of Goat Island. The interesting thing is that the members of all these species appear to have become established only within the past several decades, as though a triggering mechanism existed and their germination has been “desuppressed.” Such exotics may become overwhelming elements in the native flora as climate continues to warm, as is evident of other tree introductions, such as the Bird Cherry (Prunus avium), whose crowns, white with flowers in the spring, may be seen the length of the gorge forest, White Mulberry (Morus alba), and the Maples mentioned above. Tree ring studies of these species correlated with records of their horticultural establishment might reveal the historic decade or so when they became fully functioning members of the flora of the vicinity of Niagara Falls.

Any exotic shrub planted in the gorge area, including the islands and river margins, might become able to set seed and become noxious over time if allowed to exist adjacent to native ecosystems.

In the wet habitats on the island margins, the complex community of native species is threatened by Purple Loosestrife (Lythrum salicaria) which can severely disrupt wetland communities. Giant Hogweed (Heracleum mantegazzianum) produces dense thickets, as can be seen upriver at Buckhorn Island State Park, has established itself in two places on the islands.

Native weeds which benefit from disturbance and do tend to form monocultures to some extent, but which is appropriate within certain limits include Staghorn Sumac (Rhus typhina), note the references to its behavior in the eastern meadow before modified (see species catalogue); Slippery Elm (Ulmus rubra); Common Milkweed (Asclepias syriaca); White Snakeroot (Eupatorium rugosum); Canadian Goldenrod (Solidago canadensis); New England Aster (Aster novae-angliae); Starved Aster and Calico Aster (A. simplex and A. lateriflorus), and various thistles (Cirsium species).

Not all exotic species that have established themselves in the complex are to be considered weeds. These in themselves have scientific value: they are rare in the area (Cerastium semidecandrum, Poa chapmaniana, Sagina procumbens, Tripsacum dactyloides, etc.), or have cultural and historic value in themselves, such as the “rock garden” types of minute plants, some of which can be demonstrated to have been introduced a century ago, mostly in conjunction with activities by David F. Day. These spe-

3) Exotic species associated with the urban landscape: Chickweed (Cerastium spp.), Ox-eye Daisy (Chrysanthemum leucanthemum), Dandelion (Taraxacum officinale), Burdock (Arctium lappa, A. minor), Bitter Nightshade (Solanum dulcamara), Chickory (Cichorium intybus), Queen-anne's Lace (Daucus carota).

The above species confine themselves mostly to the margins of disturbed areas such as lawns, gardens, asphalt roads and paths. Where there is a congestion of these maintained areas, such as at the west end of the island, unless actively removed, and in the Three Sisters where native communities interact with small patches of lawn along asphalt paths, these urban weeds are most conspicuous. According to the experience of the present writer, most visitors dislike seeing these species in what they had expected to be a natural setting. These plants are what ordinary people, who confine themselves to tending their personal lawns, consider to be true weeds. They remind the visitor of carelessness and neglect.
cies include Whitlow Grass (Draba verna), Small-flowered Crane’s-bill (Geranium pusillum) and a tiny Buttercup found in the course of the present study and which cannot as yet be identified, but may be a Eurasian-Himalayan species new to the flora of New York State.

Inconspicuous, non-invasive but persistent species of both introduced and “spontaneous” establishment have scientific or biological value either in themselves because they are interesting, or because their presence as rare species in the wild distinguishes the Goat Island flora from typical floras in the region. They also reveal areas of biological importance in the complex, as they tend to cluster at habitat boundaries and other localized areas. The fact that they occur in the same general areas as the most rare native species sheds interesting light on the distribution of rare plants in general.

One species of grass which has not been reported before for the Niagara Frontier Region, Poa nemoralis, may reveal historic landscaping practices no longer in use (see species catalogue). Although, with the sudden rise in interest in historic gardens and landscapes, old garden lists of the eighteenth and nineteenth centuries have been investigated (Leighton, 1987), there has been little exploration of graminoid species used in the history of lawn-making. Lawns, although present everywhere, have received little biological attention by urban ecologists and landscape historians, although they support numerous plant species peculiar to lawns alone—primarily species growing below the height of mowing blades: on Goat Island including English Daisy (Bellis perennis), Purslane (Portulaca oleracea), Common Knotweed (Polygonum aviculare), at the lawn margins Homeless Knotweed (Polygonum achoreum), various species of Clover (Trifolium spp.) and Veronica (Veronica spp.) and so forth.

CATALOGUE AND SHORT BIBLIOGRAPHY OF NOXIOUS PLANTS IN THE GOAT ISLAND COMPLEX

Acer negundo BOX ELDER, MANITOBA MAPLE. Stations of this species in the vicinity of Niagara Falls are all recent, a conclusion based on absence of earlier reports of its occurrence in natural areas, present relative youth of trees, association with disturbed areas and rampant spreading. Old plantings in lawns just west of the Terrapin Point area have seeded heavily into the vegetation of the adjacent wooded slope in the spray zone of the Horseshoe Falls, and several seedlings and saplings have been seen at the adjacent margin of the central woods. These trees should be removed and spontaneous establishment of native trees encouraged.

Acer platanoides L. NORWAY MAPLE


Extensive plantings of this species were made on the north slope of Goat Island in the vicinity of the Spring. This tree is spreading rapidly along the north slope. Present planting practices include placing this tree in all areas of lawn on Goat Island. Note that this species is overrunning the botanically important area of Dufferin Islands in Ontario in their park system adjacent to the cataracts. Planting of this species should be discouraged and these trees should be removed.

Alliaria officinalis Andrèz. GARLIC MUSTARD.

Knoop (1986), in a request for information regarding the behavior of this species in natural ecosystems, reported this species in Ohio “turning woodlands into bleak mustard monocultures” and that it produces “large numbers of viable seeds, typical of other biennial and weedy species.” The growth of this species is considered “explosive” and “aggressive.” It prefers “moist, shaded habitat,” spreading “rapidly through mature woodlands.” The central Goat Island woods and wooded slopes are all presently heavily infested with this plant.

Hedera helix L. ENGLISH IVY.

This alien species of ground-cover has been estab-
lished by path margins in several stations in the complex, notably Luna Island, choking out a diversity of native species of herbs and seedlings of trees and shrubs. This species should be easily removed by hand pulling.

**Lonicera japonica** Thunb. JAPANESE HONEY-SUCKLE.

This species is a potential problem on Goat Island where it has been found in wet thickets near Terrapin Point. See Wagner, W. H. 1986. The Plant Press Vol. 4(3):99, who characterizes this species as a “pernicious weed which has been aggressively invading natural areas.”

**Lonicera tartarica** L. TARTARIAN [EURASIAN] HONEYSUCKLE.

“Honeysuckle controlled by hand pulling (Illinois)” R. Todd. 1985. Restoration and Management Notes Vol. 3:1 p. 41. Honeysuckle in a woody habitat was removed by hand “pulling some small shrubs after a rain storm when the ground was wet. Larger shrubs were cut to 60 cm and pulled the following year. There has been no regrowth of honeysuckle on the one-tenth ha where this method was used. Pulling can also be done after fall rains.”

Honeysuckle and Privet totally dominate one section of the east end of the First Sister and the adjacent river margin on Goat Island. Since this is one of the most pristine of the ecosystem areas in the complex, careful thought must be given to least-disruptive methods of removal. All exotic Honeysuckle shrubs should be ultimately removed from the complex.

**Lythrum salicaria** L. PURPLE LOOSESTRIFE.


“Purple Loosestrife named a noxious weed, illegal for sale, Minnesota” B. L. Harper Restoration and Management Notes, 1988 Vol. 6:2 pp. 95-96. The Minnesota State Legislature has accepted the nation’s first comprehensive statewide program to deal with the spread of this invasive plant which degrades wetland ecosystems.


Control of this weed along island margins in the Goat Island complex is needed.

**Rhamnus catharticus** L. COMMON BUCKTHORN.

“Buckthorn can be effectively controlled with careful application of herbicide to cut stumps” Hefty, R. 1984. “Buckthorn Control with 2,4-D/2, 4-DP (Wisconsin).” Restoration & Management Notes Vol. 2(1) p. 36. The herbicide was Weedone 170 (2,4-D + 2,4-DP mixed at 40g of herbicide per liter of diesel fuel to all exposed bark. The kill rate in Wisconsin after this treatment was 96 percent. “Complete drenching of all aboveground parts seems to be the key to successful treatment.”


Buckthorn has spread throughout the complex, as it has in the Niagara gorge, with old plantings visible on the north slope near the vehicular bridge. All of this species should be removed from the complex.

**Vinca minor** L. MYRTLE, PERIWINKLE.

This dense, choking ground-cover has been established throughout the complex along asphalt path margins such as on Luna Island and in woods edges at the entrances to most of the bridges, such as those to the Second Sister Island and to Green Island. This species should be easily removed by careful hand pulling, and native species allowed to reestablish themselves.

**Robinia pseudoacacia** L. BLACK LOCUST.

This tree may be considered a developing problem, as it is seeding itself along the southern slopes and new land in the rocky flats area in the river above the Horseshoe Falls from an array of mature trees planted at the escarpment or bluff-crests above these areas. It has been noted that cutting back new sprouts did little to control the spread of this species. Foliar spray with Krenite II (1:24 in water) in August was most effective, but “new


Once alien species had established themselves, they tended to persist through time, indicating that whatever the changes were in the Goat Island environment, they favored alien, opportunistic species, and not native species associated with climax plant communities (spring ephemerals, ferns, violets, woodland species generally).

Several native families and genera have lost their native members, but retained alien ones, including the Harebell family (Campanulaceae), Plantain family (Plantaginaceae); Cinquefoil (Potentilla), Columbine (Aquilegia), Thorn (Crataegus). Introduced families include an alien member of the Loosestrife family (Lythraceae) by the introduction of Purple Loosestrife (Lythrum salicaria) and the Flowering Rush family (Butomaceae) by the establishment of Flowering Rush (Butomus umbellatus).
NUMERICAL STUDIES

NUMERICAL ASSESSMENT OF FLORAL CHANGES ON GOAT ISLAND, EXCLUSIVE OF THE ADJACENT ISLANDS

The following is an account of changes in the flora of Goat Island, exclusive of other islands in the complex, based on the reports of species of plants tabulated in a publicly available database at Res Botanica Web site.

A distortion built into the figures below is caused by defining Goat Island as including island peripheral areas such as the dolomite flats on the island's south side, the limestone ledge at the edge of Terrapin Point and the base of Goat Island. These habitats are the wild habitats, isolated from maintenance activities and visitor impact. These relatively species-rich areas inflate the number of taxa presently recorded for Goat Island proper, which is profoundly impoverished by elimination of much species habitat.

The highest diversity occurs on the extreme periphery of the Goat Island platform, especially the populations of native species. These extremities are refugia from habitat elimination and alteration taking place on the island.

Note that many of the species “new” to Goat Island as a result of recent collection were noted by Day as occurring close by, perhaps on the mainland shorelines of New York and Ontario. They are not new to the vicinity, and, if common, may have simply been overlooked or disregarded if they occurred on Goat Island. Another possibility may be that, since the mainland was disturbed at an early date—by at least a century before Day’s catalogue—many weedy taxa perhaps did not occur on the Island in Day’s time, but did on the mainland. Day provided a great service by cataloguing the larger flora related to the cataract environment, of which Goat Island is only a part.

Tabulations below are for total recorded and reported number of genera and species. This figure is broken down to number of native and alien genera and species. These figures are in turn divided into number of native and alien genera and species reported up to 1940, then number of native and alien genera and species recorded since 1985. Numbers of native and alien genera and species are given for taxa extirpated or not reported since 1940, and numbers established or recorded since 1985.

“Native” refers to species that have evolved in eastern North America and were believed present in the Niagara Frontier Region before European settlement, and are based on tabulations by Zander and Pierce (1979). “Alien” refers to species introduced into the region from other floristic regions in North America and other continents. These latter are what are commonly referred to as weeds and are mainly horticultural species. These are primarily introduced by accident in garden soils, lawns or deliberately with horticultural intent.

The designations native and alien merely refer to the point of origin of a species for a particular area, and provide little biological information. However, some generalities may be made. Some species are typical of deep woods and others of open meadows. Speaking broadly, the first are generally associated with climax or near-climax habitats of shade and moisture, the second with disturbance and successional plant communities with sun and dryness. Biological strategies, such as those for pollination, seed dispersal, individual longevity, period of fruit ripening, number of offspring, will differ considerably between climax and successional species. It is unlikely that climax species from one vegetational type will persist after introduction in climax habitats of another vegetational type.

An exception may be climax tree species of one region, perhaps of the same genus as the climax tree species of another, becoming established and creating a forest in which it dominates. An example might be the new Niagara gorge forests in which Sugar Maple (Acer saccharum), the climax forest tree of the region is being replaced after disturbance by forests of alien maples composed of Sycamore Maple (Acer pseudoplatanus), Norway Maple (Acer platanoides), and Box Elder (Ash-leaved Maple, Acer negundo).

It is the opportunistic, successional species of meadows, woods boundaries, paths and pastures in their native regions that generally persist when introduced into similar habitats in other regions. Generally, habitats associated with high disturbance rates,
such as lawns and gardens, pavement boundaries and so forth, mimic habitat conditions favoring successional species. Such species, when introduced, tend to become established. With increase in disturbance of the primitive or climax woods through the past century comes a loss of climax species—all native, and an increase in the representation of alien taxa—but primarily the successional species of regions beyond the Niagara Frontier Region.

Statistics showing ever higher numbers of alien taxa on Goat Island correspond with increasing destruction of native habitat. If alien taxa were disappearing, there would be an indication that the native habitat was being allowed to recover or regenerate. This is not happening.

The single major source of disturbance affecting the following statistics is and has been maintenance policy since 1885.
NUMERICAL SUMMARY OF THE FLORA OF THE GOAT ISLAND COMPLEX
OVER THE TWO-CENTURY REPORTING PERIOD

The following figures are derived from a careful counting of species and represent all taxa reported in the literature, herbarium specimens examined and recent field work. The figures given below do not include taxa extirpated from the complex since 1940 and so indicate a higher number than are actually present.

(For the purposes of this study, it was considered that no one has made a systematic botanical study of the Goat Island complex after 1940 (limit of published records and herbarium specimens). The flora has been relatively unexamined until around 1982. Although some recent specimens may exist in storage at the Schoellkopf Geological Museum, it is assumed here that there are no substantial additions to the flora in those collections.)

Total Reports

Families: 98; Genera: 304 Species: 555
Native Genera: 221; Alien Genera: 83
Native Species: 374; Alien Species: 179

Historic records to 1940:
Native Genera: 198; Alien Genera: 39
Native Species: 313; Alien Species: 75; Total historic species: 388

Number of families reported during the course of two centuries: 100
(Note: two families occur in the complex that do not exist on Goat Island proper: Alismataceae and Selaginellaceae.)

Total number of genera reported over two centuries: 315
Total number of species reported before 1945: 399
Total number of species added to historical reports (based on field collections made since 1982): 204
Total number of species reported over two centuries: 604

Total species in the present flora, 1988: 403
Total species absent since 1945: 201

Change through time

EXTIRPATED:
Native Genera: 93 Alien Genera: 12
Native Species: 202 Alien Species: 23

INTRODUCTIONS AND NEW REPORTS:
Native Genera: 23 Alien Genera: 44
Native Species: 62 Alien Species: 104
Species Diversity in the Goat Island Complex

The highest species diversity of both native and alien plants occurs on the Second and First Sister Islands and at the base of Goat Island (diversity is probably even higher at the base since only two visits could be made there for this study).
Total Species Diversity in the Goat Island Complex.
Non-vascular plants are included (lichens, fungi, liverworts, mosses). Note that the north slope and base of Goat Island areas support a richer flora due to these inconspicuous plants, due perhaps to the higher moisture from the mist of the falls, and the north aspect. The crest is perhaps too arid to support these plants.
Three Sisters Islands.

Diversity of rare species of vascular plants, lichens, and mosses, alien species and ferns. Native species are better represented on the west than east sections for the first two Sister Islands. Note, however, the higher numbers of alien taxa (vascular plants) on the eastern ends. This alien representation may reflect the greater degree of natural disturbance and shallow to absence of soil on the eastern, upriver sections. More of the river's energy is expended on these ends, including surges in water heights and ice and debris scour.

Numbers of Species

<table>
<thead>
<tr>
<th>Island</th>
<th>S1W</th>
<th>S1E</th>
<th>S2W</th>
<th>S2E</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alien</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

First Sister Island

Second Sister Island

Third Sister Island

West section  East section  West section  East section
Three Sisters Islands.

Total diversity in numbers of species, including non-vascular plants (lichens, fungi, liverworts, mosses). Again, higher species numbers are recorded for the west sections for the First and Second Sisters than their eastern sections.

Number of Species

<table>
<thead>
<tr>
<th></th>
<th>WEST</th>
<th>EAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1W</td>
<td>Native</td>
<td>Alien</td>
</tr>
<tr>
<td>S1E</td>
<td>Native</td>
<td>Alien</td>
</tr>
<tr>
<td>S2W</td>
<td>Native</td>
<td>Alien</td>
</tr>
<tr>
<td>S2E</td>
<td>Native</td>
<td>Alien</td>
</tr>
<tr>
<td>S3</td>
<td>Native</td>
<td>Alien</td>
</tr>
</tbody>
</table>

First Sister Island

Second Sister Island

Third Sister Island

West section  East section

Botanical Heritage at the Brink of Niagara Falls
Three Sisters Islands.  Vascular Plants.

These islands are tabulated separately, due to their higher biological significance. Species are tabulated separately for the east and west sections of the first two sisters due to the complexity of their habitats and the different problems their separate management will pose. The third sister island is too small to divide into sections.

Note the higher diversity in the western sections of the First and Second Sisters (compare with tabulation of rare plants).

<table>
<thead>
<tr>
<th>Number of Species</th>
<th>Native</th>
<th>Alien</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S1W  S1E  S2W  S2E  S3
FIRST SISTER ISLAND  SECOND SISTER ISLAND  THIRD SISTER ISLAND
west section  east section  west section  east section  (vegetation confined to the extreme periphery).
DISCUSSION

Composition of the flora has changed through time, and will continue to do so. Natural populations are altered by the blowdown of large trees, which occasion provides space and sun for a certain time for herbaceous species and for young trees and shrubs to become established until the space is again filled and shaded by a tree, and the herbs are forced out. There is some evidence that this was a frequent occurrence on Goat Island before European settlement.

"... It seems likely that there was a time, probably not long ago, when other species of plants, of great beauty, were common upon the island, but which are not now to be found there. It is hardly possible that several orchidaceous plants and our three native lilies did not once embellish its woods and grassy places. Within a little while the Harebell (Campanula rotundifolia) is fast going. This is undoubtedly due to careless flower-gatherers, who have plucked and pulled without stint or reason. The same fate awaits the Sanguinaria [Bloodroot, which persists to this day], the Diclytras [= Dicentras, which have also survived] and the Trilliums [also persisting into 1988] ..." (Day, 1888).

Native peoples, the “Seneca, Tuscarora and Tonawanda Indians sold wildflowers” before Goat Island became the Niagara Reservation (The Promontory Partnership, 1981), and may to some extent have been responsible for the loss of certain species of flowers, such as Day mentioned. However, it is more likely the native peoples sold species hardy enough to become souvenirs, such as autumn sprigs of the brilliant and aromatic Climbing Bittersweet (Celastrus scandens) once sold to tourists along the Niagara River gorge. Species with desirable root-systems could have been eradicated as they became over-harvested, such as Ginseng (Panax quinquefolia), and Burning Bush (Euonymus atropurpureus) (see the species catalogue and Zenkert, 1934). George Clinton noted in his diary two instances when acquaintances asked him to locate species of wild plants desirable for medicinal reasons—one involving Common Gromwell (Lithospermum officinale) and sought for on Goat Island (populations of this introduced plant are still vigorous on the island and throughout the Niagara Gorge).

Day (1888) reported 285 native species on Goat Island, and 50 alien. Consultation with other records before 1940, which should account for all published reports of taxa observed there, has brought the number of species to 313 native, 75 alien. Since 1982 or so, native species discovered as present on Goat Island have shrunk to a total of 172 species, and the alien species count has increased to 155. Around 24 percent of the native flora has completely disappeared, and the flora of alien species has increased by 32 percent.

It must not be assumed from the species catalogue that if a species is mentioned a viable population exists. In many cases, observation has revealed only one or two individuals on the verge of extirpation from the Goat Island complex, such as False Lily-of-the-Valley (Maianthemum canadense), of which two depauperate individuals were seen at the edge of a path and which could be extirpated by one or two episodes of trampling, populations of Jack-in-the-Pulpit (Arisaema triphyllum)—two varieties of which were reported by Day (1888) as common—are represented by a few individuals, one small clump of Ramp (Allium tricoccum), also once abundant in 1888 in the central forest, and a population of American Germander (Teucrium canadense) on the Second Sister so small it escaped notice and is only included here by the assurance of another botanist (Alfred Schotz, pers. comm.). Other reports of species in the present catalogue do not suggest presence of reproducing individuals, and this may be the case with certain forest species, such as Beech (Fagus grandifolia), reduced to five or so individuals although once abundant, and Black Cherry (Prunus serotina). Many of these populations are so small or below the threshold by which they will produce offspring that a single act of man or nature could eradicate them from the Reservation altogether. This is also true in other areas in the flora of the Niagara River Gorge.

Considered on the generic level, the representation of native genera have been extirpated by 59 percent. Alien genera have increased by 52 percent.

Alteration of the central woods accounts for the heavy loss (six genera, seven species) of members of the Lily family (Liliaceae), which constitute most of the spring ephemerals blooming in the woods in spring before the leaves develop on the trees. Wood-
land violets (Violaceae) also suffered both in their reputed abundance (Day, 1901) and in the high species loss (seven species out of eight). The fern family (Polypodiaceae) has been completely eliminated from Goat Island proper (eight genera, nine species), and a few representatives only exist today on the Second Sister and at the base of Goat Island. In the Daisy family (Compositae), there has been heavy loss in the once richly diverse native genus Aster where eight out of twelve species, most of them well represented elsewhere in the Niagara gorge and associated with woods and woods edges, have been extirpated. Half of the equally diverse Goldenrod species (Solidago) have been lost (five species).

Many of the native species reported from the nineteenth century in the Daisy family that have disappeared on Goat Island probably also grew in the open prairie or meadow on the east end that was in secondary growth at that time, and which was converted to lawn early in the present century. These species are representative of the largest family of flowering plants in most parts of the temperate zone (Gleason, 1952). Certain groups, such as Goldenrods (Solidago sp.), are “native chiefly to North America, a few species extending into South America, and one or several into Eurasia; reaching its greatest complexity in eastern U.S.” (Gleason, 1952). As for the genus Aster, “in the strict sense [it] reaches its greatest complexity in eastern U.S., but some of the segregates are more highly developed elsewhere” (Gleason, 1952). Most people native to northeastern North America are surprised when visiting foreign lands not to find any of their familiar Goldenrods and Asters, even when only visiting south of the United States in subtropical to tropical Mexico when traveling in autumn—the season when species of these two genera bloom.

Visitors to the Goat Island complex whose homelands are in foreign lands would probably be fascinated by the autumn flora of the Reservation and in the Niagara River gorge. A booklet giving some key to the identification of species in these genera for foreign visitors would be valuable. These taxa are usually considered as weedy growth, which they are, favoring young areas of relatively recent disturbance. However, they are native, opportunistic taxa and very representative of the special flora that evolved in northeastern North America, and nowhere else in the world.

Several families have become eliminated due to loss of habitat. Depletion of the once abundant Beech forest component accounts for the loss of Beechdrops (Epifagus virginiana, Orobanchaceae), which is parasitic on beech (Fagus grandifolia). The sole native member of the Aristolochiaceae, Wild Ginger (Asarum canadense), was probably lost by disturbance of its woods habitat. The Heath, or Blueberry, family (Ericaceae) has been eliminated with the disappearance of four genera and species. The shrubby blueberry (Vaccinium vacillans) probably grew on the crest, or high bank on the west end where it was dry and relatively open. The other three species were probably lost by disruption of the central woods. The Phlox family (Polemoniaceae), with its two native genera and species has been lost as has the Santalaceae, with one species.

Loss of the wet, alluvial area by The Spring probably accounts for the loss of families with few members: False Mermaid family (Limnanthaceae), Lizard’s-tail family (Saururaceae), and Mezereum family (Thymelaeaceae).

Statistics for alien members of the Mint family (Labiatae) probably reflect nineteenth century interest in members of the family used for horticulture, for medicine and flavoring, especially alien members of the genus Mentha commonly known as Peppermint (M. piperita) and Spearmint (M. spicata). Some of these species were probably planted in the gardens of early settlers not for their attractiveness, but as a domestic medicinal crop. Bugle-weed (Ajuga reptans) was used for ailments such as jaundice, rheumatism, bleeding of the lungs, a “safe and mild narcotic” (Uphof, 1969) plant. Catnip (Nepeta cataria) had medicinal uses in addition to that of teasing cats. Motherwort (Leonurus cardiaca) is so-named because of its use in uterine disorders (Uphof, 1968). All of these alien species were reported as weeds growing on Goat Island in the nineteenth century—the largest representation, with seven genera and seven species, of early alien taxa of any of the families after the Compositae established by 1940.

The Bean family (Fabaceae, or Leguminosae of some texts) has lost all of its native members (four genera, seven species), and not a single one of its alien ones, to which three genera and five species have been added since 1940. Many of its members are associated closely with lawns (Trifolium or the Clovers, Lotus corniculatus, or Bird’s Foot Trefoil),
Black Locust (*Robinia pseudacacia*) has been used horticulturally on the island margins, and Crown Vetch (*Coronilla varia*) to restore disturbed soils.

Six native members of the Sedge Family (*Cyperaceae*) were probably lost when their habitats were eliminated on the east end of Goat Island (when this was covered with soil) and on dolomite flats areas, such as what is now Terrapin Point and the south side of the island in general. The Cattail family with its two species (*Typhaeae*) presently represented on the Three Sisters has been eliminated from Goat Island perhaps by the same process.

Again, native conifers such as Ground Hemlock (*Tsuga canadensis*, Taxaceae), Low Juniper (*Juniperus communis*) and Arbor Vitae (*Thuja occidentalis*, both in the Cupressaceae), all disappeared from the island, as well as nearly or all natural populations and mature individuals of other native conifers such as the White Pine (*Pinus strobus*) and Eastern Hemlock (*Tsuga canadensis*—both Pinaceae). Young planted colonies of the latter two species, however, appear to be thriving, and natural populations of Arbor Vitae occur frequently throughout the forest of the Niagara River gorge. There is a relatively high number of horticultural conifers that have been planted on Goat Island at various times for a century, and a large number of recent plantings.

One striking alteration in the flora is the presence today of nine species of the Smartweed or Buckwheat Family (*Polygonaceae*), and probably indicates loss of woodland habitat. Although numerous species were reported by Day (1888) from mostly “waste areas on the mainland,” there are no reports for members of this family anywhere in the Goat Island complex before 1940. Today there are nine species in two genera—weedy introductions and native species of disturbed or open habitats.

A suite of species associated with wet soil has been lost, probably with loss of the old wet area depicted on the 1883 Evershed map of the Niagara Reservation on the island's north shore: False Mermaid (*Floerkea proserpinacoides*), Green Dragon (*Arisaema dracontium*), Leatherwood (*Dirca palustris*), Lizard's Tail (*Saururus cernuus*), Skunk Cabbage (*Symplocarpus foetidus*), Pale Touch-me-not (*Impatiens pallida*), Poison Sumach (*Rhus vernix*), and most of these probably vanished because they grew by the heavily altered Spring area, presently dominated by old plantations of horticultural species: Buckthorn (*Rhamnus cathartica*), Lilac (*Syringa vulgaris*), Norway Maple (*Acer platanoides*), Wayfaring Tree (*Viburnum lantana*).

The island is always available for the establishment of new species. Although not researched for the present study, there is little doubt that the islands about the cataracts supported periodic influxes of migrating birds, especially water-fowl, several species of which even nested on the islands, such as Common Tern (*Sterna hirundo*), Herring Gull (*Larus argentatus*), and Ring-billed Gull (*Larus delawarensis*) (Andrle & Carroll, 1988). Some of these birds are associated with the coastline of the Great Lakes waterway; some of the diaspores of river and lake-margin plant species within the Great Lakes may be assumed to have reached the islands attached to these birds. This would be especially true of species entering the system downstream and found to migrate upstream, such as Flowering Rush (*Butomus umbellatus*).

Seeds float downstream from the shoreline of the upper Niagara River, such as those of the Giant Hogweed (*Heracleum mantegazzianum*) from stations at Beaver Island State Park, and perhaps Purple Loosestrife (*Lythrum salicaria*). It was easy to see bits of aquatic vegetation washed down from upstream habitats, such as Eel-grass (*Vallisneria americana*) and Water-weed (*Anacharis canadensis*) and bits of *Myriophyllum* and *Potamogeton*.

It is probable that quite a bit of the introduced flora of the Goat Island complex came in with “garden soil,” and other soils associated with the grading and upkeep of the lawns. Some of these species are ephemeral, found nowhere else than at the bases of recently planted trees and unlikely to spread or come up another year if for no other reason than that they will be mown or cleared away before they can become established.

The weed flora, that is, alien species introduced in a variety of ways, most intensively through horticultural maintenance activities on Goat Island, have increased dramatically. They persist in the Goat Island environment due to the high percentage of artificial, open habitats such as lawns. The ecotonal areas bordering woods and thicket areas, garden-lawn boundaries and sidewalk cracks and joints between sidewalk and masonry—where soil accumulates and cracks exist where root systems can reach through to soil—presently abound on the Island and are maintained.
As long as they are maintained, alien species will persist. The Daisy (Compositae) and Grass families (Gramineae) have proliferated mainly because large numbers of species-members, both native and alien, are opportunistic, taking advantage of any kind of disturbance in the environment to establish themselves. Native members of the Daisy and Grass family are characteristic of meadows, pastures and other open areas. Eastern North America is the center of dispersal for certain genera in the Daisy family, hence the large number of species in certain genera.

Both of these families were well represented before 1940 and are presently the largest families on the island. Still, great losses have been sustained in the representation of native species in these families: over half, or fifty percent of native members of the daisy family (27 species) have become extirpated since 1940. Eighty-four percent of the native species in the Grass family have disappeared (11 species), whereas the alien species have increased by 260 percent (accounting for the loss of one alien species since 1940).

CONCLUSIONS

a) Around half of the historic (pre-1945) flora on Goat Island and its associated islands has been extirpated. These extirpated plants are associated with the climax condition on the islands, especially the woodland flora of the central woods. Several species deliberately introduced did not remain established after 1945 or earlier.

b) Around half of the historic flora has been replaced by different species than originally existed in the complex. These new species are primarily horticultural, opportunistic (weeds) and successional.

c) Total diversity does not appear to have changed by much: the complex supports around four hundred different species of vascular plants today, as it did a century ago. Note, however, that relative abundances have changed drastically, and diversity levels vary greatly within the complex.

By around 1940 the total flora over time of Goat Island amounted to around 388 species of which approximately twenty percent were alien species and eighty percent were native. Day himself reported the loss of several species from Goat Island by 1888, although some of these he only conjectured existed there at one time, and may never have actually occurred there. Most notably some of the species reported by Douglas were not subsequently reported by botanists, and his reports seem to indicate the loss of a small boggy area during the period of private ownership. As noted above, since the area called the Spring was accessible to the public as one of the only sources of refreshment to early visitors to Goat Island, and since the course of Douglas’ description seems to indicate that he visited a boggy area on the island's north side, where the bridge and spring were, before visiting the south side, it is likely he was describing conditions at the Spring. He also noted the wet habitat was in transition—drying out. Perhaps six of his species may be said to have disappeared by Day's time. The numbers of extinctions probably would not appreciably alter the percentages.

Present records in the 1980's:
Native Genera: 126 Alien Genera: 73
Native Species: 172 Alien Species: 155
TOTAL: PRESENT SPECIES 327

In the existing flora of around 327 species, 47 percent are alien species and 53 percent are native. Of the accumulated reports up to 1940, sixty-one species could not be presently accounted for, or a 16 percent loss in the diversity of the total 1940 flora, including both alien and native representations. Note that the diversity referred to does not indicate loss of native taxa and replacement by alien species associated with
destruction of habitat, which has been ongoing throughout this century. Of the 313 native species reported for Goat Island by 1940, only 172 could be accounted for in this decade, representing a loss of fifty-five percent of the historic native flora, most of which has occurred in this century, or since state ownership of the Goat Island complex (the Niagara Reservation).

The number of exotic species, mainly due to manipulation of the native ecosystem on Goat Island, has increased by 106 percent.
BIBLIOGRAPHY


Agassiz, L. 1850. Lake Superior; its physical character, vegetation, and animals, compared with those of other and similar regions. Boston; Gould, Kendall & Lincoln.


Alec-Tweedie, Mrs. E. 1913. America as I saw it; or America revisited. Macmillan, New York.


BUF. Specimen in the Clinton Herbarium, Buffalo Museum of Science, Buffalo, New York.


——— & K. E. Miller. 1977. Late Quaternary

Cameron, R. 1893. Catalogue of the plants which have been found growing without cultivation in the Park and its outlying territories. Annual Report of the Commissioners for the Queen Victoria Niagara Falls Park. 9:appendix. [citation in Dow, 1921]


Bibliography


Goldie, John. 1819. Diary of a Journey Through Upper Canada and Some of the New England States, 1819. Privately published. In the copy seen from


Guest, Lady T. 1895. A Round Trip in North America ... Edward Stanford, London [citation in Dow, 1921].


Harvey, William Henry. 1857. Nereis Boreali-Americana. Part III—Chlorospermeae (although the fresh-water green algae were not treated due to problems in the preservation of fresh specimens).


Hennepin, F. L. 1697. A New Discovery of a Vast Country in America, extending above four thousand miles, between New France and New Mexico: with a description of the Great Lakes, Cata racts, Rivers, Plants and Animals: also the Manners, Customs and Languages of the several Native Indians: and the advantages of commerce with these different nations, &c.” Utrecht. [London, 1698].


Howitt, E. 1820. Selections from letters written during a tour through the United States in the summer and autumn of 1819. J. Dunn, Nottingham [cited in Dow, 1912].


Jennings, 0. E. 1914. Henry Willey. The Bryologist Vol. 17(2): 75-76.


Lang, 0. A. No date. David Fisher Day—Masonic Worker. mimeographed manuscript. Archives of the Buffalo and Erie County Historical Society.


Lyell, C. 1845. Travels in North America, in the years 1841-2, with geological observation on the
Mescher, D. M. [date: after 1985] Niagara Falls: Back to Olmsted’s Dream. Profile, four-page agency publication, loose-leaf format [National Park Service publication?].
Porter, Albert H. 1875. Niagara from 1805 to 1875, by an old resident. Privately printed pamphlet in Buffalo and Erie County Public Library.
———. 1900. Goat Island, in Sixteenth Annual Report of the Commission for the State Reservation at Niagara for the Year 1899. Albany, pp. 75-
Bibliography

129.


Spencer, J. W. 1907. Falls of the Niagara: Their evolution and varying relations to the Great Lakes; characteristics of the power and effects of its diversion: Geological Survey of Canada, Publication 970, 490 p.


Botanical Heritage of Islands at the Brink of Niagara Falls

and descriptions of most of the mosses peculiar to eastern North America which have not been hereto-
figures and descriptions of most of those mosses pec-

____________. 1874. Icones Muscorum, or fig-


Taylor, E. A. 1874. Icones Muscorum, or figures and descriptions of most of the mosses peculiar to North America which have not yet been figured. Supplement [posthumous], viii + 109 pp., pls. 1-81. Sever, Cambridge, Mass.


Torrey, J. 1943. A Flora of the State of New York, comprising full descriptions of the indigenous and naturalized plants hitherto discovered in the state; with remarks on their economical and medicinal properties. Vol. 1 & 2 in A Natural History of New York, Albany.

——— & A. Gray. Flora of North America, Containing Abridged Descriptions of All the Known Indigenous and Naturalized Plants Growing North of Mexico. Volume 1: Parts 1-11, 1838; Part III, 1840. Volume II:

Part 1, 1841; Part II, 1842; Part III, 1843.


Welch, Thomas V. (no date) How Niagara was Made Free. The Passage of the Niagara Reservation Act in 1885. Publication of the Buffalo Historical Society 5: 325-359.


New York State Museum and Science Service Bulletin No. 404.

Among the many travel diaries, collecting journals and other literature written by natural historians who visited Niagara Falls in the Nineteenth Century is a slim volume by the botanist John Goldie. The diary contains his observations on a trip in 1819 when he was twenty-four years old to what was known as Upper Canada and “Some of the New England States” including western New York. Mr. Goldie’s name has come down to us commemorated in the fern *Dryopteris goldiana* (Hooker) Asa Gray, better known as Goldie’s Fern. The original diary is curated by the Toronto Public Library. An edited version appeared in print in 1897, and a summary of his experiences was published in the Journal of the Edinburgh Philosophical Society in 1822 (Spawn, 1961).

Goldie’s diary is interesting because he came to the North American continent from Scotland just before many of the Victorian Ages’ major scientific accomplishments were achieved, and before the major actors of the period came on stage. This was Goldie’s first professional challenge and his mind was fresh with the expectations of his recent schooling, at that point based mostly on the authority of books and teachers, rather than that of his own experience. It was out of Scotland that Niagara received scientific attention of some international consequence in the early and later Nineteenth Century.

The distinguished botanists Sir William J. Hooker and his son Sir Joseph Dalton Hooker both were to have interests in Niagara Falls. The elder botanist was director of the Glasgow Botanic Gardens where Goldie received his education, and he underwrote Goldie’s North American trip and the following publication in the Philosophical Society. To the elder Hooker is attributed authorship of the fern named after his protégé, David Douglas, another Scot, would visit Niagara Falls in 1823 as part of a North American trip sponsored by the Royal Horticultural Society, and whose specimens from Niagara were cited in Hooker’s *Flora Boreali-Americana* (1840; Zenkert, 1934). Sir Joseph Dalton Hooker, later to become director of Kew Gardens, himself visited Niagara Falls in the company of Dr. Asa Gray in 1877, and later delivered an address before the Royal Institution of Great Britain a year later, citing the flora of Goat Island as one of two excellent examples of the distinctive richness of the Great Eastern Forest region of the United States (Turrill, 1953).

It is difficult, from the vantage of two centuries, to imagine a well educated natural historian, or scientist, such as young Goldie was, to have entertained a world view which organized the biological world according to patterns other than the ones we take for granted today, with our classifications reflecting evolutionary relationships among organisms. Every time we use binomial nomenclature, such as *Dryopteris goldiana*, to name a species, we are using a name in which is hidden the modern taxonomist’s decision on the evolutionary relationship of Goldie’s new fern to other existing ferns.

Yet in Goldie’s day, species of plants and animals were organized under a completely different system of relationships. The profound change in biological thinking which began to take definite form in Goldie’s generation had just begun. For details regarding the nature of early systems for organizing the organic world, I refer the reader to a treatment of the subject by Loren Eiseley (1961), but it may be sufficient to state that in Goldie’s day heresy still controlled the boundaries of scientific thinking. Theory must not contradict religious edict. I can only suggest the significance of some of Goldie’s interesting comments in his diary with particular reference to his experience when visiting Niagara Falls, and review how Niagara Falls came to be used as a natural time-piece against which theories based on premises involving great vistas of time could be demonstrated.

It was because Goldie approached the Falls from
the north, from York (the area around Toronto), with his mind full of pleasant apprehensions derived from the literature he had read, that he made the interesting exclamations forming the introduction to this paper. At Queenston, Ontario, he, perhaps like any young man living in the age of Napoleon, was “anxious to get upon the field of battle”—the Battle of Queenston Heights—to walk upon the recent battle grounds of the War of 1812, which had concluded with the Treaty of Ghent in 1814, and to meditate upon the death of the Englishman General Brock and the “fruits of Pride and Ambition” motivating the still rather unformed American nation to attempt to add further British dominions to their territory.

The geography Goldie began to encounter as he mounted the Heights above Queenston astonished him—not because of their intrinsic nature, but because of the gap between his expectations and the reality before him. The almost secluded concentration of erosive power in the narrow but relatively deep gorge of the Niagara River amid flat tableland gripped his intellect. As soon as he breasted the top of Queenston Heights his unbelieving eyes saw that “instead of there being a declivity, it was all level to the South & West.” “There is no perceptible rise in the land all the way to Lake Erie . . . so that it seems as if the Falls had been originally at this place.”

Even before Goldie climbed the escarpment up from the lake plain, he beheld the watergap, the entrance to the two hundred feet or so of gorge depth that lay before him. “This ridge [which he later understood to be instead the wall of the tableland to the south] is continued of exactly the same appearance on the opposite side of the river, and look as if at some period they had been joined.” Goldie was observing the continuity of rock strata exposed on facing or matching gorge walls, highly evident here due to the increased north-facing exposure of bright red layers of shale and sandstone. The stratigraphy of Niagara Falls struck him immediately—a situation which would not have happened had he arrived from the south. The modern science of geology, particularly that of the processes of stratigraphy and sedimentation, had just begun to be profoundly revised, notably through study by one of his countrymen, James Hutton, and Goldie was able to speculate on the “origin” of Niagara Falls from observations of rock features, and to formulate the temporal idea of a “period” preceding the existence of the Falls itself.

To what do we attribute Goldie’s astonishment at the levelness of terrain? “Instead of high rocks & precipices above the Falls, and low valleys & glens below them, all is perfectly level to appearance . . . there is nothing to be seen in the banks of the River that would lead you to expect any such thing as Falls at this place.” Indeed, “there is no perceptible descent in the ground all the way from Lake Erie to Queenstown so that the height of the falls is caused by the greater depth of the bed of the River below than above them.”

On the thirteenth of July, Goldie took the bridge over to Goat Island and stood looking down into the boiling cauldron of the plunge pool. The bridge had only been opened a year or so before, so Goldie may have been the first botanist of note to visit the previously inaccessible island. “It is a singular circumstance how the solid rock came to be cut to so great a depth, all the surrounding country being level”—From viewing the country here a Person would readily conclude that the Falls originally were at Queenstown—
But the time requisite for their receding so far, by the wearing of the rocks, would be a vast deal more, than, what we believe to be the duration of this earth in its present form—People who live here inform me that in the space of 30 years passed the Horse Shoe Fall has assumed its present shape from being nearly straight—Should the World continue as long as they will require to go two or three miles up the river then the Falls will be completely destroyed, for above that the bed of the river is not composed of rocks but sand.”

Here is the crux of the matter; time. How far away in time the origins of things are is a question fundamental to a perspective on the relationship between the present and the Beginning and, of course, the End. Goldie, a devout Scottish Christian, saw the Beginning in God's seven-day creation, and the ending in the Day of Judgment—an event which could very well happen before Niagara had time to erode upriver into softer sediments and collapse into rapids. Goldie saw that the evidence of Niagara Falls favored the great epochs of time required to explain all geological phenomena, evidence which would be fundamental to explaining the upcoming biological theories which would also require epochs to be consistent.

The young John Goldie was a naturalist who lived in a “pre-Darwinian” time. As a young man, he appeared to be interested, although at arms length, in the revolt of the British colonists on the east coast of North America and their further outrages against the British crown beginning in 1812. Even as he protested, in his diary, the abuses of the disloyal or revolutionary colonists, he watched with interest. As a devout Scots Christian and an intellectual, he may have also have observed with similar interest the blasphemous theories in the natural sciences which demanded more time for the workings of natural processes than allowed in the few millennia the Christians had been willing to acknowledge during the past two thousand years of European history (Eiseley, 1961). Bishop James Ussher's formulation, written around 1650 and based on accumulated inferences in the Bible, had placed the beginning of the world at 4004 B.C. The literal interpretation of the Bible was becoming increasingly difficult to integrate into scientific observations of the earth and solar system.

Since the world began, for Goldie, catastrophically (in seven days), most grand natural features owed their awesome sublimity to God's power. Huge short-term cataclysms were postulated to have thrown up the world's mountains and vast ocean deeps. But Goldie saw the cataclysmic environment of Niagara arising not in a tortuous terrain of faults and volcanics, but of flat, smooth, undisturbed farm and woodland. The regional flatness from continental glaciers and the Ice Age would be devised later in the century by Louis Agassiz—who also visited Niagara Falls, but for those of Goldie's time, the flat terrain studded with boulders bearing little relationship to the region's bedrocks was evidence of the scouring influence of episodes of great floods.

James Hutton (1726-1797), considered the father of historical geology, was also a Scotsman. He had written his Theory of the Earth in 1785 and in it he had formulated “the discovery of time in the last decade of the Eighteenth Century,” just as infinite space had been formulated in the seventeenth—the, product of astronomical discovery (Eiseley, 1961). Hutton had laid down scientific rules by which earth processes occurred, emulating those of Newton for physics, and had substituted natural for supernatural forces to explain the perceptible phenomena of the earth. The subtle, eternal processes of erosion were central to much of the length of time required to explain the existence of particular landforms. Niagara's more spectacular erosion events would be much more easily calibrated than the minute changes of sediment in the Scottish streams in which Hutton observed models of the geological processes he described. John Goldie was educated in Scotland. Perhaps it was the challenge of Hutton's ideas, published in two volumes in 1795, three years after Goldie was born, that was to color Goldie's impressions as he viewed the Falls in 1819. Hutton read his own Theory of the Earth before the Royal Society of Edinburgh in 1785 and published this paper in their Proceedings in 1788 (Eiseley, 1961). Goldie also appeared in a publication of that Society, in 1822, with an account of his two year experiences in North America (Spawn, 1961).

Geology was to provide a means of calibrating periods of earth-time by systematizing evidence of life and its organization contained in the rocks (fossils). Geology set the time required for the development of life forms throughout the duration of the planet. These ideas were essential to the framework of time and development and living processes later articulated by Charles Darwin in his theory of the evolution...
of living things.

There may have been no intellectual relationship between John Goldie and his contemporary Charles Lyell (1797-1875) who was a few years Goldie’s junior other than their familiarity with Hutton’s thinking. Lyell’s Principles of Geology was to “destroy the reigning geological doctrine and introduce unlimited time and the play of natural forces once more into geology” (Eiseley, 1961). Lyell was to have a profound effect on the formative thinking of Charles Darwin, in many ways his protégé. Lyell, in addition to his geological interests, wrote on issues of biology, formulating the ideas of competition between all organic beings, the “struggle for existence.” He “anticipated Darwin in the recognition of ecological change which could promote extinction” (Eiseley, 1961). It would take Darwin, however, to “grasp the principle [of evolution] in its full creative role” (Eiseley, 1961). The issue of recession rates of Niagara Falls, loose (recent) riverbed sediments on the banks of the Niagara River at Goat Island and the Silurian (Niagara group) fossiliferous beds exposed in the Niagara River Gorge were to provide evidence of three time-frames by which other events could be correlated, and Charles Lyell and his collaborator, the American geologist and paleontologist of the New York State Geological Survey, James Hall, were to investigate all three at Niagara. It was Hall who systematically worked out the fossil sequences in the Niagara Gorge during 1837-1843 (J. M. Clarke in Grabeau, 1901).

Charles Lyell came to Niagara in 1841. There Lyell saw “a chronometer measuring rudely, yet emphatically, the vast magnitude of the interval of years, which separate the present time from the epoch when the Niagara flowed at a higher level several miles further north across the [North American] platform ...” at Queenston, Ontario and Lewiston, New York, as Goldie had suggested before, Lyell and Hall explored the sediments on Goat Island and the terrace on the adjacent mainland, determined the sources of the sediments upstream at Buffalo, from glacial debris, and the recent ages of the buried shells (the “testaceous fauna”). Mixed with these shells of species still living in the river then, and today, were found remnants of a Mastodon—an Ice Age mammal long extinct in the region, and in the world. This evidence suggested “... how far the two events before confounded together, the entombment of the Mastodon, and the date of the first peopling of the earth by man,—may recede to distances almost indefinitely remote from each other” (Lyell, 1855). And yet, for all the great age of Niagara’s sediments and erosive development, compared to other strata explored in other areas of the earth, Niagara is young: “... however much we may enlarge our ideas of the time which has elapsed since the Niagara first began to drain the waters of the upper lakes, we have seen that this period was one only of a series, all belonging to the present zoological epoch; or that in which the living testaceous fauna, whether freshwater or marine, had already come into being. If such events can take place while the zoology of the earth remains almost stationary and unaltered, what ages may not be comprehended in those successive tertiary periods during which the Flora and Fauna of the globe have been almost entirely changed. Yet how subordinate a place in the long calendar of geological chronology do the successive tertiary periods themselves occupy! How much more enormous a duration must we assign to many antecedent revolutions of the earth and its inhabitants” (Lyell, 1855).

Such revolutions describe the evolution and extinction of floral and faunal assemblages, the present mechanisms and living evidences of which were to be detailed in Darwin’s Origin of the Species and related works. Recognizable present-day organisms can be found in old sediments—how much older must be fossils representing organisms which had “come into being” and vanished bearing no representation to any living creature? Surely all species did not come into being at one time, and become extinct—this is a process that has gone on throughout previously inconceivable periods of time, and the present is only a recent expression of this living process of biological change. Lyell used the vastly older petrified sediments of Silurian rock expose in the gorge limestones and dolomites as models to compare to the distances of the cosmos discovered by astronomers in the century before his own, based on calculations of the earth’s orbit, the distance of the sun to the nearest star and to “luminous clouds” in the night sky. “To regions of space of this higher order in point of magnitude, we may probably compare such an interval of time as that which divides the human epoch from the origin of the coralline limestone over which the Niagara is precipitated at the Falls. Many have been the successive revolutions in organic life, and many the vicissitudes in the physical geography of the globe,
and often has sea been converted into land, and land into sea, since that rock was formed “(Lyell, 1855). Amadeus Grabeau, the well-known stratigrapher and sedimentologist, who issued publications for a time through the Buffalo Society of Natural Sciences, briefly described the subsequent geological interest in establishing the age of the Falls: “The length of time required for the excavation of Niagara gorge is not merely of local interest but serves as a basis for estimating the length of time since the disappearance of the Laurentian glaciers from this region, and incidentally it has served as a chronometer for approximately measuring the age of the human race on this continent” (1901). The age of the gorge, based on a variety of evidence, is presently estimated at 12,300 years (J. C. Bastedo in Tesmer, 1981).

John Goldie may have been a small actor on the stage of scientific advancement in the first decades of the Eighteenth Century. As he stood on the brink of the Niagara River on the soil of a young, rebellious nation, looking down into the chaos of the plunge-pool of the Falls, he may have seen the great challenges to civilization in the years ahead. That he welcomed those changes may be inferred from the fact that in 1844 he took his family and emigrated to North America from the land of his birth. He settled in Waterloo County, Ontario.

Literature Cited


JOHN GOLDIE IN NORTH AMERICA
Part 2: Botanical And General Observations

by P. M. Eckel
Buffalo Museum of Science
Buffalo, NY 14211

John Goldie described his entire three-year North American itinerary in a publication of the Edinburgh Philosophical Society published in 1822 (Spawn, 1961). He had set sail for North America from Leith, Scotland, in 1817 and landed in Halifax. He then went to Montreal where he met Frederick Pursh (1774-1820), author of the two volume “Flora Americae Septentrionalis” published in 1814, which described botanical materials collected during the Lewis and Clark expedition, and which was the “first complete treatise on the plants of North America north of Mexico” (Humphrey, 1961). Pursh had been suffering from ill health and would die the year after Goldie returned to Scotland. Pursh was living in Montreal and for twelve years had been struggling to finish a flora of Canada, concentrating primarily on what is now the Province of Quebec (Humphrey, 1961). Pursh had earlier taken his North American plant collections to England, where he wrote the manuscript for his 1814 publication. It is likely he had some communication with Sir William J. Hooker, Goldie’s mentor at the Glasgow Botanical Gardens, who would himself write another North American flora in 1840 (see part one of this series). This is perhaps why Goldie chose Montreal as his first point of contact—because Pursh worked there. Although Pursh never did complete the Canadian flora, he apparently never lost sight of the importance to science of the Lewis and Clark collections from the western half of the continent for he urged Goldie to connect up with traders leaving Montreal for the north-west in the spring of the next year. This Goldie was never to do, for Pursh, perhaps too ill and perhaps not overly impressed with the young man, did not establish the connections Goldie needed to proceed into the western wilderness. This, Goldie’s successor, David Douglas, would later do, with spectacular success (see part one of this series).

It was also perhaps Pursh’s 12-year sojourn in Montreal that contributed to intellectual conditions leading to the actual publication of a two-volume flora of Canada in 1862 in French by Abbe L. Provancher, cure de Portneuf, and the rich botanical tradition in Quebec. Pursh, however, “made several important botanical excursions ... on foot and assembled important collections, especially from the Province of Quebec, but all of these were destroyed by fire. As a consequence, nothing was salvaged, and there is no record of the years of labor he had devoted to his Canadian project” (Humphrey, 1961). In the years 1812-1814 the British government had endured a further attempt at territorial expansion on the part of their former North American subjects, who had become independent of British rule during the eighteenth century and had instituted a new nation entitled the United States of America. The northern boundary of this new nation in 1814 was pretty much what it is today, south and east of Lakes Erie and Ontario and their connecting waterways, and the northern boundaries of the New England states.
British territory north of this boundary was called Canada and was divided into two provinces, Lower and Upper Canada—the generally French settlements in the east, and settlements west of these areas. Botanists and other travelers of the period mention Upper (Canada West, the Upper Province) and Lower Canada (Canada East, the Eastern Province) quite frequently, and it is useful to understand the areas included in these designations. Upper seems to refer to “upriver” in the Great Lakes. By 1855, according to a gazetteer of that year (Thomas and Baldwin, 1855), these names were obsolete. This gazetteer indicated that the boundaries of Canada proper were not fixed in 1855, except on the southern side, and did not really extend west of the prairie sections of the Great Lakes region. Canada's chief mountain chain was the Green Mountains “from the latitude of Quebec terminating between the Bay of Chaleur and Gaspe Point,” the Mealy Mountains north of these, and north again to Wotchish Mountain between the Gulf of St. Lawrence and Hudson's Bay. Far cry from the images of the Canadian Rockies today which dominate our perception of Canadian highlands! Upper and Lower Canada had been separated by the Ottawa River. “Lower Canada, or Canada East, and the peninsular portion of Canada West, is formed by the N. shores of Lakes Erie and Ontario, and the river St. Lawrence, to about long. 70° W., after which the state of Maine and the province of New Brunswick mark its N.E. limit. The W. side, again, comprising Canada West, is formed by the N. shores of Lakes Superior and Huron.” The peninsular portion terminated in Lake Erie, the southern bound-ary 280 miles in length. The eastern province terminated in Cape Gaspe. The peninsular region of Upper Canada was southern Ontario, and included the Niagara peninsula, Toronto, east to Windsor.

In his first year, Goldie walked from Montreal down through New York State to Albany, then on to New York City. He made extensive collections in the pine barrens of eastern New Jersey near Quaker's Bridge, “a country which, though barren and thinly inhabited, yet presents many rarities to the botanist, and gave me more gratification than any part of America that I have seen” (Goldie, 1822, quoted by Spawn, 1961), that is, during his three year stay. Goldie sent all these collections to Scotland, but they never arrived there, much to his disappointment. He scraped together enough money by teaching along the Mohawk River in New York before returning to Montreal where he learned he had failed to procure the patronage of Pursh. The next year, Goldie performed manual labor to support himself and botanized along the Ottawa River. These specimens, sent to Scotland, were lost in the St. Lawrence by the wreck of the ship on which they were deposited. At last, in his third year, having earned and borrowed just enough money to support his own field work, Goldie set off on his last chance to make a success of his trip to North America—the itinerary which he described in his diary of 1819.

Goldie's journal is entitled “Diary of a Journey Through Upper Canada and Some of the New England States.” His journey in Upper Canada was along the north shore of Lake Ontario from Montreal down to Niagara Falls and Fort Erie and thereon into the
states of New York and Pennsylvania. His diary does not include his visits to the New England states during the first two years of his trip, and the diary title may reflect more ambition than he was able to muster—indeed, he never published it himself, and it had only been printed privately in 1897, then heavily edited of its interesting political and social commentary (Spawn, 1961). It is to Mr. Spawn of Philadelphia, the descendants of John Goldie in Ontario and the trustees of the Toronto Public Library, who own the manuscript, that we owe thanks for having the unexpurgated version privately printed in the 1960's.

Goldie was young and eager to go somewhere, perhaps in the manner of the scholars of the French Academy invited by the brilliant young Napoleon to serve as soldiers of the French army, which was committed to one of the maddest and most successful campaigns: the conquest of ancient Egypt at the threshold of Africa, and the opening of the mysteries of its Mameluke traditions, social, political and natural historical data to an educated and curious Europe in the years just before the turning of the Eighteenth Century. Goldie was even packed and ready for an expedition to the Congo basin but was replaced at the last moment by a man with more influence (Spawn, 1961). He was ready to descend into the wilds of western North America, but was disappointed in this, too. It is almost with relief for his well being that we learn of his decision to explore the relatively civilized areas that constituted his actual exploration. The fabulous, spectacular bestselling diaries and accounts of explorers such as David Burton and H. M. Stanley in darkest Africa, where chilling accounts of barbarous traditions and events of the slave trade, of personal sickness and suffering made them imperative reading in the Victorian age set Goldie's little account in one of the minor classes of the species. Yet it is compelling reading because its author was just as serious, determined, fascinated and objective.

Six days out of Montreal, Goldie did see the spot where the corpse of a victim of a murder was found. No, not the corpse itself, but “part of the cloths still remain in the snow where he was lying.” While the great African explorers described the barbarities which lead outraged Europeans and Americans to bring the African slave trade to an end, Goldie related his dismay at one of the inns near Salina, New York, in which he lodged for the night “to witness the general inattention to even the external duties of the Sabbath, both in the States and in Canada” where the citizenry engaged in “drinking, shooting, fishing, or some such amusement, and that even by many who consider themselves to have good
moral characters.” Goldie quitted the inn in disgust. How fortunate for the young man that he did not perish on the Congo, as did the man who used his connections to take his place and as did much of the rest of that expedition (Spawn, 1961).

Goldie observed the sands that ringed Lake Ontario and impoverished the crops, being remnants of the old beaches when the Lakes were higher, or outwash and morainal deposits from what we now know to have been glacial melt sediments. Scoured, barren and uneven rocky areas ringed northern Lake Ontario, too, where farms had not been established. He was tormented by mosquitoes and blackflies day and night as he walked on foot, carrying all he owned in a knapsack, and his collections (in a collecting book— insects he kept in his hat) besides. Mosquitoes also bothered Linnaeus’ student Peter Kalm (1770), who explored the Niagara area in 1750 and in whose writings they are several times described. So prevalent were they that a traveler’s face would become covered with blood from their bites, and one’s face a swollen mass, resembling small pox, such that “people are ashamed to appear in public.” The land, especially in the glaciated regions, was much wetter than is evident now after centuries of land modifications, stream control, drainage, etc., and these insects have consequently declined, although frequently mentioned in early writings.

*Penstemon hirsutus* (L.) Willd., which grows all along the dry, wind-swept crest of the Niagara River gorge today, covered the east bank of a creek thirty miles east of the Toronto area (called by Goldie York). From here he passed through miles of “barren sandy Pine Woods, which it is probable will never be cleared” presumably due to the infertile character of the soil. More sand was observed on the cliffs of Scarborough. After having spent a productive time in the New Jersey pine barrens, Goldie was disappointed at not finding similar rarities in what the local people called the Pine Plains of York. A week was spent collecting in the woods and swamps of Lake Simcoe—still a marvelous botanical area and the type locality for one species at least, *Ranunculus rhomboideus* (Goldie); Goldie in Edinb. phil. jour. 6., p. 329, t.11 f. 1; Hook. fl. Bor-Am. I, p. 12. The type locality given as “In dry sandy fields, near Lake Simcoe, Upper Canada [Ontario Co., Ontario]” (in Jones and Fuller, 1955). Butterfly Weed (*Asclepias tuberosa*) was found there and a white-flowered *Euphorbia*. Goldie regretted his single week there for he felt new species could be found and described at this locality.

Again, “a Sandy Pine Barren” could be seen for five miles south of Toronto along the lake, so rich in botanical material that he wished “that there were more of the Pine barrens, even than what there are” and that the soils were sandy. Twenty-eight miles south of Toronto, and thirty in direct line, Goldie was met with the “incredulous surprise” of seeing a “great body of smoke on the opposite side of the Lake”—Niagara. Niagara could be heard at the same distance. Goldie now saw *Platanus occidentalis* growing naturally at the northern limit of its range. The soil along the Niagara River from Niagara-on-the-Lake to Queenston was sandy and the roads lined with cherry and peach trees, on the former of which he refreshed himself, as water was very dear.

From Queenston, Goldie ascended the escarpment and began his geological and geographic observations, some of which I have described in the first part of this series. The Whirlpool impressed him, and he observed the sheer cliff faces and the forested talus slope of the gorge walls. A 28-step ladder had been placed here from the top of the gorge to the top of the talus slope by which Goldie descended into what might have been Whirlpool Ravine today, where he found “two species of little ferns which I had not hitherto met with,” probably Maidenhair Spleenwort (*Asplenium trichomanes*) and Purple Cliff-brake (*Pellaea glabella*)—both conspicuous on the cliff-faces, and the last one in particular quite rare. He was puzzled that he could just barely make out the sound of the falls, though only a few miles south of it. So typical of the sur-
Botanical Heritage of Islands at the Brink of Niagara Falls

...that, according to Goldie, even 200 yards distant from the cataracts, the traveler could not have detected their existence. Goldie came to the cataracts from above the Niagara Moraine above what is now the Queen Victoria Park for “before getting to Table Rock you must descend a pretty steep bank at a little distance.” He was astute enough to recognize this lower area was the former bed of the Niagara River. At that time that famous dolomite ledge at the extreme flank of the Horseshoe Falls still touched water. Only seven years later (1826), the eighteen year old George Clinton would hang “with [his] body partly over Table Rock and [gaze] at the rage and turmoil below” (Zenkert, 1934). The twenty-four year old Goldie was “extremely disappointed with respect to the sound of the falling of so great a body of water ... having read that [at the bottom of the fall] the sound was there far greater than above but still had the mortification to be disappointed.” What Goldie had read, had also come to the attention of Linnaeus’s student Peter Kalm, who visited the falls in 1750, who noted “several who have spoken of these falls have declared that the roaring noise is so deafening that people ... cannot hear each other speak ... but I did not find it so” (Kalm, 1770).

Goldie observed Goat Island and that “there are 10 more Islands immediately adjoining to it, eight on the American side and two on the Canadian.” One quarter-mile downriver on the Canadian side another 28-step ladder affixed above to an Arbor Vitae tree had been set into the gorge to the top of the talus slope and he descended to the water's edge. At the bottom of the ladder “Mr. Forsyth who keeps the nearest Inn, has erected a covered stairway by which all who choose may go on paying” a fee. This lower path, obliterated since the turn of this century by power development, was “rather difficult walking ... from the quantity of loose rocks, lying along the water's edge, that have fallen from the bank” and the projecting top strata, of which, for example, Table Rock was composed, crumbled “a very small portion of them having fallen upon me ... would have been a termination of all my labors.” Here is described the wonderful sensations and danger attending the opening behind the curtain of water made by the extensive overhang of the upper strata—the precursor of the Caves of the Winds on both shores, and the air “in violent agitation” behind the curtain. It was July 12th and the vegetation on the talus slopes by the water curtain of the Horseshoe Falls presented “a number of plants which I had not hitherto observed, some of them however I had not the pleasure of seeing in blossom.” These might several weeks later have proved to have been the lovely autumn flowering Fringed Gentian (Gentianopsis procera) and Kalm’s Hypericum (Hypericum kalmianum) remarked on by other botanists in this place.

The bridge to Goat Island had just been constructed in 1818 (in 1817 the first bridge was destroyed by ice)—only one year before Goldie’s visit, such that he exclaimed “I had always considered this Island as being inaccessible to man.” No bridge had yet been made to Luna or the Three Sisters, according to the map Goldie drew in his diary. Goldie was probably the first botanist to have had opportunity to examine the primitive Goat Island flora. He was lured across the River on the ferryboat and crossed the bridge for 25 cents (children half price). David Douglas would collect on Goat Island four years later (1823) and Asa Gray, newly graduated from college in 1831, would collect botanical rarities at Terrapin Point which he would share with John Torrey and thereby begin a botanical alliance which would establish the science of botany on the American continent.

Even after only one year’s accessibility by bridge “there is a good road around the Island, and a considerable portion of the [upriver] end is cleared and at present carries a good crop of corn ... and it contains at present one log house.” The family of Peter and Augustus Porter had bought the islands at the brinks of the Falls by 1815. The clearing had been made, for turnips and an unfortunate little herd of goats by a brother of John Stecknan, survivor of the Devil’s Hole Massacre of 1763 and licensed operator of the portage on the American side when that was crown territory (Porter, 1900). This log house probably was erected during British territorial possession by the Stedman family, who enjoyed taking their visitors on the harrowing passage to the island over the shoals and shallow areas on the north side of the Niagara River immediately upstream from the rapids. The hut is depicted in Porter’s article on the history of Goat Island, was located above a natural spring on Goat Island on the north side and served as a temporary refuge for Francis Abbott, an unhappy young man whom the Porter’s permitted to live on their island for a year or so before his death—he was otherwise
known as The Hermit of Goat Island.

Goldie passed to Fort Erie, crossing to Black Rock, Buffalo, New York. The road along Lake Erie was built in the native sands there. Goldie noted “a general deficiency in the flax crop in this part of the country” south of Buffalo “owing to want of sufficient moisture.” Zenkert (1934) referred to a decline in the occurrence of a flax-parasite, Flax Dodder (*Cuscuta epilinum*) due to the decline of flax cultivation in the Niagara Frontier. In Cattaraugus, Goldie was delighted to find an expanse of swampy grown covered with *Rhododendron maximum* in flower and *Liriodendron tulipifera* with four-foot bases, called, perhaps mistakenly by Goldie, the cucumber tree by the inhabitants due to its fruit resembling a small cucumber (which rather *Magnolia acuminata* does). In the vicinity of Erie, Goldie found a water route, French Creek, from Waterford south to Pittsburgh. He stayed at an inn purporting to have boarded Joseph Bonaparte, “eldest of the Bonapartes,” brother to Napoleon, who lived in the United States from 1815 to 1844 (Spawn, 1961). Any reference to trees was to oaks, mostly in a state of regeneration, either from abandoned settlements or from fires. From Pittsburgh Goldie returned north up the Alleghany River to Olean, New York. From Olean to Angelica (32 miles) “the predominating wood is Pine, with a few of the harder woods interspersed.” He reached Bath, in Steuben Co., to Penn-Yan, to Salina in the vicinity of which Goldie observed the construction of the Erie Canal, later finished in 1825.

Governor DeWitt Clinton was governor of New York. In Auburn, New York, Goldie saw that the State was building its second prison, the first being in New York City. The Legislature had, just prior to Goldie's visit, been debating where to put this second prison. When the Porter's first made their bid to buy Goat Island “the Legislature declined to authorize the sale ... stating as its reason that it expected to use the Island itself, erecting thereon in the near future either a State prison or a State arsenal” (Porter, 1900). This is a testament to the natural impregnability and isolation the island enjoyed, and the unusual development and preservation of its ecosystem.

From Sackett's Harbor, Goldie sailed to Kingston for Montreal. Perhaps on his final return to Montreal, Goldie managed to get the roots of the species of fern which bears his name, *Dryopteris goldiana*, later published by Hooker (as *Aspidium*) in Goldie's 1822 paper. The fern was cultivated in Glasgow from these roots. The plants “which I carried with myself” were “the whole that I saved out of the produce of nearly three years spent in botanical researches.” “The botanical notes, kept separately from the diary, are believed to have been lost” (Spawn, 1961)—which accounts for why so little of a botanical nature is included in the diary. Another of the plants he collected which became type specimens includes *Helianthus microcephalus* Torr. & Gray (Gray, *Fl. N. Am.* 2:329 (1842) Type locality: “Thickets and in alluvial soil, upper Canada.' (Goldie, in herb. Hook.) Western Pennsylvania! ...” The specimens Torrey or Gray saw in Europe, in the Glasgow Botanical Garden herbarium (or Kew) where presumably Goldie's specimens were deposited, reflect the itinerary of Goldie's trip.

Acknowledgments: I would like to thank Ed Ciszek and Shaun Hardy for essential library assistance at the Buffalo Museum of Science research library. This article is part of a study of the botany associated with Niagara Falls funded by the Niagara Frontier Chapter of the Adirondack Mountain Club and the N.Y. State Dept. of Parks, Recreation and Historic Preserv-a-tion. Botanical Services, Buffalo, assisted with the cost of publication.

**Literature Cited**


Jones, G. N. & G. D. Fuller. 1955. Vascular Plants of

Joseph Darveau, Quebec.
Spawn, W. 1961. in Goldie, 1819. Ibid.
INDEX

Abbot, 158
Adam Beck, 17
Aeolus' Cave, 96
Agassiz, 44, 55, 133, 153, 158, 212, 260
algae, 98, 157, 230, 239
alien species, 277, 332
American channel, 132, 188
American Falls International Board, 18
American Staircase, 223, 227
Andrle, 314
annual reports, 6
Arbor Vitae, 86, 98, 188
asphalted path, 154
Austin, 209, 210, 261
Avery's Rock, 132
ballast, 127, 128
Bangia, 243
Barnes, 260
Bath Island, 32, 132, 137
Bath Island Bridge, 82
Beck, 213
bedrock, 16
Beech-Maple, 202
Beeton, 134
Biddle Staircase, 228
Biddle Stairs, 54, 96, 258
Bird Island, 132
birds, 204
Black Cherry, 63
Black Locust, 328
Blakeslee, 46
Botanical Garden, 232
boulder-top habitats, 178, 193
Box Elder, 326
Breen, 263
Bridal Veil Falls, 51, 97
bridge, 132, 194, 364
Brig Island, 133
Britton, 81, 148, 153, 261
Broadleaf Deciduous Forest, 201
Broadleaf Forest Corridor, 202
Brother Island, 9, 134, 178, 183, 191
bryophyte, 258
Buck, 236
Buckhorn Island State Park, 115
Buffalo Society of Natural Sciences, 232
calcereous flora, 203
Calkin, 132
Cameron, 233, 234
Canadian Falls, 233
Canal Trip, 213
cascade, 158
Cascade system, 14
Cataract Hotel, 226
Catlin, 54
Cattaraugus Indian Reservation, 49
Cave of the Winds, 95, 228
Cedar Island, 187
Celandine, 327
central woods, 64
Chamberlin, 59, 60, 87
changes in the flora, 332
channel, 23
Chapin Island, 132
chipmunk, 75
Church, 85
clay pits, 42
climate, 26
climax forest, 61
Clinton, 31, 99, 148, 213, 220, 262, 365
Clinton Herbarium, 214, 235, 236
Coastal Plain, 202
Cockburn, 189
collecting labels, 210
Commission for the Niagara Reservation, 6
Conchological Section, 43, 46
conclusions, 343
Conferva, 239
Conifer Forest, 201
Cooper, 213
crest areas, 85, 189
crestline, 189
crib-work, 23, 113
Crow Island, 132
current, 38
Darwin, 357, 358
Day, 17, 214, 222, 232, 261
De Witt, 51
destructive herbivores, 205
Detroit, 37
DeVeaux College, 59, 214
Devil's Hole, 25, 230
dewatering, 134
<table>
<thead>
<tr>
<th>Term</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>largest tree</td>
<td>206</td>
</tr>
<tr>
<td>lawn</td>
<td>127, 148</td>
</tr>
<tr>
<td>lawn-scape</td>
<td>111</td>
</tr>
<tr>
<td>Lesquereux</td>
<td>259</td>
</tr>
<tr>
<td>Letson</td>
<td>46</td>
</tr>
<tr>
<td>Lewiston</td>
<td>9, 48</td>
</tr>
<tr>
<td>lichens</td>
<td>153, 250</td>
</tr>
<tr>
<td>limestone</td>
<td>14</td>
</tr>
<tr>
<td>limestone pavements</td>
<td>202</td>
</tr>
<tr>
<td>Linnaeus</td>
<td>211</td>
</tr>
<tr>
<td>liverworts</td>
<td>258</td>
</tr>
<tr>
<td>Lockport Dolomite</td>
<td>148</td>
</tr>
<tr>
<td>Lockport Dolostone</td>
<td>15</td>
</tr>
<tr>
<td>lowered water levels</td>
<td>187, 189</td>
</tr>
<tr>
<td>Luna Island</td>
<td>73, 132, 143, 206</td>
</tr>
<tr>
<td>Lunar Trail</td>
<td>114</td>
</tr>
<tr>
<td>Lyell</td>
<td>33, 358</td>
</tr>
<tr>
<td>Macoun</td>
<td>233</td>
</tr>
<tr>
<td>made land</td>
<td>109</td>
</tr>
<tr>
<td>Maid-of-the-Mist</td>
<td>25</td>
</tr>
<tr>
<td>Marshall</td>
<td>18</td>
</tr>
<tr>
<td>massacre</td>
<td>50</td>
</tr>
<tr>
<td>Maude</td>
<td>50</td>
</tr>
<tr>
<td>Michaux</td>
<td>192, 211</td>
</tr>
<tr>
<td>microhabitats</td>
<td>153</td>
</tr>
<tr>
<td>mile-strip</td>
<td>51</td>
</tr>
<tr>
<td>mill</td>
<td>136</td>
</tr>
<tr>
<td>mist</td>
<td>31</td>
</tr>
<tr>
<td>Mitchell</td>
<td>314</td>
</tr>
<tr>
<td>Mohr</td>
<td>263</td>
</tr>
<tr>
<td>mollusk</td>
<td>33</td>
</tr>
<tr>
<td>monoculture</td>
<td>115, 154, 326</td>
</tr>
<tr>
<td>moraine</td>
<td>41</td>
</tr>
<tr>
<td>mosses</td>
<td>258</td>
</tr>
<tr>
<td>native</td>
<td>332</td>
</tr>
<tr>
<td>Natural Heritage Program</td>
<td>314</td>
</tr>
<tr>
<td>Niagara Falls Power Company</td>
<td>18</td>
</tr>
<tr>
<td>Niagara Reservation</td>
<td>48, 200</td>
</tr>
<tr>
<td>Niagara River Gorge</td>
<td>109</td>
</tr>
<tr>
<td>noise</td>
<td>127</td>
</tr>
<tr>
<td>non-native taxa</td>
<td>154</td>
</tr>
<tr>
<td>north slope</td>
<td>73</td>
</tr>
<tr>
<td>Northern Hardwoods Forest</td>
<td>201</td>
</tr>
<tr>
<td>Norway Maple</td>
<td>326</td>
</tr>
<tr>
<td>noxious plants</td>
<td>329</td>
</tr>
<tr>
<td>nursery</td>
<td>125</td>
</tr>
<tr>
<td>Nuttall</td>
<td>211</td>
</tr>
<tr>
<td>Oak-Chestnut</td>
<td>202</td>
</tr>
<tr>
<td>Oak-Hickory</td>
<td>202</td>
</tr>
<tr>
<td>Olmsted</td>
<td>88, 107</td>
</tr>
<tr>
<td>Olney</td>
<td>261</td>
</tr>
<tr>
<td>Ontario Hydro</td>
<td>26</td>
</tr>
<tr>
<td>Ozarkian element</td>
<td>202</td>
</tr>
<tr>
<td>Panton</td>
<td>38, 109, 189, 233</td>
</tr>
<tr>
<td>paper mill</td>
<td>136</td>
</tr>
<tr>
<td>parking lot</td>
<td>127</td>
</tr>
<tr>
<td>Pease</td>
<td>214</td>
</tr>
<tr>
<td>Peck</td>
<td>210, 226, 243, 259</td>
</tr>
<tr>
<td>Pettibone</td>
<td>136</td>
</tr>
<tr>
<td>pheasant</td>
<td>69</td>
</tr>
<tr>
<td>picnic area</td>
<td>127</td>
</tr>
<tr>
<td>pictures</td>
<td>189</td>
</tr>
<tr>
<td>pigeon feeding</td>
<td>120</td>
</tr>
<tr>
<td>Pleistocene</td>
<td>202</td>
</tr>
<tr>
<td>plunge pool</td>
<td>95</td>
</tr>
<tr>
<td>Point View</td>
<td>223</td>
</tr>
<tr>
<td>policies</td>
<td>208</td>
</tr>
<tr>
<td>pollution</td>
<td>32, 257</td>
</tr>
<tr>
<td>Porter</td>
<td>22, 50, 54, 105</td>
</tr>
<tr>
<td>Porter's Bluff</td>
<td>55, 105, 106, 113</td>
</tr>
<tr>
<td>Power Authority</td>
<td>26</td>
</tr>
<tr>
<td>prairie</td>
<td>203, 326</td>
</tr>
<tr>
<td>primeval forest</td>
<td>56, 59</td>
</tr>
<tr>
<td>Prospect Point</td>
<td>44</td>
</tr>
<tr>
<td>Provancher</td>
<td>233</td>
</tr>
<tr>
<td>Purple Loosestrife</td>
<td>168, 190, 328</td>
</tr>
<tr>
<td>Pursh</td>
<td>360</td>
</tr>
<tr>
<td>Queen Victoria Park</td>
<td>233</td>
</tr>
<tr>
<td>railroad</td>
<td>51</td>
</tr>
<tr>
<td>rare habitat complexes</td>
<td>313</td>
</tr>
<tr>
<td>rare lichens</td>
<td>317</td>
</tr>
<tr>
<td>rare native species</td>
<td>313</td>
</tr>
<tr>
<td>rare plants</td>
<td>314</td>
</tr>
<tr>
<td>Rau</td>
<td>260</td>
</tr>
<tr>
<td>red algae</td>
<td>242</td>
</tr>
<tr>
<td>Red Cedar</td>
<td>62</td>
</tr>
<tr>
<td>relative abundances</td>
<td>343</td>
</tr>
<tr>
<td>remedial work</td>
<td>109</td>
</tr>
<tr>
<td>retaining walls</td>
<td>75</td>
</tr>
<tr>
<td>Ring-necked Gull</td>
<td>100</td>
</tr>
<tr>
<td>Robertson</td>
<td>46</td>
</tr>
<tr>
<td>Robinson</td>
<td>236</td>
</tr>
<tr>
<td>Robinson and Chapin islands</td>
<td>132</td>
</tr>
<tr>
<td>rock fall</td>
<td>96</td>
</tr>
<tr>
<td>rodents</td>
<td>205</td>
</tr>
<tr>
<td>Russell</td>
<td>239</td>
</tr>
<tr>
<td>Sartwell</td>
<td>213</td>
</tr>
</tbody>
</table>
Third Sister Island, 178
Three Sisters Islands, 9, 152, 211
timber, 136
Tiplin, 106
Tonawanda, 136
Torrey, 109, 209, 233
tower, 105
Townsend, 214
trampling, 45, 340
Treaty of Ghent, 105
tree cover, 30
Tuckerman, 251
type specimen, 237
Underwood, 81, 261
Vaux, 107, 194
Victorian period, 211
visitors, 143
vugs, 15
water levels, 24
weeds, 115, 324
weir, 19
Welch, 22, 60, 138, 260
western prairies, 203
Whirlpool, 222, 224
White Mulberry, 328
White Pine, 62, 86, 158, 167, 342
Whitlow, 213
Wied-Neuwied, 133
Wiley, 227
Willey, 251
Wilson, 153, 241, 250
winds, 28, 65, 88, 152
winter storms, 69
Wolle, 99, 209, 241
Wood, 240
Woodhull, 17
Wright, 214
Xerothermic, 26, 202
Zenkert, 44, 201, 214

scaling, 95
scenery, 98
Schoellkopf Power Plant, 18
Schoellkopf, 17, 136
Schoellkopf Geological Museum, 334
Scovill, 223
sea lamprey, 325
Second Sister, 167
sedges, 159
sediments, 19, 33
shells, 113
Ship Island, 132, 190
slumping, 75
Smaller Fringed Gentian, 108
snails, 46
soils, 33, 44
south bank, 114
southern shore, 113
specimens, 235
spray zones, 88
St. Clair, 37
stairs, 85
Stedman, 50
stone bridge, 158
storm, 28, 152
strait, 325
strata, 15
stratigraphy, 356
Strawberry Island, 221
study area, 9
succession, 170
Sullivant, 209, 259
Suspension Bridge, 220
Table Rock, 188, 221
talus, 228, 230
talus slope, 95, 98
Tartarian honeysuckle, 326
terrace, 43
Terrapin bridge, 221
Terrapin Point, 51, 105, 107, 188
Terrapin Rock, 25
The Spring, 20, 54, 79, 341
thicket, 60