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Richard H. Zander[1] & Heinjo J. During[2]

Summary

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Neophoenix matoposensis is a newly described taxon obtained after forced growth from soil of experimental fire plots in southern Zimbabwe. It is related to three other austral genera with transparent thecae, but differs in several gametophytic and sporophytic characters. Forced diaspore bank analysis is shown to be of value in uncovering mosses that are small in stature and appear to have a short life cycle and limited time of above-ground exposure. The technique may prove useful in biodiversity analysis in general. Two similarly hyalothecoid pottiaceous species were also uncovered in soil samples from the same area: *Bryoceuthospora aethiopica* is new to Zimbabwe, *Uleobryum occultum* (of which *U. curtisii* is a new synonym) is new to Africa, having been previously known from Brazil and Australia.

Neophoenix matoposensis R. H. Zander & During, **gen. & spec. nov.** – Holotype: cultivated from spores originating from Zimbabwe, Bulawayo Region, Rhodes Matopos National Park, Matopos Sandveld (Hazelside) Fire Plots experimental area, near Maleme (20°35'S, 28°30'E), in annually burnt plot, *During 98202,* soil sampled 29 Jan 1997, plants harvested Jul 1998 (BUF; isotype: U). – Fig. 1.

Plantae breves, autoicae vel paroicae. *Caules* filo centrali atque pilis axillaribus brevibus praediti. *Folia* in KOH saturate lutescentia; ambitu lanceolata; marginibus plana vel laxe incurva, integra vel apicem versus subdentata, serie singula cellularum laevium vel vix papillosarum limbata; apice abrupte obtusa vel late acuta, mucronata; parte basali secus margines et costam protracta, parietibus cellularum tenuibus; cellulis caeteris arcte papillosis, papillis lumen obscurantibus. *Costa* dorso saepe denticulata, in mucronem acutum excurrens, cellulis faciei ventralis quadratis, stratis stereidarum binis, filo hydroideo nullo. *Seta* perbrevis. *Capsulae* cleistocarpae sphaericae late apiculatae, cellularum exothecii hyalinarum parietibus undique aequo modo tenuibus. *Calyptra* conica, scabra. *Sporae* 18-20 µm diametro, dense papillosae, brunneae.

Protonema forming a confervoid turf of branching filaments. Plants paroicous or autoicous, lacking asexual reproduction, gregarious, green. Stems 0.10-0.15 cm long, branching occasionally, rounded-pentagonal in transverse section, lacking both hyalodermis and sclerodermis, the central strand present but weak; rhizoids red, scattered in the soil; axillary hairs small, 1-2 cells in length, all cells hyaline. Cauline leaves reacting deep yellow with KOH, appressed to weakly spreading when dry, spreading to weakly recurved when moist, lanceolate, 1.5-2.0 mm long; adaxial surface broadly channelled; base broadly elliptical; distal margins plane to weakly and broadly incurved, entire or very weakly denticulate, usually bordered by 1 row of smooth or barely papillose, thick-walled cells, up to twice as long as wide,

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Fig. 1. Neophoenix matoposensis (drawn from type). – a-b, habit; c, sporophyte and calyptra; d, optical section of apex of sporophyte, showing spores through clear capsule walls; e, calyptra; f, stem, transverse section; g-l, cauline leaves; m, distal abaxial surface of costa; n, Basal leaf cells; o, marginal leaf cells; o', leaf apex; p, transverse section at midleaf; q-r, perichaetial leaves. – Scale bars: 1 (= 1 mm) for a-b; 2 (= 0.3 mm) for c & m; 3 (= 100 µm) for d-e; 4 (= 50 µm) for f & n-p; 5 (= 0.5 mm) for g-l & q-r.

running from the distal portion of the leaf base to near the apex; apex obtuse to broadly acute, excurrent in a sharp, usually oblique mucro; lamina inserted laterally on the costa; costa stout, strongly protuberant and nearly smooth to strongly denticulate abaxially, somewhat bulging but lacking outgrowths adaxially, transverse section round to short-elliptical; adaxial costa epidermis differentiated, its cells quadrate, in 5-6 rows, papillose; abaxial epidermis not differentiated, its cells elongate; adaxial stereid band present, of ca. 3-5 cells, guide cells 4 in 1 layer, hydroid strand absent; abaxial stereid band present, strong, reniform in sectional shape; basal portion differentiated in the proximal ¼-½ of leaf but rising higher both medially and along margins, cells thin-walled, rectangular, 13-15 μm long, 4-6 times as long as wide; distal medial cells subquadrate, 9-11 μm wide, crowded, solid, bearing 4-6 bifid or 1-2 multifid papillae per lumen, their cell walls evenly thickened, bulging on both sides of the lamina.

Perigonia lateral or terminal on short branches. Perichaetia terminal, their leaves similar to the cauline or the innermost leaves, very small, parenchymatous and cucullate, the outer ones 0.5-1.5 mm long, elliptical, broadly obtuse or rounded, with costa ending up to 20-25 cells below the apex, sheathing in the lower ½, with basal laminal cells parenchymatous. Sporophytes 1(-2) per perichaetium. Seta very short, with a weak area just below the theca; theca cleistocarpous, hyaline (yellow in KOH), spherical, c. 200 μm in diameter, its apiculus conical, c. 80 m long; exothecial cells quadrate, 35-45 μm wide, thin-walled. Calyptra conical, c. 400 μm long, rough with distally pointing papillae. Spores 18-20 μm in diameter, densely papillose, brown.

Etymology. – The new genus is appropriately named for the mythical bird that dies in fire and is reborn from ashes. The gender of the Latin generic name is therefore masculine.

The new genus is similar to three other austral genera, *Bryoceuthospora, Uleobryum,* and *Trachycarpidium,* by the sessile, rounded, cleistocarpic, apiculate capsules with a transparent exothecium and absent columella, the theca falling entire and without dehiscing from a weak abscission area of the seta. It differs from these three genera in its somewhat longer stems and more robust habit; the costa abaxially weakly or strongly denticulate, adaxially with quadrate cells, lacking hydroids (which may be present or absent in the other genera); the perichaetial leaves often short-elliptical, apically rounded, and with a costa ending several cells below the apex; the theca 200 μm in diameter (in other genera it is mostly 250-400 μm in diameter); and the smaller spores, 18-20 μm (as opposed to 25-35 μm) in diameter. Like *Trachycarpidium* and *Uleobryum, Neophoenix* has densely papillose trichostomoid leaves with less papillose or smooth and weakly thick-walled marginal cells. These several traits, and especially the quadrate adaxial costa cells, render the new genus quite distinctive.

Aschisma Lindb. of the Mediterranean region and central North America has a somewhat similar trichostomaceous gametophyte and cleistocarpic capsule, but the theca is brown (though somewhat translucent) and the exothecial cells are thin-walled and longitudinally elongate. A full discussion of the generic relationships of *Aschisma, Bryoceuthospora, Trachycarpidium* and *Uleobryum* is given by Zander (1993; see also Kiguchi & al., 1996).

The plants here described as new were obtained by forced growth from soil samples from the Matopos Sandveld (Hazelside) Fire Plots in the savannah region close to Matopos, Zimbabwe. This experimental field station houses a series of long-term permanent plots with differing management regimes, including various fire treatments. The type material of *Neophoenix matoposensis* emerged from soil from a plot that was burnt annually at the end of the dry season; some additional plants of the same species emerged from soil of a plot which was mown annually, and others from a control plot exempt of mowing or burning. This savannah grows on sandy, rather infertile soil of varying depth. The sands are derived from a gneissic granite rich in feldspar (Kennan, 1972). The region has a summer rainfall climate with a comparatively short rainy season. Rainfall is erratic, with annual totals varying from 260 to 1375 mm per year, averaging 585 mm (Kennan, 1972). The soil was sampled from the top 3 cm soil layer, cleaned of visible bryophyte fragments (when present), stored in plastic bags, and kept in darkness at room temperature. The samples were transported to the Netherlands on 2 Feb 1997, then stored in darkness at 4°C. On 4 Mar 1997, a thin (c. 5 mm) layer of each sample was spread out over sterilised sand in two 7 × 7 × 4 cm (length × width × depth) transparent plastic boxes with similar lids and re-moistened with sterilised water, after which the boxes were closed and placed in a greenhouse at c. 23°C. Automatic shutters prevented overheating by full sunlight. Screening and, when necessary, re-moistening with sterilised water took place every 2-3 months; in July and August 1998 most moss species had formed mature sporophytes and were collected and dried. Some cultures with *Neophoenix* were maintained, and additional sporulating material was collected in December 1998.

Several moss species were recovered in this manner (During & Moyo, 2000), including two other species of *Pottiaceae* with transparent, cleistocarpic capsules: *Bryoceuthospora aethiopica* (*During 9l8201, 98275,* BUF, U) and *Uleobryum occultum* (*During 98240, 98272*, BUF, U). The former was known from Mexico and Angola and is here reported as new to Zimbabwe; the latter had been previously known from Brazil and Australia (as *U. curtisii* I. G. Stone, a new synonym) and is new to the whole of Africa. As noted by Zander (1993), previously available authentic material of *U. occultum* and *U. curtisii* was scanty and rather similar, and the new material from Africa is variable and of intermediate features. *B. aethiopica* has weakly lens-like exothecial cells in Mexican specimens and in the type, a feature that is not evident in the material from Zimbabwe. On the other hand, the characteristic lens-like thickenings of *U. occultum* are well developed in the growth chamber material, which is similar, though perhaps somewhat more robust, to material from the wild. For this reason, we consider the lack of exothecial wall thickenings in *Neophoenix* as a character unaffected by culture conditions, and other traits are expected to match those of plants collected in the future in nature. The fact that in all three cleistocarpic *Pottiaceae* the seta has a weak spot, causing the theca to fall without dehiscing, suggests that although the spores are fairly small, the dispersal range is very restricted, as in most annual desert bryophytes (Longton, 1988). We assume that after dispersal the spores are incorporated into the diaspore bank in the soil, where they may remain viable for a long time. This assumption is supported by the fact that the soil samples from the control plot did not contain less diaspores than those from the other, managed plots (During & Moyo, 2000), although the dense litter layer in the control plot had probably prevented growth of above-ground moss shoots for many years.

In her description of *Uleobryum curtisii,* Stone (1984) mentioned that the plants were found in a year of exceptional autumn and winter rains. It may well be that the three species behave as do *Physcomitrium sphaericum* (C. F. Ludw.) Fürnr. (Furness & Hall, 1981) and *Micromitrium tenerum* (Bruch & Schimp.) Crosby (Heras & Infante, 1998), emerging from the diaspore bank only in years with very unusual weather conditions, in this case apparently in years with exceptionally high rainfall. This would partly explain why the *Pottiaceae* species are collected so rarely. Seed-bank studies are not new, nor are those focused on spores (reviewed by During, 1997). Forced growth of spores from soil samples is here demonstrated as successful in detecting moss species with apparently short life cycles and correlated short exposure time above ground. We conclude that diaspore bank study may prove a valuable tool in analysis of biological diversity in highly stressed environments, especially those with sparse, sporadic, or highly seasonal precipitation.

Key to species of Pottiaceae *with transparent cleistocarpic capsules*

1 Leaves long-elliptical, distally serrulate, distal medial cells lax (*Bryoceuthospora* H. A. Crum & L. E. Anderson) 2
– Leaves lanceolate, entire to weakly serrulate at midleaf, distal medial cells firm .. 3
2 Calyptra smooth, paroicous [Mexico, Angola, Zimbabwe] ..... *B. aethiopica* (Welw. & Duby) R. H. Zander
– Calyptra sharply conic-mamillose, rhizautoicous [Mexico] ..... *B. mexicana* (E. B. Bartram) H. A. Crum & L. E. Anderson
3 Exothecial cells of capsule medially thickened, lens-like (*Uleobryum* Broth.) ... 4
– Exothecial cells of capsule evenly thickened or nearly so 6
4 Leaves obovate, calyptra roughened with bulging cells [Mexico, Peru, Virgin Islands, Australia] ..... *U. peruvianum* Broth.
– Leaves lanceolate, calyptra nearly smooth 5
5 Leaves ovate-lanceolate, autoicous, calyptra lobed [Australia, Brazil, Zimbawe] .... *U. occultum* (G. Roth) R. H. Zander
– Leaves linear-lanceolate, dioicous, calyptra not lobed [Japan] ..... *U. naganoi* Kiguchi
6 Leaves short-lanceolate, adaxial cells of costa quadrate, exothecial cells very weakly convex, hyaline [Zimbabwe] ..... *Neophoenix matoposensis* R. H. Zander & During
– Leaves long- to linear-lanceolate, adaxial cells of costa elongate, exothecial cells usually protuberant or pustulate, yellowish (*Trachycarpidium* Broth.) 7
7 Capsules ovoid, pustulate only below the middle [Australia] ..... *T. brisbanicum* (Müll. Hal.) I. G. Stone
– Capsules spherical, evenly pustulate or colliculate 8
8 Capsules strongly pustulate [New Guinea] ..... *T. echinatum* Dixon
– Capsules nearly smooth to colliculate 9
9 Capsule apiculus large, basally half as wide as the capsule [Brazil] ..... *T. lonchophyllum* (G. Roth) R. H. Zander
– Capsule apiculus small, basally not much broader than an exothecial cell [New Caledonia] (characters from Brotherus, 1924) ..... *T. verrucosum* (Besch.) Broth.

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