



Alsophila weidenbrueckii (Cyatheaceae), a new scaly tree fern from Papua New Guinea

M. Lehnert¹

Key words

Bismarck range
Malesia
scaly tree ferns
sphaeropteroid indusia

Abstract The scaly tree fern *Alsophila weidenbrueckii* is described and illustrated as new to science. It occurs in the Bismarck range in north-eastern New Guinea at 1200–2100 m in evergreen wet mountain forest. The species reaches maturity at a comparatively old age and large size and regenerates only in intact forests on mineral soil exposed by small landslides or tree falls.

Published on 26 February 2016

INTRODUCTION

Cyatheaceae or scaly tree ferns comprise c. 600 spp. distributed in the tropics, subtropics and southern temperate regions (Smith et al. 2006). For a long time two conflicting generic systems existed for the family. Holttum (1963) recognized only one universal genus *Cyathea* with subgenera and sections based on his studies focused on Paleotropical species (Holttum 1957, Holttum & Sen 1961), whereas Tryon (1970, 1976) recognized six genera from his insights gained mainly from Neotropical taxa. A controversy ensued that was not settled during the authors' lifetime (Holttum & Tryon 1977). Genera currently supported by phylogenetic analyses and autapomorphies are *Sphaeropteris* Bernh., *Alsophila* A.Br. (including *Gymnosphaera* Blume, *Nephelea* R.M.Tryon) and *Cyathea* J.Sm. (including *Cnemidaria* C.Presl, *Trichopteris* C.Presl, *Hymenophyllopsis* Goebel). *Sphaeropteris*, characterized by petiole scales lacking differentiated margins, is usually resolved as sister to the remaining clades, which share petiole scales with differentiated margins (Korall et al. 2007, Korall & Pryer 2014). Among these, the so-called *Gymnosphaera* clade (c. 30 spp.) is sometimes resolved as sister to *Cyathea*, sometimes to *Alsophila*, but always on a weakly supported branch that collapses in strict consensus analyses (Korall & Pryer 2014). Species of the *Gymnosphaera* clade have no commonly shared character that sets them apart from the rest of the scaly tree ferns. Rather they retain characters that are interpreted as ancestral, like 64 spores per sporangium (reduced to 16 in *Alsophila*) and apical setae in the petiole scales (lost in *Cyathea*). Tryon (1970) subsumed the name *Gymnosphaera* under *Alsophila*, and it seems wiser for the stability of nomenclature to keep it that way until it has been unambiguously proven that both are not sister clades and that *Gymnosphaera* has to be resurrected as a genus to reflect natural relationships (Smith et al. 2006, Christenhusz et al. 2011, Christenhusz & Chase 2014).

Cyatheaceae are especially diverse in wet mountain forests, and many new species have been discovered in the Neotropics during the past years (see Lehnert 2011 and references therein). However, since Holttum's revisionary work of the Paleotropics (Holttum 1963, 1964, 1965, 1981a, b, 1982, Holttum &

Sen 1961), few new discoveries have been reported from the Malesian region (Hovenkamp & De Joncheere 1988, Kato 1990, Takeuchi 2007). This may speak for Holttum's insight and thoroughness, but certainly also reflects the logistic difficulties an island archipelago poses to scientific exploration.

Within the Malesian region, the island of New Guinea is still covered with pristine forests and is suspected to harbour many species unknown to science (Mittermeier et al. 2003). I was fortunate to study New Guinean scaly tree ferns in vivo during two botanical fieldtrips, first to the Vogelkop Peninsula and the area of Lake Habbema in the Indonesian part in March 2011, then to the north-eastern highlands (Bismarck range) of Papua New Guinea in August 2014. On these occasions, the community composition of the lycophytes and ferns was investigated along elevational transects from the lowland to above the tree line, with eight plots of 400 m² every 500 m (see Karger et al. 2014). The distances between the plots and most plot sites were covered by foot and across zonal and azonal vegetation types of varying degrees of degradation, so the ecological observations on the documented fern species may be regarded as exhaustive.

While working in the Bismarck range of Papua New Guinea in 2014, some juvenile tree ferns of the genus *Alsophila* (*Alsophila* clade) were found at 2065 m that showed a characteristic morphology with reddish brown trunks without petiole bases, colourful dark brown to blackish petioles and frond axes and deep green fronds. They were only seen on three occasions at the plot sites on the root discs of large overturned trees, where the young plants rooted in the still exposed mineral substrate. None were found elsewhere in the understory where other species of the genus were quite abundant in different sizes and ages. In a gorge nearby, a small group of larger plants of this species was observed with trunks to 2.5 m tall. Only after closer inspection it became clear that these, too, had germinated on a root disc of a fallen tree (of c. 80 cm trunk dbh) and despite their size and exposure to sunlight, these plants were still sterile. The species became more frequent towards lower elevations, always connected with tree fall gaps and small landslides in mature forest with little human impact. Fertile plants were first observed at 1700 m, and these were at least 4 m tall, whereas several larger plants ranging from 2 m tall growing nearby were still sterile. This is an interesting demography since most Cyatheaceae start sporulation when reaching 2 m trunk

¹ Nees-Institut für Biodiversität der Pflanzen, Rheinische Friedrich Wilhelms-Universität Bonn, Meckenheimer Allee 170, D-53115 Bonn, Germany; mlehnert@uni-bonn.de.

height if not before. This species was absent above 2200 m and below 1200 m, and was not seen in disturbed forests with open canopy and undergrowth dominated by grasses. The fertile specimen showed that the species belongs to a small group within the genus *Alsophila* that is characterized by completely closed (so-called sphaeropteroid) indusia that remain as few large, clear-cut fragments in mature sori (Holtum 1963). Based on previous field experience, it was assumed from first sight that this species was unknown to science, and consultation of literature and online resources confirmed that it is morphologically separable from all other species of the sphaeropteroid indusiate group. It is here described as new to science. Terminology of anatomical features follows Lellinger (2002) and Lehnert (2011).

***Alsophila weidenbrueckii* Lehnert, sp. nov. — Fig. 1**

A newly recognized species of *Alsophila* with sphaeropteroid indusia, bipinnate-pinnatifid to tripinnate laminae and fine scurf of setate squamules which stands out among its most similar congeners *A. archboldii* (C.Chr.) R.M.Tryon and *A. foersteri* (Rosenst.) R.M.Tryon by having dark brown petioles and frond axes (vs stramineous to pale brown), smaller petiole scales (c. 11 by 2 mm vs to 20 by 3 mm) and a sparser indument of smaller setate squamules on midveins and veins abaxially (to 0.2 mm long vs mostly 0.5–1 mm long, characteristically dense in *A. archboldii*, variable in *A. foersteri*). *Alsophila weidenbrueckii* further has long petioles that shed cleanly from the trunk (just as in *A. archboldii* vs petiole bases persisting in *A. foersteri*) and basal pinnae that are not greatly reduced in size (usually more than half the length of longest pinna, just as in *A. archboldii* vs pinnae basally tapering in *A. foersteri*). — Type: *M. Lehnert 2900* (holotype BONN (3 sheets); isotypes LAE, Z), Papua New Guinea, Madang, Madang District, plot sites of Binatang Research Center above Bundi, S05°45.337' E145°11.170', 1700 m, 8 Aug. 2014. Sterile plant with trunk 0.6 m tall; fertile parts distributed under this number come from a fragmentary collection of an adjacent plant 4 m tall and are to be treated as *M. Lehnert 2900 bis*.

Epitype. *M. Lehnert 2900 bis* (holoepitype BONN; isoepitypes LAE, Z), Papua New Guinea, Madang, Madang District, plot sites of Binatang Research Center above Bundi, S05°45.337' E145°11.170', 1700 m, 8 Aug. 2014.

Paratype. Papua New Guinea, Madang Province, Madang District, between Plot 3T-P26 and P 29, S05°45.625' E145°11.184', 2065 m, 4 Aug. 2014, *M. Lehnert 2889* (BONN, LAE, Z).

Etymology. The species is dedicated to Barbara Weidenbrück of Bonn, Germany, in recognition of her friendship and support of botanical studies.

Tree fern. *Trunk* to at least 6 m tall, erect, without old petiole bases, to 7 cm diam; pale reddish brown to stramineous scales dense on the exposed apex between the petioles and on the croziers, sparser in lower parts, long persisting as a fine cover of easily abraded pale brown scurf, epidermis pale green to dark brown beneath the scurf; frond scars ovate-elliptic, to 5 by 3 cm, remote, small ovate to elliptic lenticels present but inconspicuous, c. 9–15 by 5 mm, running down from each side of the petiole bases and frond scars in \pm converging lines; adventitious buds absent. *Fronds* to 270 cm long, loosely arranged around apex, in wide spiral in smaller plants, more approximate in a loose fascicle in larger plants, patent to arching, the tips drooping. *Petioles* to 90 cm long, inermous but densely muricate in lower half, brown to reddish brown when young due to scurf, glabrescent, dark brown to atropurpureous or blackish when older, on each side with an interrupted line of remote elongate pneumathodes, each to 20 by 2 mm, inconspicuous, brown, only present towards petiole bases; petiole scales only present in croziers, caducous in fully expanded fronds, ovate to ovate-lanceolate, to 11 by 2 mm, stramineous to dull medium brown, one apical seta, no lateral setae, margins narrow with strongly exerted cell rows, these darker brown than scale centre. *Laminae* to 180 by 120 cm, ovate-lanceolate, bipinnate-pinnatifid to tripinnate, dark green adaxially (dark olive when dried), paler greyish green abaxially. *Frond axes* atropurpureous or dark brown, inermous but rhachises and costae abaxi-

ally scabrous, costae not green-alate between the pinnules in distal half. *Pinnae* to 60 by 20 cm, sessile, towards the lamina base also stalked to 6 cm, 11–12 pairs, often opposite or nearly so, basal ones patent to weakly reflexed, more than 1/2 the length of the longest central pinnae. *Largest pinnules* to 100 by 25 mm, linear-lanceolate to narrowly triangular, sessile to subsessile, the stalk to 1 mm long and hidden between the segments, base weakly cuneate, fully pinnate in lower half, basal segments free, pinnules apically attenuate; segments to 14 by 3 mm, in smaller segments the margins subentire, in larger segments coarsely crenate to inciso-serrate, veins flat to weakly raised and not contrasting adaxially, flat to weakly immersed and contrasting dark with laminar tissue abaxially, fertile veins forked. *Sori* proximal, to 1.0 mm diam, each with c. 40 sporangia, deeply castaneous in fresh material; indusia subsphaeropteroid to sphaeropteroid without umbo, papery, brown when dry, not translucent, receptacles globose, c. 0.2 mm diam; paraphyses absent or very few, straight, shorter than sporangia, < 0.1 mm long. Spores not examined. *Hairs and scales*: Frond axes adaxially with pale brown to white, sometimes translucent multicellular hairs, antrorsely curved ones 1.0 mm long, with longer spreading ones, quite dense except on central and lower rhachises, abaxially without hairs, frond axes abaxially with ample fine scurf like indument on petioles, consisting of reddish brown, flat setate squamules to 0.2 mm long, also present on costules, midveins and veins but here paler and sparser; costules and midveins also with some larger ovate squamules to 0.6 by 0.3 mm, dark brown with reddish brown margins.

Distribution — Known so far only from the north-eastern escarpment of the Bismarck range in Papua New Guinea.

Habitat & Ecology — This species is found at c. 1200–2100 m in the understory of evergreen wet mountain forests, regenerating only on exposed mineral soil.

Notes — The epitype was collected under the same number as the type in the hope to encounter more fertile material soon afterwards, which would make this fragmentary collection disposable. Since this did not happen, the epitype *Lehnert 2009 bis* remains the only fertile material available of the species. I have chosen the sterile plant *Lehnert 2009* as type because the defining scaly indument is preserved in a better condition.

Morphologically, *A. weidenbrueckii* may be confused with *A. archboldii* and *A. foersteri*, two widespread species in New Guinea and presumably also present on adjacent islands (Holtum 1963). These species share the presence of sphaeropteroid indusia, pale petiole scales and the lack of hairs and bullate squamules abaxially on the fronds. *Alsophila weidenbrueckii* is set apart from these species by the rather sharp contrast between the pale shaggy trunk and the dark shiny, glabrescent petioles; in the other species the scales are continuous from the trunk to the petioles, which are covered by longer lasting reddish scurf that obscures the comparatively pale (matte brown to yellowish) epidermis. *Alsophila archboldii* and *A. foersteri* also differ in retaining some larger elongate scales of the crozier stage in the axils of the frond axes (vs absent in *A. weidenbrueckii*) and having larger scurf squamules (0.5–1.0 mm, on petioles also grading into larger scales vs uniformly < 0.5 mm long on petioles and frond axes in *A. weidenbrueckii*). Other species of this alliance are easily distinguished by their darker scales and scurf (most scales with darker brown central stripe in *A. nigrolineata* (Holtum) R.M.Tryon, almost uniformly dark brown petiole scales and dark brown squamellae covering the abaxial lamina in *A. percrassa* (C.Chr.) R.M.Tryon).

In Holtum's treatment of the family for the Flora Malesiana (1963: 79), *A. weidenbrueckii* may key out at couplet (54) to *Cyathea insulana* Holtum (= *A. insulana* (Holtum) R.M.Tryon). However, *A. weidenbrueckii* is distinguished by having the mid-

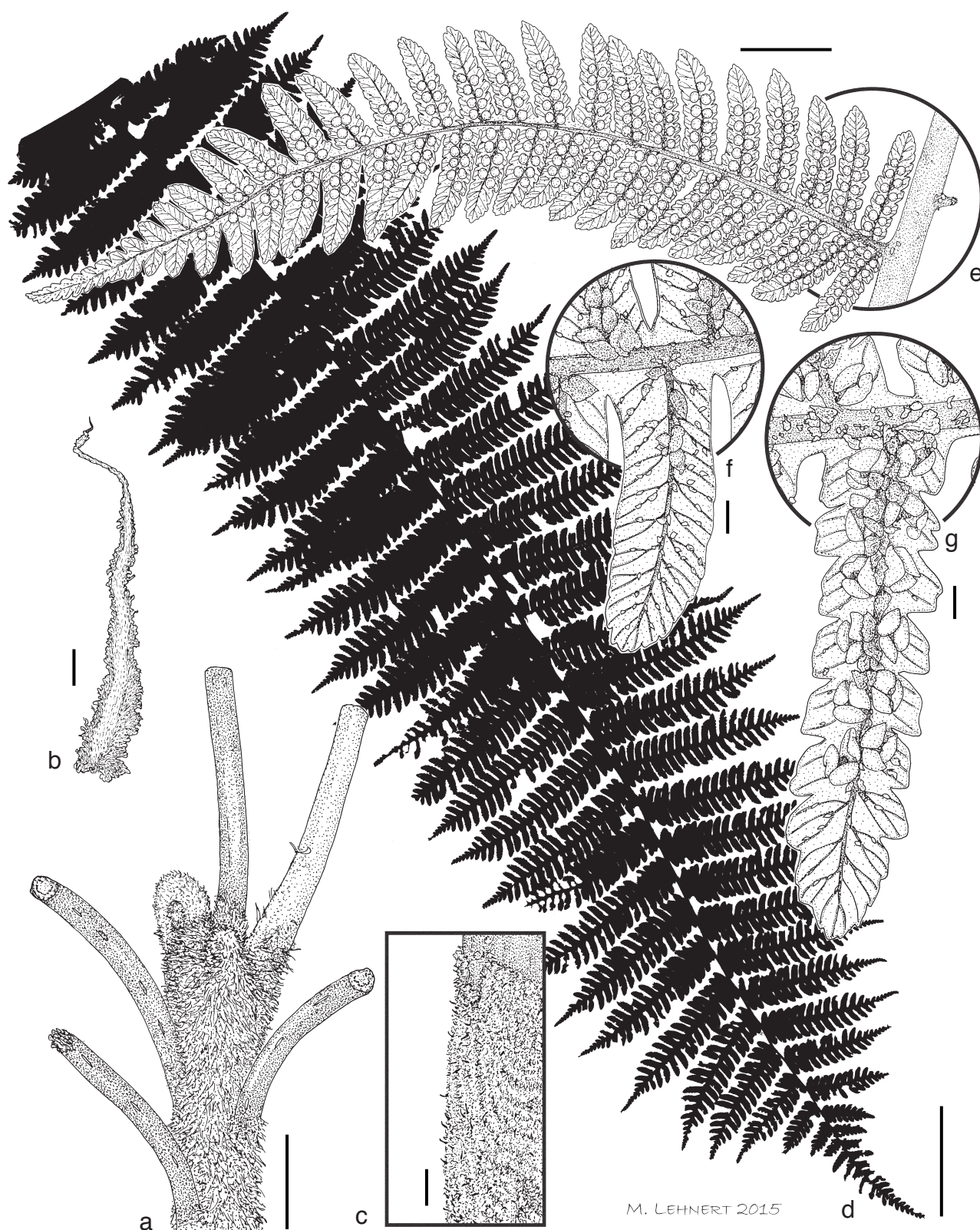


Fig. 1 *Alsophila weidenbrueckii* Lehnert. a. Trunk apex, showing loose arrangement of fronds, blades removed, showing discrepancy between pale scurfy young petiole (upper right) and glabrescent older petiole; b. scale from petiole base; c. detail of scurf, consisting of setiferous squamellae; d. medial pinna of fertile frond; e. fertile pinnules, abaxially; f. sterile segment, abaxially; g. fertile segment, abaxially (a–d, f: based on *Lehnert 2889* (BONN), e, g: based on *Lehnert 2990 bis* (BONN)). — Scale bars: a, d = 5 cm; b, c, f, g = 1 mm; e = 1 cm. — Drawing by M. Lehnert (BONN), 2015.

veins (= costules sensu Holttum 1963) not set apart so far (4 mm or less vs 5 mm or more in *A. insulana*) and having paler petiole scales (pale brown vs castaneous).

Acknowledgements I thank Michael Kessler, Dirk Karger, Jürgen Kluge, Stefan Abrahamczyk, Karola Maul, Sarah Noben, Boon-Chuan Ho, Yu-Mei Wei, Lily Lewis, Michael Sundue and Dietmar Quandt for their company in the field. I am deeply indebted to Vojtech Novotny, Pagi Toko, Elvis Tamtai, Bonny Koane and the rest of the staff of the Binatang Research Center in Madang for their indispensable help in organizing the field trip to the Bismarck range. The PNG Forest Research Institute, Lae, kindly issued the necessary permits for collecting and exporting specimens (CITES export permit number 0215-2014, file 121-17-10). Financial support for the fieldtrips by the German Research Foundation (DFG grants to Lehnert LE 1826/3 and Quandt QU 153/7) and the Swiss National Fund (SNF grants to Kessler 31003A_125468/1 & 310030L_14906/1) is greatly acknowledged.

REFERENCES

- Christenhusz MJ, Chase MW. 2014. Trends and concepts in fern classification. *Annals of Botany* 113: 571–594.
- Christenhusz MJ, Zhang XC, Schneider H. 2011. A linear sequence of extant families and genera of lycophytes and ferns. *Phytotaxa* 19: 7–54.
- Holttum RE. 1957. The scales of Cyatheaceae (with special reference to *Schizocaena* J.Sm.). *Kew Bulletin* 12: 41–45.
- Holttum RE. 1963. Cyatheaceae. *Flora Malesiana* II 1: 65–176.
- Holttum RE. 1964. The tree-ferns of the genus *Cyathea* in Australasia and the Pacific. *Blumea* 12: 241–274.
- Holttum RE. 1965. Tree-ferns of the genus *Cyathea* Sm. in Asia (excluding Malaysia). *Kew Bulletin* 19: 463–487.
- Holttum RE. 1981a. The tree-ferns of Africa. *Kew Bulletin* 36: 463–482.
- Holttum RE. 1981b. Addenda, corrigenda et emendanda. *Flora Malesiana* II, 1: 561–564.
- Holttum RE. 1982. Species of *Cyathea* in the western Pacific related to *C. multiflora* Sm. and allies in America. *Kew Bulletin* 37: 383–388.
- Holttum RE, Sen U. 1961. Morphology and classification of the tree-ferns. *Phytomorphology* 11: 406–420.
- Holttum RE, Tryon RM. 1977. An exchange of views on the Cyatheaceae. *Flora Malesiana Bulletin* 30: 2835–2842.
- Hovenkamp PH, De Joncheere GJ. 1988. Additions to the fern flora of Sulawesi. *Blumea* 33: 395–409.
- Karger DN, Weigelt P, Amoroso VB, et al. 2014. Island biogeography from regional to local scales: evidence for a spatially scaled echo pattern of fern diversity in the Southeast Asian archipelago. *Journal of Biogeography* 41: 250–260.
- Kato M. 1990. Taxonomic studies of pteridophytes of Ambon and Seram (Moluccas) collected by Indonesian/Japanese botanical expeditions IV. Tree fern families. *Journal of the Faculty of Science, Imperial University of Tokyo, Botany* 14: 369–384.
- Korall P, Conant DS, Metzgar J, et al. 2007. A molecular phylogeny of scaly tree ferns (Cyatheaceae). *American Journal of Botany* 94: 873–886.
- Korall P, Pryer KM. 2014. Global biogeography of scaly tree ferns (Cyatheaceae): evidence for Gondwanan vicariance and limited transoceanic dispersal. *Journal of Biogeography* 41, 2: 402–413.
- Lehnert M. 2011. The Cyatheaceae (Polypodiopsida) of Peru. *Brittonia* 63: 11–45.
- Lellinger DB. 2002. Modern multilingual glossary for taxonomic pteridology. American Fern Society.
- Mittermeier RA, Mittermeier CG, Brooks TM, et al. 2003. Wilderness and biodiversity conservation. *Proceedings of the National Academy of Sciences* 100: 10309–10313.
- Smith AR, Pryer KM, Schuettpelz E, et al. 2006. A classification for extant ferns. *Taxon* 55: 705–731.
- Takeuchi W. 2007. *Cyathea lamoureuxii* (Cyatheaceae): a remarkable new species from the Papuan peninsula of New Guinea. *Blumea* 52: 147–152.
- Tryon RM. 1970. The classification of the Cyatheaceae. *Contributions from the Gray Herbarium* 200: 3–50.
- Tryon RM. 1976. A revision of the genus *Cyathea*. *Contributions from the Gray Herbarium* 206: 19–98.