Polystichum manickamianum (Dryopteridaceae), a New Species from South India

A. Benniamin
Botanical Survey of India, Arunachal Pradesh Circle, Itanagar, 791 111, India.
fernsbenni@yahoo.co.in

C. R. Fraser-Jenkins
Student Guest House, Thamel, P.O. Box 5555, Kathmandu, Nepal. chrisophilus@yahoo.co.uk

V. Irudayaraj
Centre for Biodiversity and Biotechnology, Department of Plant Biology and Biotechnology, St. Xavier's College (Autonomous), Palayamkottai 627 002, Tamil Nadu, India.
fernraj@yahoo.co.in

ABSTRACT. A new pteridophyte species, *Polystichum manickamianum* Benniamin, Fraser-Jenkins & Irudayaraj, is described and illustrated from the Agasthiar Hills, South Western Ghats, South India. It is a member of *Polystichum* Roth sect. *Macropolystichum* Daigobo (Dryopteridaceae) and is distinguished from its nearest relatives by its relatively short, wide fronds with large, ovate-rhombic, crenate, dark green pinnules with submarginal sori, sparsely hairy upper stipe, rachis, and costae, and by the absence of subapical proliferous bulbils on the rachis. It is endemic to Tamil Nadu, South India, and is considered to be Critically Endangered (CR) based on IUCN Red List criteria. A key is provided to South Indian *Polystichum*, and some problematic related names are discussed. A lectotype is designated for *Aspidium tacticopterum* Kunze. *Polystichum kunthianum* B. K. Nayar & Geevarghese is newly synonymized into *P. subinerme* (Kunze) Fraser-Jenkins.

Key words: Agasthiar Hills, Dryopteridaceae, IUCN Red List, sect. *Macropolystichum*, *Polystichum*, pteridophyte, South India.

The genus *Polystichum* Roth (Dryopteridaceae) contains about 250 or more species in Asia (Fraser-Jenkins, 1991, 1997), with 46 species known from India and the introduction of a 47th here. Although the sections of the genus present in South India are also represented in the Indo-Himalayan region, only three species are found in both of these phytogeographical regions—*P. piceopaleaceum* Tagawa, *P. mucronifolium* (Blume) C. Presl (sect. *Metapolystichum* Tagawa), and *P. squarrosum* (D. Don) Fée (section *Duropolystichum* Fraser-Jenkins)—and the first and last species mentioned have a slightly different range of morphological variation between the north and south. A further four species are known to be present in South India, occurring in the Western and Eastern Ghats, namely: *P. harpophyllum* (Zenker ex Kunze) Sledge (sect. *Polystichum*), the very rare *P. anomalum* (Hooker & Arnott) J. Smith (forma *travancoricum* (Beddome) Fraser-Jenkins), *P. subinerme* (Kunze) Fraser-Jenkins, and *P. palniense* Fraser-Jenkins (Fraser-Jenkins, 2008b) (sect. *Macropolystichum* Daigobo). Accounts of most of the South Indian species have been given by Manickam and Irudayaraj (1992, 2003), although the names used there have been revised and further details given by Fraser-Jenkins (1991, 1997). *Polystichum walkerae* (Hooker) Sledge, *P. harpophyllum*, *P. biaristatum* (Blume) T. Moore (sect. *Macropolystichum*), *P. anomalum*, *P. mucronifolium*, and *P. piceopaleaceum* are present in adjacent Sri Lanka.

Of two problematic South Indian *Polystichum* names that could apply to the new species, the first, *P. tacticopterum* (Kunze) T. Moore, described from the Nilgiri Hills, was utilized by Sledge (1973) and some subsequent authors to refer to *P. mucronifolium* until revised by Fraser-Jenkins (1991). Apart from the lectotype designated below, no other possible type of Kunze's appears to exist in B, BM, JE, K, LZ, TUB, W, or other herbaria, and many of the Rev. B. Schmid's collections from Ootacamund were destroyed in 1944 in Kunze's main herbarium by British bombing in Leipzig during World War II. Kunze mentioned that he had only seen a single, but distinctive frond. In his careful and detailed description, he mentioned it as having a coriaceous indusium, which immediately appears to preclude *P. mucronifolium* and previously led Fraser-Jenkins in June 1990 to doubt whether the

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lectotype below represented the correct species. However, from Kunze's original description of only a slightly coriaceous, wide (12.5 × 5 in.), truncate-based lamina; approximate pinnae; minute, truncate, trapezoid-ovate pinnules that are minutely rusty-scaly beneath and have large, adpressed, aristate-serrate teeth and crenations; and the rachis with very large, biformed, rusty scales (but an incomplete stipe), *Aspidium tacticopterum* Kunze appears most likely to refer to the fairly common Nilgiri species, *P. mucronifolium*, a name mentioned only tentatively and adjacent to it by Kunze. Difficulty is only caused by its apparently differing significantly in having a coriaceous, brown indusium, whereas that of *P. mucronifolium* is diagnostically very thin and usually vestigial to absent. However, the very large rachis-scales are highly diagnostic for *P. mucronifolium*, and all other features agree well with it as opposed to all other South Indian *Polystichum* species. The species is therefore lectotypified here from the specimen suggested by Sledge (1973), with the name apparently written by Kunze, although Alston annotated it as being by Reichenbach and stated on it, "S. India: Nilgiris, Schmid 28 (type)." It is assumed here, as by Fraser-Jenkins (1991: 276), that Kunze's description of the indusium must, unusually, have been due to some confusion, rather than its being as variable in this species as suggested by Sledge.

Polystichum mucronifolium (Blume) C. Presl, Abh. Königl. Böhm. Ges. Wiss., ser. 5, 6: 415. 1849 [1851]. Basionym: *Aspidium mucronifolium* Blume, Enum. Pl. Javae 2: 164. 1828. TYPE: Java. *Blume s.n.* (holotype, L).

Aspidium tacticopterum Kunze, Linnaea 24: 210. 1851. *Polystichum tacticopterum* (Kunze) T. Moore, Index Filic. 105. 1858. TYPE: India. "India orientalis," s.d., s. coll., s.n. (lectotype, designated here, W [Hb. C. Koch, Hb. Musei Palat. Vindob.]).

The second name requiring study is *Polystichum moluccense* (Blume) T. Moore, which was first put forward tentatively by Fraser-Jenkins (1991) as the identity of the species now called *P. palniense* Fraser-Jenkins (Fraser-Jenkins, 2008b). *Polystichum palniense* is indeed closely related to *P. moluccense*, but is not conspecific, differing in having less finely lobed pinnules and in not having the abundant narrow fibrillose scales on the axes of the latter. The South Indian plant was then reidentified as being *P. kunthianum* B. K. Nayar & Geevarghese (Nayar & Geevarghese, 1993) by Fraser-Jenkins (1997: 209), on the basis of material of *P. palniense* mistakenly sent to him as authentic for *P. kunthianum* by Geevarghese in 1981. But on recently studying the immature, barely fertile holotype and isotype of *P. kunthianum*, it turns out that this was a further misidentification as the types are not *P. palniense*, but a poor specimen of *P. subinerme*, with more rhombic, less long-acute pinnules, submarginal sori, and extended frond apices as is the condition in the proliferous *P. subinerme*. It is too juvenile a plant to have developed subapical proliferous bulbils, although some narrowed pinna bases shortly below the apex are suggestive that it would have developed bulbils at those points had it matured further. *Polystichum subinerme* is present at Silent Valley, and thus *P. kunthianum* is reduced here to the synonymy of *P. subinerme* and *P. moluccense* is clarified as a name misapplied to *P. palniense* and not present in either India or Sri Lanka.

Polystichum subinerme (Kunze) Fraser-Jenkins, Aspects Pl. Sci. 13: 265. 1991. TYPE: India. Nilgiris, s.d., *Kurr s.n.* (holotype, K). Figure 1.

Polystichum kunthianum B. K. Nayar & Geevarghese, Fern Fl. Malab.: 214–216. 1993. Syn. nov. TYPE: India. Walakkad Forest, Silent Valley, West Nilgiri Hills, s.d., *K. [K. Geevarghese] 10661* (holotype, CALI; isotype, CALI).

The southernmost section of the Western Ghats, often known as the Southern Ghats, which lie in Tamil Nadu state, is an unusually rich floristic area with a high concentration of endemic plants (Henry et al., 1984; Ahmedullah & Nayar, 1987), more so than other comparable areas in South India. They have also been less well collected than higher parts of the Western Ghats until more recently by Father Manickam. The Tirunelveli Hills, which include the Agasthiar Hills, are one of the so-called hot spots of biodiversity in the Indian flora (Davis et al., 1995; Nayar, 1996). The presence of an undescribed species there is therefore not as unexpected as it might be in other better-known areas of the Western Ghats.

After publication of preliminary pteridophyte floras of the Western Ghats and Nilgiri Hills based on their new collections (Manickam & Irudayaraj, 1992, 2003), further revision of a number of pteridophytes has become necessary from time to time. Thus, one of Father Manickam's collections from the Agasthiar Hills, which had previously been listed under *Polystichum subinerme*, appeared distinctly different in its frond morphology and was preliminarily recognized by Manickam and Irudayaraj (2003) as an unnamed variation of the species. This is now recognized, below, as a distinct new species.

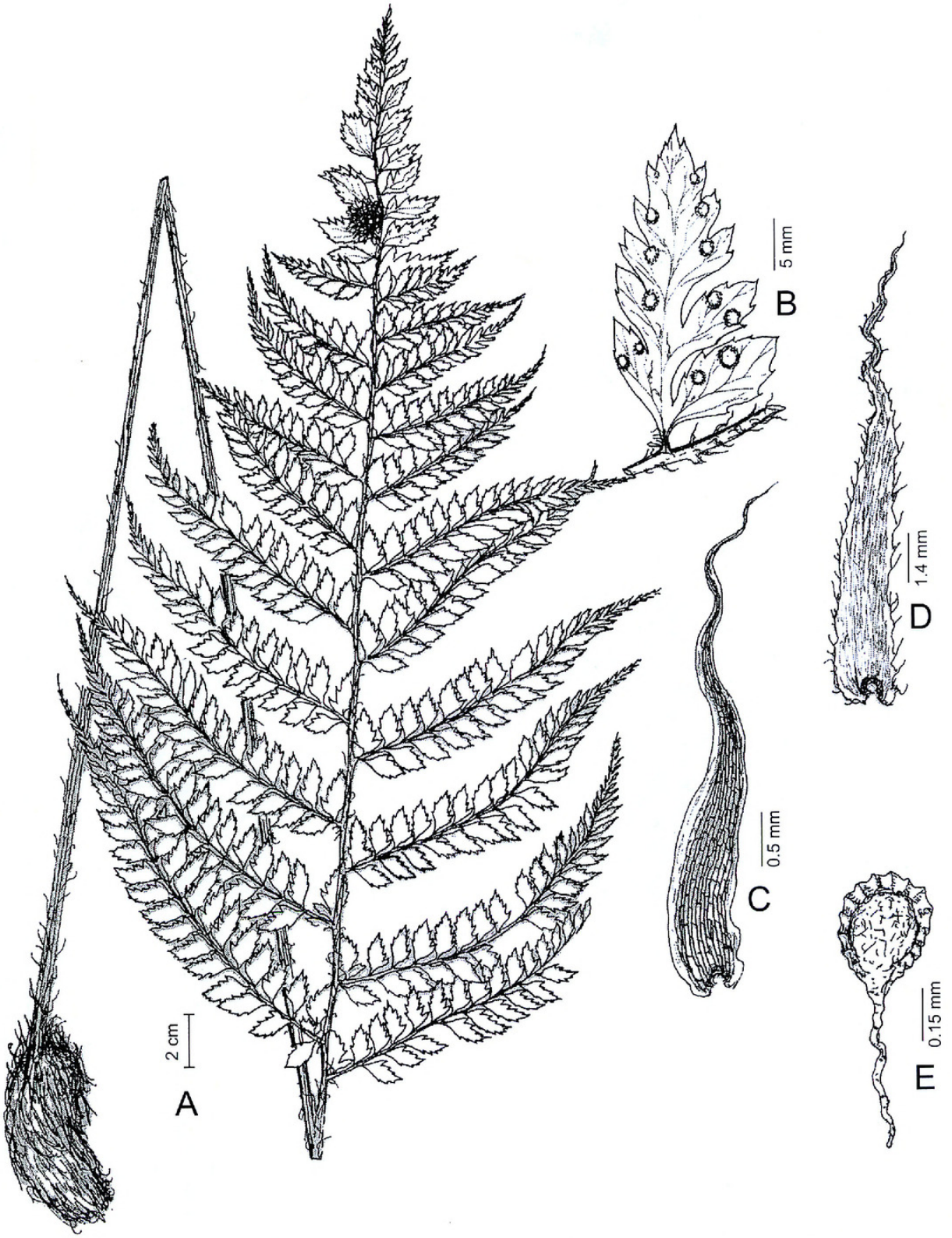

Figure 1. *Polystichum subinerme* (Kunze) Fraser-Jenkins. —A. Habit. —B. Lower median pinnule. —C. Stipe base scale. —D. Middle stipe scale. —E. Sporangium. Drawn from *V. S. Manickam XCH 1433* at XCH (India. Tamil Nadu: Nilgiri Dist., Kotagiri taluk, Kodanadu Valley shola [wood], 1800 m, 12 Feb. 1992).

Polystichum manickamianum Benniamin, Fraser-Jenkins & Irudayaraj, sp. nov. TYPE: India. Tamil Nadu: Tirunelveli Dist., Ambasamudram taluk, Kannikkatty Hills, Sangumuthirai (just below Agasthiar hilltop), stream banks, fully shaded, forest interior, 1500 m, 9 Apr. 1985, *V. S. Manickam RHT 32403* (holotype, RHT; isotypes, MH, XCH). Figure 2.

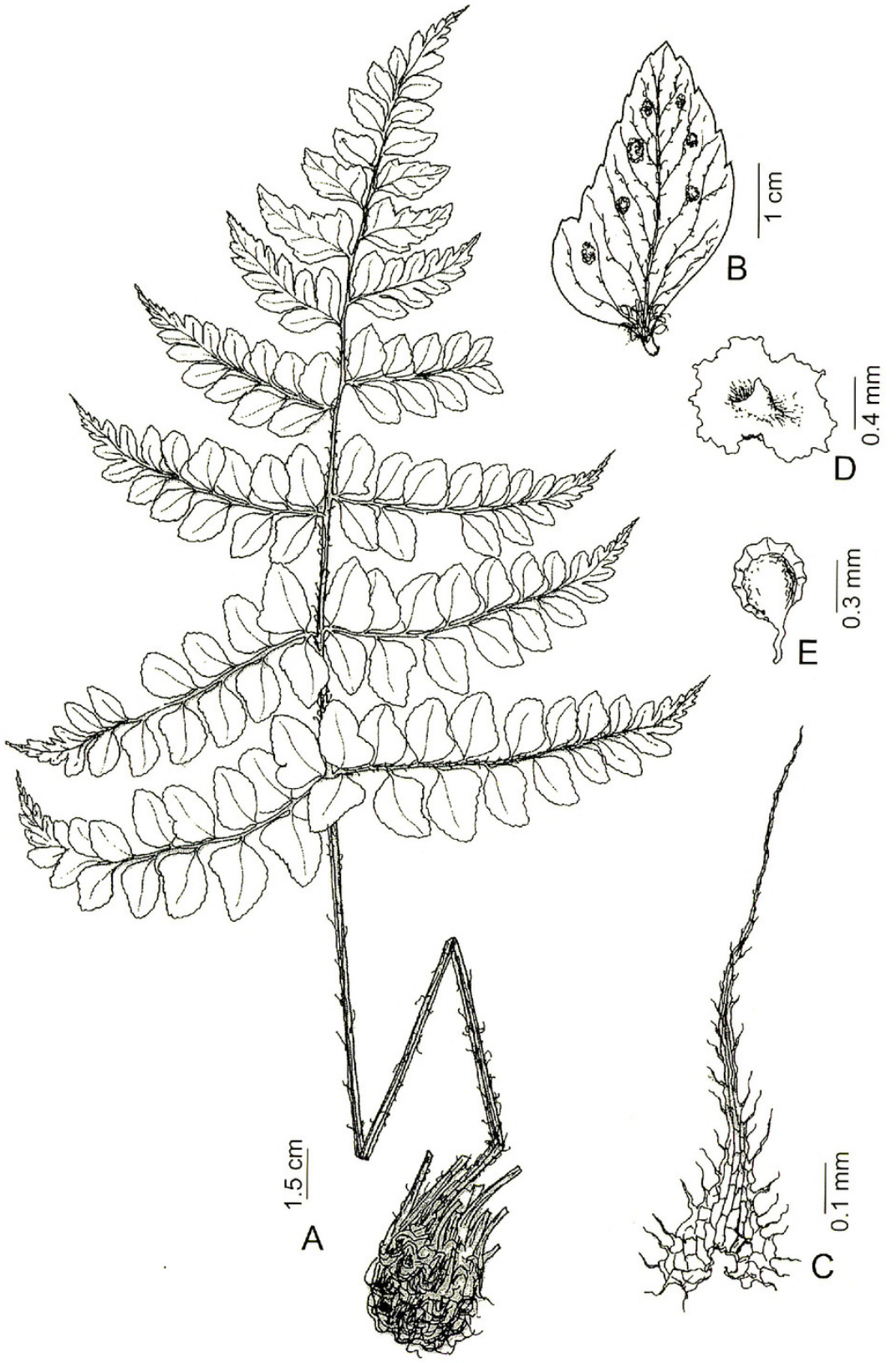

Figure 2. *Polystichum manickamianum* Benniamin, Fraser-Jenkins & Irudayaraj. —A. Habit. —B. Lower median pinnule. —C. Stipe base scale. —D. Indusium. —E. Sporangium. Drawn from the isotype, *Manickam RHT 32403* (XCH).

Species bene distincta; *Polysticho scarioso* (Roxburgh) C. V. Morton et *P. subinermi* (Kunze) Fraser-Jenkins affinis, sed rhizomate breve, erecto, stipite sparse paleaceo, paleis superioribus linearibus rufo- vel atro-brunneis, fronde brevi latissime deltata, segmentis magnis ovato-rhombiformibus crenato-dentatis, soris submarginalibus distinguitur.

Rhizome short, erect, ca. 8 cm thick, densely scaly at its apex. Fronds to 60 cm tall, arising in a tuft or crown-like arrangement, erecto-patent; stipe ca. 30 cm long, densely scaly only at its base, sparsely so above, scales lanceolate, dark reddish brown with a

scarious margin, fimbriate edges, and attenuated, acute apices, becoming linear or hair-like above; rachis and costae bearing scattered, pale brown hair-like fibrils; lamina ca. 30 × 20 cm, bipinnate, but rather abruptly becoming pinnate as it suddenly narrows toward the apex, deltate-lanceolate and widest from the middle to base, stiff-coriaceous, dark green adaxially when alive; pinnae ca. 5 to 12 pairs, the largest ca. 10 × 2 cm, borne at right angles to the rachis, elongated-rectangular, abruptly narrowing to acute apices, the lowest acroscopic pinnule sometimes enlarged and more lobed, pinnate; pinnules ca. 10 to 14 pairs, markedly stipitate with stalks ca. 0.2 cm, large, ca. 1 × 0.5–0.75 cm, the basal acroscopic pinnule of each pinna sometimes enlarged and deeply lobed, the rest ovate-rhombic, with ± obtusely narrowed apices, or the pinnule sometimes ± square with rounded corners in outline, markedly asymmetrical, the acroscopic base enlarged into a wide, rounded auricle, crenate at the edges, with a single acuminate, cartilaginous tooth at the apex; sori rather few and well apart, in 2 submarginal lines on each side of the pinnule, indusiate; indusium brown, thin, shrivelling and partly dropping off on ripening; spores non-abortive, rather large, ca. 45–48 μm, regular in size, dark brown, perisporiate with short rounded folds of perispore.

Distribution and habitat. Despite *Polystichum manickamianum* being known only from three collections from one locality on a single hilltop, this species is nevertheless so distinct that we have no hesitation in recognizing it as a new species.

It is presumed to be a species of Southeast Asian affinity, in keeping with most of the species of *Polystichum* sect. *Macropolystichum*. It is probably most closely related to *P. subinerme* and *P. scariosum*. Many other South Indian endemic ferns are of Southeast Asian affinity and, in some cases, have been found to be pseudo-endemics, already known from Southeast Asia, or otherwise the Himalayan region or tropical Africa (Fraser-Jenkins, 2008a).

Relationships and taxonomy. Polystichum subinerme is a very large, long-fronded species with many pinnae, bearing small, rounded-rhombic to acute-apexed pinnules with submarginal sori. The stipe is densely covered with pinkish brown, often widely lanceolate scales and the attenuated frond apex bears two to four scaly, subapical proliferous bulbils in the axils of the small upper pinnae, which are often missing a basal acroscopic lobe where the bud is borne. Although often reported from Southeast and East Asia in error, mainly for *P. scariosum*, it is a very rare species (with the potential IUCN status of Critically Endangered [CR], assessed by Chandra et al., 2008) that is confined as a South Indian endemic species to the Nilgiri Hills (Western Ghats) and Shevaroy [Servarayan] Hills (Eastern Ghats). In both areas, it is rare and decreasing with the increasing destruction of the forest cover by fire and cutting, and Chandra et al. (2008) have identified both *P. subinerme* and the new species *P. manickamianum* as two of 13 special Indian endemic target species for cases to be made for inclusion in the IUCN Red List (IUCN, 2001) as Critically Endangered (CR) species for India. We correct here the erroneous citation of *P. subinerme* (including specimen nos. *XCH 1367* and *1433*, cited below), together with *P. palniense*, under the name *P. moluccense* by Manickam and Dominic Rajkumar (1999), which partly explains the apparent polymorphicity and different cytotypes they described.

On 28 February 1987, Fraser-Jenkins misidentified a specimen (*Manickam 32444*) shown to him by Father Manickam as being a small specimen of *Polystichum subinerme*. But on his seeing its photograph (in Manickam & Irudayaraj, 2003) and going to South India to see the whole collection as well as a living plant grown in the Tropical Botanic Garden, Thiruvananthapuram (Trivandrum), by Raju Antony, it became obvious that it was a distinct species previously unrecorded from India. It differs from *P. subinerme* (which is not known from the Agasthiar Hills) in being a much shorter-fronded species, with a thinner stipe, bearing only a few, scattered, darker reddish brown scales and a wider-based, relatively wider frond, with obviously larger segments. Significantly, it is also without subapical proliferous bulbils, unlike those in *P. subinerme*.

The new species is also related to *Polystichum scariosum*, found in Southeast Asia, east Indo-Himalayas, Burma/Myanmar, Thailand, and China, and is placed here in the same section (sect. *Macropolystichum*). However, *P. scariosum* is a large, long-fronded species and has the middle to upper pinnules on each pinna decurrent to the costa and hardly basally auriculate, not markedly stalked or stipitate as in *P. manickamianum*. It also has a subapical proliferous bulbil toward the tip of each frond, though not always present on all fronds.

On Fraser-Jenkins' further investigation of the various Southeast Asian and Chinese species of the section, the status of *Polystichum manickamianum* as a new species was confirmed. It is named in honor of its collector, Rev. Dr. V. S. Manickam (b. 1941), of St. Xavier's College, Palyamkottai (formerly at Trivandrum [Thiruvananthapuram] University and St. Joseph's College, Tiruchchirappalli), the well-known pteridologist and indefatigable botanical collector and teacher in South India.

Cytology. The paratype of *Polystichum manickamianum* (*RHT 32444*) has been investigated by Irudayaraj (Manickam & Irudayaraj, 1988, sub *P. subinerme*) and found to have $n = 82$ (82 bivalents in the spore mother cells) at meiosis. However, no mitotic count has been carried out to ascertain whether it is a sexual tetraploid or an apomictic diploid species. Unfortunately, most of the spores have been shed in the material collected, and no further information is available as to the number of spores in the sporangia, which would also cast light on its mode of reproduction.

Polystichum subinerme from the Nilgiri Hills (Droog to Pathirakaliamman Koil path, 1700 m, *V. S. Manickam XCH 1367*) also had 82 bivalents at meiosis, but so far no mitotic count has been carried out. However, Benniamin has subsequently found that the above specimen only has ca. 7% normal sporangia containing 32 normal spores, the rest producing abortive spores. The percentage of normal sporangia he reports here is surprisingly low compared to many known apomicts, but this nevertheless suggests that the taxon may perhaps be an apomictic diploid ($n = 2n = 82$), although further study and the possibility of hybridity need to be considered. The spores of *P. subinerme* from the Shevaroy Hills are reported here by Fraser-Jenkins to be mostly fully formed (cultivated at the Botanical Garden, Yercaud, from Shevaroy Temple hill, near Yercaud, 5 Feb. 2007, *C. R. Fraser-Jenkins s.n.*, TAIF). The sample contains predominantly nonabortive, rather large spores, with a surface ornamentation of many small papilla-like wings of perispore, but occasional giant, spherical spores are also present.

Unfortunately, much confusion prevails concerning the cytotype of *Polystichum subinerme* and *P. palniense*, as both have been confused and misidentified taxonomically and variously reported as diploid and tetraploid. *Polystichum subinerme* was reported as $n = 82$ and interpreted as tetraploid by Ghatak (1977: 107) sub *P. biaristatum* (Blume) T. Moore s.l. from the Shevaroy Temple, Shevaroy Hills (voucher *G 251* in K), although this could also have referred to a diploid apomict as no mitotic count was done; it is reported herein as $n = 82$, perhaps diploid apomict. Probable *P. palniense* was reported as $n = 82$ by Manickam and Irudayaraj (1992: 269) sub *P. moluccense*, but without locality or number; however, *P. palniense* (voucher from Bear Shola Falls, Kodaikanal, *S. M. Vasudeva 1145* in PUN, reidentified by Fraser-Jenkins) was previously reported as $n = 41$, diploid sexual, by Bir and Vasudeva (1979: 223) sub *Arachniodes aristata* (G. Forster) Tindale. Manickam and Dominic Rajkumar (1999), who also included *P. subinerme* in their concept of *P. moluccense*, concluded that the latter probably contained two cytotypes, but most of the specimens they cited with ploidy were assumptions based on spore size, with no actual diploid counts. One of their cited specimens (*XCH 1433*) is *P. subinerme*, while another was assumed to be a hybrid partly on the spurious basis of irregular pinnule lobing. Manickam (1986) had previously listed four morphological and spore-fertility entities in this group of species, but their identity was not made clear. It is thus impossible at present to extrapolate the cytotype of either *P. subinerme* or *P. palniense* definitively.

Paratypes. INDIA. **Tamil Nadu:** Tirunelveli Dist., Ambasamudram taluk, Agasthiar Hills, Peak Shola [wood], forest floor, 1500 m, 10 Apr. 1985, *V. S. Manickam RHT 32444* (MO, RHT, XCH); Ambasamudram taluk, Kannikkatty Hills, forest at top of Agasthiar Hills, 1500 m, 9 Apr. 1985, *V. S. Manickam RHT 32386* (RHT).

KEY TO SOUTH INDIAN *POLYSTICHUM* SPECIES

1a. Fronds simply pinnate . . . . . *P. harpophyllum*
1b. Fronds bipinnate 2
2a. Subapical proliferous bulbils present. . . . . *P. subinerme*
2b. Proliferous bulbils absent 3
3a. Stipe-base scales predominantly yellowish or reddish brown 4
3b. Stipe-base scales predominantly blackish with pale edges 7
4a. Lamina nearly as wide as long . . . *P. manickamianum*
4b. Lamina much longer than wide 5
5a. Stipe and rachis densely covered with broadly lanceolate to lanceolate, russet-brown scales, some at the base with dark red central bases . . . *P. squarrosum*
5b. Scales of upper stipe and rachis smaller and not broadly ovate, russet-brown, brown, or dark brown, the basal ones with darker, but not red central bases . . . 6
6a. Pinnules obtuse with short-rhombic apices; stipe base without raised scars where the scales are attached; scales mostly pinkish brown . . *P. anomalum*
6b. Pinnules acute with long-acute apices; stipe base with raised scar-ridges where the scales are attached; scales yellowish brown . . . . . *P. palniense*
7a. Middle pinnules of the pinnae markedly basally auriculate and rhombic; rachis with small narrow scales; indusia prominent and thick . . *P. piceopaleaceum*
7b. Middle pinnules of the pinnae nonauriculate, falcate or slightly S-shaped; rachis with tufts of large broad scales at junctions with pinnae; indusia vestigial, very small, thin, or absent . . . . . *P. mucronifolium*

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