

The Genera *Microsorium* and *Phymatosorus* (Polypodiaceae) in Thailand

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Abstract.— Based on the examination of herbarium specimens and on observations of most Thai species in their natural habitat, an updated account and status of the *Microsorium sensu lato* (Polypodiaceae) is presented. This includes 11 species of *Microsorium* Link and four species of *Phymatosorus* Pic. Serm. The descriptions, distributional and ecological information of all previously recognized taxa have been completed and corrected where necessary. The nomenclatural status and synonyms were thoroughly reviewed with typifications of all names. Determination keys to the species of both genera in Thailand are provided.

KEY WORDS: microsoroid ferns, *Microsorium*, *Phymatosorus*, revision

INTRODUCTION

The polypodiaceous fern genus *Microsorium* was established by Link in 1833 based on the type species, *M. irregular*. This is an old world genus which has a wide distribution in tropical parts of the Old World, extending from the Pacific Islands to northeast Australia, Malaysia, Southeast Asia and southern China, and from the Indian subcontinent to Madagascar and tropical Africa (Kramer and Green, 1990). However, the generic delimitation and the taxonomic position of *Microsorium* is equivocal and covers unsolved. According to Bosman's monograph (1991), *Microsorium* is unique in that the sori are exclusively irregularly scattered on simple or pinnatifid lamina or sometimes arranged in two-more rows, parallel to each secondary vein, or on smaller veins and tertiary veins are catadromous. Accordingly, many species, such as *Phymatosorus* (epiphytic or lithophytic ferns with variously lobed or 1-

pinnately compound lamina and one row sunken sori), were excluded from *Microsorium* in that classification. In her work. Although the generic name *Phymatosorus*, a genus having sori located in distinct cavities and appear as small tubercles on the upper surface of the lamina (Pichi Sermoli, 1973), has been quite widely adopted by modern pteridologists, such as Bosman (1991), some authors still prefer to place all species into the more broadly circumscribed genus, *Microsorium* (McCarthy, 1998; Nooteboom, 1997; Tagawa and Iwatsuki, 1989). Nooteboom (1997) has confirmed that some of the diagnostic characters of *Phymatosorus*, as interpreted by Bosman, are not as consistent as Bosman (1981) implied, or were interpreted incorrectly. In addition, the application of the terms anadromous and catadromous is of doubtful value when applied to areolate venation. Recent studies suggested that *Microsorium* are polyphyletic and required more investigate to delimit the

boundary of the genus (Schneider *et al.*, 2004; Kreier *et al.*, 2008), where some cryptic genera should be recognized from *Microsorium membranaceum* clade (Kreier *et al.*, 2008).

In Thailand, most of the 10 currently species of Thai *Microsorium* were established based mainly on material deposited in two major Thai herbaria: BK and BKF (Tagawa and Iwasuki, 1989). Since then, large numbers of new collections from across the country have been made, with two new species and two new records been added to the Thai account (Boonkerd and Nooteboom, 2001; Boonkerd *et al.*, 2004; Boonkerd, 2006; Petchsri *et al.*, 2009) bringing the total number of Thai *Microsorium* up to 14 species. In this paper we follow the classification system proposed by Smith *et al.* (2006) who recognized *Microsorium* and *Phymatosorus* as separated genera. Likewise, Christenhusz *et al.* (2011) placed *Microsorium* and *Phymatosorus* in the subfamily *Microsoroideae* of Polypodiaceae.

MATERIALS AND METHODS

This revision is based on the study of ca. 350 herbarium sheets from BCU, BKF, K, L, and QBG (abbreviations according to Thiers, 2014). Measurements were made on the herbarium materials. In addition, field work was performed in some areas of N, NE, C, W and S Thailand.

SYSTEMATICS

Identification Key

1. Sori superficial, not sunk in cavities. Frond simple to pinnatifid.....1.
Microsorium

- Sori sunk in cavities, forming 1(-2) rows per large areole on a soral vein. Frond pinnatifid to pinnately compound.....2. ***Phymatosorus***

Genus *Microsorium* Link

Microsorium Link, Hort. Berol. 2: 110. 1833; Bosman, Leiden Bot. Ser. 14: 69. 1991; Noot., Blumea 42: 294. 1997. Type: *Microsorium irregulare* Link (= *Microsorium punctatum*).

Dendroconche Copel., Philipp. J. Sc., Bot. 6: 91. 1911. Type: *Dendroconche annabellae* H.O. Forbes (= *Microsorium linguiforme*).

Myuroteris C. Chr., Dansk Bot. Ark. 6 no. 3: 73, t. 9, f. 1-2, t. 10, f. 3. 1929. Type: *Myuroteris cordata* C. Chr. (= *Leptochilus cordatus* (H. Christ) Ching).

Rhizome: creeping, white waxy or not, bearing fronds rather closely (or rather remotely in *M. sarawakense*), roots sparsely to densely set; phyllopodia more or less distinct. **Rhizome scales:** peltate or pseudopeltate, slightly sparsely to densely covered, appressed to spreading, at least brown to opaque on centre, clathrate throughout or clathrate with hyaline margin, margin entire or dentate to denticulate, central region glabrous or bearing multiseptate hairs. **Stipe:** sessile or very short to long, indistinct from the midrib, slightly raised to raised on both surfaces or raised on lower surface and grooved on upper surface, green to stramineous or brown; glabrous to scaly at base. **Fronds:** simple or pinnatifid to trifoliate, monomorphic or slightly dimorphic, membranaceous to thinly herbaceous to papyraceous or subcoriaceous to coriaceous, iridescent blue or light to dark green or blackish; margin subentire to entire or undulate, decurrent downwards to long wings of stipe or not, covered with glandular hairs, acicular hair

and/or scale absent. *Sori*: separate or sometimes in part confluent, round to oblong, superficial or slightly immersed, forming two irregular rows between adjacent veins or irregularly scattered on junction of veinlets or simple free included veins, spreading throughout or $\frac{1}{2}$ – $\frac{2}{3}$ of the lamina surface, existing in all areoles or absent in the costal and marginal areoles; paraphyses absent or uniseriate.

The Plant List (2013) includes 36 accepted species names and 82 unassessed species names for the genus *Microsorium*. Of these, 11 are found in Thailand.

Key to the species

1. Fronds simple, trifoliate or pinnatifid near base, tertiary veins between each pair of adjacent veins at most 3.....**2**
 - Fronds exclusively simple, tertiary veins between each pair of adjacent veins at least 3.....**3**
2. Rhizome not waxy. Rhizome scale pseudopeltate, central region glabrous. Frond simple to pinnatifid. Stipe and midribs not scaly.....**2. *M. insigne***
 - Rhizome at least sometimes waxy under the scales or often waxy. Rhizome scale peltate, central region bearing long hairs. Frond simple to trifoliate. Stipe and midribs scaly.....**5. *M. pteropus***
3. Living frond iridescent blue-green.....**4**
 - Living frond light green.....**5**
4. Costa grooved on upper surface; hydathode absent.....**10. *M. thailandicum***
 - Costa slightly raised on upper surface; hydathode distinct on upper surface.....**8. *M. siamense***
5. Rhizome slender, scandent, with fronds far apart.....**6**
 - Rhizome thick, creeping, never scandent.....**7**
6. Rhizome scale round or elliptic, centrally dark, margin hyaline, cells small, more or less isodiametric.....**7. *M. sarawakense***
 - Rhizome scale not as above, cells longitudinally rectangular towards the apex.....**9. *M. superficiale***
7. Lateral main veins distinctly raised at least on lower surface.....**8**
 - Lateral main veins hardly visible.....**6. *M. punctatum***
8. Sori irregularly scattered, abundant.....**9**
 - Sori in two regular rows between adjacent main veins.....**11. *M. zippelii***
9. Stipe distinct, winged to the base. Lamina thinly herbaceous to paperaceous, light to dark green**10**
 - Stipe indistinct or absent. Lamina subcoriaceous, light green when living.....**4. *M. musifolium***
10. Rhizome scales up to 8 mm long, clathrate except the hyaline marginal region, margin entire, central region bearing multiseptate hairs at least when young. Stipe less than 4.5 mm long, stramineous or greenish, few scales at base**3. *M. membranaceum***
 - Rhizome scales 1–4.5 mm long, clathrate, margin dentate, central region glabrous. Stipe up to 35 cm long, winged nearly to the base, indistinct from the midrib, stramineous; scaly at base.....**1. *M. heterocarpum***

1. *Microsorium heterocarpum* (Blume) Ching (Fig. 1)

Microsorium heterocarpum (Blume) Ching, Bull. Fan Mem. Inst. Biol. Bot. 4: 295. 1933; Holttum, Rev. Fl. Malaya 2: 178, f. 87. 1954; Tagawa & Iwatsuki, Southeast As. St. 3(3): 77. 1965; 5: 52. 1967; Fl. Thailand 3(4): 526. 1989; Bosman, Leiden Bot. Ser. 14: 83. 1991; Nooteboom, Blumea 42: 327. 1997; Hovenkamp *et al.*, Flora Malesiana.

Ser. II. 3: 109. 1998. — *Polypodium heterocarpum* Blume, Fl. Jav. Fil.: 167. t. 75. 1829. Type: Philippines, Elmer 9868 (BM!).

Pleopeltis heterocarpa T. Moore, Index Filic.: 78. 1857. Type: Java, Blume s.n. (holotype L!, photo C).

Polypodium zollingerianum Kunze, Bot. Zeitung (Berlin) 6: 422. 1846. Type: Java, Zollinger 1499 (BM!, Z).

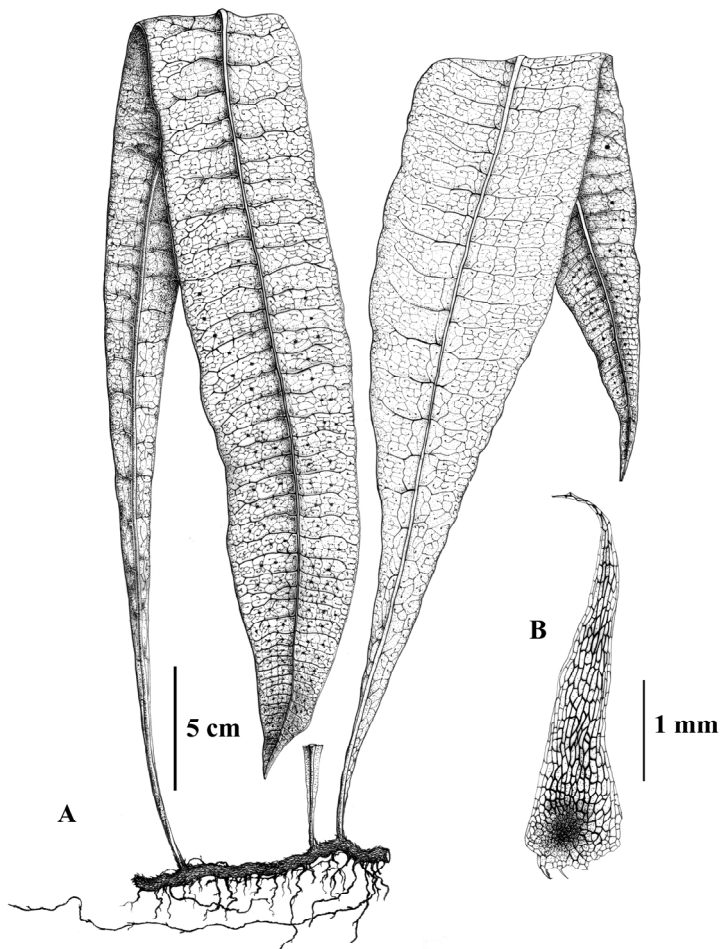


FIGURE 1. *Microsorium heterocarpum*: A. Habit; B. A rhizome scale. (A-B from Yuyen 70). (Draw by Wilaiwan Nuchthongmuang)

Rhizome: creeping, cylindrical to dorsiventrally compressed, 3–6 mm diam., not white waxy, bearing fronds closely; roots tightly set; phyllopodia distinct, up to 10 mm apart. **Rhizome anatomy:** bundle sheaths sclerenchymatous, vascular bundles in cylinder 8–13; sclerenchyma strands 10–15. **Rhizome scales:** pseudopeltate, lightly arranged, scaly on young portion, appressed, ovate or oblong, 1–4.5 by 0.5–1.5 mm, clathrate, margin dentate, apex attenuate, central region glabrous, inner layer of thickened cell wall smooth. **Stipe:** 0.5–3.5 cm long, 1.5–3.5 mm diam., raised on both surfaces, winged nearly to the base, indistinct from the midrib, stramineous; scaly at base. **Fronds:** simple, usually slightly dimorphous, fertile fronds usually much taller with long stipes; thinly herbaceous, light green; lamina narrowly oblong; 30–75, up to 10 cm, widest about middle of lower, base narrowly cuneate, decurrent downwards to long wings of stipe, margin subentire or slightly sinuate, apex acuminate to attenuate, covered with short glandular hairs, scale and acicular hair absent. **Venation pattern:** connecting veins forming a row of about equally sized areoles between each pair of adjacent secondary veins, main lateral veins and smaller veins prominent and distinct; secondary veins 5–9 mm apart, dichotomously branched near lamina margin; tertiary veins catadromous; smaller veins variously anastomosing; free included veinlet simple or 1-forked. **Sori:** round or slightly oblong, sometimes in part confluent, superficial, irregularly scattered on junction of veinlets, spreading throughout the surface of lamina, 7–20 per cm², 1 mm diam., existing in all areoles; paraphyses uniseriate, 2- or 3-celled. **Sporangia:** annulus 18–20-celled; indurated cells 11–13.

Thailand.— NORTHERN: Chiang Mai, Phitsanulok; SOUTH-WESTERN: Phetchaburi, Prachuap Khiri Khan; SOUTH-EASTERN: Chanthaburi; PENINSULAR: Trang.

Distribution.— Malesia (Philippines, type).

Ecology.— On moist rocks or terrestrial in shady and wet places, near streams or waterfalls, sometimes also on rather dry slopes in dense evergreen forest, altitude 100–1,600 m. asl

2. *Microsorum insigne* (Blume) Copel. (Fig. 2)

- Microsorum insigne* (Blume) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Nooteboom, Blumea 42: 329. 1997; Hovenkamp *et al.*, Flora Malesiana. Ser. II. 3: 110. 1998. — *Polypodium insignis* Blume, Enum. pl. Javae. 2: 127, add. 3. 1828. — *Pleopeltis insignis* (Blume) Bedd., Ferns Brit. India: t. 214. 1866. — *Colysis insigne* (Blume) J. Sm., Hist. Fil.: 101. 1875; Bosman, Leiden Bot. Ser. 14: 108. 1991. Type: Java, Zippelius *s.n.* (holotype L!, paratype L!, photo C).
- Drynaria decurrens* Brack., U.S. Expl. Exp., Filic. 16: 48. 1854. — *Pleopeltis decurrens* (Brack.) T. Moore, Index Fil.: 345. 1862. — *Microsorum decurrens* (Brack.) Copel., Fern Fl. Philip. 3: 481. 1960. Type: Philippines, Brackenridge 11 (holotype US, isotype K!).
- Polypodium diffundens* Kunze, Bot. Zeitung (Berlin) 4: 422. 1846. Type: Java, Zollinger 1299 (P!, Z).
- Polypodium dilatatum* Wall. ex Hook., Sp. Fil. 5: 85. 1864, nom. illeg., non Hoffm. 1795. — *Pleopeltis dilatata* (Wall. ex Hook.) Bedd., Ferns Brit. India: t. 122. 1866. — *Colysis dilatatum* J.Sm., Hist. Fil.: 101. 1875.

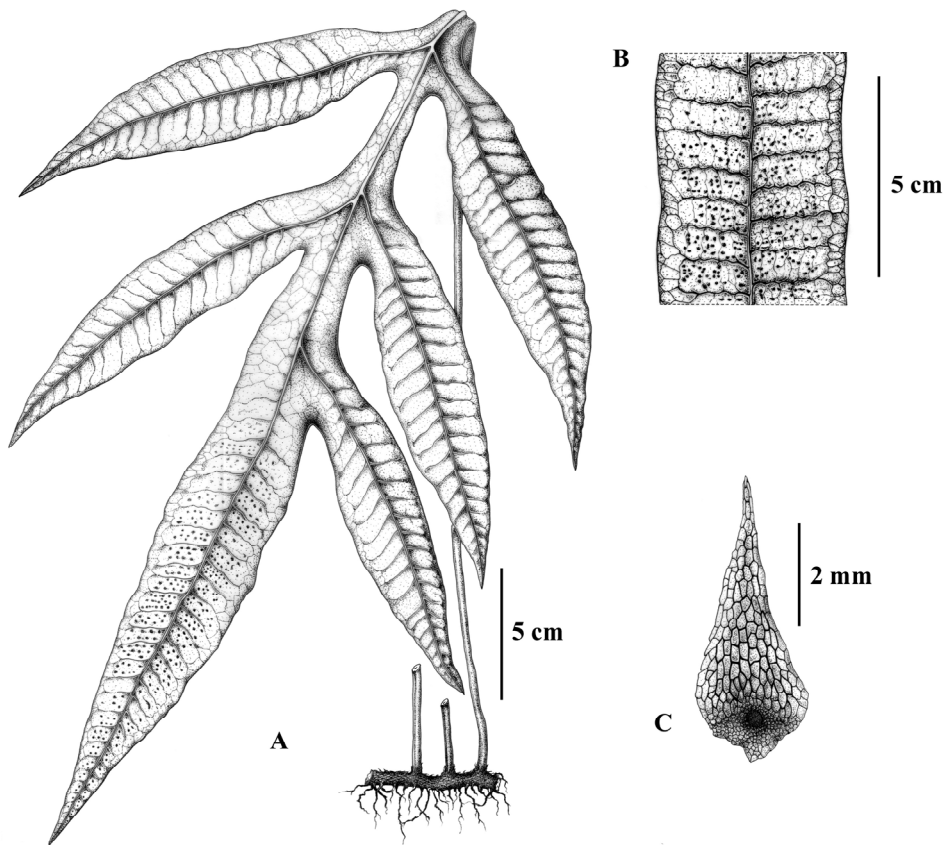


FIGURE 2. *Microsorium insigne*: A. Habit; B. Venation pattern and sori; C. A rhizome scale. (A-C from Rattanathirakul 69). (Draw by Wilaiwan Nuchthongmuang)

— *Microsorium dilatatum* (Bedd.) Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 2(5): 143. 1960; Tagawa & Iwatsuki, Southeast As. St. 5: 53. 1967; Fl. Thailand 3(4): 530. 1989. — *Kaulinia dilatata* (Wall. ex Hook.) B.K. Nayar & S. Kaur, Comp. Beddome's Handb. Ferns Brit. India: 89. 1974. Type: Nepal, *Wallich* 295 (holotype K!, isotype US).

Polypodium hancockii Baker, J. Bot. 23: 106. 1885. — *Microsorium hancockii*

Ching, Bull. Fan Mem. Inst. Biol. Bot. 4: 309. 1933; Holttum, Rev. Fl. Malaya 2: 174, f. 82. 1954. — *Kaulinia hancockii* (Baker) B.K. Nayar, Taxon 13: 67. 1964. Type: Taiwan, *Hancock* 100 (BM, K!).

Pleopeltis insignis f. *aperta* Alderw., Bull. Jard. Bot. Buitenzorg, sér. 2, 16: 29. 1914. Type: Sumatra, *Matthew* 670 (holotype K!).

Rhizome: creeping, cylindrical to dorsiventrally compressed, 2.5–10 mm diam., not white waxy, bearing fronds rather closely; roots tightly set; phyllopodia more or less distinct, up to 10 mm apart. *Rhizome anatomy*: bundle sheaths sclerenchymatous, vascular bundles in cylinder 10–15; sclerenchyma strands absent. *Rhizome scales*: pseudopeltate, apically densely set, appressed to slightly spreading, ovate or subtriangular, up to 7 by 0.5–2 mm, clathrate, margin entire to denticulate, apex long acuminate, central region glabrous, inner layer of thickened cell wall smooth. *Stipe*: up to 20 cm long, up to 10 mm diam., raised lower surface, grooved upper surface, stramineous; scaly at base. *Fronds*: simple or pinnatifid, monomorphous or slightly dimorphous; thinly herbaceous to papyraceous, light green. *Simple fronds*: lamina narrowly obovate; up to 65 by 2–7 cm, widest at or above middle, base narrowly angustate, decurrent downwards to long wings of stipe, margin entire, apex acute to acuminate, covered with short glandular hairs, scale and acicular hair absent. *Pinnatifid fronds*: up to 100 by 55 cm, widest below the middle, lateral lobes 10–15 pairs, longest lobes at position 1–3 (–5) from base, adnate with winged rachis, up to 25 by 2–5 cm, upper one gradually becoming smaller, apical lobe widest below or about the middle. *Venation pattern*: connecting veins form a row of about equally sized areoles between each pair of adjacent secondary veins, sometime form a row of main large areoles along both midrib sides bordered by one or more marginal rows of smaller areoles, main lateral veins prominent and distinct, smaller veins more or less hidden; secondary veins 5–16 mm apart, dichotomously branched near lamina margin; tertiary veins anadromous; smaller veins variously anastomosing; free included

veins simple, 1-forked. *Sori*: round, sometimes in part confluent, superficial, irregularly scattered on small veinlets, restricted to distal $\frac{1}{2}$ – $\frac{2}{3}$ of lamina, 18–25 per cm², 1–1.5 mm diam., existing in all areoles or absent in marginal areoles; paraphyses uniseriate, 2- or 3-celled. *Sporangia*: annulus 18–22-celled; indurated cells 10–15.

Thailand.—NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Phrae, Phitsanulok; NORTH-EASTERN: Loei; SOUTH-WESTERN: Prachuap Khiri Khan; SOUTH-EASTERN: Chanthaburi; PENINSULAR: Nakhon Si Thammarat, Trang.

Distribution.—Himalayas, India, Sri Lanka, Myanmar, China, Taiwan, S Japan, Indo-China, Peninsular Malaysia, Sumatra, Java (type) and, Philippines.

Ecology.—On muddy rocks or on wet sandy ground along stream in deep shade in dense forest, 55–1,900 m asl.

3. *Microsorium membranaceum* (D. Don) Ching

- Microsorium membranaceum* (D. Don) Ching, Bull. Fan Mem. Inst. Biol. Bot. 4: 309. 1933; Sledge, Bull. Brit. Mus. Nat. Hist. (Bot.) 2(5): 142. 1960; Tagawa & Iwatsuki, Southeast As. St. 5: 52. 1967; Fl. Thailand 3(4): 526. 1989; Bosman, Leiden Bot. Ser. 14: 91. 1991. — *Polypodium membranaceum* D. Don, Prodr. Fl. Nepal. 2. 1825. — *Colysis membranacea* J.Sm., Cat. Cult. Ferns: 11. 1857. — *Pleopeltis membranaceum* (D. Don) T. Moore, Index Filic.: 191. 1860. Type: Nepal, Wallich s.n. (holotype K!, isotype B!).
- Polypodium hymenodes* Kunze, Linnaea 23: 279, f. 319. 1850. Type: cult. Leipzig, Kunze s.n. (holotype B!).
- Polypodium membranaceum* D. Don var. *grandifolium* (Wall. ex Christ) Alderw.,

Malayan Ferns: 649. 1908. Type: Nepal, *Wallich* 282 (holotype K!, isotype BM!).

Rhizome: creeping, cylindrical to dorsiventrally compressed, up to 10 mm diam., not white waxy; roots densely set; phyllopodia more or less distinct, up to 11 mm apart. **Rhizome anatomy:** bundle sheaths not differentiated, vascular bundles in cylinder 15–20; sclerenchyma strands 54–97. **Rhizome scales:** pseudopeltate, apically densely set, otherwise more or less sparsely set, slightly spreading, ovate or triangular, up to 8 by 2.5 mm, clathrate except hyaline marginal region, margin entire, apex acute, central region bearing multiseptate hairs at least when young. **Stipe:** 0.5–4.5 mm long, 2.5–7 mm diam., raised on lower surface, slightly raised adaxially, stramineous or greenish. **Fronds:** simple, monomorphous or slightly dimorphous; membranaceous to thinly herbaceous, with short glandular hairs, scale and acicular hair absent, light to dark green; lamina narrowly elliptic to narrowly ovate; 20–95 by 1.5–14 cm, widest below or at middle; base narrowly angustate, margin subentire to dully waved, decurrent downwards to long wings of stipe, apex acuminate. **Venation pattern:** first connecting vein forms one row of small primary costal areoles parallel to costa, others form a row of about equally sized areoles between each pair of adjacent secondary veins, all veins distinct; secondary veins 5–15 mm apart, ichotomously branched near lamina margin; tertiary veins catadromous; smaller veins variously anastomosing; free veinlets simple or 1–2-forked, angle between midrib and main lateral veins 13–31 degree; midrib raised abaxially, main lateral veins prominent. **Sori:** round or slightly elongate; superficial or slightly immersed at vein joint, forming 2–4 irregular rows between

main lateral veins on whole lamina surface, or usually occupying upper (apical) half portion of lamina, 5–22 per cm², 1.1–3.2 mm diam., absent in marginal areoles, generally present in costal areoles; paraphyses absent. **Sporangia:** annulus 17–20-celled; indurated cells 10–13.

Thailand.— NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Nan, Lamphun, Lampang, Tak, Phitsanulok; SOUTH-WESTERN: Ratchaburi.

Distribution.— India, Sri Lanka, Nepal (type), Sikkim, Bhutan, Myanmar, S China, Taiwan, N Laos, N Vietnam and Philippines.

Ecology.— On mossy tree-trunks, muddy cliffs or moist rocks by streams in dense evergreen; common on limestone in evergreen hill forests, 420–2,175 m. asl

4. *Microsorium musifolium* (Blume) Copel.

Microsorium musifolium (Blume) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Bosman, Leiden Bot. Ser. 14: 94. 1991; Petchsri et al., Nat. Hist. J. Chulalongkorn Univ. 9(1): 100, f. 101. 2009. — *Polypodium musifolium* Blume, Enum. pl. Javae. 2: 125, add. 3. 1828. — *Pleopeltis musifolia* T. Moore, Index Filic.: 78. 1857. — *Drynaria musifolia* J.Sm., Cat. Cult. Ferns: 14. 1857. Type: Java, *Blume s.n.* (holotype L!).

Rhizome: creeping, cylindrical to dorsiventrally slightly compressed, 5.5–8.5 mm diam., not white waxy; roots very densely set forming a thick mat; phyllopodia obscure; up to 10 mm apart. **Rhizome anatomy:** bundle sheaths collenchymatous, vascular bundles in cylinder 19–20, sclerenchyma strands 45–87. **Rhizome scales:** peltate, apically densely covered, appressed, ovate, 3–4.5 by 1–2 mm, clathrate, margin entire, apex acuminate, central region glabrous, dark with hyaline

marginal region. *Stipe*: sessile or indistinct, up to 13 mm long, 3–9 mm diam. with a few scales, raised on lower surface, slightly raised on upper surface, dark green or brown. *Fron*ds: simple, usually clustered into irregular basket shape, subcoriaceous, with a few scales and short glandular hairs, acicular hairs absent, light green when living; lamina narrowly obovate to broad oblanceolate, 43.5–138 by 5–14 cm, widest at or above middle of lamina, base truncate to obtuse, margin entire to undulate, apex acute to acuminate. *Venation pattern*: connecting veins form a row of about equally sized areoles between each adjacent secondary vein pair, all veins clearly distinct; secondary veins 7–15 mm apart, dichotomously branched near the lamina margin; smaller veins variously anastomosing; free included veins simple, 1–2-forked. *Sori*: round, superficial, mostly irregularly scattered on simple free included veins, cover whole lamina surface or occupy upper (apical) half portion of lamina, 33–46 per cm², 1.2–1.5 mm diam., absent in marginal areoles, occasionally present in costal areoles; paraphyses uniseriate, 2- or 3-celled. *Sporangia*: annulus 19–20-celled; indurated cells 13–15.

Thailand.— PENNISULAR: Narathiwat (Sirindhon Falls).

Distribution.— S Myanmar, Peninsular Malaysia, Singapore, Sumatra, Java (type), Borneo, Philippines, New Guinea.

Ecology.— Low epiphytes or lithophytes in dense tropical rain forest, 100 (–900) m asl.

Note.— *M. musifolium* was introduced into cultivation in Thailand before the finding of this fern species from the wild.

5. *Microsorium pteropus* (Blume) Copel. (Fig. 3)

Microsorium pteropus (Blume) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Holttum, Rev. Fl. Malaya 2: 172, f. 80. 1954; Sledge, Bull. Brit. Mus. Nat. Hist. (Bot.) 2(5): 143. 1960; Tagawa & Iwatsuki, Southeast As. St. 3(3): 77. 1965; 5: 53. 1967; Fl. Thailand 3(4): 526. 1989; Nooteboom, Blumea 42: 350. 1997; Hovenkamp *et al.*, Flora Malesiana. Ser. II. 3: 120. 1998. — *Polypodium pteropus* Blume, Enum. pl. Javae. 2: 125, add. 3. 1828. — *Pleopeltis pteropus* T. Moore, Index Fil.: 78. 1857. — *Kaulinia pteropus* (Blume) B.K.Nayar, Taxon 13: 67. 1964. — *Colysis pteropus* (Blume) Bosman, Leiden Bot. Ser. 14: 112. 1991. Type: Java, *Blume s.n.* (lectotype L!).

Polypodium tridactylum Wall. [Cat. no. 315. 182., nom. nud.] ex Hook. et Grev., Ic. Fil.: t. 209. 1831. — *Phymatodes tridactyla* C. Presl., Tent. Pterid.: 196. 1836. — *Drynaria tridactyla* Fée, Gen. Fil.: 271. 1852. — *Pleopeltis tridactyla* T. Moore, Index Fil.: 78. 1857. — *Colysis tridactylon* J.Sm., Hist. Fil.: 101. 1875. Type: Mt. Sylhet Dehlu, *Wallich 315* (holotype K!, isotypes BM, C, UC).

Polypodium raapii Alderw., Bull. Dép. Agric Indes Néerl. 18: 23. 1908. — *Pleopeltis raapii* Alderw., Bull. Dép. Agric Indes Néerl. 27: 5. 1909. Type: Sumatra, *Raap 671* (BO).

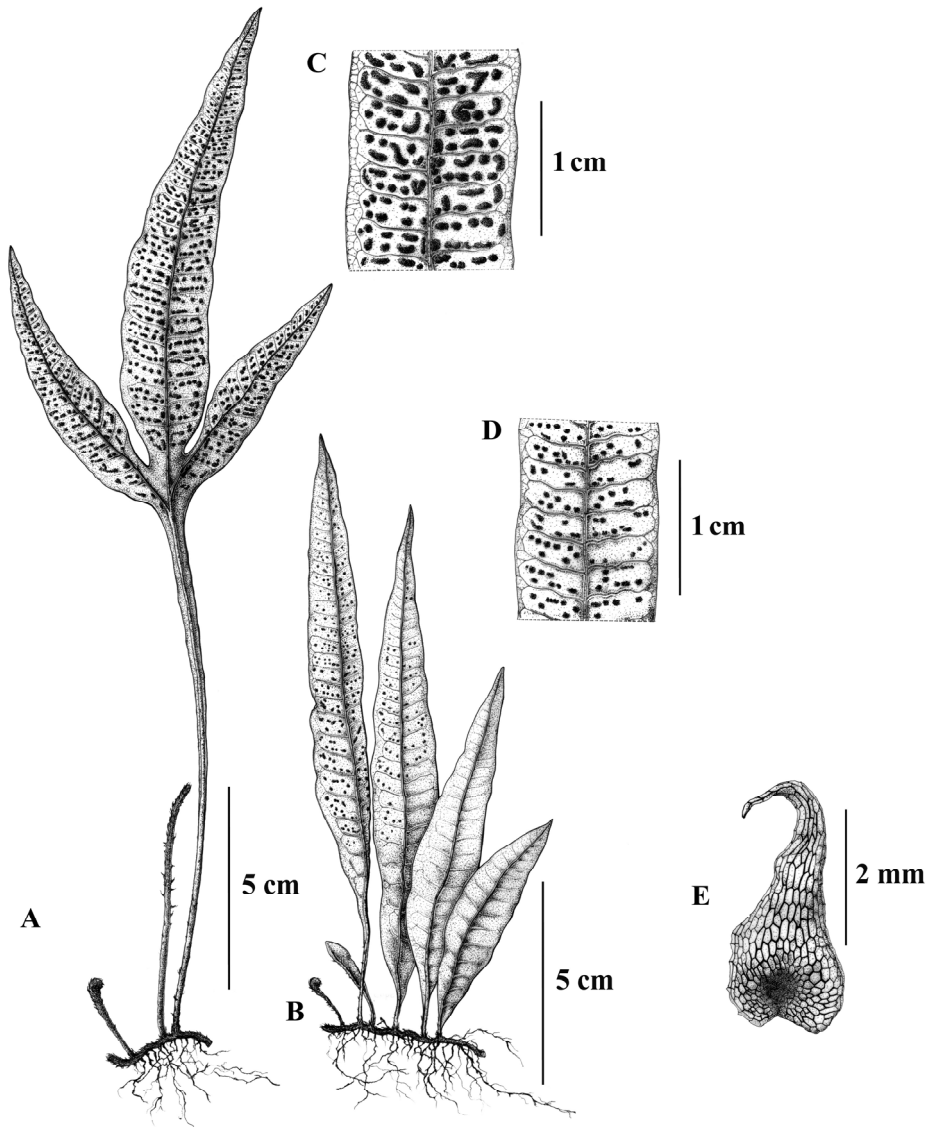


FIGURE 3. *Microsorium pteropus*: A-B. Habit; C-D. Venation pattern and sori; E. A rhizome scale. (A-E from Ratchata 289). (Draw by Wilaiwan Nuchthongmuang)

Polypodium paucijugum Alderw., Bull. Dép. Agric Indes Néerl. 18: 24. 1908. — *Pleopeltis paucijuga* (Alderw.) Alderw., Bull. Dépt. Agric. Indes Néerl. 27: 8. 1909. — *Microsorium*

paucijugum (Alderw.) Iwatsuki & Kato, Acta Phytotax. Geobot. 32: 132. 1981; Kato *et al.*, J. Fac. Sci. Univ. Tokyo, sect. 3, Bot. 15: 104. 1991. Type: Borneo, *Teuscher s.n.* (BO).

Drynaria dubia J.Sm., J. Bot. 3: 397. 1841, nom. nud. Type: Philippines, *Cuming* 324 (BM, K!, L, P).

Polypodium aquaticum H. Christ, Nova Guinea. 8: 153. 1909. Type: Papua New Guinea, *Versteeg* 1203 (K!, L, sketch BM).

Rhizome: moderately long-creeping, 1–5 mm diam., dorsiventrally flattened, not white waxy, bearing fronds rather closely; roots densely set; phyllopodia more or less distinct, up to 18 mm apart. **Rhizome anatomy:** bundle sheaths collenchymatous, vascular bundles in cylinder 9–15, sclerenchyma strands absent. **Rhizome scales:** pseudopeltate, densely set, appressed to slightly spreading, oblong-lanceolate, up to 5 by 0.5–1 mm, distinctly clathrate, margin entire, gradually narrowing towards acuminate apex, base round, central region opaque and glabrous, inner layer of thickened cell wall smooth, cells longitudinally rectangular. **Stipe:** subsessile, covered with scales at base like those on rhizome, stramineous, up to 15 cm long, 1.5–2.5 mm diam., raised on lower surface, grooved on upper surface. **Fronds:** simple-pinnatifid or trifoliate, sessile to stipitate, usually monomorphic, herbaceous to thinly papery, dark green to blackish. **Simple fronds:** lamina narrowly elliptic to lanceolate; up to 15 by 2.5–3.5 cm, widest at lower 1/3 portion, base narrowly angustate, decurrent downwards to long wings of stipe, margin entire, apex acute to long acuminate, densely covered with scales and short glandular hairs, acicular hairs absent. Trifoliate or pinnatifid fronds: 15–50 by 6–25 cm, widest at or above the middle, lateral lobes various in size and form, basal lobes rarely bearing a small basiscopic lobe, 5–16 by up to 5 cm; apical lobe widest below the middle or just above base or like simple laminae. **Venation pattern:** single

connecting veins form a row of main large areoles nearly extend to margin along both sides of midrib, bordered by 1–2 marginal rows of smaller areoles, all veins bordering main, marginal areoles distinct, smaller veins more or less unclear; secondary veins 3–8 mm apart, dichotomously branched near the margin of the lamina; tertiary veins anadromous; smaller veins variously anastomosing; free included veins simple, once- and in part twice-forked. **Sori:** round or oblong, sometimes in part confluent, superficial, mostly irregularly scattered on small veinlets within main areole, spreading all over the lamina, 5–20 per cm², 1–2.5 mm diam., absent in costal and marginal areoles; paraphyses uniseriate, 2- or 3-celled. **Sporangia:** annulus 19–22-celled; indurated cells 13–15.

Thailand.— NORTHERN: Chiang Mai, Chiang Rai, Nan, Lampang, Tak, Phitsanulok; NORTH-EASTERN: Loei, Udonthani; SOUTH-WESTERN: Kanchanaburi, Ratchaburi, Phetchaburi, Prachuap Khiri Khan; CENTRAL: Saraburi, Nakhon Nayok; SOUTH-EASTERN: Sa Kaeo, Prachinburi, Chon Buri, Chanthaburi; PENINSULAR: Chumphon, Ranong, Surat Thani, Phangnga, Nakhon Si Thammarat, Trang, Satun, Yala.

Distribution.— India, East Asia, Indo-China, Malesia (Java, type), Australia.

Ecology.— In rock crevices along stream banks, in stream-beds prone to flooding, or in the spray of waterfalls, 20–800 m asl

Vernacular.— Kut hang nok kaling (กูดหางนกคะลิง).

6. *Microsorium punctatum* (L.) Copel.

Microsorium punctatum (L.) Copel., Univ. Calif. Publ. Bot. 16: 111. 1929; Holttum, Rev. Fl. Malaya 2: 179. 1954; Seidenfaden, Nat. Hist. Bull. Siam Soc.

- 19: 86. 1958; Sledge, Bull. Brit. Mus. Nat. Hist. (Bot.) 2(5): 143. 1960; Tagawa & Iwatsuki, Southeast As. St. 3(3): 76. 1965; Acta Phytotax. Geobot. 23: 52. 1968; Fl. Thailand 3(4): 528. 1989; Bosman, Leiden Bot. Ser. 14: 97. 1991; Nooteboom, Blumea. 42: 353. 1997; Hovenkamp *et al.*, Flora Malesiana. Ser. II. 3: 121. 1998. — *Acrostichum punctatum* L., Sp. Pl. ed. 2: 1524. 1763. — *Polypodium punctatum* (L.) Sw., Schard. J. Bot. 1800(2): 21. 1801, non Thunb. (1784). — *Phymatodes lingulata* C. Presl, Tent. Pterid. 198. 1836. — *Pleopeltis punctata* (L.) Bedd., Ferns Br. Ind. Suppl.: 22. 1876. Type: China, *Fothergill s.n.* (not found in LINN).
- Polypodium polycarpon* Sw., Schard. J. Bot. 1800(2): 21. 1801, non. Illeg., non Cavanilles. Type: Java, *Thunberg s.n.* (not located).
- Polypodium polycarpon* Cav., Descr. Pl.: 246. 1802. — *Niphobolus polycarpus* (Cav.) Spr., Syst. Veg. 4: 45. 1827. — *Phymatodes polycarpa* (Cav.) C. Presl, Tent. Pterid.: 198, t. 8 f. 19. 1836. — *Pleopeltis polycarpa* (Cav.) T. Moore, Index Filic.: 78. 1857. — *Microsorium polycarpon* (Cav.) Tardieu, Fl. Madag. Fam 5: 114. 1960. Type: *Née s.n.* (not located).
- Polypodium irioides* Poir., Encycl. 5: 513. 1804. — *Phymatodes irioides* C. Presl, Tent. Pterid.: 196. 1836. — *Microsorium irioides* (Poir.) Fée, Mém. Fam. Foug. 5: 268, t. 20B. 1852. — *Pleopeltis irioides* (Poir.) T. Moore, Index Filic.: 78. 1857. Type: Mauritius, *Commerson s.n.* (holotype P!).
- Polypodium ambiguum* Blume, Enum. pl. Javae. 2: 125, add. 3. 1828. Type: *Reinwardtia s.n.* (L!).
- Polypodium glabrum* Wall. ex Roxb., Calc. J. Nat. Hist. 4: 482. 1844, non Burman (1768). Type: India, *Wallich 281* (isotypes BM, K!).
- Phymatodes sessilis* (Kaulf. ex Kunze) C. Presl, Tent. Pterid.: 198. 1836. — *Polypodium sessile* Kaulf. ex Kunze, Bot. Zeit. (Berlin) 6: 116. 1848. — *Microsorium sessile* (Kaulf. ex Kunze) Fée, Mém. Foug. 5. Gen. Filic.: 268. 1852. — *Pleopeltis sessilis* (Kaulf. ex Kunze) T. Moore, Index Filic.: 78. 1857. Type: Mauritius, *Sieber 31* (B!, BM, K!).
- Polypodium millisorum* Baker, J. Linn. Soc. Bot. 15: 109. 1877. — *Pleopeltis millisora* (Baker) Alderw., Bull. Dép. Agric. Indes Néerl. 27: 8. 1909. Type: Kai Is., *Moseley 3412* (BM, K!).
- Polypodium validum* Copel. in Perkins, Fragm. Fl. Philipp. 3: 191. 1905. — *Microsorium validum* (Copel.) Ching, Bull. Fan Mem. Inst. Biol. Bot. 4: 295. 1933. Type: Philippines, *Copeland 973* (not located).
- Polypodium punctatum* (L.) Sw. ssp. *subdrynariaceum* H. Christ, Bull. Herb. Boissier 2: 994. 1906. — *Polypodium punctatum* (L.) Sw. var. *subdrynariaceum* (H. Christ) Alderw., Malayan Ferns: 654. 1908. Type: Singapore, *Ridley 8935* (holotype P!).
- Polypodium punctatum* (L.) Sw. ssp. *subirideum* H. Christ, Bull. Herb. Boissier 2: 994. 1906. — *Polypodium punctatum* (L.) Sw. var. *subirideum* (H. Christ) Alderw., Malayan Ferns: 654. 1908. — *Microsorium subirideum* (H. Christ) Copel., Gen. Fil.: 197. 1947. Type: Philippines, *Elmer 5884* (holotype K!, isotype P!); Java, *Endert 1506* (paratype L!).

Polypodium antrophyoides Alderw., Bull. Dépt. Agric. Indes Néerl. 18: 22. 1908. Type: Sumatra, *Forbes 3119* (BM!).

Polypodium neoguineense Copel., Philipp. J. Sci. 6, Bot. 89. 1911. — *Pleopeltis neoguineensis* (Copel.) Alderw., Malayan Ferns Suppl. 1: 390. 1917. — *Microsorium neoguineense* (Copel.) Copel., Gen. Fil.: 196. 1947. Type: Papua New Guinea, *King 335* (lectotype K!, photo BM).

Rhizome: creeping, cylindrical, up to 11 mm diam., often white waxy or at least sometimes glaucous under the scales, bearing fronds closely; roots very densely set; phyllopodia more or less distinct, up to 13.5 mm apart. **Rhizome anatomy:** bundle sheaths not differentiated vascular bundles in cylinder 15–20, sclerenchyma strands 50–100. **Rhizome scales:** pseudopeltate, sometimes peltate, apically densely set, slightly spreading, narrowly ovate to subtriangular, 1.5–5.6 by 0.7–2.6 mm, clathrate throughout to subclathrate, margin dentate to denticulate, apex acuminate, central region glabrous, inner layer of thickened cell wall smooth. **Stipe:** not distinct from laminae, scaly at base, stramineous to greenish, 0.7–10 mm long, 2.5–8 mm diam., sharply raised on upper and lower surface. **Fronds:** simple, usually monomorphic, subcoriaceous to coriaceous, light to dark green; lamina narrowly obovate, elliptic to narrowly oblanceolate; 28–172 by 2.5–19 cm, widest at or above middle of lamina length, base cordate to narrowly angustate, margin entire or undulate, sometimes revolute, or sinuate (in cultivar variety), gradually narrowing both towards and decurrent downwards to form wing of stipe, apex rotundate to acuminate, with few scales and short glandular hairs, acicular hairs absent. **Venation pattern:** connecting veins form a row of about

equally sized areoles between each adjacent secondary vein pair, all veins, secondary and smaller veins more or less immersed and obscured (at least in living specimen), secondary veins 6–25 mm apart, dichotomously branched near lamina margin; tertiary veins catadromous; smaller veins variously anastomosing; free included veins simple, 1–2-forked. **Sori:** round, superficial, mostly irregularly scattered on the free included veins on whole lamina surface, or form irregular rows parallel to each secondary vein pair, 14–74 per cm², 1–2.5 mm diam., absent in marginal areoles, generally absent in costal areoles; paraphyses uniseriate, 2- or 3-celled. **Sporangia:** annulus 19–26-celled; indurated cells 12–18 (–20).

Thailand.— NORTHERN: Chiang Mai, Chiang Rai, Lampang, Tak, Phitsanulok, Nakhon Sawan; NORTH-EASTERN: Phetchabun, Loei; EASTERN: Chaiyaphum, Nakhon Ratchasima; SOUTH-WESTERN: Kanchanaburi, Ratchaburi, Phetchaburi, Prachuap Khiri Khan; SOUTH-EASTERN: Sa Kaeo, Prachin Buri, Chon Buri, Rayong, Chanthaburi, Trat; PENINSULAR: Ranong, Surat Thani, Phangnga, Phuket, Krabi, Nakhon Si Thammarat, Trang, Songkhla, Satun, Yala, Narathiwat.

Distribution.— Paleotropics and subtropics (China, type).

Ecology.— Epiphyte and also epilithic or terrestrial in various types of forest, sometimes in savannah but also in wet places in streambeds. Altitude from sea level to 900 m.

Vernacular.— Kraprok hang sing (กระปรอกหางสิงห์), Prue mai (ปรีอไม้), Lin phi mai (ลั่นฟ้าไม้), Hang nok wa (หางนกหัว), Ai-ka bu-kong kawaeng (ไถกานูกงกะแวง).

7. *Microsorum sarawakense* (Baker) Ching (Fig. 4)

- Microsorum sarawakense* (Baker) Ching, Bull. Fan Mem, Inst. Biol. 4: 295. 1933; Holttum, Rev. Fl. Malaya 2: 175. 1954; Nootboom, Blumea 42: 358. 1997. — *Polypodium sarawakense* Baker, Adansonia 22: 228. 1887. — *Pleopeltis sarawakensis* Alderw., Bull. Dépt. Agric. Indes Néerl. 27: 4. 1909. — *Neocheiropteris sarawakense* Parris, Sandakania 9: 81. 1997. Type: Borneo, Hose 125 (K!).
- Polypodium forbesii* Alderw., Bull. Dépt. Agric. Indes Néerl. 18: 23. 1908. — *Pleopeltis forbesii* Alderw., Bull. Dépt. Agric. Indes Néerl. 27: 5. 1909. Type: Sumatra, Forbes 2333 (BM!, BO, US).
- Microsorum rizalense* Copel., Philipp. J. Sc. 81: 42. 1952. Type: Philippines, Ramos & Edaño BS 29648 (K!).

Rhizome: long creeping, cylindrical, 1–2 mm in diam., not white waxy, bearing fronds rather remotely; roots sparsely set; phyllopodia distinct, up to 12 cm apart. *Rhizome anatomy*: bundle sheaths more or less sclerenchymatous, vascular bundles in cylinder 9–13; sclerenchyma strands up to 15–21. *Rhizome scales*: peltate, densely set, appressed, round or ovate, rather small, 1 by 1–1.5 mm, round or ovate at base, apex rounded, clathrate, hyaline at margin, entire, cells small, more or less equal size, central region dark brown, glabrous. *Stipe*: 2.5–3 cm long, stramineous, glabrous. *Fronds*: simple, monomorphic, subcoriaceous, light green; lamina elliptic to oblong-ovate; 7.5–13.5 by 2.5–3 cm, widest below or at middle, base cuneate-angustate, gradually narrowing towards acuminate to caudate apex, entire at margin, glabrous on lower surfaces. *Venation pattern*: connecting veins

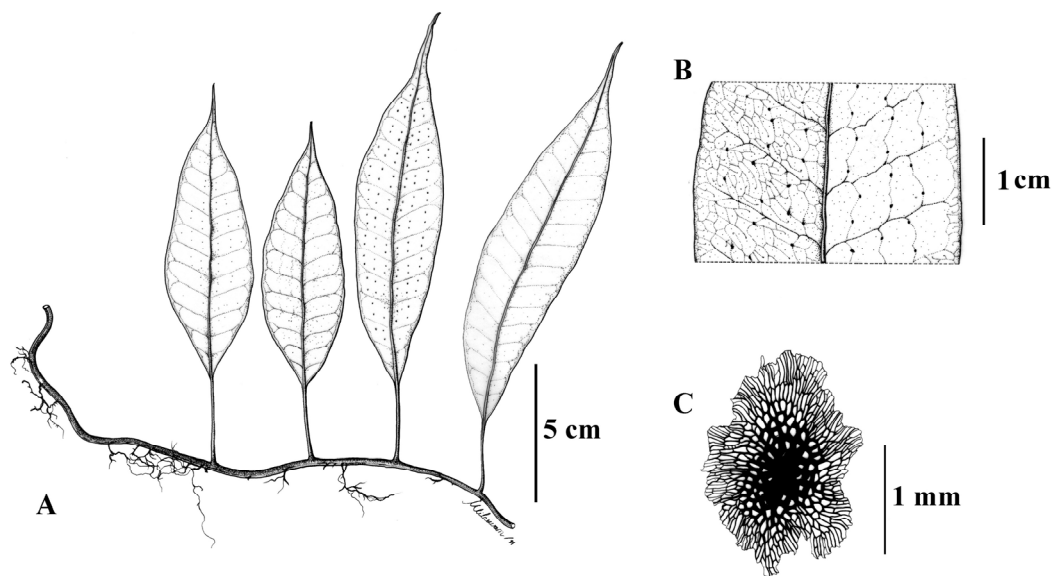


FIGURE 4. *Microsorum sarawakense*: A. Habit; B. Venation pattern and sori; C. A rhizome scale. (A–C from Suksathan 2445). (Draw by Wilaiwan Nuchthongmuang)

form several rows of equally sized areoles, dichotomously branched near the margin, first connecting vein often form distinct soral vein, all veins immersed and indistinct; secondary veins 6–10 mm apart, tertiary veins anadromous; smaller veins variously anastomosing, form dense reticulation with areole, but not within costal areole; free included veins simple or 2- forked. *Sori*: separate, round, c. 2 mm in diam., in two irregular rows between each pair of lateral main vein, on the whole surface or absent from the basal part of lamina; paraphyses uniseriate hairs with glandular apical cells. *Sporangia*: annulus 18–20-celled; indurated cells 14–18.

Thailand.— PENINSULAR: Yala.

Distribution.— Peninsular Malaysia, Sumatra, Java, Borneo (type), Philippines.

Ecology.— Terrestrial or epiphyte, in humid places or mossy tree trunks at 1,050 m asl

Note.— This is the first official report of this fern species in Thailand.

8. *Microsorium siamense* Boonkerd

Microsorium siamense Boonkerd, Blumea 51: 143, f. 144. 2006. Type: Thailand, *P.V. Fern 1* (holotype L!, isotype BCU!).

Rhizome: short creeping, cylindrical, 3–4 mm diam., not white waxy; roots densely set; phyllopodia more or less distinct, 2.5–4 mm apart. *Rhizome anatomy*: bundle sheaths not differentiated, vascular bundles in cylinder 9–10, sclerenchyma strands 60–240. *Rhizome scales*: peltate, densely set, slightly spreading, ovate to triangular, up to 1.3 by 2.5–3 mm, clathrate, margin denticulate, apex acuminate to slightly caudate, dark black on central region. *Stipe*: scaly at base, stramineous to greenish, 10–25 mm long, up to 2.6 mm diam., raised on lower surface, slightly raised on upper surface. *Fronds*: simple,

monomorphic, subcoriaceous to coriaceous, iridescent blue when living, Havana brown to raw umber in dry specimens; lamina elliptic, up to 13.5 by 3–4 cm, widest at or above midregion, base attenuate and decurrent downwards to form short stipe wing, margin entire to undulate, acute to long acuminate, with short glandular hairs, scales and acicular hairs absent, hydathodes scattered on upper surface. *Venation pattern*: connecting veins form a row of about equally sized areoles between each adjacent secondary vein pair, no prominent main lateral veins, all veins, secondary and smaller veins more or less immersed and obscured (at least in living specimen), secondary veins 4–8 mm apart, dichotomously branched near lamina margin; smaller veins variously anastomosing; free included veinlet simple or 1–2- forked, angle between primary and secondary vein 28–32°. *Sori*: round, superficial, mostly irregularly scattered on free included veins or 2 or 3 connecting veins, restricted to apical half of lamina, 7–13 per cm², 1–1.5 mm diam., absent in marginal areoles, occasionally present in costal areoles; paraphyses absent. *Sporangia*: annulus 20–22-celled; indurated cells 11–14.

Thailand.— PENINSULAR: Yala.

Distribution.— Endemic.

Ecology.— In rock crevices of limestone hill in semi-shade, 100 m alt.

Vernacular.— Fern Waeo Phek Malang Thub Siam (เฟิร์นแววปักแมลงทับสยาม).

9. *Microsorium superficiale* (Blume) Ching

Microsorium superficiale (Blume) Ching, Bull. Fan Mem. Inst. Biol. Bot. 4: 299. 1933; Tagawa & Iwatsuki, Southeast As. St. 5: 52. 1967; Fl. Thailand 3(4): 525. 1989; Holttum, Rev. Fl. Malaya

ed. 2. 2: 632. 1966; Hovenkamp *et al.*, Fl. Malesiana Ser. II. 3: 129. 1998. — *Polypodium superficiale* Blume, Enum. pl. Javae. 2:123, add. 3. 1828. — *Colysis superficiale* (Blume) J.Sm. Hist. Fil.:101. 1875. — *Pleopeltis superficialis* (Blume) Bedd., Ferns Brit. India: t. 75. 1865 — *Neocheiropteris superficialis* (Blume) Bosman, Leiden Bot. Ser. 14: 121. 1991. Type: Java, Blume s.n. (L!).

Polypodium nigrocinctum H. Christ, Bull. Herb. Boissier 6: 874. 1896. Type: China, Henry 9264 & 11454 (syntype P!).

Rhizome: very long creeping, dorsiventrally compressed 2–3.5 mm diam., not white waxy; roots sparsely set; phyllopodia distinct, up to 10 mm apart. **Rhizome anatomy:** bundle sheaths sclerenchymatous, vascular bundles in cylinder 9–15; sclerenchyma strands 10–15. **Rhizome scales:** pseudopeltate, more or less densely set, throughout, slightly spreading, oblong to subtriangular, 1.5–5 by 1–2.5 mm, clathrate with hyaline margin, margin entire or slightly denticulate, apex acuminate, irregularly round at base, central region with long hairs, inner layer of thickened cell wall smooth. **Stipe:** 5–15 cm long, 2–2.5 mm diam., distinctly raised on lower surface, grooved on upper surface, green, stramineous or dark at base; scaly at base. **Fronde:** simple, monomorphic, herbaceous to papyraceous, light green; lamina narrowly oblong to lanceolate; 15–40 by 3–6 cm, widest at or below middle, base narrowly angustate, decurrent downwards to form short stipe wing, margin entire and flat, apex acuminate, covered with short glandular hairs and scale, acicular hairs absent. **Venation pattern:** connecting veins form a row of about equally sized areoles between each adjacent secondary vein pair,

main lateral veins and smaller veins immersed; secondary veins 5–10 mm apart, dichotomously branched near lamina margin; smaller veins variously anastomosing; free included veins simple, 1-forked. **Sori:** round, superficial, irregularly scattered on junction of veinlets, spreading all over the lamina abaxially, 7–20 per cm², up to 2 mm diam., present in all areoles; paraphyses uniseriate, 3–6 celled. **Sporangia:** annulus 18–24-celled; indurated cells 13–16.

Thailand.— NORTHERN: Chiang Mai, Nan, Tak, Phitsanulok; NORTH-EASTERN: Loei.

Distribution.— Tibet, India, Myanmar, S China, Japan, N Vietnam, Peninsular Malaysia, Sumatra, Java (type).

Ecology.— On mossy tree trunks along streamlets in dense evergreen forest, 1,200–2,100 m. asl

10. *Microsorium thailandicum* Boonkerd & Noot.

Microsorium thailandicum Boonkerd & Noot., Blumea 46: 518. f. 582. 2001. Type: Thailand, T. Boonkerd 1442 (holotype L!, isotype BCU!).

Rhizome: moderately creeping, cylindrical, 4–5 mm diam., not white waxy, bearing fronds closely; roots moderately set; phyllopodia more or less distinct, 1.5–3.6 mm apart. **Rhizome anatomy:** bundle sheaths not differentiated, vascular bundles in cylinder 8–12, sclerenchyma strands 40–245. **Rhizome scales:** pseudopeltate, densely set, slightly spreading, narrowly ovate to subtriangular, 2.6–3.3 by 1–1.2 mm, clathrate, margin denticulate, apex acuminate to slightly caudate, dark black on central region. **Stipe:** not distinct from laminae, scaly at base, stramineous to greenish, 10.8–13.2 mm long, 2.7–3.2 mm diam., raised on lower surface, grooved on

upper surface. *Fronde*s: simple, monomorphic, subcoriaceous to coriaceous, iridescent blue color living, linoleum brown in dry specimens; lamina narrowly elliptic, 21.3–39.6 by 1.2–1.9 cm, the widest indistinct, base attenuate and decurrent downwards to form stipe wing, margin entire, apex long acuminate, with short glandular hairs, scales and acicular hairs absent. *Venation pattern*: connecting veins form row of about equally sized areoles between each adjacent secondary vein pair, small primary areoles parallel to costa, all veins, secondary and smaller veins more or less immersed and obscured (at least in living specimen), secondary veins 8–10 mm apart, dichotomously branched near the margin of the lamina; smaller veins variously anastomosing; free included veinlet simple or 1–2-forked, angle between primary and secondary veins 47–52°. *Sori*: round, superficial or slightly immersed, mostly irregularly scattered on free included veins or 2 or 3 connecting veins, restricted to apical half of lamina, 15–23 per cm², 1.2–1.4 mm diam., absent in marginal areoles, occasionally present in costal areoles; paraphyses absent. *Sporangia*: annulus 20–31-celled; indurated cells 15–20.

Thailand.—PENINSULAR: Chumphon.

Distribution.—Endemic.

Ecology.—In rock crevices of limestone hill in semi-shade, 150–300 m. asl. Natural leaf iridescent blue remains in home garden cultivation.

Vernacular.—Fern Wao Phek Malang Thub (เฟิร์นแววปักแมลงทับ).

11. *Microsorium zippelii* (Blume) Ching (Fig. 5)

Microsorium zippelii (Blume) Ching, Bull. Fan Mem. Inst. Biol. Bot. 4: 308. 1933; Holttum, Rev. Fl. Malaya 2: 176, f. 85. 1954; Tagawa & Iwatsuki, Southeast As. St. 5: 52. 1967; Fl. Thailand 3(4): 525. 1989; Nooteboom, Blumea 42: 371. 1997; Hovenkamp *et al.*, Fl. Malesiana. ser. II. 3: 130. 1998. — *Polypodium zippelii* Blume, Fl. Jav. Fil.: 172, t.80 1829. — *Pleopeltis zippelii* (Blume) T. Moore, Index Filic.: 348. 1862; Bedd. Handb.: 357. 1883. — *Neochheiropteris zippelii* (Blume) Bosman, Leiden Bot. Ser. 14: 123. 1991. Type: Java, *Zippelius s.n.* (holotype L!, photo B, BM).

Polypodium oxyphyllum Kunze, Bot. Zeitung (Berlin) 6: 116. 1848. Type: Java, *Zollinger 2029* (L!), 2332 (BM, L, LE, P, PR).

Polypodium luzonicum Copel., Philipp. J. Sc. 1, Suppl. 162. t. 23. 1906. — *Pleopeltis luzonica* (Copel.) Alderw., Bull. Dépt. Agric. Indes Néerl. 27: 7. 1909. — *Microsorium luzonicum* (Copel.) Tagawa, Acta Phytotax. Geobot. 16: 51. 1955. Type: Philippines, *Copeland 1918* (P!, S, SING, US).

Drynaria subfalcata J.Sm., J. Bot. 3: 397. 1841. nom. nud. Type: Philippines, *Cuming 113* (A, BM, K!, L, LE, P, PC, US).

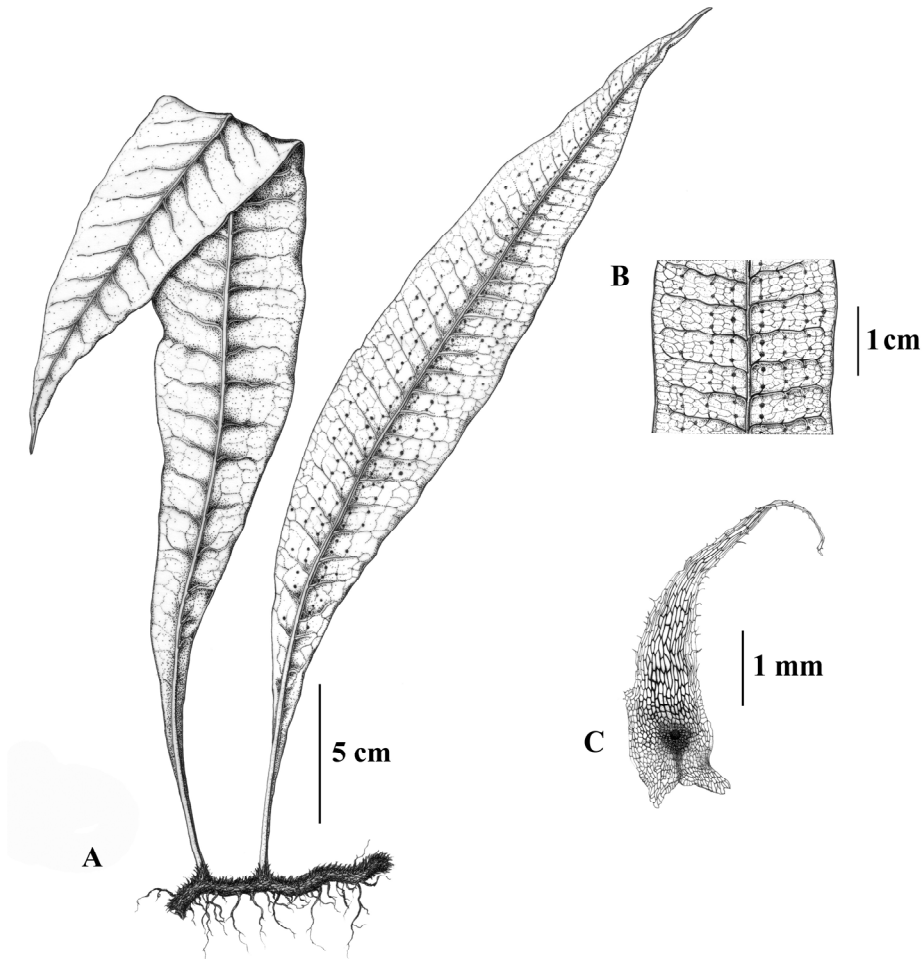


FIGURE 5. *Microsorium zippelii*: A. Habit; B. Venation pattern and sori; C. A rhizome scale. (A-C from *T. Boonkerd* 1159). (Draw by Wilaiwan Nuchthongmuang)

Rhizome: long creeping, 1–5 mm diam., about cylindrical, not white waxy, bearing fronds up to 2 cm apart; roots densely set; phyllopodia distinct, up to 5.5 cm apart. **Rhizome anatomy:** bundle sheaths collenchymatous, vascular bundles in cylinder 10–15, sclerenchyma strands at least 65. **Rhizome scales:** pseudopeltate, densely covered, distinct spreading, oblong-subtriangular, up to 7 by 1–2 mm, clathrate, margin toothed, gradually narrowing

towards acuminate apex, base cuneate, central region glabrous, inner layer of thickened cell wall smooth, cells longitudinally rectangular in apical part. **Stipe:** more or less present, with few scales like those on rhizome at base, green to stramineous, 0.5–7 cm long, up to 2.5 mm diam., raised on both surfaces. **Fronds:** simple, mostly monomorphic, herbaceous to papyraceous, dark green to blackish; lamina elliptic to oblong-lanceolate; 40–65 by up to

7 cm, widest at or above middle, base narrowly angustate, decurrent downwards to long stipe wing, margin entire, apex acuminate, covered with short glandular hairs, scales and acicular hairs absent. *Venation pattern*: connecting veins form regular row of about equally sized areoles between adjacent secondary vein pair, small primary areoles parallel to costa, all veins distinct or smaller veins more or less obscured, secondary veins 5–8 mm apart, dichotomously branched near the margin; smaller veins variously anastomosing; free included veins simple, 1–2-forked. *Sori*: round-oblong, superficial, forming two irregular rows between adjacent veins, spreading all over the lamina, 8–12 per cm², 1.5–2 mm diam., absent in marginal areoles; paraphyses uniseriate, 3- or 4-celled. *Sporangia*: annulus 19–22-celled; indurated cells 15–19.

Thailand.— NORTHERN: Chiang Mai, Chiang Rai, Phitsanulok; NORTH-EASTERN: Phetchabun, Loei; EASTERN: Nakhon Ratchasima; SOUTH-WESTERN: Kanchanaburi, Phetchaburi; Prachuap Khiri Khan; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chon Buri; PENINSULAR: Trang, Yala.

Distribution.— Himalayas, S China, Indo-China, Peninsular Malaysia, Sumatra, Java (type), Borneo, Philippines, Sulawesi, New Guinea.

Ecology.— On hill slope by stream in dense forest, sometimes growing on sandstone or limestone, 200–1,500 m. asl

Genus *Phymatosorus* Pic.Serm.

Phymatosorus Pic.Serm., *Webbia* 28: 457. 1973. Type: *Phymatosorus scolopendria* Pic.Serm.

Phymatodes Presl, *Tent. Pterid.*: 195. 1836, nom. illeg., p.p. excl. type.; Bedd., *Ferns Brit. India*: t. 344. 1866; Tard. &

C.Chr. in *Fl. Indo-Chine*. 7(2): 479. 1941; Holttum, *Rev. Fl. Malaya* 2: 191, f. 94-95. 1954.

Rhizome: long creeping, white waxy or not, bearing fronds rather remotely, roots sparsely to densely set; phyllopodia distinct. *Rhizome scales*: peltate or pseudopeltate, sparsely to densely covered, appressed to distinctly spreading, at least brown to dark brown on centre, clathrate, hairy or toothed at margin, central region glabrous or bearing multiseptate hairs. *Stipe*: long, raised on both surfaces, green to stramineous or light to pale castaneous; glabrous. *Fronds*: deeply pinnatifid to imparipinnate, monomorphic or slightly dimorphic, herbaceous thinly papyraceous to coriaceous, light to dark green; lateral pinnae more or less ascending, entire to subentire or crisped to undulate at margin, connected by a wing of rachis, glabrous on both surfaces. *Sori*: separate, round to oblong or elongate, in 1-2 irregular rows on each side of costa, on whole surface or absent from the basal part of lamina, borne on slight or deep hollows on lower surface and raised on upper surface; paraphyses uniseriate or biseriate.

The Plant List (2013) includes 19 accepted species names and 10 unassessed species names for the genus *Phymatosorus*. Of these four are found in Thailand.

Key to the species

1. Lamina pinnate; pinnae with distinct stalks. Sori nearly superficial.....1. *P. cuspidatus*
- Lamina simple, pinnatifid to pinnatisect. Sori clearly sunken.....2
2. Lamina yellowish green to light green, lateral lobes usually 1–5 pairs; veins immersed and obscured on both surfaces. Sori uniseriate or two irregular rows on each side of costule.....4. *P. scolopendria*

- Lamina dark green, lateral lobes 7 or more pairs; veins distinct on both surfaces. Sori in one row on each side of costule.....**3**
- 3. Rhizome usually submerged. Lateral lobes of lamina usually 15–30 pairs.....**2. *P. longissimus***
- Rhizome terrestrial. Lateral lobes of lamina usually 7–12 pairs.....**3. *P. membranifolium***

1. *Phymatosorus cuspidatus* (D. Don) Pic. Serm.

Phymatosorus cuspidatus (D. Don) Pic.Serm., Cytotax. Atl. Pterid.: 83. 1977. — *Polypodium cuspidatum* D. Don, Prod. Fl. Nepal.: 2. 1825. — *Phymatodes cuspidata* (D. Don) J.Sm., Cat. Cult. Ferns: 10. 1857. — *Microsorium cuspidatum* (D. Don) Tagawa in Hara, Fl. East. Himal.: 495. 1966; Tagawa & Iwatsuki, Southeast As. St. 5: 53. 1967; Fl. Thailand 3(4): 531. 1989. Type: Nepal, *Wallich s.n.* (BM!)

Polypodium lucidum Roxb., Calcut. Journ. Nat. Hist. 4: 486. 1844. — *Phymatodes lucida* (Roxb.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2(3): 61. 1933; Tard. & C.Chr. in Fl. Indo-Chine. 7(2): 475. 1941. — *Phymatosorus lucidus* (Roxb.) Pic.Serm., Webbia 28(2): 459. 1973. — *Microsorium lucidum* (Roxb.) Copel., Gen. Fil.: 196. 1947; Nooteboom, Blumea 42: 335. 1997; Hovenkamp *et al.*, Fl. Malesiana. ser. II 3: 113. 1998. Type: *Roxburgh drawing 1922* (lectotype).

Polypodium leiorhizum Wall. [Cat. no. 303. 1829, nom. nud.] Mett. Fil. Lips.: 37, t. 25, f. 7. 1856. — *Pleopeltis leiorhiza* T. Moore, Index Filic.: 346. 1862. Type: Nepal, *Wallich 303* (K!, L, P).

Rhizome: long-creeping, fleshy, light green, 1.5–2.5 cm diam, cylindrical, not white waxy; roots sparsely set; phyllopodia distinct, up to 8 cm apart. *Rhizome anatomy*: bundle sheaths collenchymatous, vascular bundles in cylinder 10–16, sclerenchyma strands at least 30. *Rhizome scales*: peltate, sparsely to densely covered, appressed, circular, up to 8–10 by 6–8 mm, cells larger in central portion becoming smaller towards entire margin, dark brown on centre, paler towards margin, clathrate, central region glabrous. *Stipe*: with scales like those on rhizome base, stramineous, 25–50 cm long, up to 3 mm diam. *Fronde*s: imparipinnate, articulate to rhizome, stipitate, usually monomorphic, herbaceous or subcoriaceous, light to bluish green; lamina oblong to oblong-subdeltoid; 30–50 by 20–25 cm, widest below middle, lateral pinnae 6–20 pairs, more or less ascending, linear-lanceolate, 15–20 (–25) by 2–3.5 cm, long acuminate at apex, entire-undulate at margin, cuneate at base, with 5–10 mm long stalks, glabrous on both surfaces; rachis like stipes, costa raised, stramineous. *Venation pattern*: connecting veins form regular row of about equally sized areoles between adjacent secondary vein pair, small primary areoles parallel to costa, main veins distinct, veinlets obscure, secondary veins 5–8 mm apart, forked near the margin; tertiary veins anadromous; smaller veins variously anastomosing; free included veins simple, 1-forked. *Sori*: round, slightly sunken, forming one irregular row on each side of costa; paraphyses uniseriate, 3- or 4-celled. *Sporangia*: annulus 20–22-celled; indurated cells 16–19.

Thailand.— NORTHERN: Chiang Mai, Chiang Rai; NORTH-EASTERN: Loei, Nong Khai; EASTERN: Chaiyaphum.

Distribution.— India, Nepal (type), Myanmar, S China, Laos, N Vietnam.

Ecology.— Epiphytes on tree-trunks, on rather dry rocks or on rugged limestone in opened or semi-shaded area in mixed forest or hill evergreen forest, 480–1,600 m. asl

Vernacular.— Kut Cham (กูดฉ่ำ).

2. *Phymatosorus longissimus* (Blume) Pic. Serm.

Phymatosorus longissimus (Blume) Pic. Serm. *Webbia* 28(2): 459. 1973; Liu & Kuo, *Taiwania* 52(2): 185. 2007. — *Polypodium longissimum* Blume, *Enum. pl. Javae*: 127. 1828., non *Microsorium longissimum* J.Sm. ex Fée, *Gen. Filic.*: 268, t. 20B, f. 2. — *Polypodium myriocarpum* (C. Presl) Mett., *Pol.*: 105, no. 198, t. 1, f. 3. 1857. — *Phymatodes longissima* (Blume) J.Sm., *Cat. Cult. Ferns*: 10. 1857; Holttum, *Rev. Fl. Malaya* 2: 191. 1954; DeVol & Kuo, *Fl. Taiwan* 1: 199, pl. 69. 1975. — *Pleopeltis longissima* (Blume) T. Moore, *Index Fil.*: 78. 1857. — *Colysis longissima* (Blume) J.Sm., *Hist. Fil.*: 101. 1875. Type: Java, *Blume* 35 (lectotype L!).

Drynaria rubida J.Sm., *J. Bot. (Hook.)* 3: 397. 1841. — *Polypodium rubidum* (J.Sm.) Kunze, *Bot. Zeit.* 6: 117. 1848. — *Microsorium rubidum* (J.Sm.) Copel., *Gen. Fil.*: (Ann. Cryptog. Phytopathol. 5): 197. 1947; Shieh *et al.*, *Fl. Taiwan* 2nd ed. 1: 502. 1994; Nooteboom, *Blumea* 42: 356. 1997; Hovenkamp *et al.*, *Fl. Malesiana ser. II*. 3: 125. 1998. — *Microsorium rubidum* (Kunze) Copel., *Gen. Fil.*: 197. 1947; Tagawa & Iwatsuki, *Southeast As. St.* 5: 53. 1967; *Acta Phytotax. Geobot.* 23: 53. 1968; *Fl. Thailand* 3(4): 532. 1989. Type: Philippines, *Cuming* 241 (BM, K!, L, P, US).

Polypodium suisha-stagnale Hayata, *Ik. Pl. Formos.* 6: 160. 1916. — *Phymatosorus suisha-stagnalis* (Hayata) Pic.Serm., *Webbia* 28(2): 460. 1973. Type: Taiwan, *Hayata s.n.* (TAIF!).

Rhizome: long creeping, dorsiventrally compressed, 4–8 mm diam., not white waxy; roots densely set; phyllopodia distinct. **Rhizome anatomy:** bundle sheaths sclerenchymatous, vascular bundles in cylinder 12–20; sclerenchyma strands absent. **Rhizome scales:** pseudopeltate, sparsely or densely covered at rhizome apex and base of stipe, appressed, ovate or subdeltoid, 3–5 by 1.5–3 mm, rounded at base, acuminate at apex, thinly clathrate, subentire to irregularly toothed at margin, central region glabrous or bearing multiseptate hairs, inner layer of thickened cell wall smooth. **Stipe:** up to 100 cm long, raised on both surfaces, glabrous, winged only on the upper portion, green to stramineous; scaly at base. **Fronde:** deeply pinnatifid with a rachis wing 0.1–1 cm wide, monomorphic or slightly dimorphic, herbaceous to thinly papyraceous, dark green; lamina elliptic to oblong; 40–100 (130) by 25–30 (60) cm, widest at or below middle, base narrowly angustate, decurrent downwards to long stipe wing, lateral pinnae 15–30 (40) pairs, linear-lanceolate, ascending, longest lobes located at lower 1/3 of lamina, usually 14–30 by 1.5–3.5 cm, caudately acuminate at apex, entire or crisped at margin, connected by a wing of rachis, glabrous on both surfaces. **Venation pattern:** connecting veins form row of small primary costal areoles bordered by one row of conspicuous large areoles, main lateral veins and smaller veins distinct; secondary veins 4–10 mm apart, marginal vein absent or obscure; tertiary veins anadromous; smaller veins variously anastomosing; free included veins simple, once- to twice-

forked. *Sori*: round to oblong, deeply sunken, visible as protrusions on upper surface, usually distributed on whole surface or except lower portion of lamina underneath, 3–5 mm diam., one sorus in each main areole, in one row on each costule side; paraphyses biseriate, 2- or 3-celled. *Sporangia*: annulus 19–21-celled; indurated cells 15–17.

Thailand.— NORTHERN: Chiang Mai, Chiang Rai, Lampang; NORTH-EASTERN: Nong Bua Lam Phu; EASTERN: Chaiyaphum, Nakhon Ratchasima; CENTRAL: Lop Buri, Nakhon Nayok; PENINSULAR: Surat Thani, Phangnga, Nakhon Si Thammarat.

Distribution.— India, Sri Lanka, S China, Hong Kong, Taiwan, Japan, Vietnam, Malaysia, Indonesia (Java, type), Philippines, Polynesia.

Ecology.— Terrestrial on muddy areas or on muddy rocks along streams in light shade or fully exposed areas in dry evergreen forest, at 100–250 m. asl

Vernacular.— Kraprok bai chaek (กระปรอกใบแฉก).

3. *Phymatosorus membranifolium* (R.Br.)

S.G. Lu

(Fig. 6)

Phymatosorus membranifolius (R.Br.) S.G. Lu, *Guihaia* 19(1): 27. 1999. — *Phymatosorus membranifolium* (R.Br.) Tindale, *Australian Systematic Botany* 15(6): 904. 2002. — *Polypodium membranifolium* R.Br., *Prodr.*: 147. 1810. — *Microsorium membranifolium* (R.Br.) Ching, *Bull. Fan Mem. Inst. Biol. Bot.* 10: 239. 1941. Type: Australia, *Banks s.n.* (BM!).

Polypodium nigrescens Blume, *Enum. pl. Javae*: 126. 1828, *Fl. Java. Fil.*: 161. 1847. — *Phymatodes nigrescens* (Blume) J.Sm., *Ferns Brit. For.* 94. 1866; *Holtum, Rev. Fl. Malaya* 2: 193, f. 95. 1954; *Seidenfaden, Nat. Hist. Bull. Siam Soc.* 19: 86. 1958. — *Pleopeltis nigrescens* (Blume) Carr. in *Seem., Fl. Vit.*: 368. 1873. — *Microsorium nigrescens* (Blume) Copel., *Occ. Pap. B. P. Bish. Mus.* 14: 74. 1938; *Sledge, Bull. Brit. Mus. Nat. Hist. (Bot.)* 2(5): 143. 1960; *Tagawa & Iwatsuki, Southeast As. St.* 3(3): 77. 1965; 5: 54. 1967; *Acta Phytotax. Geobot.* 23: 53. 1968; *Fl. Thailand* 3(4): 532. 1989. — *Phymatosorus nigrescens* (Blume) Pic.Serm., *Webbia* 28(2): 459. 1973. Type: Java, *Blume s.n.* (L!).

Phymatodes variabilis Ching, *Contr. Inst. Bot. Nat. Acad. Peiping* 2(3): 64. pl. 3. 1933. — *Phymatodes nigrescens* (Blume) J.Sm. var. *variabilis* (Ching) C.Chr. & Tard., *Fl. Gen. Indo-Chine* 7(2): 473. 1941. — *Phymatosorus variabilis* (Ching) Pic. Serm., *Webbia* 28(2): 460. 1973. Type: China, Chun & Tso 43735 (isotype NY!).

Pleopeltis longissima (Blume) T. Moore in *Bedd., Ferns S. Ind.* pl. 176. 1864 (excl. nom.). Type: Unknown.

Polypodium ithycarpum Copel., *Philipp. J. Sc., Bot.* 12: 64. 1917. — *Microsorium ithycarpum* (Copel.) Parris, *Pl. Mt. Kinabalu* [in J.H. Beaman *et al.*] 105. 1992. Type: Borneo, *Topping 1578* (lectotype US).

Microsorium alternifolium (Willd.) Copel., *Gen. Fil.*: 197. 1947. — *Polypodium alternifolium* Willd., *Sp. Pl.* 5: 168. 1810. Type: Unknown.

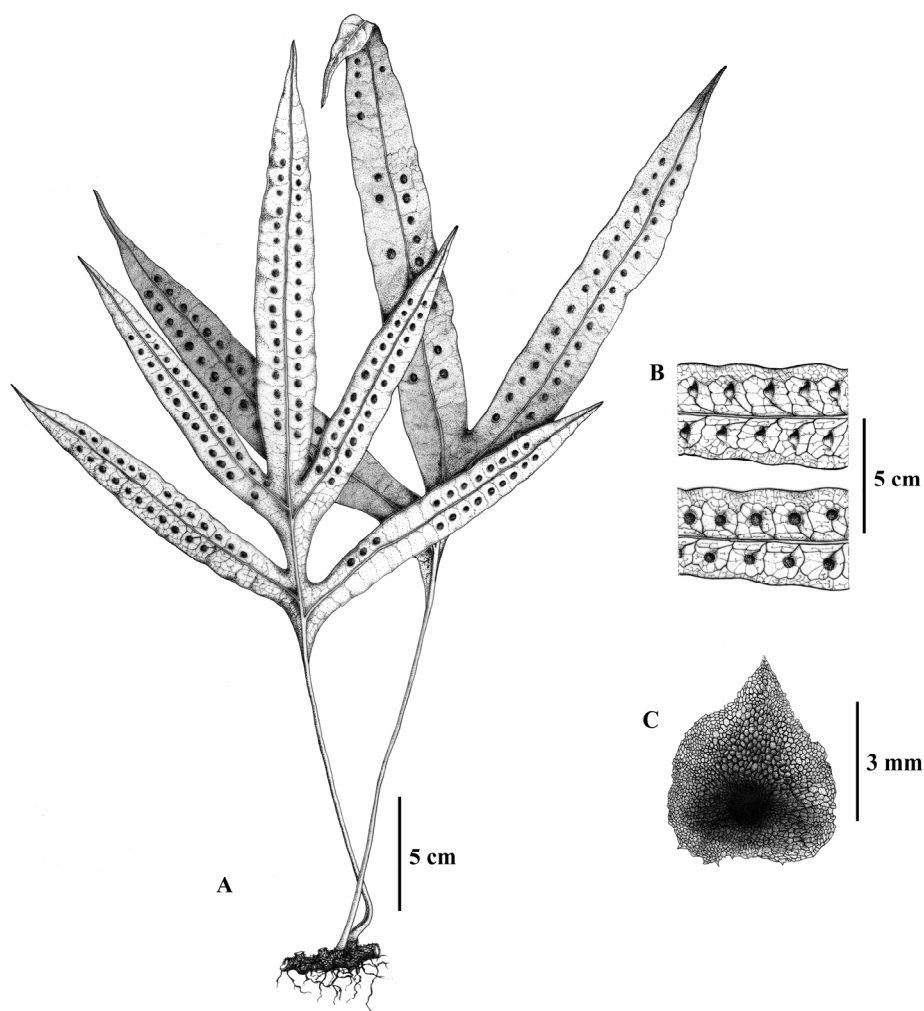


FIGURE 6. *Phymatosorus membranifolius*: A. Habit; B. Venation pattern and sori; C. A rhizome scale. (A-C from Ratana 50). (Draw by Wilaiwan Nuchthongmuang)

Rhizome: long creeping, more or less cylindrical, thick, about 1–1.5 cm in diam., not white waxy, bearing fronds rather remotely up to 5 cm; roots densely set; phyllopodia distinct. *Rhizome anatomy*: bundle sheaths collenchymatous, vascular bundles in cylinder 12–20; sclerenchyma strands up to 150. *Rhizome scales*: pseudopeltate, sparsely set, appressed,

ovate, circular or oblong, 3–5 in both directions, rounded to moderately acute at apex and base, brown, clathrate, thinly, irregularly toothed at margin, central region glabrous or bearing multiseptate hairs, internal wall gradually becoming thinner outwards. *Stipe*: 30–40 (50) cm long, c. 5 mm diam., raised on both surfaces, glabrous, stramineous; scaly at base. *Fronds*:

deeply pinnatifid nearly to rachis, monomorphic or slightly dimorphous, herbaceous to thinly papyraceous, dark green; lamina subdeltoid to oblong; 50–80 by 30–40 cm, widest at or below middle, lateral pinnae 7–12 pairs, broad-lanceolate, ascending, lowest lobes free, to 10 mm stalked, longest lobes located at lamina base or basal most ones a little reduced, gradually becoming smaller upwards, usually 15–30 by 3–4.5 cm, caudately acuminate at apex, subentire or entire at margin, somewhat narrowing towards base, connected by a wing of rachis, glabrous on both surfaces. *Venation pattern*: connecting veins form row of small primary costal areoles bordered by one row of conspicuous large areoles, all veins distinct; secondary veins 5–7 mm apart, marginal vein absent or obscure; tertiary veins anadromous; smaller veins variously anastomosing; free included veins simple or once-forked. *Sori*: separate, round, large, c. 4 mm in diam., one sori per primary costal areole, in one row on each side of costa, medial, on whole surface or absent from basal lamina, borne distinctly hollow on lower surface and distinctly raised on upper surface; paraphyses uniseriate hair with glandular top cells. *Sporangia*: annulus 18–20-celled; indurated cells 15–19.

Thailand.— EASTERN: Chaiphaphum, Nakhon Ratchasima; SOUTH-WESTERN: Kanchanaburi, Ratchaburi, Prachuap Khiri Khan; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Sa Kaeo, Prachin Buri, Chanthaburi, Trat; PENINSULAR: Ranong, Phangnga, Phuket, Nakhon Si Thammarat, Trang, Pattani, Yala, Narathiwat.

Distribution.— S. India, Sri Lanka, S. China, Taiwan, Vietnam, Cambodia, Malesia, Australia (type), Polynesia.

Ecology.— Terrestrial near streams or on mossy to rather dry rocks in deep shady place in dry evergreen forest or tropical rain forests, 0–800 m. asl

Vernacular.— Ka-lo ra-wa (กาโลราวา).

4. *Phymatosorus scolopendria* (Burm.f.)

Pic.Serm.

(Fig. 7)

Phymatosorus scolopendria (Burm.f.) Pic.Serm., Webbia 28(2): 460. 1973; Bosman, Leiden Bot. Ser. 14: 133. 1991; Wagner, Contr. Univ. Michigan Herb. 20: 258. 1995. — *Polypodium scolopendria* Burm.f., Fl. Ind.: 232. 1769. — *Phymatodes scolopendria* (Burm.f.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2(3): 63. 1933; Holttum, Rev. Fl. Malaya 2: 191, f. 94. 1954; Seidenfaden, Nat. Hist. Bull. Siam Soc. 19: 86. 1958. — *Microsorium scolopendria* (Burm.f.) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 2(5): 143. 1960; Tagawa & Iwatsuki, Southeast As. St. 3(3): 77. 1965; 5: 54. 1967; Acta Phytotax. Geobot. 23: 53. 1968; Fl. Thailand 3(4): 532. 1989. Type: Java, *Pryon* s.n. (lectotype G).

Polypodium phymatodes L., Mant. Pl.: 306. 1771. — *Chrysopteris phymatodes* (L.) Link, Fil. Sp.: 122. 1841. — *Drynaria phymatodes* (L.) Fée, Gen. Fil.: 270. 1852. — *Pleopeltis phymatodes* (L.) T. Moore, Index Fil.: 78. 1857; Bedd., Handb. Ferns Brit. India: 366. 1883; E. Smith, J. Siam Soc. Nat. Hist. Suppl. 8: 6. 1929. — *Phymatodes phymatodes* (L.) Maxon, Contr. U.S. Nat. Herb. 9: 352, t. 63. 1905. Type: Madagascar, *Petit* s.n. (P!).

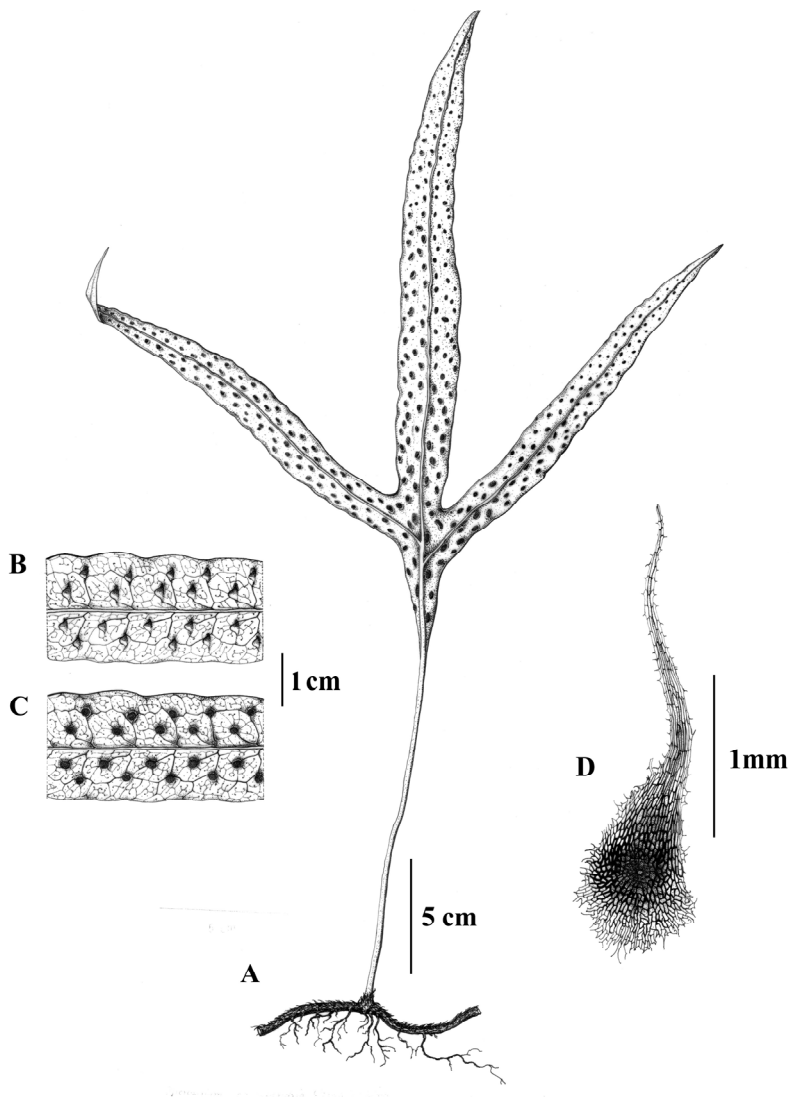


FIGURE 7. *Phymatosorus scolopendria*: A. Habit; B-C. Venation pattern and; D. A rhizome scale. (A-C from T. Boonkerd 44/464). (Draw by Wilaiwan Nuchthongmuang)

Phymatodes vulgaris Presl, Tent. Pterid.: 96. 1836, nom. illeg., — *Drynaria vulgaris* (Presl) J.Sm., Journ. Bot. 3: 397. 1841. Type: Philippines, *Cuming* 201 (BM, K!, P).

Phymatodes banerjiana S. Pal & N. Pal, Amer. Fern J. 53: 103. 1963. Type: cult. Calcutta, *Pal* s.n. (isotype K!).

Rhizome: long creeping, cylindrical, fleshy, c. 3–5 mm diam., white waxy, dark in surface, bearing fronds rather remotely up to 1.5–5 cm; roots sparsely to densely set;

phyllopodia distinct. *Rhizome anatomy*: bundle sheaths more or less sclerenchymatous, vascular bundles in cylinder 10–30; sclerenchyma strands up to 90. *Rhizome scales*: peltate, sparsely set, appressed to distinctly spreading, ovate-lanceolate, rather small, up to 3–6 by 0.7–1.5 mm, irregularly lacerate or ovate at base, narrowing from centre towards long-acuminate apex, dark brown, clathrate, hairy or toothed at margin, cells longitudinally rectangular in narrow apical part, central region glabrous or bearing multiseptate hairs. *Stipe*: usually 20–30 (–50) cm long, raised on both surfaces, stramineous or light to pale castaneous; glabrous. *Fronde*: deeply pinnatifid broadly winged along the rachis, rarely simple or pinnately ternate (trilobed), monomorphous or slightly dimorphous, coriaceous, light to dark green; lamina subdeltoïd to oblong-ovate; 20–40 by 30–35 cm, widest at or below middle, lateral pinnae 3–6 pairs, lanceolate, ascending, apical lobe longer than upper lateral lobes, longest lobes located at 1–2 from base, usually 12–20 by 2–3 cm in fertile and 5 cm broad in sterile ones, gradually narrowing towards acuminate apex, entire at margin, connected by a rachis wing, rachis' wings about same breadth as lobes, glabrous on both surfaces. *Venation pattern*: connecting veins form several rows of equally sized areoles or one row of conspicuous, large areoles, dichotomously branched near marginal or middle, each costal areole giving rise to two lateral veins, all veins immersed and indistinct; secondary veins 4–10 mm apart, tertiary veins anadromous; smaller veins variously anastomosing, forming a dense reticulation with areole; free included veins simple or once-forked. *Sori*: separate, round or elongate, c. 3 mm in diam., in 1–2 irregular rows on each costa side, on the whole surface or absent from

basal part of lamina, borne on deep hollows on lower surface and raised on upper surface; paraphyses uniseriate hair with glandular top cells. *Sporangia*: annulus 21–23-celled; indurated cells 14–18.

Thailand.— SOUTH-EASTERN: Prachin Buri, Chon Buri; CENTRAL: Bangkok; PENINSULAR: Chumphon, Ranong, Surat Thani, Phangnga, Krabi, Nakhon Si Thammarat, Trang, Songkhla, Pattani, Yala, Narathiwat.

Distribution.— Africa, India, Sri Lanka, S China, Taiwan, Japan (Ryukyus), Indo-China, Malesia (Java, type), New Guinea, Australia, Polynesia.

Ecology.— On sandy sea shore or epiphytic on dry muddy rocks or on tree-trunks in semi-shaded or open area at low altitudes.

Vernacular.— Yai pheak (ยาไผ่).

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APPENDIX

Specimens Examined

1. *Microsorium heterocarpum*: T. Boonkerd 1334 (BCU); Garrett 391 (BCU); Tagawa et al. 5577 (BKF); Tagawa & Yamada 206 (BKF); TDBS 1287 (BKF); Yuyen 70 (BCU).
2. *Microsorium insigne*: T. Boonkerd 1335 (BCU), 1345 (BCU); EH 3383 (BKF), 3934 (BKF), 3596 (BKF); Geesink et al. 8072 (BKF); Hennipman 3554 (BKF), 3607 (BKF), 3834 (BKF); Iwatsuki et al. 3692 (BKF); Larsen et al. 34391 (BKF); Niyomdham & Puudjaa 5493 (BKF); Pooma 904 (BKF); Rattanathirakul 69 (BCU), 206 (BCU); Smitinand 5520 (BKF); Srisanga & Suksathan 3252 (QBG); Suksathan 1308 (QBG), 4424 (QBG); Tagawa et al. 1301 (BKF), 2664 (BKF), 7172 (BKF); TDB 12806 (BKF); Watthana & Suksathan 1600 (QBG), 1658 (QBG); Yuyen 45 (BCU).
3. *Microsorium membranaceum*: T. Boonkerd 57 (BCU), 84 (BCU); Garrett 591 (K, BKF); Hennipman 3420 (BKF); Iwatsuki et al. 9600 (BKF), 11119 (BKF), 15642 (K); Larsen et al. 2314 (K), 34431 (BKF); Maxwell 85-752 (BKF), 88-974 (BKF), 94-994 (BKF), 02-251 (BKF), 02-293 (BKF); Murata et al. 14973 (BKF), 15624 (BKF), 15642 (BKF), 15732 (BKF), 51675 (BKF); Nanakorn et al. 4597 (QBG); Phengklai et al. 7129 (BKF), 7144 (BKF); Phusomsaeng 82 (BKF); Ratchata 258 (BCU), 318 (BCU); Rattanathirakul 75 (BCU); Shimizu 10102 (BKF), 10212 (BKF), 20417 (BKF), 20458 (BKF); Smith 1187 (K); Smitinand 4727 (BKF), 6664 (BKF); Srisanga et al. 800 (QBG); Srisanga 94-5 (BKF); Suksathan 517 (QBG), 1336 (QBG); Takahashi 62630 (BKF); Tagawa et al. 2649 (BKF), 9322 (BKF), 10000 (BKF); Unesco 1077 (BKF); Watthana et al. 641 (QBG); Winit 1012 (BKF).
4. *Microsorium musifolium*: T. Boonkerd & Pollawatn 243-2 (BCU); Suksathan 2957 (QBG).
5. *Microsorium pteropus*: T. Boonkerd 538 (BCU), 560 (BCU), 645 (BCU), 646 (BCU), 1185 (BCU), 1436 (BCU), 1526 (BCU); Chongko 25 (BKF); Geesink et al. 7282 (BKF); Hennipman 3533 (BKF), 3955 (BKF); Iwatsuki et al. 8509 (BKF); Middleton et al. 1305 (BKF), 1395 (BKF), 1769 (BKF), 2579 (BKF); Phengklai et al. 551 (BKF), 1769 (BKF); Ps. 209 (BKF), 804 (BKF); Ratchata 289 (BCU); Suan Pheung Trip 64 (BCU); Shimizu et al. 7690 (BKF), 21974 (BKF), 26421 (BKF); Smitinand 1090 (BKF), 3446 (BKF); Srisanga 2574 (QBG); Vongthavone 135 (BKF); Wannasri 43 (BCU); Winit 1015 (BKF); Yuyen 99 (BCU).
6. *Microsorium punctatum*: T. Boonkerd 123 (BCU), 124 (BCU), 157 (BCU), 169 (BCU), 277 (BCU), 1525 (BCU); Bunchuai 1701 (BKF); Bunak 384 (BKF, K), 1388 (BKF); Charoenphol, Larsen & Warncke 5078 (BKF); Garrett 288 (BKF); Geesink & Phengklai 6196 (BKF); Hennipman 3531 (BKF), 3808 (BKF), 4010 (BKF); Iwatsuki et al. 5493 (BKF), 10900 (BKF), 11693 (BKF); Kertsawang 814 (QBG), 992 (QBG); Larsen et al. 3096 (BKF), 31354 (BKF), 33334 (BKF), 45626 (BKF); Maxwell 85-450 (BKF), 95-599 (BKF), 97-672 (BKF), 06-568 (QBG); Middleton et al. 1729 (BKF), 2107 (BKF), 2523 (BKF), 2851 (BKF), 2734 (BKF); Murata et al. 16387 (BKF), 17676 (BKF), 38246 (BKF), 38604 (BKF), 49606 (BKF), 51675 (BKF), 52193 (BKF); Nanakorn et al. 3884 (QBG); Niyomdham et al.

- 6109 (BKF); Phengklai et al. 396 (BKF), 13352 (BKF), 13401 (BKF), 14767 (BKF); Ratana 49 (BCU); Suan Pheung Trip 63 (BCU); Srprartet 171 (BCU); Smitinand 5681 (BKF), 6741 (BKF), 7097 (BKF); Tagawa et al. 358 (BKF), 1308 (BKF), 2028 (BKF), 8654 (BKF); Tagawa & Yamada 140 (BKF); TDBS. 11209 (BKF); Th.s. et al. 73 (BKF); van Beusekom & Phengklai 258 (BKF); Vongthavone 027 (BKF), 165 (BKF); Wannasri 36 (BCU); Watthana & Srisanga 3093 (QBG); Winit 1049 (BKF); Yuyen 7 (BCU).
7. *Microsorium sarawakense*: Suksathan 2445 (QBG).
 8. *Microsorium siamense*: P.V. fern 1 (BCU, L).
 9. *Microsorium superficiale*: T. Boonkerd 602 (BCU), 1321 (BCU); Garrett 863 (BCU, BKF); Geesink et al. 8192 (BKF); Hennipmam 3283 (BKF), 3384 (BKF); Koyama et al. 15645 (BKF); Konta et al. 4998 (BKF); Murata et al. 15198 (BKF), 15653 (BKF); Pooma 448 (BKF); Rattanathirakul 42 (BCU); Shimizu et al. 11466 (BKF), 11598 (BKF); Smithinand 6660 (BKF); Srisanga & Suksathan 3245 (QBG); Srisanga & Watthana 708 (QBG); Suksathan 20 (QBG), 1351 (QBG), 2356 (QBG), 3829 (QBG); Tagawa et al. 1504 (BKF), 2643 (BKF), 4216 (BKF); Wongprasert s.n. (BKF).
 10. *Microsorium thailandicum*: T. Boonkerd 1367 (BCU), 1442 (BCU, L).
 11. *Microsorium zippelii*: T. Boonkerd 143 (BCU), 144 (BCU), 145 (BCU), 560 (BCU), 645 (BCU), 646 (BCU), 1159 (BCU); Chongko 122 (BKF); Garrett 539 (BKF); Maxwell 02-349 (BKF), 06-498 (QBG); Middleton et al. 1771 (BKF); Ratchata 49 (BCU); Sathapattayanon 158 (BCU); Smith 1544 (BKF); Tagawa et al. 1285 (BKF); Watthana & Suksathan 1663 (QBG); Yuyen 10 (BCU).
 12. *Phymatosorus cuspidatus*: T. Boonkerd 1276 (BCU); T. Boonkerd et al. 2011-51 (BCU), 2011-100 (BCU); Bunchuai 1509 (BKF); Charoenphol 474 (BKF); Garrett 260 (BKF); Maxwell 89-223 (BKF); Murata et al. 51403 (BKF); Pooma 761 (BKF), 1216 (BKF); Ratchata 266 (BCU); Suksathan 1407 (QBG), 3603 (QBG); Tagawa et al. 388 (BKF), 1085 (BKF); van Beusekom et al. 4199 (BKF); Winit 1018 (BKF).
 13. *Phymatosorus longissimus*: T. Boonkerd 1120/1 (BCU), 1580 (BCU); Bunchuai 548 (BKF); Maxwell 93-437 (BKF), 06-979 (QBG); Murata et al. 50946 (BKF), 50965 (BKF), 50974 (BKF); Rachata 341 (BCU); Tagawa et al. 4500 (BKF); van Beusekom et al. 4095 (BKF); Winit 1050 (BKF).
 14. *Phymatosorus membranifolium*: T. Boonkerd 5 (BCU), 6 (BCU), 15 (BCU), 637 (BCU), 644 (BCU), 1379 (BCU); Chongko 80 (BKF); Geesink & Hattink 6428 (BKF); Hennipman 3727 (BKF); Iwatsuki et al. 5293 (BKF), 7319 (BKF); Kwaipan 104 (BCU); Larsen et al. 4126 (BKF), 31315 (BKF), 32719 (BKF), 41048 (BKF), 42257 (BKF); Lukchant 16 (BCU); Maxwell 85-101 (BKF), 86-889 (BKF); Middleton 215 (BK), 1085 (BK), 2738 (BK); Murata et al. 16395 (BKF); Neamsuvan 69 (BCU); Nimanong & Sangkhachand 1292 (BKF); Niyomdham 1042 (BKF); Niyomdham & Puudjaa 4670 (BKF); Phengklai et al. 13561 (BKF); Ratana 50 (BCU); Sangkhachand 181 (BKF); Santisuk 177 (BKF); Santisuk & BN. 355 (BKF); Sathapattayanon 162 (BCU); Suan Pheung trip 084 (BCU); Seelanan 14 (BCU); Shimizu et al. 14686 (BKF), 23594 (BKF); Smith 2004 (BKF);

Suksathan 2512 (QBG); *Suvarnakoses* 1747 (BKF); *Tagawa et al.* 6976 (BKF); *Tagawa & Yoda* 207 (BKF); *van Beusekom* 397 (BKF); *van Beusekom & Charoenpol* 1925 (BKF); *van Beusekom & Geesink* 3367 (BKF); *van Beusekom & Santisuk* 2896 (BKF); *Vongthavone* 148 (BKF); *Wannasri* 47 (BCU); *Winit* 40 (BKF); *Yoda* 633 (BKF); *Yuyen* 103 (BCU).

15. *Phymatosorus scolopendria*: *T. Boonkerd* 44/464 (BCU), 44/465 (BCU), 1192 (BCU); *Bunnak* 700 (BKF); *Geesink et al.* 7784 (BKF); *Maxwell* 85-638 (BKF), 05-506 (QBG); *Niyomdham et al.* 1600 (BKF), 6242 (BKF); *Phengkhai* 1132 (BKF); *Pooma et al.* 6699 (BKF); *Sangkhachand* 910 (BKF); *Smith* 1533 (BKF); *Tagawa et al.* 4499 (BKF); *Wattana & Pumicong* 2074 (QBG).