FLORA OF THAILAND

VOLUME THREE **PART FOUR**

PTERIDOPHYTES

M. TAGAWA K. IWATSUKI

DIPTERIDACEAE
CHEIROPLEURIACEAE
POLYPODIACEAE
GRAMMITIDACEAE

MARSILEACEAE
SALVINIACEAE
AZOLLACEAE

FLORA OF THAILAND

VOLUME THREE PART FOUR

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28. DIPTERIDACEAE

There is a single genus known to this family.

DIPTERIS

Reinw., Sylloge Pl. 2: 3. 1824; Copel., Gen. Fil.:177. 1947.

Rhizome creeping, stout, densely covered with hairs; hairs multicellular, sometimes consisting in several rows of cells, bristle-like. Stipes erect, smooth, glabrous. Fronds completely divided into two halves, each half divided into several unequal segments; main veins branched several times dichotomously, smaller veins anastomosing with free included veinlets in the areoles; texture coriaceous. Sori small, usually round, naked, scattered irregularly on the whole under surface of fronds, usually at junction of the smaller veins.

This is often considered as a primitive genus of the Polypodioid series of ferns, though some authors follow Bower to treat this close to *Matonia*. By the chaetopteroid rhizome and dichotomous frond construction, this is distinct from the Polypodiaceae, and is better ranked as a distinct family. There are eight species of *Dipteris* known mainly in Southeast Asia, i.e. from NE. India to Polynesia. Among them only one species is known in Peninsular Thailand.

Dipteris conjugata Reinw., Syll. Pl. 2: 3. 1824; Tard. & C. Chr. in Fl. Gén. I.-C. 7(2): 442. 1941; Holtt., Rev. Fl. Malaya 2: 135. f. 55. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 46. 1967; Acta Phytotax. Geobot. 23: 52. 1968.— *Dipteris horsefieldii* (R. Br.) Bedd., Ferns Br. Ind.: t. 321. 1869; Handb.: 336. f. 185. 1883. Figure 49. 1 – 2.

Rhizome wide-creeping on cleyey ground, about 1 cm or more diam., bearing fronds remotely, densely covered with hairs; hairs 4 to 5 mm long, 0.2 mm diam., sometimes the basal portion consisting in a few rows of cells, stiff, dark brown, shining. *Stipes* up to 2 m long, densely hairly at base, glabrous above, stramineous to brown. *Laminae* up to 50 cm or more long, 70 cm wide, bilobed almost to the base, the lobes spreading fan-shaped, divided more than halfway to the base into four unequal segments which again lobed once or more times less deeply and unequally; ultimate segments narrowly subtriangular, gradually narrowing towards caudately acuminate apex, irregularly waved at margin; main veins dichotomously branched several times, 2 – 4 main veins entering into ultimate segments, venation copiously anastomosing with included veinlets; coriaceous, green on upper surface, paler or

Figure 49. 1–2: *Dipteris conjugata*; 1. three leaves, x 0.25; 2. venation enlarged (left) and scale on rhizome (x 10). 3–6: *Cheiropleuria bicuspis*; 3. two sterile leaves (left and below) and fertile leaf (x 0.4); 4. paraphyses; 5. venation enlarged; 6. sporangium. 7–11: *Platycerium wallichii*; 7. fertile leaf. (x 0.33); 8. nest leaf (x 0.33); 9. sporangium; 10. stellate hair; 11. scale on rhizome and marginal portion enlarged. 12–13: *Drymoglossum piloselloides*; 12. plant (x 0.5); 13. stellate hairs on leaves (below) and sporangium (left).

glaucous beneath. *Sori* small, numerous, irregularly scattered all over the lower surface of fronds, without indusia, mixed with club-shaped paraphyses.

T h a i l a n d.— PENINSULAR: Surat Thani (Ko Phangan), Nakhon Si Thammarat (Khao Luang), Phangnga (Khao Phota Luang Kaeo), Yala (Gunong Ina).

D i s t r i b u t i o n.— Vietnam and Cambodia, throughout Malesia to Polynesia and Australia, northwards to Taiwan and S. Ryukyus (Iriomote).

E c o l o g y.— Usually on cleyey slopes in or at edge of evergreen forests and in the places with sufficient light at high altitudes higher than 1000 m in Peninsular, rather common and abundant.

V e r n a c u l a r.— Bua chaek (บัวแฉก) (Peninsular).

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29. CHEIROPLEURIACEAE

This is another family often referred to the Polypodiaceae. There is a single monotypic genus included in the Cheiropleuriaceae.

CHEIROPLEURIA

Presl, Epim. Bot.:189. 1849; Copel., Gen. Fil.:178. 1947.

Rhizome short-creeping, densely covered with hairs; hairs multicellular, rather soft, pale brown. Stipes close together, pale green to stramineous. Fronds dimorphic. Sterile fronds simple or bilobed at apex, the main veins dichotomous; venation drynarioid, copiously reticulate with simple or branched included veinlets. Fertile fronds simple, narrower, acrostichoid or whole the under surface covered with sporangia mixed with simple club-shaped paraphyses.

The type and the sole species is known in the Old World tropics extending its range to Thailand.

Cheiropleuria bicuspis (Bl.) Presl, Epim. Bot.:189. 1849; Tard. & C.Chr. in Fl. Gén I.-C. 7(2): 443. f. 51, 4–5. 1941; Holtt., Rev. Fl. Malaya 2: 136. f. 56. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 47. 1967.— *Polypodium bicuspe* Bl., En. Pl. Jav.:125. 1828. Figure 49. 3–6.

Rhizome creeping, 6–10 mm diam., densely covered with hairs, bearing fronds 0.3–1.5 cm apart; hairs soft, pale brown, up to 5 mm or more long, multiseptate. *Fronds* dimorphic. *Sterile fronds*: stipes up to 30 cm long, hairy at base, glabrous above, stramineous or darker; smaller laminae simple, narrowly bilobed, round at base, entire, up to 15 cm long, 12 cm wide; lobes acuminate with broad rounded sinus between them, up to 8 cm long, entire; main veins several times branching dichotomously, smaller veins forming elaborate network; coriaceous, deep green, paler beneath. *Fertile fronds* taller; laminae linear-lanceolate, gradually narrowing towards both base and apex, up to 15 cm long, 1.5 cm broad, lower surface wholly covered with sporangia in acrostichoid condition except on main veins and narrow strip at edge, mixed with simple club-shaped hairs.

Thailand.— NORTH-EASTERN: Loei (Phu Kradueng); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution.— S. China, Vietnam, Malesia generally (Sumatra to

New Guinea, type from Java), northwards to the warmer parts of Japan through Taiwan and the Ryukyus.

E c o l o g y.— On clayey slope along path in dense forests at higher altitudes (1000 – 1800 m), rather rare.

V e r n a c u l a r.— Bua chaek (บัวแฉก) (Peninsular).

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30. POLYPODIACEAE

Excluding Dipteridaceae, Cheiropleuriaceae and Grammitidaceae, the Polypodiaceae in the most strict sense contains some 50 genera and 600 species mainly from the tropical regions. Most of the species of this family are to some extent specialized to the epiphytic habitat, and are generally small to mediocre in size.

Twenty genera of this family are known from Thailand, representing 102 species there as enumerated below. Comparing with 68 species in Malaya (HOLTTUM, 1955) and 101 in Indochina (TARDIEU-BLOT & CHRISTENSEN, 1941), the figure in Thailand is comprehensive. The same members of genera are represented in Indochina; in Malaya, *Arthromeris* is not known and *Merinthosorus*, *Pycnoloma* and *Lecanopteris* are recorded.

KEY TO THE GENERA

1. Fronds simple, or pinnate with pinnae not jointed to rachis
 2. Nest leaves present
  3. Normal leaves repeatedly forked; stellate hairs present **1. Platycerium**
  3. Foliage leaves pinnate; stellate hairs absent **12. Drynaria**
 2. Nest leaves lacking
  4. Fronds simple
   5. Fronds covered when young with stellate hairs
    6. Fronds dimorphic. Sori continuous along the margin of linear fertile fronds **2. Drymoglossum**
    6. Fronds monomorphic or dimorphic. Sori round and distinct, or more or less continuous on linear monomorphic fronds **3. Pyrrosia**
   5. Fronds not having stellate hairs
    7. Fronds bearing peltate scales on surface or in sori
     8. Sori round or continuous along the margin of fronds
      9. Rhizome not ant-inhabited
       10. Fronds coriaceous. Rhizome-scales glabrous
        11. Fronds usually over 8 cm long, fertile part not especially narrowed **4. Lepisorus**
        11. Fronds less than 8 cm long, fertile apical part very narrow or fronds dimorphic as a whole **5. Lemmaphyllum**
       10. Fronds herbaceous. Rhizome-scales bearing a few long hairs at base **7. Neocheiropteris**
      9. Rhizome ant-inhabited **9. Myrmecophila**
     8. Sporangia acrostichoid, scattered on the lower surface of narrow apical portion of fronds **6. Belvisia**
    7. Fronds not bearing any peltate scale
     12. Fronds dimorphic and sporangia acrostichoid **11. Leptochilus**
     12. Fronds monomorphic or hardly dimorphic, never acrostichoid having distinct sori
      13. Sori round or nearly so
       14. At least the middle part of scales clathrate **8. Microsorium**

14. Scales not clathrate throughout **16. Crypsinus**
13. Sori forming continuous or broken lines oblique to the midribs of fronds
15. Fronds thick, coriaceous, main veins distinct **17. Selliguea**
15. Fronds thin, or when leatherly main veins obscure
16. Stipes jointed to rhizome; papyraceous **10. Colysis**
16. Stipes not jointed to rhizome; chartaceous **20. Loxogramme**
4. Fronds pinnate or pinnately lobed
17. Sporangia not acrostichoid, forming distinct sori
18. Fronds very large, sessile, basal portion like nest leaves **13. Aglaomorpha**
18. Fronds with stipes, basal portion nothing particular
19. Sori terminal on distinct free veins **19. Polypodium**
19. Sori compital or on reticulate veins
20. At least the middle part of scales clathrate **8. Microsorium**
20. Scales not clathrate **16. Crypsinus**
17. Fronds dimorphic and sporangia acrostichoid **15. Christiopteris**
1. Fronds pinnate with pinnae jointed to rachis
21. Sori not distinct, sporangia covering whole the under surface of narrow upper pinnae **14. Photinopteris**
21. Sori round, separate
22. Included veinlets branched and variously directed **18. Arthromeris**
22. Included veinlets simple and excurrent **19. Polypodium**

1. PLATYCERIUM

Desv., Mém. Linn. Soc. 6: 213. 1827; Copel., Gen. Fil.: 179. 1947; Hennipm. & Roos, Verh. Kon. Ned. Akad. Wet. Nat. 80: 74. 1982.

Epiphytic; rhizome covered by a mass of fronds and roots, short-creeping, scaly; scales terminally attached, sometimes bi-coloured, fimbriate at margin though becoming entire in older ones, not clathrate. Fronds close, in two kinds. Scale-leaves (or nest-leaves) erect, sessile, persistent, broad and cordate at base, imbricate, basal portion thick and fleshy, protecting a mass of stems, roots and other decaying substances, with dichotomous main veins and reticulate small ones, shallowly lobed dichotomously. Normal leaves (or fertile leaves) erect or pendulous, articulate at base, repeatedly forked dichotomously, margin entire, venation anastomosing with branched included veinlets; all parts densely covered when young with stellate hairs. Sporangia spreading on specialized areas of normal leaves, mixed with stellate paraphyses.

This is a primitive genus of this family as appeared in the dichotomous branching of the fronds, and is raised up as a monotypic family by CHING (1940). Concerning to the alliance of this genus, COPELAND (1947) related it to *Pyrrosia* based mainly on the presence of the stellate hairs. The plants of this genus are usually found in open places or in the places with a plenty of light, and this exposure to light seems to be protected by the morphological peculiarity, one by the production of the special scale-leaves and the other by the dense stellate hairs covering the whole surface of plants.

There are about a dozen of species known in the Old World tropics, from Madagascar to Australia, one extending to S. America. In Thailand three species have been recorded.

KEY TO THE SPECIES

1. Sporangia on lower surface of fertile lobes which are at the base of sinus of the normal leaves, subsequently divided several times dichotomously
2. Sporangia on larger areas of the lower surface in the two or more basal sinus of the normal leaves. Rhizome-scales very narrow, less than 1 cm broad **1. P. wallichii**
2. Sporangia on lower surface of much longer normal leaves with only one dichotomy in a single fertile area. Rhizome-scales broad, up to 1.5 mm broad **2. P. holttumii**
1. Sporangia on special stalked lobes without further division **3. P. coronarium**

1. Platycerium wallichii Hook., Gard. Chron. 1858: 765; Fil. Exot.: t. 97. 1859; Bedd., Handb.: 445. f. 272. 1883; C.Chr., Contr. U.S. Nat. Herb. 26: 335. 1931; Holtt., Rev. Fl. Malaya 2: 141. 1955; Dansk Bot. Ark. 23: 229. 1965; Tagawa & K.Iwats., Southeast As. St. 5: 47. 1967; Hennipm. & Roos, Verh. Kon. Ned. Akad. 80: 113. f. 27, e-g, 30. pl. 1, 8b. 1982. Figure 49. 7–11.

Rhizome short-creeping, less than 1 cm diam., bearing fronds densely covered with scales; scales linear, up to 1 cm by 0.4 mm, pale with dark brown central portion, stiff. *Scale-leaves* 40 cm or more in length, as wide as long, dichotomously lobed, the deepest sinus more than 20 cm deep, lobes round or moderately acute at apex, longer than wide; main veins and secondary veins raised on both surfaces, smaller ones hardly visible; main veins dichotomous, secondary ones forming network, smaller ones more copiously anastomosing; very thick and fleshy near base, more than 1 cm thick, thin and green at upper portion. *Normal leaves* up to 50 cm or more long, pendulous, repeatedly dichotomously branching, the base broadly cuneate; ultimate lobes narrow, up to 15 cm by 3 cm, entire; main veins distinct, dichotomous, smaller ones hardly visible, copiously anastomosing with included veinlets; thick but not leatherly, densely stellate hairy; a large area of the lower surface at base of the two first sinus covered with sporangia, mixed with stellate paraphyses.

T h a i l a n d.— NORTHERN: Chiang Rai (Mae Suai), Chiang Mai (Fang, Ping Khong, Doi Suthep), Mae Hong Son (Ban Mae Pang), Lampang (Huai Thak), Nakhon Sawan (Pang Ma Kham Pom, Takhli); NORTH-EASTERN: Loei (Phu Luang, Pha Nok Khao), Nong Khai (Pak Cheng); CENTRAL: Saraburi (Phrieo); SOUTH-EASTERN: Chon Buri (Si Racha); SOUTH-WESTERN: Kanchanaburi (Erawan Falls, Wangka); PENINSULAR: Ranong (Kapoe), Satun.

D i s t r i b u t i o n.— E. India, Burma (Tenasserim) and Yunnan to Malay (Langkawi; Kedah, type).

E c o l o g y.— Epiphytic on tree-trunks usually in not so dense forests, not so rare at lower elevation throughout the country.

V e r n a c u l a r.— Ka-cho-pho-na (กะฉอโพน่า) (Karen/Northern); kraprok hua mu (กระปรอกหัวหมู), kraprok yai (South-eastern); chai pha sida (ชายผ้าสีดา) (Central); tong ho khao ya ba (ตองห่อข้าวย่าบา) (Northern); hua thao i ba (หัวเฒ่าอีบา) (North-eastern); Staghorn Fern.

2. Platycerium holttumii Jonch. & Hennipm., Brit. Fern Gaz. 10: 116. pl. 12, f. 1–3. 1970; Hennipm. & Roos, Verh. Kon. Ned. Akad. 80: 101. f.25, 26. pl. 2. 1982.— *Platycerium grande* J. Sm. ex Hook. sensu Bedd., Handb.: 445. f. 271. 1883, p.p.; C.Chr., Contr. U.S. Nat. Herb. 26: 335. 1931; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 446. f. 52, 1. 1941. Plate I:1.

Similar to *P. wallichii* but different from it in: rhizome-scales larger, up to 15 by 1.5 mm, fimbriate; normal leaves much longer, with a single broad fertile area in the basal sinus.

T h a i l a n d.— NORTHERN: Chiang Mai (Fang, Ban Huai Bong), Tak; NORTH-EASTERN: Nong Khai (Pak Cheng), Loei (Ban Na Luang); EASTERN: Chaiyaphum (Nam Phrom), Nakhon Ratchasima (Khao Yai, type); SOUTH-EASTERN: Chanthaburi (Khao Phra Bat); SOUTH-WESTERN: Kanchanaburi (Erawan Falls).

D i s t r i b u t i o n.— Indochina and Malaya.

E c o l o g y.— On tree-trunks in monsoon forests at low altitudes, rather rare.

V e r n a c u l a r.— Chai pha sida (ชายผ้าสีดา) (Central); Holttum's Staghorn Fern.

N o t e.— The above two species are similar to each other, but different from each other distinctly in rhizome-scales. It is regrettable that the rhizome-scales are often not available on the herbarium sheets, and the specific identification is hardly possible in such incomplete specimens.

3. Platycerium coronarium (Koen.) Desv., Prodr.: 213. 1827; C.Chr., Bot. Tidsskr. 32: 349. 1916; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 445. 1941; Holtt., Rev. Fl. Malaya 2: 138. f. 57. 1955; Tagawa & K.Iwats., Southeast As. St. 3(3): 75. 1965; Hennipm. & Roos, Verh. Kon. Ned. Akad. 80: 92. f. 20, e-h, 21. 1982.— *Osmunda coronaria* Koen. in Mull., Naturf. Halle 21: 107. f. 3. 1785.— *Platycerium biforme* (Sw.) Bl., Fl. Jav. Fil. 14. t. 18. 1829; Bedd., Handb.: 445. f. 173. 1883; Christ, Bot. Tidsskr. 24: 105. 1901.— *Acrostichum biforme* Sw., Schrad. J. Bot. 1800 (2): 11. 1801. Plate II:2.

Rhizome short-creeping, more than 1 cm diam., fleshy, covered with scales at apex; scales broad, up to 1.5 by 1 cm, brown, herbaceous. *Scale-leaves* about 40 cm long, dichotomously lobed, the deepest sinus more than 20 cm deep, the lobes round at apex, about 5 cm in both length and width or longer; main veins raised on both surfaces, dichotomous, smaller veins copiously anastomosing, invisible; very thick, up to 1.5 cm thick and fleshy at base. *Normal leaves* 100 cm or more in length, pendulous, several times dichotomously branching, lower branch unequal, bearing short sterile branches and a single simple fertile lobe, upper branching almost equal; ultimate segments narrowly subtriangular, not pointed, entire, main veins dichotomous, raised, smaller veins hardly visible, forming copious network; fertile lobes stalked, almost circular to deeply cordate, up to 15 cm broad, the whole concave lower surface covered with a dense felt of stellate hairs and sporangia.

T h a i l a n d.— NORTH-EASTERN: Nong Khai (Khong Kao); SOUTH-EASTERN: Chon Buri (Si Racha), Trat (Ko Chang); PENINSULAR: Phuket (Khao Phara), Krabi, Trang (Khao Chong), Satun (Tarutao), Yala (Bannang Sata).

D i s t r i b u t i o n.— Burma (Tenasserim), Vietnam, Cambodia and N. & W. Malesia.

E c o l o g y.— Epiphytic on trunk of larger trees in open places at low altitudes, rather common.

V e r n a c u l a r.— Kraprok krachat (กระปรอกกระจาด) (South-eastern); hua sida (หัวสีดา) (South-western); ho khao sida (ห่อข้าวสีดา) (Central, Peninsular); Elkhorn Fern.

N o t e.— Owing to the apparent peculiarity of the fertile lobes, this species is considered as distinct from the other members of this genus, but the fertile lobes of this species are not so different morphologically as explained appropriately by HOLTTUM (1955). This species is close to *P. holttumii*, and almost the same but for the difference in the fertile lobes and in the structure of the sporangia. As described above, Thai plants are not so large as those in Singapore or in Java, attaining sometimes more than 2 m in length in the normal leaves.

2. DRYMOGLOSSUM

Presl, Tent. Pterid.: 227. pl. 10. f. 5, 6. 1836; C.Chr., Dansk Bot. Ark. 6: 83. pl. 12, 13. 1929. Nom. Cons.— *Pteropsis* Desv., Prodr.: 218. 1827; Copel., Gen. Fil.: 194. 1947.

Rhizome long-creeping, slender, densely scaly with peltate scales. Fronds dimorphic. Sterile fronds circular to elliptic, round at apex, round to roundly cuneate at base, shortly stalked. Fertile fronds linear, round at apex, gradually narrowing downwards; veins anastomosing to form areoles with simple or branched included veinlets; both surfaces of laminae sparsely stellate hairy. Sori linear, in longitudinal furrow along margin.

This is a derivative of *Pyrrosia* along the parallel course with that of *Lemmaphyllum* from *Pleopeltis*. Except for the linear marginal sori in elongate fertile leaves, we find no peculiarity for this genus from the species of *Pyrrosia*.

Among half a dozen of species known in the Old World tropics, only one has been found in Thailand.

Drymoglossum piloselloides (Linn.) Presl, Tent. Pterid.: 227. 1836; Bedd., Handb.: 411. f. 244. 1883; Christ, Bot. Tidsskr. 24: 105. 1901; C.Chr., Dansk Bot. Ark. 6(3): 86. 1929; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 516. f. 60, 1. 1941; Holtt., Rev. Fl. Malaya: 149. f. 64. 1955; Dansk Bot. Ark. 20: 19. 1961; Seidenf., Bull. Nat. Hist. Siam Soc. 19: 86. 1958; Tagawa & K. Iwats., Southeast As. St. 3(3): 76. 1965, 5: 49. 1967.— *Pteris piloselloides* Linn., Sp. Pl. ed. 2: 1530. 1763.— *Pyrrosia piloselloides*

(Linn.) Price, Kalikasan 3: 176. 1974; Ravensb. & Hennipm., Leid. Bot. Ser. 9: 302. f. 1, e, j, 2, e, i. 1986.— *Drymoglossum heterophyllum* (Linn.) C.Chr., Bot. Tidsskr. 32: 348. 1916; Bonap., Not. Ptérid. 14: 63. 1923; E.Sm., J. Siam Soc. Nat. Hist. Suppl. 8: 8. 1929.— *Acrostichum heterophyllum* Linn., Sp. Pl. 2: 1067. 1753. Figure 49. 12–13.

Rhizome long-creeping, about 1 mm diam., bearing fronds 1.5–4 cm apart, densely scaly throughout; scales small, ovate-oblong, irregularly toothed, up to 1 mm in length and breadth, dark brown in central portion, paler at edges. *Stipes* very short, a few milimeters long. *Fronds* distinctly dimorphic. *Sterile fronds*: laminae nearly circular, oblong or elliptic, round at apex, round to cuneate at base, up to 4 by 1.5 cm; midrib distinct on lower half of fronds, veins hardly visible, anastomosing; coriaceous, both surfaces very sparsely stellate hairy or glabrescent. *Fertile fronds*: laminae linear-lanceolate, round at apex, gradually narrowing towards attenuate base, 3–15 by up to 0.8 cm; midrib distinct throughout, slightly raised on both surfaces. *Sori* forming a continuous marginal lines up to 2 mm in breadth, covered with stellate hairs when young.

T h a i l a n d.— NORTH-EASTERN: Nong Khai (Ban Bang); EASTERN: Chaiyaphum (Thung Kamang, Tat Ton); CENTRAL: Nakhon Nayok (Khao Yai), Krung Thep (Bangkok); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Khao Sabap, Ban Takhian Thong, Makham), Trat (Ko Chang, Dong Poi Yen, Khao Saming); SOUTH-WESTERN: Kanchanaburi (Wangka, Phomphi); PENINSULAR: Chumphon, Krabi, Ranong (Ko Chang); Surat Thani (Ban Na San, Ko Tao, Khun Thale Lake), Phangnga (Yan Yao), Nakhon Si Thammarat (Khiriwong, Khao Luang, Chawang), Trang, Songkhla, Satun, Narathiwat (Bacho Falls), Yala (Bannang Sata).

D i s t r i b u t i o n.— Himalayas, Indochina, S. China (Hainan) and Malesia throughout.

E c o l o g y.— Usually on tree-trunks in not so dense forests at low altitudes, rather common.

V e r n a c u l a r.— Klet nakkharat (เกล็ดนาคราช) (Central); kip ma lom (กีบม้าลม) (Northern); man hia (มันเหี้ย) (South-eastern).

N o t e.— In sterile fronds this species is distinct from *Pyrrosia nummularifolia* in less hairy fronds with coriaceous texture and oblong to lanceolate rhizome-scales with fimbriate margin.

3. PYRROSIA

Mirbel, Hist. Nat. Veg. 5: 91. 1803; Ching, Bull. Chin. Bot. Soc. 1: 36. 1935; Copel., Gen. Fil.: 192. 1947; Hovenk., Leid. Bot. Ser. 9: 139. 1986.— *Niphobolus* Kaulf., Enum. Fil.: 124. 1824; Gies., Farng. *Niphobolus*: 87. 1901.

Rhizome long-creeping, usually slender, scaly; scales peltate (in a few species terminally attached), fringed with hairs or entire, not clathrate. Fronds simple to palmately lobed, entire, fleshy, rarely dimorphic; venation anastomosing, completely hidden; surfaces more or less entirely covered with stellate hairs, generally caducous on upper surface. Sori round, large, in a single row or more commonly in several close rows at each side of midribs, sometimes taking an appearance of the acrostichoid condition, naked, but protected when young by a dense matt of stellate hairs.

This is the genus very well circumscribed by the presence of the stellate hairs, and distinct among the polypodiaceous ferns by this feature. Almost all of the species of this genus grow in open places, and every character of them is adapted to xerophytic habitat: the simple smaller fronds densely covered by stellate hairs, fleshy fronds, and so on.

About 100 species are credited to this genus mainly from the Old World, and a few in the New World. In Thailand following eighteen species will be described, though the specific boundary is in some cases still obscure.

KEY TO THE SPECIES

1. Sori continuous in one row at half way between midribs and margin of laminae or interrupted, protected when young by the peculiar marginal lip of laminae **1. P. angustissima**
1. Sori round or oblong, distinct, usually dispersed on the soriferous laminae beneath, without peculiar marginal lip.
2. Fronds typically dimorphic with longer fertile fronds
3. Sterile laminae almost circular to broadly oblong, 1.5 – 2.5 cm long **2. P. nummularifolia**
3. Sterile laminae oblong or broadly lanceolate, 3 – 6 cm long **3. P. adnascens**
2. Fronds not or hardly dimorphic
4. Sori large, in one regular row at each side of midrib **5. P. angustata**
4. Sori smaller, usually in more than one rows at each side of midrib
5. Upper surface of laminae lacking any hydathodes
6. Rhizome-scales oblong-ovate, appressed. Fronds 20 – 50 cm long **4. P. longifolia**
6. Rhizome-scales linear or lanceolate, shaggy. Fronds up to 25 cm long
7. Fronds subglabrous or very sparsely hairy, fertile fronds more or less taller than the sterile ones; fronds usually more than 1.5 cm broad
8. Stipes 1 – 4 cm long, sparsely hairy; midrib dark brown **6. P. varia**
8. Stipes less than 1 cm long, densely hairly; midrib stramineous to pale green or rarely dark **7. P. nuda**
7. Fronds densely hairy beneath, not dimorphic; fronds up to 2 cm broad
9. Upper surface of fronds hairy. Rhizome-scales hairy at margin of apical portion **8. P. lanceolata**
9. Upper surface of fronds subglabrescent. Rhizome-scales entire **9. P. floccigera**
5. Upper surface of fronds with distinct hydathodes
10. Laminae linear-lanceolate to narrower, up to 2 cm broad. Rhizome short-creeping, bearing fronds more or less closely; veins hardly visible
11. Rhizome-scales hairy to lacerate at least at apical half, commonly bi-coloured with blackish center and brown edges
12. Laminae linear, typically up to 7 (or exceptionally up to 10) mm, broad; lower surface densely covered with appressed grey hairs and rather sparsely with short-armed stellate hairs **10. P. tonkinensis**

12. Laminae oblanceolate, usually up to 1.2 (or rarely up to 1.7) cm broad; lower surface densely covered with brown stellate hairs **11. P. mollis**
11. Rhizome-scales entire, concolorously dark brown **12. P. mannii**
10. Laminae oblong or oblong-lanceolate, up to 3 cm or more broad; lateral main veins more or less distinct
13. Rhizome short-creeping, bearing fronds close together
14. Lower surface of fronds covered with loose stellate hairs. Sori larger, about 2 mm diam., covering the apical part of the under surface of laminae leaving marginal sterile portion **13. P. penangiana**
14. Lower surface of fronds covering with closely interlocking stellate hairs. Sori smaller, less than 1 mm diam., covered the under surface of laminae nearly to the margin
15. Stipes more or less distinct. Laminae lanceolate or oblanceolate, the base cuneate to narrowly so
16. Laminae subquadrangular to broadly spathulate, acute to rotundate at apex, rather suddenly broadly cuneate at base **14. P. flocculosa**
16. Laminae lanceolate, attenuately acuminate at apex, cuneate at base **15. P. stigmosa**
15. Stipes usually indistinct, winged throughout with decurrent base of laminae. Laminae broadly spathulate or oblanceolate **16. P. costata**
13. Rhizome long-creeping, bearing distant fronds
17. Laminae oblong-lanceolate to oblong with acuminate apex and caudate base **17. P. eberhardtii**
17. Laminae ovate-oblong to elliptic with rotundate apex and round or shortly cuneate base **18. P. heteractis**

1. Pyrrosia angustissima (Gies. ex Diels) Tagawa & K. Iwats., Acta Phytotax. Geobot. 26: 171. 1975; Ravensb. & Hennipm., Leid. Bot. Ser. 9: 297. f. 1 d,m,t, 2. b, k. 1986.— *Niphobolus angustissimus* Gies. ex Diels in Engl. & Prantl, Nat. Pfl.-fam. 1(4): 326. 1899, based on *Polypodium angustissimum* Bak., Ann. Bot. 5: 472. 1891, non Fée 1869.— *Saxiglossum angustissimum* (Diels) Ching, Acta Phytotax. Sin. 10: 301. 1965. Figure 50. 1–2.

Rhizome long-creeping, up to 1 mm or more diam., densely scaly throughout; scales narrowly oblong-subdeltoid with long-tailed apex and round base, entire, up to 5 mm long including the tails more than half in length, up to 0.7 mm broad, pale brown to brown with dark central portion. *Stipes* indistinct or up to 2 cm long, densely scaly at base, stellate hairy or glabrescent. *Laminae* monomorphous, linear, round to moderately acute at apex, gradually narrowing towards base, involute, up to 12 cm by 4 mm, thick-leatherly, sparsely stellate-hairy above, densely covered with short-armed stellate hairs as well as wooly hairs beneath, the margin usually broad and involuting to form a broad flap on the ventral side covering the sori in their early stage of development; veins hardly visible, forming loose anastomosis without free included veinlets. *Sori* elongate, at midway between midrib and margin of laminae, usually covered by the involute margin of laminae.

T h a i l a n d.— SOUTH-WESTERN: Kanchanaburi (Khao Ngi Yai).

D i s t r i b u t i o n.— Warm part of China (type) and Taiwan.

E c o l o g y.— Epiphytic, very high on dead tree in deciduous or evergreen forests, 700–1150 m alt.

N o t e.— This is the species on which Ching described *Saxiglossum* chiefly based on the features of the taenoid sori and of having the peculiar inframarginal lip covering the sori as false indusium. In the soral construction this is similar to *Drymoglossum*, though we prefer to retain this species among *Pyrrosia*. The receptacles of this species are not quite continuous but interrupted, and we can find the construction similar to this in *Pleopeltis sinensis*. The linear arrangement of the sori is known in the other species of *Pyrrosia*, for instance in *P. linearifolia* with linear laminae.

2. Pyrrosia nummularifolia (Sw.) Ching, Bull. Chin. Bot. Soc. 1: 47. 1935; Holtt., Rev. Fl. Malaya 2: 144. f. 59. 1955; Tagawa & K.Iwats., Southeast As. St. 3(3): 75. 1965; 5: 47. 1967; Acta Phytotax. Geobot. 23: 52. 1968; Hovenk., Leid. Bot. Ser. 9: 214. f. 23. 1986.— *Acrostichum nummularifolium* Sw., Syn. Fil.: 191, 419. t. 2. f. 1. 1806.— *Niphobolus nummularifolius* (Sw.) J.Sm., J. Bot. 3: 396. 1841; Bedd., Handb.: 334. f. 183. 1883.

Rhizome long-creeping, about 1.5 mm diam., bearing two rows of close to imbricate fronds, densely scaly throughout; scales linear, up to 6 by 0.6 mm, pale brown with deep brown center, hairy at margin, marginal hairs longer. *Fronds* distinctly dimorphic. *Sterile fronds*: stipes very short, up to 3 mm long, scaly at base; laminae almost circular to broadly oblong, round at apex, 1.5 – 2.5 cm long; midrib distinct at lower half of the upper surface, veins completely hidden, anastomosing; fleshy, upper surface stellate hairy or glabrescent, lower surface densely hairy with stellate hairs. *Fertile fronds*: stipes 1 – 1.5 cm long, slender; laminae lanceolate, up to 7 by 0.8 cm, round to moderately acute at apex, gradually narrowing towards base. *Sporangia* covering the whole under surface, sori embedded in thick layer of hairs.

T h a i l a n d.— SOUTH-WESTERN: Kanchanaburi (Wangka); PENINSULAR: Surat Thani (Ban Na, Bang Bao), Phangnga, Nakhon Si Thammarat (Khao Luang, Khiriwong, Thung Song), Trang (Khao Chong, Khao Khao), Satun (Khuan Kalong, Khlong Tan, Pulang Kapong), Yala (Bannang Sata).

D i s t r i b u t i o n.— India, Burma, W. Malesia (type from Java) east to the Philippines, Celebes and Lesser Sunda Islands.

E c o l o g y.— Epiphytic on tree-trunks or on rocks in light shade or in open places usually at low altitudes, rather common.

N o t e.— This species is similar in appearance to *Drymoglossum*. In sterile fronds, this species is rather difficult to be distinguished from *D. piloselloides*, though the construction of the fertile fronds is quite different, and the under surface of this species is thickly coated by wooly brown hairs. *P. nummularifolia* grows usually in lowlands in Peninsular, closely attached to tree-trunks or on rocks in moist shady places. In such habit, this species is rather distinct from the other species of this genus.

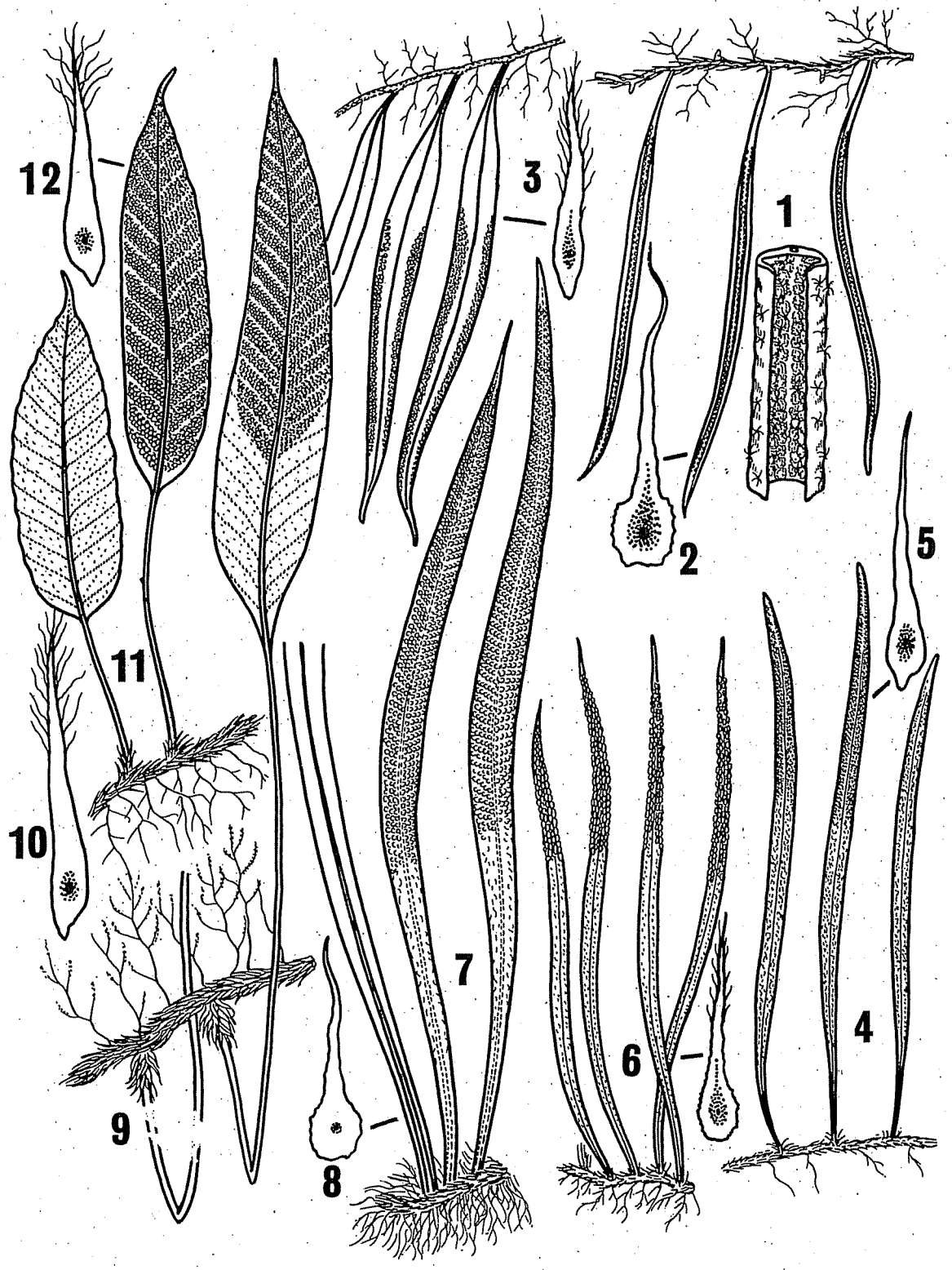

Figure 50. *Pyrrosia* spp. 1–2: *P. angustissima*; 1. plant (x 0.5) and part of fertile frond enlarged; 2. scale enlarged. 3. *P. nuda*; plant (left, x 0.5) and scale enlarged. 4–5: *P. floccigera*; 4. plant (x 0.5); 5. scale enlarged. 6. *P. tonkinensis*; plant (x 0.5) and scale enlarged. 7–8: *P. mannii*; 7. plant (x 0.5); 8. scale enlarged. 9–10: *P. eberhardtii*; 9. plant (x 0.5); 10. scale enlarged. 11–12: *P. heteractis*; 11. plant (x 0.5); 12. scale enlarged.

3. Pyrrosia adnascens (Sw.) Ching, Bull. Chin. Bot. Soc. 1:45. 1935; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 505. 1941; Holtt., Rev. Fl. Malaya 2: 144. f. 60. 1955; Dansk Bot. Ark. 20: 18. 1961; 23: 230. 1965; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1959; Tagawa & K. Iwats., Southeast As. St. 3(3): 75. 1965; 5: 47. 1967.— *Polypodium adnascens* Sw., Syn. Fil.: 25, 222. pl.2. f.2. 1806.— *Niphobolus adnascens* (Sw.) Kaulf., Enum.: 124. 1824; Bedd., Handb.: 325. f. 176. 1883; Christ, Bot. Tidsskr. 24: 105. 1901.— *Cyclophorus adnascens* (Sw.) Desv., Berl. Mag. 5: 300. 1811; Hoss., Beih. Bot. Centr. 28(2): 364. 1911; C.Chr., Bot. Tidsskr. 32: 348. 1916; E.Sm., J. Siam Soc. Nat. Hist. Suppl. 8: 7. 1929.— *Pyrrosia lanceolata* (Linn.) Farw.; Hovenk., Leid. Bot. Ser. 9: 191. 1986, p.p.

Rhizome long-creeping, 1 – 2 mm diam., bearing fronds 1 – 3 cm apart, dark brown, densely scaly throughout; scales oblong-subdeltoid, round at base, attenuate at apex, up to 3 by 0.6 mm, dark brown in central portion, gradually paler outwards to pale margin, hairy at margin, appressed, imbricate. *Fronds* typically dimorphic. *Sterile fronds*: stipes about 1 cm long, scaly at base, stellate hairy, dark brown or pale upwards; laminae lanceolate, round at apex, gradually narrowing towards base, usually up to 6 by 1.7 cm, but sometimes up to 15 cm long, and up to 1.8 cm broad; midrib grooved on upper surface, raised beneath, pale green, veins completely hidden, anastomosing; thick and fleshy, upper surface stellate-hairy or glabrescent, lower surface densely hairly with appressed stellate hairs with brown centre. *Fertile fronds* longer, up to 20 by 1 cm, with stipes of up to 4 cm in length, moderately acute at apex. *Sporangia* covering the whole lower surface of apical half, becoming narrow in soriferous portion; sori close, naked, covered with dense stellate hairs when young, curved back in dried condition.

T h a i l a n d.— NORTHERN: Chiang Rai (Chiang Khong, Mae Suai), Chiang Mai (Fang, Mae Rim, Doi Chiang Dao, Doi Saket, Doi Suthep, Mae Klang, Sop Aep), Lampang (Khao Tham Pha Thai), Phitsanulok (Thung Salaeng Luang), Tak (Ban Musoe, Huai Krasa, Lan Sang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Pha Nam Thop), Khon Kaen(Pha Nok Khao), Nong Khai (Ban Kun Ka), Mukdahan;EASTERN: Nakhon Ratchasima (Khao Lotueng), Chaiyaphum (Tat Ton, Phu Khieo), Buri Ram (Chan Thuek); CENTRAL: Saraburi (Muak Lek), Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chon Buri (Si Racha, Ko Sichang), Chanthaburi (Makham, Khlung, Laem Sing, Khao Sabap), Trat (Ban Saphan Hin, Ko Chang, Ko Rang Yai); SOUTH-WESTERN: Kanchanaburi (Erawan), Prachuap Khiri Khan (Huai Yang, Bang Saphan); PENINSULAR: Ranong (Khao Sai Daeng), Surat Thani (Ko Tao, Ko Kut, Ban Don), Phangnga (Takua Thung, Ko Kho Khao, Thung Maphrao, Ko Similan), Phuket (Ko Phu), Nakhon Si Thammarat (Khiriwong, Chawang, Khao Luang), Trang (Khao Chong), Phatthalung, Narathiwat (Bacho Falls), Yala (Bannang Sata).

D i s t r i b u t i o n.— Very widely known in the tropics of Asia, India to S.China, Indochina, Taiwan and the Ryukyus, Malesia throughout to Polynesia.

E c o l o g y.— Epiphytic on dry tree-trunks or on rocks in open places or in light shade, common throughout the country usually in low altitudes lower than 1000 m, especially common in villages or in cultivated areas.

V e r n a c u l a r.— Phak pik kai (ผักปีกไก่) (Northern).

N o t e.— This is a species of lowlands, not in the deep mountain forest but common along road in villages and in open places in cultivated areas. As usual in the case of such common species, this is much variable, especially in form and size of fronds. Typically, this species has dimorphic fronds, with oblong or broader lanceolate, short sterile fronds and linear tall fertile fronds with the sporangia on the upper half. In some cases, however, the sterile fronds become linear-lanceolate attaining a height of 20 cm with longer stipes. On the other hand, lower sterile portion of fertile fronds takes an appearance of the sterile fronds having the width of more than 2 cm. In extremely dry places, where this species is usually found, the fronds are curled up for fairly a long term, still living and expanding when a shower brings them sufficient moisture.

Lacking the hydathodes on the upper surface of fronds, this species seems to belong to the group of *P. longifolia*, probably with close relationship to *P. lanceolata* which is rather rare in Thailand.

4. Pyrrosia longifolia (Burm.f.) Mort., J. Wash. Acad. Sci. 36: 168. 1946; Holtt., Rev. Fl. Malaya 2: 148. f. 63. 1955; Dansk Bot. Ark. 20: 19. 1961; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958; Tagawa & K. Iwats., Southeast As. St. 3(3): 75. 1965; Acta Phytotax. Geobot. 23: 52. 1968; Hovenk., Leid. Bot. Ser. 9: 208. f.25. 1986.— *Acrostichum longifolium* Burm.f., Fl. Ind. : 228. 1768.— *Cyclophorus acrostichoides* (Forst.) Presl, Epim. Bot.:130. 1849; C.Chr., Bot. Tidsskr. 32: 348. 1916; E. Sm., J. Siam Soc. Nat. Hist. Suppl. 8 : 7. 1929.— *Niphobolus acrostichoides* (Forst.) Richt.; Bedd., Handb.: 327. 1883; Christ, Bot. Tidsskr. 24: 105. 1901.— *Pyrrosia acrostichoides* (Forst.) Ching, Bull. Chin. Bot. Soc. 1: 69. 1935; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 514. 1941.

Rhizome long-creeping, stout, about 2.5 mm diam., bearing fronds 1 – 5 cm apart, densely scaly throughout; scales oblong-ovate, acute at apex, round at base, about 2.5 mm long, up to 1 mm broad, distinctly bi-coloured with dark brown to nearly black central portion and pale ferrugineous margin, subentire or more or less irregular at margin. *Stipes* short, up to 5 cm long, indistinct, green to pale brown, usually on high hydathodes of about 7 mm in height, scaly on hydathodes, glabrescent in other portion. *Laminae* linear, gradually narrowing towards acute apex, attenuate at base and decurrenting towards wings of stipes, 20 – 50 by 1 – 2 cm, more or less involute at margin; midrib distinctly raised beneath, veins all hardly visible, anastomosing; rigid coriaceous, upper surface covered with stellate hairs, paler. *Sori* round, distinct, densely covered on the upper half of fronds underneath, the soriferous portion more or less narrowing.

T h a i l a n d.— NORTH-EASTERN: Khon Kaen (Pha Nok Khao), Sakon Nakhon; EASTERN: Chaiyaphum (Tat Ton), Nakhon Ratchasima (Pak Thong Chai, Khao Yai), Buri Ram (Kathok); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Makham, Khao Sabap, Pong Raet), Trat (Khao Saming, Ban Taphan Hin, Khlong Yai, Ko Chang); SOUTH-WESTERN: Prachuap Khiri Khan (Huai

Yang); PENINSULAR: Ranong (Lam Liang), Surat Thani (Ko Tao, Ko Samui, Ko Kut), Phuket (Thalang, Khao Kluai), Nakhon Si Thammarat (Khao Luang), Phangnga, Krabi, Phatthalung, Satun (Khuan Kalong, Adang, Phu Lan Kai), Narathiwat (Tak Bai), Yala (Ban Chana).

D i s t r i b u t i o n.— Widely known in Malesia and Polynesia, southwards to Australia and northwards to S. China (Hainan) and N. Vietnam; also recorded from Ceylon and S. India.

E c o l o g y.— Epiphytic on tree-trunks in open places or in light shade, common at low altitudes or in villages.

V e r n a c u l a r.— Sa-mong (สะโมง) (Malay/Peninsular).

N o t e.— This is a large epiphyte common in lowlands in the southern part of Thailand. The fronds are usually more than 50 cm long, and more or less involute in open dry air. The small plants are sometimes similar in appearance to *P. varia* or *P. adnascens*, though *P. longifolia* is easily distinguished from them by oblong-ovate appressed rhizome-scales.

5. Pyrrosia angustata (Sw.) Ching, Bull. Chin. Bot. Soc. 1: 49. 1935; Holtt., Rev. Fl. Malaya 2: 143. f. 58. 1955; Tagawa & K. Iwats., Acta Phytotax. Geobot. 23: 52. 1968; Hovenk., Leid. Bot. Ser. 9: 156. f.24. 1986.—*Polypodium angustatum* Sw., Syn. Fil.: 27, 224. 1806.— *Pleopeltis angustata* (Sw.) Presl, Tent.: 193. 1836; Bedd., Handb.: 351. 1883.

Rhizome long-creeping, about 1.5 mm diam., hard, densely scaly throughout; scales oblong-lanceolate, distinctly bi-coloured, the basal portion dark brown to black, appressed, the apical portion pale brown to stramineous, hairy at margin, patent, caducous, up to 5 by 0.7 mm. *Stipes* 5 – 12 cm long, brown, glabrescent. *Fronds* narrowly lanceolate, up to 30 by 3 cm, the soriferous apical portion about a half in breadth, entire and more or less involute at margin, cuneate at base, long-acuminate at apex; midrib distinctly raised beneath, a little grooved on upper surface, veins all invisible, copiously anastomosing; thick, leatherly, upper surface glabrescent, without hydathodes, lower surface covered with pale stellate hairs with shorter arms. *Sori* large, up to 10 by 4 mm broad, arranging in one regular row at each side of rachis on apical half of the fronds, usually sunk in shallow hollows, appearing raised on upper surface.

T h a i l a n d.— PENINSULAR: Narathiwat (Waeng), Yala (Ban Chana).

D i s t r i b u t i o n.— Malesia, also recorded in Burma and Hong Kong.

E c o l o g y.— On tree-trunks in light shade at low altitudes.

N o t e.— This is close to *P. longifolia* in various respects but distinct from the latter by the sori similar in appearance to *Pleopeltis*. The sterile fronds are not so long as the fertile ones and are usually oblong to oblong-lanceolate in outline. The young portion of rhizome seems paler by the apical portion of scales, but the older portion is dark as the apical pale portion of scales falls down soon.

6. Pyrrosia varia (Kaulf.) Farw., Amer. Midl. Nat. 12: 302. 1931; Ching, Bull. Chin. Bot. Soc. 1: 70. 1935; Holtt., Rev. Fl. Malaya 2: 146. f. 61. 1955; Tagawa & K.Iwats., Southeast As. St. 3(3): 75. 1965; 5: 48. 1967; Acta Phytotax. Geobot. 23: 52. 1968.— *Niphobolus varius* Kaulf., Enum. Fil.: 125. 1824.— *Pyrrosia lanceolata* (Linn.) Farw.; Hovenk., Leid. Bot. Ser. 9: 191. 1986, p.p.

Rhizome long-creeping, bearing fronds 1 – 3 cm apart, up to 2 mm diam., densely scaly throughout; scales spreading, lanceolate, attenuate at apex, up to 8 by 1.2 mm, dark brown in central portion, paler at margin, bearing pale downy hairs at margin of apical part. *Stipes* 1 – 4 cm long, brown to nearly black, scaly at base, sparsely stellate hairy or glabrescent upwards. *Laminae* subdimorphic, oblong-lanceolate to lanceolate, acuminate at apex, round to cuneate at base, 7 – 16 by 1 – 2.5 cm, often involute at margin; midrib raised beneath, dark brown, veins more or less visible, anastomosing; coriaceous, both surfaces very sparsely hairy or glabrescent; fertile fronds narrower and longer, sometimes less than half in breadth and 1.5 times as long as the sterile ones. *Sori* round, distinct or close to the neighbourings, covering the whole lower surface of the upper part of fronds.

T h a i l a n d.— EASTERN: Nakhon Ratchasima (Pak Thong Chai); SOUTH-EASTERN: Chanthaburi (Takhamao Falls); SOUTH-WESTERN: Kanchanaburi (Wangka); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Phangnga (Takua Pa), Trang (Khao Chong), Satun (Thung Wa), Pattani (Bacho).

D i s t r i b u t i o n.— Throughout Malesia, Sumatra and Malaya to New Guinea; also recorded from Polynesia.

E c o l o g y.— On tree-trunks in forests, usually along streamlets, at low altitudes.

7. Pyrrosia nuda (Gies.) Ching, Bull. Chin. Bot. Soc. 1: 70. 1935; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 514. 1941; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 110. 1968.— *Niphobolus nudus* Gies., Niph.: 149. 1901.— *Pyrrosia lanceolata* (Linn.) Farw.; Hovenk., Leid. Bot. Ser. 9: 191. f.25. 1986, p.p. Figure 50. 3.

Very close to the preceding species, differs in: stipes short, up to 1 cm long, densely hairy; fronds hardly dimorphic, rachis raised beneath, stramineous to pale green, or rarely dark; rhizome-scales densely downy hairy.

T h a i l a n d.— NORTHERN: Tak (Ban Musoe, Khao Phra Wo).

D i s t r i b u t i o n.— Himalayas (type from Assam), Burma, SW. China (Yunnan), Vietnam and Laos.

E c o l o g y.— On mossy tree-trunks in dense forests at about 900 m alt.

N o t e.— It is already stated by Giesenhagen and by Ching that the above two species are similar to each other and are often hardly distinguished without the information of their geographical ranges. Our collection seems to stand as an intermediate between the two typical forms. Sterile fronds are broader than the Indian plants and thus seemingly more or less dimorphic.

8. Pyrrosia lanceolata (Linn.) Farw., Amer. Midl. Natur. 12: 245. 1931; Ching, Bull. Chin. Bot. Soc. 1: 70. 1935; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 515. 1941; Tagawa, J. Jap. Bot. 38: 326. 1963; Hovenk., Leid. Bot. Ser. 9: 191. f.25. 1986, p.p.— *Acrostichum lanceolatum* Linn., Sp. Pl. 2: 1067. 1753.— *Cyclophorus spissus* (Bory) Desv., Berl. Mag. 5: 301. 1811; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958.— *Niphobolus adnascens* (Forst.) Kaulf. sensu Bedd., Handb.: 325. f. 176. 1883.

Rhizome long-creeping, about 1.5 mm diam., bearing fronds 2 – 5 cm apart, densely scaly throughout; scales larger, lanceolate, gradually narrowing towards apex, up to 7 by 1.2 mm, brown in central portion, paler towards margin, bearing downy hairs at margin of apical portion. *Stipes* very short, up to 2 mm long, scaly at base, densely hairy. *Laminae* linear-lanceolate, gradually narrowing towards both apex and base, 5 – 13 cm long, up to 5 – 8 (– 13) mm broad; midrib distinct on both surfaces, not raised, veins invisible, anastomosing; coriaceous, thick, both surfaces densely covered with a tomentum of stellate hairs. *Sori* round, covering the lower surface of apical part of fronds.

T h a i l a n d.— NORTHERN: Chiang Rai (Mae Lao), Chiang Mai (Chiang Dao, Mae Klang, Mae Hoi), Mae Hong Son; SOUTH-WESTERN: Chanthaburi (Khao Sabap), Trat (Ko Chang).

D i s t r i b u t i o n.— Himalayas to Burma, SW. China (Yunnan) and Indochina, S. India and Sri Lanka (type); also reported from Polynesia.

E c o l o g y.— This species is close to *P. adnascens* in one hand and to *P. nuda* and *P. varia* on the other hand, from the latter easily distinguished by not dimorphic fronds and rather densely persistent-hairy under surface of fronds, and also by the large less bi-coloured rhizome-scales.

9. Pyrrosia floccigera (Bl.) Ching, Bull. Chin. Bot. Soc. 1: 71. 1935; Holtt., Rev. Fl. Malaya 2: 147. 1955; Dansk Bot. Ark. 20: 18. 1961; Tagawa & K.Iwats., Southeast As. St. 5: 49. 1978.— *Niphobolus flocciger* Bl., En. Pl. Jav.: 107. 1828.— *Pyrrosia albicans* (Bl.) Ching; Hovenk., Leid. Bot. Ser. 9: 153. 1986, p.p. Figure 50. 4 – 5.

Rhizome long-creeping, 1 – 2 mm diam., bearing fronds 1 – 3 cm apart, densely scaly throughout; scales lanceolate, up to 5 mm long with tailed apex, 0.7 mm broad, dark brown to nearly black at central portion, the other part deep brown to paler, hairy at margin. *Stipes* 2 – 5 cm long, pale brown to darker, scaly at base, glabrescent. *Laminae* linear-lanceolate, up to 25 by 0.8 – 1.25 cm, very gradually narrowing towards both apex and base; midrib distinctly raised beneath, veins hardly visible, anastomosing, upper surface glabrescent, lower surface densely covered with greyish to pale brown, stellate hairs with long arms or becoming glabrescent in older fronds; rigid coriaceous, fronds usually involute at margin. *Sori* round, distinct, covering the whole lower surface of the apical part of fronds, covered with hairs.

T h a i l a n d.— NORTHERN: Tak (Ban Musoe); SOUTH-WESTERN: Kanchanaburi (Si Sawat); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong).

D i s t r i b u t i o n.— W. Malesia (Sumatra and Malay to the Philippines and Java, type).

E c o l o g y.— On tree-trunks or on rocks usually in light shade in mountain forests at medium altitudes.

10. Pyrrosia tonkinensis (Gies.) Ching, Bull. Chin. Bot. Soc. 1: 55. 1935; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 506. 1941; Tagawa & K. Iwats., Southeast As. St. 5: 48. 1967.— *Niphobolus tonkinensis* Gies., Niph.: 144. 1901.— *Pyrrosia porosa* (Presl) Hennipm. var. *tonkinensis* (Gies.) Hovenk., Blumea 30: 208 (1984); Leid. Bot. Ser. 9: 229. 1986. Figure 50. 6.

Rhizome creeping, about 2 mm diam., bearing fronds rather closely, densely scaly except in older portion; scales oblong-subulate, long-tailed at apex, up to 4 by 1 mm, dark brown to nearly black in central portion, brown in other part, thin, entire, without marginal hairs. *Stipes* not distinct with wings decurrent from laminae. *Laminae* linear, up to 30 cm long, commonly up to 7 mm but rarely up to 10 mm broad, gradually narrowing towards both apex and base;midrib grooved on upper surface, raised beneath, glabrescent; fleshy, rather leatherly, veins invisible, upper surface stellate hairy or glabrescent, lower surface covered with two kinds of hairs, the lower grey appressed hairs and the upper pale stellate hairs with short stalks. *Sori* on the whole lower surface of upper half of fronds, covered with stellate hairs when young.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Chiang Dao), Lamphun (Doi Khun Tan); EASTERN: Chaiyaphum (Nam Phrom, Chulaphon Dam), Nakhon Ratchasima (Khao Lotueng); NORTH-EASTERN: Loei (Phu Luang); SOUTH-WESTERN: Kanchanaburi (Si Sawat).

D i s t r i b u t i o n.— S. China (Kweichow, Kwangsi, Hainan), Laos and N. Vietnam (type).

E c o l o g y.— On mossy tree-trunks or on rocks usually in mountain forests at high altitudes (600 – 1600 m), rather rare.

N o t e.— *P. tonkinensis* is distinguished from *P. mollis* by linear fronds, typically less than 7 mm broad, covered densely with greyish tomentum and rather sparsely with short-stalked stellate hairs.

11. Pyrrosia mollis (Kunze) Ching, Bull. Chin. Bot. Soc. 1: 53. 1935; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 506. 1941; Tagawa, J. Jap. Bot. 38: 327. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 48. 1967.— *Niphobolus mollis* Kunze, Bot. Zeit. 6: 121. 1848.— *Niphobolus fissus* (Bl.) Bedd., Ferns Br. Ind. Corr.: ii, 1870; Handb.: 330. f. 179. 1883, nom. sol., non Bl.— *Pyrrosia penangiana* (Hook.) Holtt.; Hovenk., Leid. Bot. 9: 218. 1986, p.p.

Rhizome creeping, bearing fronds closely, up to 2.5 mm diam., densely scaly throughout; scales oblong-lanceolate, gradually narrowing towards tailed apex, 3 – 5 by up to 1 mm, dark brown to nearly black in central portion, pale brown at edges, hairy at margin, thin. *Stipes* indistinct, winged almost to base. *Laminae* oblanceolate, acute to acuminate at apex, gradually narrowing towards attenuate base, up to 25 by 0.7 – 1.2 (– 1.7) cm; midrib raised on lower surface, not raised on upper part of upper surface, veins hidden, anastomosing; thickly fleshy, upper surface green, hairy with downy stellate hairs or glabrescent, with scattered distinct hydathodes, lower surface densely hairy with two kinds of hairs, one with soft wavy rays, the other with long stiff brown rays. *Sori* scattered on the lower surface of the upper half of fronds, almost covering the whole under surface, covered with stellate hairs.

T h a i l a n d.— NORTHERN: Chiang Rai (Phu Langka), Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Khun Kong San, Doi Hua Mot, Doi Suthep, Doi Inthanon, Pang Bo), Lampang (Mae Mo, Mae Ta); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-EASTERN: Trat (Ko Chang).

D i s t r i b u t i o n.— Sri Lanka, Himalayas to SW. China, Upper Burma and Indochina.

E c o l o g y.— On mossy tree-trunks usually in evergreen forests at medium or high altitudes (1000 – 2000 m), rather common.

V e r n a c u l a r.— Kut mak (กูดหมาก) (Northern).

N o t e.— This species is similar to the following in every character except for the structure of the rhizome-scales. This is typically a Himalayan species, with a few collections from Malesia, and the type came from Java. The Javanese plants belong doubtlessly to this species as indicated by the rhizome scales, though we are still not sure for the specific identity of the Himalayan plants and the Malesian.

12. Pyrrosia mannii (Gies.) Ching, Bull. Chin. Bot. Soc. 1: 55. 1935; Holtt., Dansk Bot. Ark. 20: 19. 1961; Hovenk., Leid. Bot. Ser. 9: 212. f.18. 1986.— *Niphobolus mannii* Gies., Niph.: 107. 1901. Figure 50. 7 – 8.

Rhizome short-creeping, bearing fronds close together, about 3.5 mm diam., densely scaly throughout; scales linear-lanceolate, 4 – 7 by up to 0.7 mm, brown, concolorous, entire, bearing no hairs. *Stipes* indistinct with wings decurrent from laminae. *Laminae* linear-lanceolate, gradually narrowing towards both apex and base, attenuately acuminate at apex, broadest at middle or upper $\frac{1}{3}$ way, up to 12 by 0.8 cm; midrib distinct on both surfaces, usually covered with stellate hairs; thick fleshy, veins invisible, anastomosing, upper surface stellate hairy, lower surface densely covered with two kinds of hairs. *Sori* scattered on the whole under surface except the lower portion, nearly embedded in thick layer of hairs.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Inthanon, Khun Kong San, Mae Suai), Tak (Doi Pae Poe); NORTH-EASTERN: Loei (Phu Paek); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai, Bo Rae).

Distribution.— Himalayas (type from Assam), SW. China (Yunnan), and Burma.

Ecology.— Rather rare in Thailand, collected on trees or on rocks in evergreen forests at 1300–1600 m alt.

13. Pyrrosia penangiana (Hook.) Holtt., Rev. Fl. Malaya 2: 146. f. 62. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 52. 1968; Hovenk., Leid. Bot. Ser. 9: 218. f.18. 1986.— *Niphobolus penangianus* Hook., Ic. Pl. t. 203. 1840; Bedd., Handb.: 332. f. 182. 1883.— *Cyclophorus penangianus* (Hook.) C.Chr., Ind. Fil.: 200. 1905; Bonap., Not. Ptérid. 14: 66. 1923.

Rhizome short, bearing stipes closely on short phyllopodes, scaly; scales attached at base, linear-lanceolate, gradually narrowing from base towards tailed apex, up to 7 by 0.5 mm, entire, brown to pale brown, concolorous, entire and hairless at margin. *Stipes* very short, not distinct from rachis with decurrent laminae on both sides, densely stellate hairy. *Fronds* spathulate, broadest at apical $\frac{1}{3}$ portion, up to 8 cm broad, narrowing towards base and then broadly decurrent as wings of stipes, up to 50 cm long including stipes; rachis raised on both surfaces, main lateral veins more or less visible, the smaller veins obscure, copiously reticulate; thick but rather soft, the upper surface glabrescent, the lower surface densely covered with stellate hairs. *Sori* on the apical portion of fronds on the lower surface except marginal areas, one to each areoles, in distinct oblique bands.

Thailand.— PENINSULAR: Phangnga, Satun, Yala (Ban Chana, Bannang Sata).

Distribution.— W. Malaysia (type), Sumatra and Java; also recorded from Burma (Tenasserim).

Ecology.— Collected on rocks (often limestone) at low altitudes.

14. Pyrrosia flocculosa (D. Don) Ching, Bull. Chin. Bot. Soc. 1:66. 1935; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 512. 1941; Tagawa & K.Iwats., Acta Phytotax. Geobot. 24: 61. 1969; Hovenk., Leid. Bot. Ser. 9: 179. f. 19. 1986.— *Polypodium flocculosum* D.Don, Prodr. Fl. Nepal.: 1. 1825.— *Niphobolus flocculosus* (D.Don) Spr., Syst. 4: 45. 1827; Bedd., Handb.: 331. f. 180. 1883.

Rhizome short-creeping bearing fronds closely, densely scaly; scales basally attached, linear-subtriangular, gradually narrowing towards apex, cordate at base, entire, usually up to 6 by 9 mm, more or less bi-coloured with brown central portion and pale brown margin. *Stipes* up to 7 cm long, very narrowly winged, covered with pale stellate hairs. *Laminae* subquadrangular to broadly spathulate, acute to rotundate at apex, rather suddenly broadly cuneate at base, up to 20 by 6.5 cm; midrib raised beneath, main veins more or less visible, other veins invisible, copiously anastomosing; thick, upper surface deep green, very sparsely hairy with pale stellate hairs, with hydathodes, lower surface densely covered with short-armed stellate hairs. *Sori* round, small, more or less distinct, about 1 mm

diam., covering the under surface of fronds from the upper portion downwards, remaining narrow marginal sterile portion.

T h a i l a n d.— NORTHERN: Chiang Mai (Sop Aep).

D i s t r i b u t i o n.— Himalayas (type from Nepal), Burma and Vietnam.

E c o l o g y.— Epiphytic in evergreen forests along stream, about 750 m alt.

N o t e.— Thai plants from which the above description is drawn are rather small comparatively with the Himalayan plants.

15. Pyrrosia stigmosa (Sw.) Ching, Bull. Chin. Bot. Soc. 1: 67. 1935; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 513. 1941; Holtt., Rev. Fl. Malaya 2: 148. 1955; Dansk Bot. Ark. 20: 19. 1961; 23: 230. 1965; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958; Tagawa & K.Iwats., Southeast As. St. 5: 48. 1967; Hovenk., Leid. Bot. Ser. 9: 252. f.17. 1986.— *Polypodium stigmosum* Sw., Schrad. J. Bot. 1800(2): 21. 1801.— *Niphobolus stigmosus* (Sw.) Moore, Ind.: 276. 1861; Bedd., Handb.: 328. f. 178. 1883.

Rhizome short-creeping, bearing fronds closely, about 3 mm diam., dark brown to nearly black, densely scaly at apical portion; scales attached at base, ovate with long tails, about 1 mm diam. at base, about 6 mm long, bi-coloured with nearly black central portion at base, dark brown margin of base and long tails, rather stiff but downy at apical portion. *Stipes* up to 25 cm long, scaly at base with those like rhizome-scales, densely hairy throughout, brown. *Laminae* lanceolate, attenuately acuminate at apex, cuneate at base, not so long decurrent downwards, 15 – 30 by 2.5 – 5 cm, the upper surface stellate hairy or glabrescent, green, with many scattered hydathodes, lower surface densely hairy; midrib and main veins distinct, raised beneath, veins hardly visible, anastomosing, the margin sometimes involute; rigid coriaceous. *Sori* round, covering the whole upper portion of the fronds underneath.

T h a i l a n d.— NORTHERN: Chiang Rai (Phu Langka), Chiang Mai (Fang, Doi Chiang Dao), Mae Hong Son, Lampang (Mae Mo, Mae Long, Ngao, Tham Pha Thai), Tak (Khao Phra Wo, Lan Sang, Huai Krasa, Rahaeng), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang), Nakhon Phanom (Mukdahan); CENTRAL: Saraburi (Muak Lek, Khao Khao), Nakhon Nayok (Nang Rong); SOUTH-EASTERN: Prachin Buri (Ban Hills), Chanthaburi (Takhamao Falls); SOUTH-WESTERN: Kanchanaburi (Huai Ban Kao, Linthin, Sai Yok), Prachuap Khiri Khan (Huai Yang); PENINSULAR: Chumphon (Tha Ko), Surat Thani (Khao Hua Khwai, Khao Na Daeng), Phangnga (Thap Put), Yala (Bannang Sata).

D i s t r i b u t i o n.— Burma, Indochina and southwards to W. & C. Malesia (type from Java).

E c o l o g y.— On dry to moist rocks usually in light shade at low altitudes less than 500 m or rarely to 1300 m alt., not so rare throughout Thailand.

V e r n a c u l a r.— Kha kai (ขาไก่) (Central).

16. Pyrrosia costata (Presl ex Bedd.) Tagawa & K.Iwats., Acta Phytotax. Geobot. 22: 100. 1967; Southeast As. St. 5: 48. 1967; Hovenk., Leid. Bot. Ser. 9: 171. f.17. 1986.— *Niphobolus costatus* Presl ex Bedd., Ferns Brit. India: t. 120. 1868, nom. sol., based on *Polypodium costatum* Wall. ex Mett., Abhandl. Senchkenb. Naturf. Ges. 2: 131. 1857, non Kunze 1834.— *Niphobolus beddomeanus* Gies., Niph.: 101. 1901.— *Pyrrosia beddomeana* (Gies.) Ching, Bull. Chin. Bot. Soc. 1: 68. 1935.

Rhizome short-creeping, bearing fronds closely, about 3 mm diam., densely scaly at least at apex; scales linear-subulate, up to 1 mm broad at base, long-tailed, up to 1 cm long, more or less bi-coloured with dark brown to nearly black basal portion and brown to dark brown marginal portion and tails. *Stipes* usually indistinct, the base of laminae long decurrent and winged nearly to the base, stramineous or pale brown, scaly at base, densely hairy throughout. *Laminae* broadly spathulate or oblanceolate, broadest at about $\frac{1}{3}$ way from apex, caudately acuminate at apex, very gradually narrowing towards attenuate base and decurrent downwards to wings of stipes, the end not distinct, up to 40 cm long including indistinct stipes of 5 – 10 cm long, 2.5 – 5.5 cm broad, the sterile and the fertile fronds not different; midrib and main veins distinct, raised beneath, the other veins invisible, copiously anastomosing; thick but not stiff, upper surface deep green, stellate-hairy or glabrescent, with scattered hydathodes, lower surface densely covered with a mat of stellate hairs, closed to surface. *Sori* round, small but distinct, about 0.8 mm diam., usually covered the whole under surface of fronds except the lower portion.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Chiang Dao); NORTH-EASTERN: Loei (Phu Luang).

D i s t r i b u t i o n.— Himalayas (type from Nepal), SW. China (Yunnan, Tibet), Upper Burma and Vietnam.

E c o l o g y.— On rocks usually in light shade in evergreen forests at 800 – 1500 m alt., rather rare.

N o t e.— The above two are rather difficult to discriminate, especially in Northern Thailand where the two grow in the same region. In the soriferous leaves of *P. costata* the sterile area often runs upwards along midrib, though this feature is also indistinct in the materials difficult to refer to any of the two species.

17. Pyrrosia eberhardtii (Christ) Ching, Bull. Chin. Bot. Soc. 1: 59. 1935; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 507. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 48. 1967.— *Cyclophorus eberhardtii* Christ, J. Bot. France 21: 237, 270. 1908.— *Pyrrosia mannii* (Gies.) Ching et *Pyrrosia stigmosa* (Sw.) Ching sensu Holtt., Dansk Bot. Ark. 20: 19. 1961, p.p.— *Pyrrosia lingua* (Thunb.) Farw. var. *heteractis* Hovenk., Blumea 30: 208. 1984; Leid. Bot. Ser. 9: 206. 1986, p.p. Figure 50. 9 – 10.

Rhizome long-creeping, 2.5 – 3.5 mm diam., bearing fronds 2 – 5 cm apart, scaly throughout; scales appressed or patent at least in the upper part especially in

younger portion, narrowly subtriangular, gradually narrowing from broadest peltate portion towards attenuate apex, up to 7 by 1.2 mm, usually bi-coloured with nearly black basal portion and brown marginal portions, entire at margin, bearing long downy hairs at margin of apical portion. *Stipes* up to 30 cm long, scaly at base with those like rhizome-scales, densely hairy throughout, brown. *Laminae* oblong-lanceolate to oblong, acute to acuminate at apex, caudate or very shortly decurrent at base, 10 – 22 by 3 – 7 cm, sterile fronds usually lower and broader; midrib and main veins distinct, raised beneath, veins hardly visible, anastomosing; rigidly coriaceous, upper surface stellate hairy or glabrescent, with scattered hydathodes, the lower surface densely covered with dense mat of stellate hairs greyish in colour. *Sori* round, distinct, scattered on all the lower surface or in upper part of it, embedded in stellate hairs, not confluent.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Inthanon, Doi Suthep, Pha Mon), Phitsanulok (Phu Miang, Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Phu Paek); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao), Trat (Khao Kuap); SOUTH-WESTERN: Kanchanaburi (Si Sawat); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Khao Phra Mi), Phangnga (Khao Phota Luang Kaeo), Trang (Khao Chong).

D i s t r i b u t i o n.— S. China (Hainan) and Vietnam (type).

E c o l o g y.— On rocks or on tree-trunks in exposed places, in light shade or in rather dense forests at various elevations, rather common throughout Thailand.

V e r n a c u l a r.— Lin kuram (ลิ้นกุรัม) (Eastern).

N o t e.— It is evident that this species is a close ally of *P. lingua* which is widely distributed in Japan, China, Taiwan and the northern part of Indochina. *P. eberhardtii* is distinguished from *P. lingua* by having dimorphous hairs on the underside of fronds. The short armed stellate hairs are common to these two species but the lower hairs each provided with filiform appendages are not quite distinct for both species. It is rather strange that *P. eberhardtii* is rather common also in Peninsular Thailand but has never been found in Malaya.

18. Pyrrosia heteractis (Mett. ex Kuhn) Ching, Bull. Chin. Bot. Soc. 1: 57. 1935; Tagawa, J. Jap. Bot. 38: 327. 1963.— *Polypodium heteractium* Mett. ex Kuhn, Linnaea 36: 140. 1869.— *Niphobolus heteractus* (Mett. ex Kuhn) J. Sm., Ferns Br. For.: 296. 1877; Bedd., Handb.: 327. 1883.— *Pyrrosia lingua* (Thunb.) Farw. var. *heteractis* Hovenk., Blumea 30: 208. 1984; Leid. Bot. Ser. 9: 206. 1986, p.p. Figure 50. 11 – 12.

Rhizome long-creeping, bearing fronds 1.5 – 5 cm apart, 2 – 3 mm diam., densely scaly throughout; scales patent, lanceolate to oblong-lanceolate, about 5 by 1.5 mm, concolorously brown, dark at peltately attached point, or bi-coloured with nearly black central portion, thin, bearing downy hairs at apical margin. *Stipes* 3 – 10 cm long, densely scaly at base with those like rhizome-scales, very densely

covered throughout with greyish ferrugineous hairs and dark stellate hairs. *Laminae* ovate-oblong to elliptic, rotundate at apex, round or shortly cuneate at base, 8 – 16 by up to 4.5 cm, the soriferous fronds hardly different form, or a little taller than, the sterile ones; coriaceous, midrib and main veins distinct on both surfaces, raised beneath, the other veins hardly visible, copiously anastomosing, the margin of fronds often involute; the upper surface stellate hairy or glabrescent, with dispersed brown hydathodes, the lower surface densely covered with hairs in two kinds, the lower layer grey ferrugineous hairs and needle-like arms. *Sori* round, large, distinct, densely arranged on the whole under surface.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok), Tak (Doi Pae Poe), Phitsanulok (Phu Miang).

D i s t r i b u t i o n.— Himalayas (type from Assam), Upper Burma and SW. China (Yunnan).

E c o l o g y.— On mossy tree-trunks or on rocks at ridge in evergreen forests at high altitudes (1400 – 2000 m), rather rare.

V e r n a c u l a r.— Thao hin (เถาหิน) (North-eastern).

var. **minor** (C.Chr.) Ching, Bull. Chin. Bot. Soc. 1: 58. 1935.— *Cyclophorus heteractis* var. *minor* C.Chr., Contr. U.S. Nat. Herb. 26: 335. 1931.

Different from the type variety in smaller size of plants: stipe 1 – 3 cm long, fronds 3 – 6 by up to 2 cm.

T h a i l a n d.— NORTHERN: Chiang Mai [Doi Chom Chaeng (= Doi Suthep), type], Phitsanulok (Phu Miang).

D i s t r i b u t i o n.— Endemic; known only from the above two localities.

E c o l o g y.— On rather dry rocks along river in half-shaded places at high altitudes (1200 – 1600 m).

N o t e.— This may be a variant in more open places, for the species of *Pyrrosia* become smaller in size often in such condition and our variety is distinct only in the smaller size of plant.

4. LEPISORUS

(J. Sm.) Ching, Bull. Fan Mem. Inst. Biol. 4: 47. 1933.— *Drynaria & Lepisorus* J. Sm., Bot. Mag. 72. Comp. 13. 1846.— *Pleopeltis* Humb. & Bonpl. ex Willd., Sp. Pl. 5: 211. 1810; Copel., Gen. Fil.: 183. 1947, p.p.

Rhizome creeping, bearing fronds closely, scaly; scales peltate, more or less clathrate. Stipes articulate to rhizome, sometimes indistinct from laminae, scaly at least at base. Fronds simple, entire, usually leatherly, bearing peltate scales or glabrescent; veins usually invisible, copiously anastomosing with included free

veinlets in areoles. Sori usually at junction of veins, round or rarely elongate, in some species fusing to form linear submarginal lines, superficial or sunk in cavities, exindusiate but covered when young with umbrella-shaped peltate paraphyses.

About fifty species are included in this genus from the tropical regions of the Old World. This is often included in *Pleopeltis* of the New World.

There are eleven species of *Lepisorus* in Thailand. The species of Himalayan regions are still ill defined, and the numbers of species given here are rather tentative. The size and form of fronds are variable, and the soral characters are nearly the same in many species. One of the most reliable features to determine the species of this genus may be the structure of rhizome-scales.

KEY TO THE SPECIES

1. Sori round or oblong, distinct, rarely the adjacent ones fused together in maturity
 2. Fronds annual, texture herbaceous to chartaceous
  3. Scales discolorous with dark central portion and paler margin **2. L. bicolor**
  3. Scales concolorous, brown
   4. Leaves decurrent to short stipes **3. L. scolopendrium**
   4. Leaves not decurrent downwards but subrounded and nearly sessile at base **4. L. oosphaerus**
 2. Fronds persistent, texture subcoriaceous to coriaceous
  5. Sori marginal, distinctly immersed in cavities **1. L. longifolius**
  5. Sori not marginal, superficial or nearly so
   6. Fronds linear-lanceolate, up to 2 cm or even more broad
    7. Rhizome-scales brown, entire, clathrate with larger cells **5. L. nudus**
    7. Rhizome-scales fuscous, with irregular teeth at margin
     8. Rhizome-scales concolourous. Sori close to midribs; veins more or less visible **6. L. sublinearis**
     8. Rhizome-scales discolourous. Sori medial; veins hardly visible **7. L. suboligolepidus**
   6. Fronds linear, at most 1.5 cm broad
    9. Rhizome-scales brown, clathrate with narrow central band **8. L. contortus**
    9. Rhizome-scales dark brown to black, clathrate only at marginal portion, with irregular teeth at margin
     10. Sori ovate-oblong, far apart **9. L. heterolepis**
     10. Sori often twice as long as broad **10. L. subconfluens**
1. Sori linear and continuous, the lower portion usually interrupted **11. L. sinensis**

1. Lepisorus longifolius (Bl.) Holtt., Rev. Fl. Malaya 2: 151. f. 65. 1955.— *Pleopeltis longifolia* Bl., En. Pl. Jav. addend. 1828; Bedd., Handb.: 349. f. 196. 1883; Tagawa & K.Iwats., Southeast As. St. 5: 50. 1967; Acta Phytotax. Geobot. 23: 52. 1968.— *Paragramma longifolia* (Bl.) Moore, Ind.: xxxii. 1857; Copel., Gen. Fil.: 190. 1947.— *Polypodium revolutum* C.Chr. sensu Bonap., Not. Pterid. 14: 65. 1923. Figure 51. 5.

Rhizome short-creeping, bearing fronds closely, glaucous on surface, scaly; scales oblong-ovate with attenuate apex, up to 2.5 by 0.8 mm, light brown, more or less clathrate, sharply toothed at margin. *Stipes* indistinct, scaly at base, stramineous, winged nearly to the very base. *Fronds* linear, up to 50 by 3.5 cm,

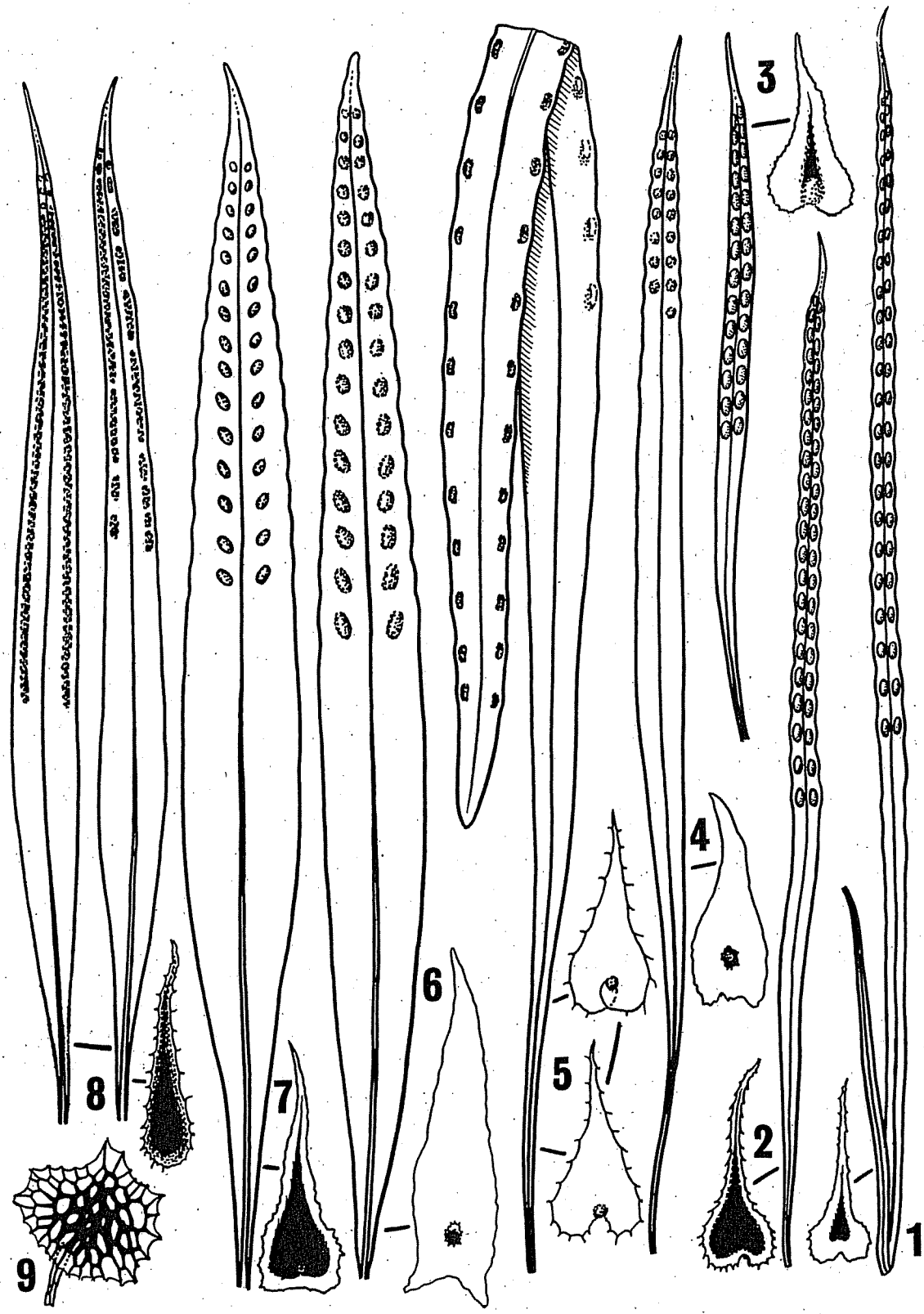

Figure 51. *Lepisorus* spp. 1. *L. heterolepis*; fertile leaf (x 0.6) and scale enlarged (left). 2. *L. subconfluens*; fertile leaf (x 0.6) and scale enlarged (left). 3. *L. contortus*; fertile leaf (x 0.6) and scale enlarged. 4. *L. nudus*; fertile leaf (x 0.6) and scale enlarged (right). 5. *L. longifolius*; fertile leaf (x 0.6) and scales enlarged (right). 6. *L. scolopendrium*; fertile leaf (x 0.6) and scale enlarged (right). 7. *L. bicolor*; fertile leaf (x 0.6) and scale enlarged (right). 8–9: *L. sinensis*; 8. two fertile leaves (x 0.6) and scale enlarged; 9. paraphysis enlarged.

broadest at usually about $\frac{1}{4}$ way from base, gradually narrowing towards both ends, attenuate towards but round or pointed at the very apex, attenuate towards base; midrib raised on both surfaces; coriaceous, veins invisible on both surfaces, copiously anastomosing with included free veinlets. *Sori* oblong or longitudinally elongate along margin, more or less immersed in cavities, up to 2 mm broad, sometimes, up to 1 cm in length.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao); PENINSULAR: Chumphon (Tha San), Ranong (Kapoe), Phangnga, Nakhon Si Thammarat (Khao Luang, Thung Song), Satun (Adang, Klong Ton), Narathiwat (Sungai Padi), Yala (Betong).

D i s t r i b u t i o n.— NE. India, Burma, W. Malesia to the Philippines and Java (type); there are the records from New Guinea and Polynesia.

E c o l o g y.— On tree-trunks in dense evergreen forests or along streams in light shade, rather common at low altitudes in Peninsular.

N o t e.— This is a representative of this genus in Malesia and peculiar in having oblong submarginal sori more or less sunk in cavities. COPELAND (1947, 60) followed MOORE (1857) to recognize the genus *Paragramma* for this and another New Guinea species.

2. Lepisorus bicolor (Takeda) Ching, Bull. Fan Mem. Inst. Biol. 4: 66. 1933.— *Polypodium excavatum* var. *bicolor* Takeda, Notes Roy. Bot. Gard. Edinb. 8: 279. 1915.— *Pleopeltis bicolor* (Takeda) Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 138. 1960; Tagawa & K.Iwats. Acta Phytotax. Geobot. 23: 48. 1968.— *Polypodium excavatum* Bory ex Willd., Pl. Sp. 5: 158. 1810; C.Chr., Contr. U.S. Nat. Herb. 26: 334. 1931. Figure 51. 7.

Rhizome creeping, bearing fronds sparsely, glaucous on surface, densely scaly; scales ovate with long attenuate apex, bi-coloured with dark brown central portion and paler margin, up to 3 by 1 mm, minutely toothed at margin. *Stipes* indistinct, winged nearly to the base, stramineous, scaly at base. *Fronds* linear-lanceolate, gradually narrowing towards both ends, broadest usually at middle portion, up to 30 by 3.5 cm; midrib raised on both surfaces; papyraceous; veins forming fine areoles with included veinlets. *Sori* medial or closing to midrib, round, up to 3 mm diam., olive-yellow to pale brown.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Suthep, Huai Mae Pan, Doi Inthanon, Doi Khun Huai Pong).

D i s t r i b u t i o n.— Himalayas (type) and SW. China.

E c o l o g y.— On mossy tree-trunks at ridge in evergreen forests, not so abundant at high altitudes in the North.

N o t e.— This is very close to *Lepisorus morrisonensis* (Hayata) H.Ito of Taiwan, which is different from our species in non-glaucous rhizome bearing dense larger scales.

3. Lepisorus scolopendrium (Ham. ex D.Don) Tagawa in Hara, Fl. East. Himal. 494. 1966.— *Polypodium scolopendrium* Ham. ex D.Don, Prodr. Fl. Nepal.: 1. 1825.— *Lepisorus excavatus* var. *scolopendrium* (Ham. ex D.Don) Ching, Bull. Fan Mem. Inst. Biol. 4: 69. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 456. 1941.— *Pleopeltis scolopendrium* (Ham. ex D.Don) Alst. & Bonn., Candollea 15: 207. 1956; Tagawa, J. Jap. Bot. 38: 326. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 49. 1967.— *Polypodium excavatum* Bory ex Willd., Sp. 5: 158. 1810; C. Chr., Contr. U.S. Nat. Herb. 26: 334. 1931, p.p. Figure 51. 6.

Rhizome creeping, bearing a few fronds closely, dark brown on surface, scaly; scales dense, thin, gradually narrowing towards acuminate apex, up to 7 by 2 mm, concolorously light brown, clathrate, rather irregular at paler margin. *Stipes* short, indistinct, usually up to 2 cm long. *Fronds* variable in size and form, linear-lanceolate, often broadest at $\frac{1}{3}$ part from base, up to 40 by 3.5 cm, gradually narrowing towards both ends, entire but variously waved at margin; midrib raised on both surfaces; papyraceous to herbaceous, light green; veins copiously anastomosing with branched included veinlets. *Sori* round to oblong, large, one between adjacent main veins, medial, up to 4 mm broad, sometimes obliquely elongate up to 1 cm or more long, never fused to the next ones, the receptacles raised with hollows on upper surface.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Pong Pho, Doi Pha Hom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon, Doi Hua Mot, Huai Mae Pan), Lamphun (Doi Khun Tan), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Ban Don).

D i s t r i b u t i o n.— Himalayas (type) and Tibet, SW. China, Upper Burma and Indochina.

E c o l o g y.— On branches of mossy trees in dense forests at ridge in the North, or terrestrial on mossy mountain slope near ridge in open places or in light shade on Phu Luang, locally rather abundant.

V e r n a c u l a r.— Kut chak khep (กูดจักเขีบ) (Northern).

N o t e.— In dry season (December to January) we could not find any leaves of this species in the North but in rainy season (August to October) almost every branch of larger trees at ridge of higher mountains with daily mist is covered with this species mixed with some other epiphytes. As usual in the case of such abundant species, this is so variable in size and form of fronds and sori that the following species seems to be a variant of this, though further observation will give a conclusion.

From African *L. excavatus* this is hardly distinguishable except in the difference in not so distinctly glaucous rhizome, large and rather irregularly formed sori and herbaceous but not so thin texture.

4. Lepisorus oosphaerus (C.Chr.) Ching, Bull. Fan Mem. Inst. Biol. 4: 70. 1933;

Bir & Trikha, Amer. Fern J. 64: 58. 1974.— *Polypodium oosphaerum* C.Chr., Contr. U.S. Nat. Herb. 26: 334. pl. 29. 1931.— *Pleopeltis oosphaera* (C.Chr.) Tagawa & K.Iwats., Acta Phytotax. Geobot. 22: 100. 1967.

Similar to the preceding species, differs in: fronds large, 40 by 5 – 6 cm, very shortly stipitate, rotund-truncate at base, about 2 cm broad at extreme base; sori obliquely elliptical, 6 by 4 mm.

T h a i l a n d.— NORTHERN: Chiang Mai [Doi Chom Chaeng (= Doi Suthep), type; Doi Hua Mot].

D i s t r i b u t i o n.— Endemic.

E c o l o g y.— On branches of trees at 1500 – 1650 m alt.

5. Lepisorus nudus (Hook.) Ching, Bull. Fan Mem. Inst. Biol. 4: 83. 1933; Holtt., Dansk Bot. Ark. 20: 19. 1961.— *Pleopeltis nuda* Hook., Exot. Fl. 1: t. 63. 1823; Tagawa, J. Jap. Bot. 38: 326. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 50. 1967.— *Pleopeltis linearis* (Thunb.) Kaulf. sensu Bedd., Handb.: 346. f. 194. 1883, p.p.— *Lepisorus* sp.; Holtt., Dansk Bot. Ark. 20: 19. 1961.— *Lepisorus macrosphaerus* (Bak.) Ching sensu Holtt., Dansk Bot. Ark. 23: 230. 1965. Figure 51. 4.

Rhizome long-creeping, 1.5 – 2 mm diam., green on surface, bearing fronds rather remotely, scaly throughout; scales ovate-oblong with gradually narrowing attenuate apex, up to 4 by 1 mm, concolorously light brown, clathrate, entire. *Stipes* 2 – 7 mm long, stramineous, castaneous or dark, winged on the upper part, scaly at base. *Fronds* linear, broadest usually at middle portion, linear-lanceolate, gradually narrowing towards both long-attenuate ends, up to 30 by 2 cm, entire or a little revoluted at margin; coriaceous, minutely and sparsely scaly underneath. *Sori* medial, round or oblong or a little obliquely elongate, up to 3.5 mm broad, more or less raised, hollowing on upper surface.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tung, Doi Phacho), Chiang Mai (Doi Nang, Doi Luang, Doi Hua Mot, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Tak (Khao Phra Wo, Ban Musoe); NORTH-EASTERN: Loei (Phu Kradueng); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

D i s t r i b u t i o n.— Sri Lanka, S. India, Himalayas (type), Upper Burma to SW. China (Yunnan); also recorded from Sumatra.

E c o l o g y.— On mossy tree-trunks or on branches of trees usually in dense evergreen forests at high altitudes.

N o t e.— This is distinct among the allied species by the rhizome-scales, which are concolorously light brown, broadly ovate-oblong, entire and more or less clathrate. The size and form of fronds are to some extent variable according to the habitats.

6. Lepisorus sublinearis (Bak. ex Takeda) Ching, Bull. Fan Mem. Inst. Biol. 4:

78. 1933: Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 459. 1941.— *Polypodium sublineare* Bak. ex Takeda, Notes Roy. Bot. Gard. Edinb. 8: 276. 1915; C.Chr., Contr. U.S. Nat. Herb. 26: 320. pl. 22. 1931.— *Pleopeltis sublinearis* (Bak. ex Takeda) Tagawa & K.Iwats., Acta Phytotax. Geobot. 22: 100. 1967; Southeast As. St. 5: 50. 1967.

Rhizome creeping, about 5 mm diam., bearing fronds rather closely, densely scaly; scales oblong-subtriangular, round at base, gradually narrowing towards long-attenuate apex, irregularly toothed at margin, up to 6 by 2.5 mm, concolorously brown, distinctly clathrate throughout. *Stipes* very short, indistinct, scaly at base. *Fronds* linear-lanceolate, broadest usually at basal $\frac{1}{3}$ part, gradually narrowing towards the long-attenuate apex and base, up to 30 by 3.5 cm, entire or a little revoluted at margin; coriaceous or subcoriaceous; veins more or less visible, copiously anastomosing. *Sori* close to midrib, round to elliptic, often oblique, up to 4 mm broad, superficial.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Inthanon).

D i s t r i b u t i o n.— Burma, SW. China (Yunnan, type) and Indochina.

E c o l o g y.— On mossy tree-trunks or on mossy cliffs in dense forests at high altitudes in the North, rather rare.

7. Lepisorus suboligolepidus Ching, Bull. Fan Mem. Inst. Biol. 4: 77. 1933.— *Pleopeltis suboligolepida* (Ching) Tagawa & K. Iwats., Acta Phytotax. Geobot. 26: 172. 1975.

Rhizome creeping, 2 mm diam., bearing fronds rather closely, dark on surface, densely scaly throughout; scales ovate-subtriangular with long-attenuate apex, irregularly toothed at margin, up to 3 by 1.5 mm, the central portion dark brown, not transparent, the marginal portion distinctly clathrate. *Stipes* up to 2 cm long, stramineous, scaly at base. *Fronds* linear-lanceolate, broadest at middle, narrowing towards both the attenuate ends, entire and plane at margin, up to 20 by 2 cm; subcoriaceous; veins invisible, copiously anastomosing, sparsely minutely scaly on lower surface. *Sori* medial, round, about 2 mm diam., distinct from the next ones, superficial.

T h a i l a n d.— NORTH-EASTERN: Loei (Phu Kradueng).

D i s t r i b u t i o n.— SW. China (Yunnan, type) and Taiwan.

E c o l o g y.— In mossy crevices of mossy rocks by streams at about 1200 m alt.; collected only in one locality in Thailand.

8. Lepisorus contortus (Christ) Ching, Bull. Fan Mem. Inst. Biol. 4: 90. 1933.— *Polypodium lineare* var. *contortum* Christ, Nuov. Giorn. Bot. Soc. Ital. N.S. 4: 98. pl. 1. f. 3. 1897.— *Polypodium contortum* Christ, Bot. Gaz. 51: 347. 1911.— *Pleopeltis contorta* (Christ) Alst. & Bonn., Candollea 15: 209. 1956; Tagawa & K.Iwats., Southeast As. St. 5: 49. 1967. Figure 51. 3.

Rhizome creeping, about 2.5 mm diam., bearing fronds with intervals less than 0.5 cm, densely scaly throughout; scales dark brown, slightly clathrate, minutely toothed at margin, oblong-subdeltoid, gradually narrowing towards attenuate apex, up to 2 by 0.7 mm. *Stipes* very short, indistinct. *Fronds* linear, attenuate towards both ends, in matured large fronds about 15 cm by 0.7 cm, the margin more or less recurved; coriaceous; veins hardly visible, copiously anastomosing. *Sori* round, medial, oblong.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Inthanon).

D i s t r i b u t i o n.— Himalayas, Tibet and China (type).

E c o l o g y.— On mossy tree-trunks in dense mountain forests at high altitudes.

9. Lepisorus heterolepis (Rosenst.) Ching, Bull. Fan Mem. Inst. Biol. 4: 86. 1933.— *Polypodium lineare* var. *heterolepis* Rosenst., Rep. Sp. Nov. 12: 247. 1913.— *Pleopeltis heterolepis* (Rosenst.) Tagawa & K. Iwats., Acta Phytotax. Geobot. 22: 100. 1967; Southeast As. St. 5: 49. 1967. Figure 51. 1.

Rhizome creeping, about 2.5 mm diam., bearing fronds with intervals of less than 1 cm, densely scaly; scales linear-subtriangular, long-attenuate at apex, toothed at margin, up to 5 by 0.7 mm, central portion with longitudinal, thick-walled cells, marginal portion with more or less clathrate cells, black in colour. *Stipes* up to 3 cm long, variously winged on upper part, castaneous to stramineous, scaly at base. *Fronds* linear, long-attenuate at both ends, up to 30 by 1.3 cm; coriaceous; veins invisible, copiously anastomosing. *Sori* medial, round to elliptic, only on the upper half of frond, sometimes fusing to the next ones in the upper portion.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Suthep), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang).

D i s t r i b u t i o n.— Sikkim (type) and SW. China (Yunnan).

E c o l o g y.— On mossy tree-trunks in dense forests at ridge at medium to high altitudes, rather rare.

10. Lepisorus subconfluens Ching, Bull. Fan Mem. Inst. Biol. 4: 85. 1933; Bir & Trikha, Amer. Fern J. 64: 60. 1974.— *Pleopeltis subconfluens* (Ching) Tagawa & K.Iwats., Acta Phytotax. Geobot. 22: 100. 1967; Southeast As. St. 5: 49. 1967.— *Polypodium lineare* auct. non Thunb. sensu C.Chr., Contr. U.S. Nat. Herb. 26. 334. 1931. Figure 51. 2.

Rhizome creeping, about 2.5 mm diam., bearing fronds rather closely near apex, scaly; scales oblong-subtriangular with round base and long-attenuate apex, up to 3 by 1 mm, sharply toothed at margin, dark brown to nearly black; the basal marginal portion brown and more or less clathrate. *Stipes* up to 3 cm long, indistinct from the base of fronds, scaly at base, dark stramineous to nearly black. *Fronds*

linear, up to 30 by 1.2 cm, commonly about 20 by 0.8 cm, attenuate towards both ends; leatherly. *Sori* medial, round to elliptic, about 2.5 mm broad, up to 5 mm long, sometimes fusing to the next ones; the sterile portion of fronds usually revoluted, in contrast to the remaining soriferous portion.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon).

D i s t r i b u t i o n.— Bhutan and SW. China (Yunnan, type).

E c o l o g y.— On mossy tree-trunks in dense evergreen forests at high altitudes.

11. Lepisorus sinensis (Christ) Ching, Bull. Fan Mem. Inst. Biol. 4: 63. 1933.— *Neurodium sinense* Christ, Bull. Herb. Boiss. 6: 880. 1898.— *Pleopeltis sinensis* (Christ) Copel., Gen. Fil.: 184. 1947; Tagawa & K.Iwats., Southeast As. St. 5: 50. 1967. Figure 51. 8–9.

Rhizome creeping, about 2 mm diam., densely scaly; scales gradually narrowing from the broadest attaching point towards attenuate apex, round at base, dark brown with thick internal walls, the marginal portion clathrate, the margin toothed, up to 3 by 0.7 mm. *Stipes* usually 1 cm apart, scaly at base, narrowly winged nearly to the base, stramineous. *Fronds* linear, 8–20 by 0.7–1.7 cm, broadest at $\frac{1}{3}$ way from base, gradually narrowing towards both ends, attenuate at apex; midrib raised on both surfaces; subcoriaceous, green, bearing sparse small peltate hairs appressed to both surfaces. *Sori* elongate along medial or submarginal strands, often interrupted, usually confined to the upper half of fronds, about 2 mm broad at maturity.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao).

D i s t r i b u t i o n.— Bhutan and SW. China (Yunnan, type).

E c o l o g y.— On mossy branches of trees or on mossy rocks in dense evergreen forests at ridge at 1500–2000 m alt. in the North.

N o t e.— By the elongate coenosori, this species was once referred to *Paltonium* by CHRISTENSEN (1906) and to *Lemmaphyllum* by the same author (1929), though he changed his concept later and considered that this is a species close to *Lepisorus thunbergiana*. The species of *Lemmaphyllum* are usually referred to the derivatives of *Lepisorus* and the soral condition is a prominent feature evolved from their mother stock.

5. LEMMAPHYLLUM

Presl, Epim. Bot.: 157. 1849; Copel., Gen. Fil.: 189. 1947.— *Weatherbya* Copel., Gen. Fil.: 191. 1947.

Rhizome long-creeping, slender, bearing fronds rather remotely, scaly; scales peltate, concolorously dark, clathrate. Fronds simple, entire, usually dimorphous, leatherly, bearing peltate scales or glabrescent. Sterile fronds usually smaller, ovate to oblong-pyriform; veins hardly visible, copiously anastomosing with included free veinlets in areoles. Sori round and polypodioid, or continuous along margin, with peltate toothed paraphyses.

This genus was at first appropriately recognized by Christensen in Dansk Bot. Ark. 6(3): 44. 1929, and was followed by the revision of Sino-Himalayan species by Ching in Bull. Fan Mem. Inst. Biol. 4: 95 – 103. 1933.

Soral characters are various among the species of this genus. In *L. subrostratum* fronds are hardly dimorphic and round sori are arranging in polypodioid condition, and in *L. drymoglossoides* the fertile fronds are narrower than the sterile ones. In *L. accedens* the sori are placed on narrow apical portion, though the sori are still round and polypodioid in their particular portion. In *L. microphyllum* and *L. carnosum* the fronds are distinctly dimorphic and the fertile fronds are linear bearing submarginal linear coenosori, and appearing as acrostichoid. Copeland (1947) described *Weatherbya* based on *L. accedens* and another New Guinea species by its partially dimorphic fronds. As the soral structure differs conprehensively among the members of this genus, we do not consider it necessary to separate *Weatherbya* generically based solely on the soral structure.

Lemmaphyllum is related to *Lepisorus* from which different by definition only in small ovate outline of the sterile fronds. The soral structure is also variable in *Lepisorus* as noted in the pages of this genus, and the variation seems to be resulted from the parallel evolution within each genus.

According to Ching (1933), about ten species are credited to this genus in the regions of the warm humid part of the continental Asia and neighbouring islands, extending eastwards to Polynesia and Queensland. Two of them have been collected in Thailand.

KEY TO THE SPECIES

1. Sori round and polypodioid in two distinct rows on narrow apical portion of soriferous fronds; species in Peninsular **1. L. accedens**
1. Sori covering the whole under surface of the linear fertile fronds; species in Northern and North-Eastern **2. L. carnosum**

1. Lemmaphyllum accedens (Bl.) Donk, Reinwardtia 2: 409. 1954; Holtt., Rev. Fl. Malaya 2: 152. f. 66. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 52. 1968.— *Polypodium accedens* Bl., En. Pl. Jav.: 121. 1828.— *Pleopeltis accedens* (Bl.) Moore, Ind.: lxxvii. 1857; Bedd., Handb.: 345. 1883.— *Weatherbya accedens* (Bl.) Copel., Gen. Fil.: 191. 1947. Figure 52.1.

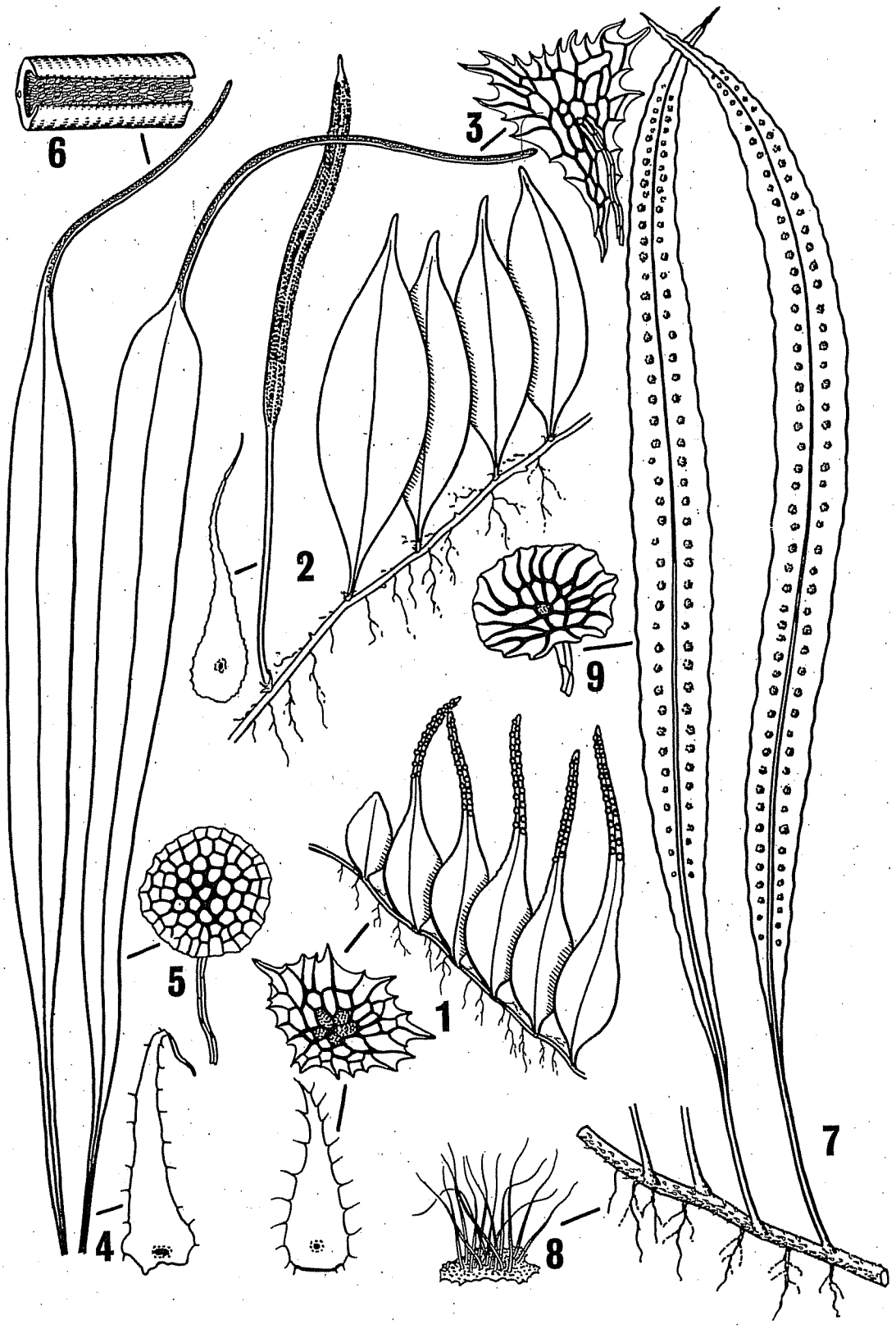

Figure 52. 1. *Lemmaphyllum accedens*; plant (natural size), paraphysis (left) and scale on rhizome (below), both enlarged. 2–3: *L. carnosum*; 2. plant (x 0.6) and scale on rhizome (left, enlarged); 3. paraphysis enlarged. 4–6: *Belvisia mucronata*; 4. two fertile leaves (x 0.5), and scale on rhizome enlarged (right); 5. paraphysis enlarged; 6. portion of fertile segment, enlarged. 7–8: *Neocheiropteris normalis*; 7. plant (x 0.5); 8. trichomes-bearing scale on rhizome, enlarged.

Rhizome long-creeping, slender, about 1 mm diam., bearing fronds remotely, scaly; scales narrowly subtriangular, gradually narrowing from base towards long-attenuate apex, up to 4 by 0.8 mm, clathrate, distinctly toothed at margin, pale brown. *Fronds* all sessile or nearly so, indistinctly dimorphic. *Sterile fronds* ovate to ovate-oblong, round to moderately acute at apex, narrowly round to cuneate at base, 2 – 8 by 1 – 3 cm; midrib prominent, veins obscure, copiously anastomosing; coriaceous, cartilagineous at margin. *Fertile fronds* elongate at apex to bear narrow fertile portion. *Sori* in two distinct rows, each row at medial portion between midrib and margin; fertile portion usually at upper half of fronds, 2 – 5 cm long, usually up to 5 mm broad, or the sori extending downwards nearly to the base of fronds.

T h a i l a n d.— PENINSULAR: Yala (Betong, Ban Chana).

D i s t r i b u t i o n.— Malesia throughout (type from Java) to Polynesia and Queensland.

E c o l o g y.— On tree-trunks at low altitudes in the southernmost part of Peninsular.

N o t e.— Describing the genus *Weatherbya*, Copeland compared this with *Pleopeltis* and not with *Lemmaphyllum*, though this species seems to be most closely related to the group of *L. subrostratum* and *L. pyriforme*.

2. Lemmaphyllum carnosum (Hook.) Presl, Epim. Bot.: 158. 1849; C.Chr., Dansk Bot. Ark. 6(3): 49. pl. 5. f. 7, a-d. 1929; Ching, Bull. Fan Mem. Inst. Biol. 4: 103. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 462. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 51. 1967.— *Drymoglossum carnosum* J.Sm. ex Hook., Gen. Fil.: pl. 78 A. 1841; Bedd., Handb.: 411. f. 243. 1883.— *Microsorium* sp.; Holtt., Dansk Bot. Ark. 20: 20. 1961, p.p. Figure 52. 2 – 3.

Rhizome long-creeping, slender, about 1 mm diam., bearing fronds more than 2 mm apart, densely scaly throughout; scales ovate, each with a long tail, the ovate basal portion about 1 mm in diameter, pale brown with thin-walled cells, the central portion continuous to the tail, up to 2 cm or more in length, with thick-walled long cells, dark brown. *Fronds* simple, dimorphic. *Sterile fronds*: stipes very short, up to 5 mm long, densely scaly at base; laminae ovate to ovate-oblong, acuminate at apex, cuneately attenuate at base, 3 – 8 by 1.5 – 3 cm; coriaceous, midrib distinct, veins more or less visible, copiously anastomosing, the margin cartilagineous. *Fertile fronds*: stipes up to 3 cm long, slender; laminae up to 10 cm long, about 5 mm broad. *Sporangia* covering whole the under surface of laminae except midrib and margin.

T h a i l a n d.— NORTHERN: Chiang Rai, Chiang Mai (Doi Chiang Dao, Doi Suthep); NORTH-EASTERN: Loei (Phu Luang).

D i s t r i b u t i o n.— Himalayas (type from Nepal) to SW. China (Yunnan & Kwangsi) and N. Vietnam.

E c o l o g y.— On branches of tree-trunks usually in dense mossy forests at medium or high altitudes.

N o t e.— As noted by CHING, this is close to *L. microphyllum* of warm temperate China and Japan, especially through the form called var. *obovatum*. The comparison with ample materials from S.China may result in treating *L. carnosum* specifically identical with *L. microphyllum* distinguishing them only in the rank of variety, though *L. carnosum* is the older name and stand as the correct name of the species even in the broader sense.

6. BELVISIA

Mirb., Hist. Nat. Veg. 5: 111. 1803; Underw., Mem. Torrey Bot. Club 6: 276. 1899; Copel., Gen. Fil.: 191. 1947; Holtt., Rev. Fl. Malaya : 153. 1955.— *Hymenolepis* Kaulf., Enum.: 146. 1824, non Cassini 1817; C.Chr., Dansk Bot. Ark. 6: 142. 1929.

Rhizome short-creeping, bearing stipes usually close together, densely scaly; scales peltate, usually dark, ovate to lanceolate. Fronds jointed to rhizome, with short indistinct stipes, simple, entire, papyraceous to coriaceous, peltate scaly or glabrescent; veins copiously anastomosing, visible or hardly so; fertile portion on narrow apical part of fronds, usually wholly covered by sporangia on the lower surface, sometimes separated from the vegetative part by construction. Sporangia mixed with stalked peltate paraphyses and protected also by the narrow reflexed edge of laminae.

This genus is close to *Lepisorus* as known by the venation, trichomes, and general construction of fronds. The distinct difference is found in the sori, but this may be recognized to be the case that the coenosori of *L. sinensis* type are restricted to the upper portion of fronds and arrive at an seemingly acrostichoid condition. This partial dimorphism is well comparable to that in *Lemmaphyllum* which is another genus directly derived from *Lepisorus*. Contrary to the above opinion stated by CHRISTENSEN (1929) and his followers, HOLTTUM (1955) considers that *Belvisia* is a genus close to *Phymatodes* in habit, scales and venation.

About a dozen species are known in the tropics of Asia, from Sri Lanka to Polynesia, one species extending to the African tropics. Four of them are recorded in Thailand.

KEY TO THE SPECIES

1. Rhizome-scales concolorous, clathrate, toothed at margin
   2. Fronds up to 2.5 cm broad, constricted at base of the apical fertile portion **1. B. mucronata**
   2. Fronds more than 2.5 cm broad, not constricted at base of the apical fertile portion
      3. Rhizome-scales narrowly lanceolate, up to 5 mm long; stipes hardly distinct. Fronds rather abruptly narrowing near apex of the sterile portion, the apical fertile portion wholly covered with the sporangia on the underside **2. B. henryi**
      3. Rhizome-scales oblong-ovate, up to 2 mm long. Stipes more than 3 cm long. Fronds gradually narrowing upwards, the apical fertile portion with marginal sterile portion **3. B. annamensis**
1. Rhizome-scales bi-coloured, with dark central portion and pale ferrugineous marginal portion without prominent teeth **4. B. revoluta**

1. Belvisia mucronata (Fée) Copel., Gen. Fil.: 192. 1947; Holtt., Rev. Fl. Malaya 2: 155. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 51. 1967.— *Hymenolepis mucronata* Fée, Gen. Fil.: 82. pl. 6 B. f. 1. 1852. Figure 52. 4–6.

Rhizome creeping, about 3 mm diam., bearing fronds rather closely, scaly; scales narrow, gradually narrowing from base towards long-attenuate apex, up to 5 by 1 mm, broadest at basal portion, dark brown, clathrate, toothed at margin. *Stipes* short, not distinct from lower part of midribs of fronds, narrowly winged, castaneous to dark, scaly at base. *Fronds* linear-lanceolate, gradually narrowing towards both ends, attenuate at both apex and base, entire or a little revoluted at margin, up to 30 by 2.5 cm; subcoriaceous, veins hardly visible, copiously anastomosing; fertile portion of fronds at apex, usually constricted at junction with sterile portion, linear, up to 7 by 0.3 cm, wholly covered by sporangia except the very margin enrolled to protect the young sori.

T h a i l a n d.— SOUTH-EASTERN: Chanthaburi (Takhamao Falls); PENINSULAR: Nakhon Si Thammarat (Khiriwong, Khao Luang), Yala (Betong).

D i s t r i b u t i o n.— Tropics of Asia (type from Malay Isl.), from Sri Lanka to Polynesia, north to Vietnam.

E c o l o g y.— On tree-trunks in dense evergreen forests at low or medium altitudes.

2. Belvisia henryi (Hieron. ex C.Chr.) Tagawa in Hara, Fl. East. Himal.: 490. 1966; Tagawa & K.Iwats., Southeast As. St. 5: 51. 1967.— *Hymenolepis henryi* Hieron. ex C.Chr., Dansk Bot. Ark. 6(3): 67. f. 1. 1929; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 451. 1941.

Rhizome short-creeping, up to 5 mm diam., bearing fronds closely, densely scaly; scales narrowly subtriangular, gradually narrowing from base towards apex, long-attenuate and tailed at apex, up to 5 by 1.5 mm, broadest at basal portion, concolorously brown, clathrate, toothed at margin. *Stipes* short, castaneous, narrowly winged, scaly at base. *Fronds* narrowly oblong, rather suddenly narrowing at apex, bearing linear fertile portion, narrowly cuneate at base, the sterile portion about 25 by 3–5 cm; papyraceous to thin chartaceous, veins hardly visible, the margin of fronds usually plane; fertile portion linear, not constricted at base, up to 15 by 0.4 cm, sporangia occupying the whole under surface except the midrib and margin, the margin hardly revolute.

T h a i l a n d.— NORTHERN: Chiang Rai (Mae Talop), Chiang Mai (Doi Suthep, Doi Inthanon), Mae Hong Son (Khun Kong San), Phitsanulok (Phu Miang), Tak (Huai Krasa, Ban Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Phu Tong); EASTERN: Nakhon Ratchasima (Khao Yai).

D i s t r i b u t i o n.— Himalayas to SW. China (Yunnan, type) and N. Vietnam.

E c o l o g y.— On mossy tree-trunks or on mossy rocks in dense evergreen forests at high altitudes.

N o t e.— The teeth of the rhizome-scales are the intercellular walls of the marginal cells whose surface walls have been destroyed when young.

3. Belvisia annamensis (C.Chr.) Tagawa, Acta Phytotax. Geobot. 22: 107. 1967; Tagawa & K.Iwats., Southeast As. St. 5: 51. 1967.— *Hymenolepis annamensis* C.Chr., Dansk Bot. Ark. 6(3): 68. f. 1. 1929; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 452. f. 53, 1 – 2. 1941.— *Belvisia callifolia* (Christ) Copel. sensu Holtt., Dansk Bot. Ark. 20: 19. 1961.

Rhizome short-creeping, about 2.5 mm diam., bearing fronds closely, densely scaly throughout; scales oblong-ovate, acuminate at apex, round at base, up to 2 by 1 mm, brown, clathrate, toothed at margin. *Stipes* up to 3 – 5 cm long, narrowly winged on upper portion, scaly at base, stramineous to pale castaneous. *Fronds* lanceolate, broadest at $\frac{1}{3}$ way from base, gradually narrowing upwards, cuneate at base, plane at margin, about 15 cm long excluding the fertile apical portion, 2.2 – 3.2 cm broad; thin chartaceous; lateral main veins more or less distinct, the other veins hardly visible, copiously anastomosing; fertile portion continuously narrowing from the narrow apices of the sterile portion, about 5 by 0.5 cm, bearing a pair of medial linear sori.

T h a i l a n d.— NORTHERN: Tak (Ban Musoe); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Trat (Khao Saming); PENINSULAR: Chumphon (Tha San), Ranong (Khlong Nakha), Trang (Khao Chong).

D i s t r i b u t i o n.— Laos and Vietnam (type).

E c o l o g y.— On mossy tree-trunks in light shade or in dense forests usually in moist places at medium altitudes.

4. Belvisia revoluta (Bl.) Copel., Gen. Fil.: 192. 1947; Holtt., Rev. Fl. Malaya 2: 155. f. 67. 1955; Dansk Bot. Ark. 20: 19. 1961; Tagawa & K.Iwats., Southeast As. St. 5: 50. 1967.— *Hymenolepis revoluta* Bl., En. Pl. Jav.: 201. 1828; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 452. 1941.— *Gymnopteris spicata* (Linn.f.) Presl, Tent. 244. t. 11, f. 7. 1836; Bedd., Handb.: 432. f. 261. 1883.

Rhizome short-creeping, 3 – 5 mm diam., bearing many fronds closely, densely scaly; scales oblong-subtriangular, gradually narrowing from base towards apex, round at base, attenuate at apex, entire, about 3 by 1 mm, the central portion dark with thick internal walls, the marginal portion consisting in smaller cells with thinner internal walls, thus paler in colour. *Stipes* up to 5 cm long, not distinct from the midribs of fronds, narrowly winged on the upper portion, stramineous to pale castaneous, scaly at base. *Fronds* linear-lanceolate, usually broadest at middle portion, attenuate towards both ends, 15 – 25 cm long in sterile portion, 1 – 2.5 cm broad, the margin more or less revolute; softly chartaceous; veins hardly visible, copiously anastomosing; fertile portion linear, with distinct constriction at base, up to 15 by 0.3 cm broad, covered wholly with sporangia except on the midribs and margin.

T h a i l a n d.— NORTHERN: Tak (Mae Sot, Ban Musoe); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); EASTERN: Nakhon Ratchasima; PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong).

D i s t r i b u t i o n.— Tropics of Asia (type from Java), from Sri Lanka to Tahiti.

E c o l o g y.— On tree-trunks in forests at medium to high altitudes.

N o t e.— HOLTTUM (1955) considers that there are two distinct subgroups in this genus indicated by the features of the rhizome-scales. The cellular construction of the rhizome-scales is, in appearance, surely different between *B. mucronata* and *B. revoluta*, though the scales of the latter species are peculiar in having smaller cells with thinner internal walls. As seen in the case of *Lepisorus*, the marginal portion of rhizome-scales often takes such construction, and fringed with weak internal walls. The margin of scales in *B. mucronata* is toothed by the remains of the thick internal walls of the marginal cells.

7. NEOCHEIROPTERIS

Christ, Bull. Soc. Bot. France 62 Mém. 1: 21. 1905; Copel., Gen. Fil.: 188. 1947.— *Neolepisorus* Ching, Bull. Fan Mem. Inst. Biol. 10: 11. 1940.

Rhizome long-creeping, rather fleshy, scaly; scales usually fuscous, peltate, more or less clathrate, with a tuft of setose, long, multicellular, brown hairs at the point of attachment. Stipes jointed to rhizome, indistinct with the attenuate base of fronds. Laminae simple and entire, trifid, lobed, or pedate, herbaceous to chartaceous; venation copiously anastomosing with free included veinlets in areoles. Sori round, somewhat irregularly arranging in one or two rows between midrib and the margin of leaves, covered when young with peltate umbrella-shaped paraphyses.

There are various opinions as to the circumscription of this genus. In his detailed study of Chinese Polypodiaceous ferns, CHING (1940) delimited the genus to *Neolepisorus palmatopedata* and those closely related to this, enumerating five species from continental Asia and one from Africa. Most of the recent authors seem to follow him, except COPELAND (1947) who suggested that *N. normale* and *N. subhastata* should be included in *Pleopeltis* group, though CHING transferred them to *Microsorium*. Both of these species are similar to *Microsorium* in habit, but are identical to *Neocheiropteris* in the umbrella-shaped paraphyses and the peculiar construcation of rhizome-scales with a tuft of hairs. The habitat of these two problematic species may better be taken into account: *N. normale* on trees and *N. subhastata* on rocks, never appearing terrestrial as in the case of the other species belonging to *Neocheiropteris*.

Here this genus is treated in the broader sense, and eight species are included in this genus from the Old World. Among them one species is known from Thailand.

Neocheiropteris normalis (D.Don) Tagawa, J. Jap. Bot. 27: 217. 1952; Tagawa & K.Iwats., Southeast As. St. 5: 51. 1967.— *Polypodium normale* D.Don, Prodr. Fl. Nepal.: 1. 1825; Hoss., Beih. Bot. Centrl. 28(2): 366. 1911.— *Pleopeltis normalis* (D.Don) Moore, Ind.: 347. 1862; Bedd., Handb.: 353. 1883.— *Microsorium normale* (D.Don) Ching, Bull. Fan Mem. Inst. Biol. 4: 299. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 479. 1941; Holtt., Rev. Fl. Malaya 2: 175. f. 83. 1955.— *Neolepisorus normalis* (D.Don) Ching, Bull. Fan Mem. Inst. Biol. 10: 13. 1940. Figure 52. 7–8.

Rhizome long-creeping, 2–3 mm diam., bearing fronds with irregular intervals, 0.5–3 cm remote, densely scaly throughout; scales ovate, round at base, moderately acute at apex, entire, about 2 by 1 mm, pale brown, concolorous, hardly clathrate, bearing a tuft of setose hairs, dark brown, up to 4 mm in length. *Stipes* up to 5 cm long, winged at upper part, scaly at lower portion, stramineous. *Laminae* narrowly lanceolate, attenuately long-acuminate at apex, broadest at middle portion, gradually narrowing downwards towards attenuate base, entire and flat or slightly waved at margin, up to 45 by 3 cm; midrib distinctly raised on both surfaces; lateral veins more or less visible, copiously anastomosing; herbaceous, the margin of fronds cartilagineous. *Sori* rather irregular in one row between midrib and the margin of fronds, costular, round, up to 2.5 mm diam.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Khun Huai Pong, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai).

D i s t r i b u t i o n.— Himalayas (type from Nepal), Upper Burma, S.China, Vietnam and W. Malesia (Malaya & Sumatra).

E c o l o g y.— Scandent highly on tree-trunks in gloomy dense evergreen forests at high altitudes, locally abundant.

V e r n a c u l a r.— Kut chak khep (กูดจักเขี็บ) (Chiang Mai).

N o t e.— As noted above and shown in the synonymy, the systematic position of this species is different according to the authors. In appearance *N. normalis* is to some extent different from *N. palmatopedata*, the type of this genus, but these two are quite identical in the essential features as in having the peltate paraphyses and the rhizome-scales with a tuft of hairs. The apparent similarity between *N. normalis* and *Microsorium superficiale* might be derived by the parallel evolution in the similar habitats.

8. MICROSORIUM

Link, Hort. Berol. 2: 110. 1833; Ching, Bull. Fan Mem. Inst. Biol. 4: 293. 1933; Copel., Gen. Fil.: 195. 1947.

Rhizome creeping, densely scaly in apical portion; scales peltate, usually thin, brown to darker, distinctly clathrate. Stipes articulate to rhizome, sometimes indistinct from the attenuate base of laminae. Laminae simple and entire, lobed, hastate, or pinnate, the margin of laminae or lobes not toothed; venation copiously anastomosing with free included veinlets in areoles. Sori round to oblong, usually small and scattered, rarely fused, without peltate paraphyses.

Concerning the systematic position of *Phymatodes* there are different opinions. CHING (1933) separated it from *Microsorium* and recognized very broadly including some species of *Crypsinus*; TARDIEU-BLOT & CHRISTENSEN (1941) followed CHING. COPELAND (1947) separated *Phymatodes* from *Crypsinus* and reduced it to *Microsorium*, noting that there was no diagnostic feature to separate *Phymatodes* from *Microsorium*. HOLTTUM (1955) distinguished these three as the distinct genera, *Phymatodes* and *Microsorium* by the sori sunk in cavities. In the feature of rhizome-scales, *Phymatodes* is distinct from *Crypsinus*, and there are close species in spite of the difference in soral characters, as in the case of *M. dilatatum* and *M. cuspidatum*. We follow here to COPELAND including some sixty species in *Microsorium* from the Old World tropics.

Microsorium is another mother stock of several smaller genera, such as *Myrmecophila*, *Leptochilus*, *Colysis* and the group of *Drynaria*. On the other hand, *Microsorium* itself has an affinity to *Crypsinus*, from which the former is distinguished in definition only by the construction of the rhizome-scales, though there are some additional features to diagnose these two genera. In Thailand following eleven species have been collected.

KEY TO THE SPECIES

1. Sori superficial, not sunk in cavities
 2. Fronds usually simple, entire or slightly undulate
  3. Rhizome slender, scandent, with fronds far apart **1. M. superficiale**
  3. Rhizome thick, short-creeping, never scandent
   4. Lateral main veins distinctly raised at least on lower surface
    5. Sori in two regular rows between adjacent main veins **2. M. zippelii**
    5. Sori irregularly scattered, abundant
     6. Receptacles punctate; plants of Northern **3. M. membranaceum**
     6. Receptacles elongate; plants of Peninsular **4. M. heterocarpum**
   4. Lateral main veins hardly visible **5. M. punctatum**
 2. Fronds of well-grown plants deeply lobed
  7. Fronds trilobate. Stipes and midribs beneath scaly; dark green to blackish in colour **6. M. pteropus**
  7. Fronds pinnatifid with more than one pairs of lateral lobes. Stipes and midribs not densely scaly; light green in colour **7. M. dilatatum**
1. Sori sunk in cavities
 8. Sori uniseriate on either side of midrib; main veins distinct
  9. Fronds pinnate usually with more than 12 pairs of pinnae
   10. Pinnae with distinct stalks. Sori not so deeply sunk in cavities **8. M. cuspidatum**
   10. Pinnae adnate at base. Sori immersed in deep hollow **9. M. rubidum**
  9. Fronds lobed with less than 12 pairs of broader lobes **10. M. nigrescens**
 8. Sori in two rather irregular rows on either side of midrib; veins hardly visible **11. M. scolopendria**

1. Microsorium superficiale (Bl.) Ching, Bull. Fan Mem. Inst. Biol. 4: 299. 1933; Tard & C.Chr. in Fl. Gén. I.-C. 7(2): 480. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 52. 1967; Holtt., Rev. Fl. Malaya ed. 2. 2: 632. 1968.— *Polypodium superficiale* Bl., Fl. Jav. Fil.: 136. t. 56. f. 1. 1828.— *Pleopeltis superficialis* (Bl.) Bedd., Handb.: 350. 1883. Figure 53. 1.

Rhizome very long-creeping, scandent on tree, about 3 mm diam., scaly throughout; scales narrowly oblong-subtriangular, gradually narrowing towards apex, irregularly round at base, entire, about 5 by 2 mm, brown, consisting in smaller cells with distinct internal walls. *Stipes* 10 – 20 cm long, winged only on the upper portion, scaly at base, green, stramineous or dark at basal portion. *Fronds* lanceolate, broadest at middle, gradually narrowing towards both ends, acuminate at apex, attenuate at base, entire and flat at margin, 20 – 40 by 3 – 5 cm; midrib distinctly raised beneath, veins more or less visible, copiously anastomosing; thin chartaceous. *Sori* round, punctate, at junction of veinlets, scattered on whole the under surface of fronds, up to 2 mm diam.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang).

D i s t r i b u t i o n.— Himalayas to Malesia throughout (type from Java).

E c o l o g y.— On mossy tree-trunks in dense evergreen forests at high altitudes, locally abundant.

2. Microsorium zippelii (Bl.) Ching, Bull. Fan Mem. Inst. Biol. 4: 308. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 479. 1941; Holtt., Rev. Fl. Malaya 2: 176. f. 85. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 52. 1967.— *Polypodium zippelii* Bl., Fl. Jav. Fil.: 172. t. 80. 1829.— *Pleopeltis zippelii* (Bl.) Moore, Ind.: 348. 1862; Bedd., Handb.: 357. 1883.

Rhizome creeping, 3 – 5 mm diam., bearing fronds more than 1 cm apart, densely scaly throughout; scales narrowly oblong-subtriangular, gradually narrowing towards attenuate apex, up to 7 by 1.5 mm, dark brown, clathrate, toothed at margin. *Stipes* 5 – 8 cm long, indistinct on the upper, winged portion, scaly at base, green to stramineous. *Laminae* oblong-lanceolate, caudately acuminate at apex, broadest at middle portion, gradually narrowing towards long-attenuate base, entire and flat at margin, up to 40 by 7 cm; midrib and main lateral veins raised on both surfaces, veins more or less distinct, anastomosing, smaller areoles in 3 rows between adjacent main veins with branched included veinlets; papyraceous. *Sori* round, usually at junction of veinlets, arranging in two rows between main veins, about 2 mm diam.

T h a i l a n d.— NORTHERN: Chiang Rai (Mae Len), Chiang Mai (Doi Chiang Dao); NORTH-EASTERN: Loei (Phu Luang).

D i s t r i b u t i o n.— Himalayas to Malesia throughout (type from Java), northeast to S. China (Hainan) and Indochina.

E c o l o g y.— In muddy crevices of rocks or on mountain slopes by streams in dense evergreen forests at high altitudes, rather rare.

N o t e.— The sori are placed between the smaller areoles, thus arranging in two rows between the main lateral veins. In this species, therefore, the regular arrangement of sori in two rows is based upon the pattern of venation and thus a distinct specific feature. The size of Thai plants is smaller comparing with the plants from the other regions.

3. Microsorium membranaceum (D.Don) Ching, Bull. Fan Mem. Inst. Biol. 4: 309. 1933; Tard & C.Chr. in Fl. Gén. I.-C. 7(2): 478. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 52. 1967.— *Polypodium membranaceum* D.Don, Prodr. Fl. Nepal.: 2. 1825; C.Chr., Contr. U.S. Nat. Herb. 26: 334. 1931.— *Pleopeltis membranacea* (D.Don) Moore, Ind.:191. 1860; Bedd., Handb.: 355. 1883. Figure 53. 2.

Rhizome creeping, up to 6 mm or more diam., bearing fronds closely, usually near apical portion, scaly; scales larger, oblong-subtriangular, gradually narrowing towards apex, up to 10 by 2.5 mm, clathrate with smaller cells, bi-coloured, the central portion dark greyish-brown, the margin brown and more or less fringed. *Stipes* about 12 cm long, winged almost to the base, stramineous or greenish. *Laminae* narrowly oblong, broadest at basal $\frac{1}{4}$ to $\frac{1}{6}$ portion, roundly narrowing and then attenuate to the base, gradually narrowing towards acuminate apex, subentire to dully waved at margin, up to 70 by 15 cm; midrib raised prominently beneath, main lateral veins prominent, main areoles visible, smaller areoles hardly visible, many in number and irregularly arranged; membraneous to thinly herbaceous. *Sori* at joint of veins, round and distinct, small, irregularly scattered usually in 2–5 rows between main lateral veins, up to 1.5 mm diam.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Mae Hong Son (Mae Sariang), Lamphun (Doi Khun Tan), Lampang (Mae Ngao), Tak (Khao Phra Wo).

D i s t r i b u t i o n.— Sri Lanka, Himalayas (type from Nepal) to S. China, Taiwan, N. Vietnam and the Philippines.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests or on moist rocks by streams in dense forests, common at high altitudes in the North.

4. Microsorium heterocarpum (Bl.) Ching, Bull. Fan Mem. Inst. Biol. 4: 295. 1933; Holtt., Rev. Fl. Malaya 2: 178. f. 87. 1955; Tagawa & K.Iwats., Southeast As. St. 3(3): 77. 1965; 5: 52. 1967.— *Polypodium heterocarpum* Bl., Fl. Jav. Fil.: 167. t. 75. 1829.

Rhizome creeping, about 5 mm diam., bearing fronds rather closely, scaly on young portion; scales ovate-oblong with gradually narrowing attenuate apex, up to 5 by 1.5 mm, dark brown, clathrate, the central cells larger and thick-walled, the

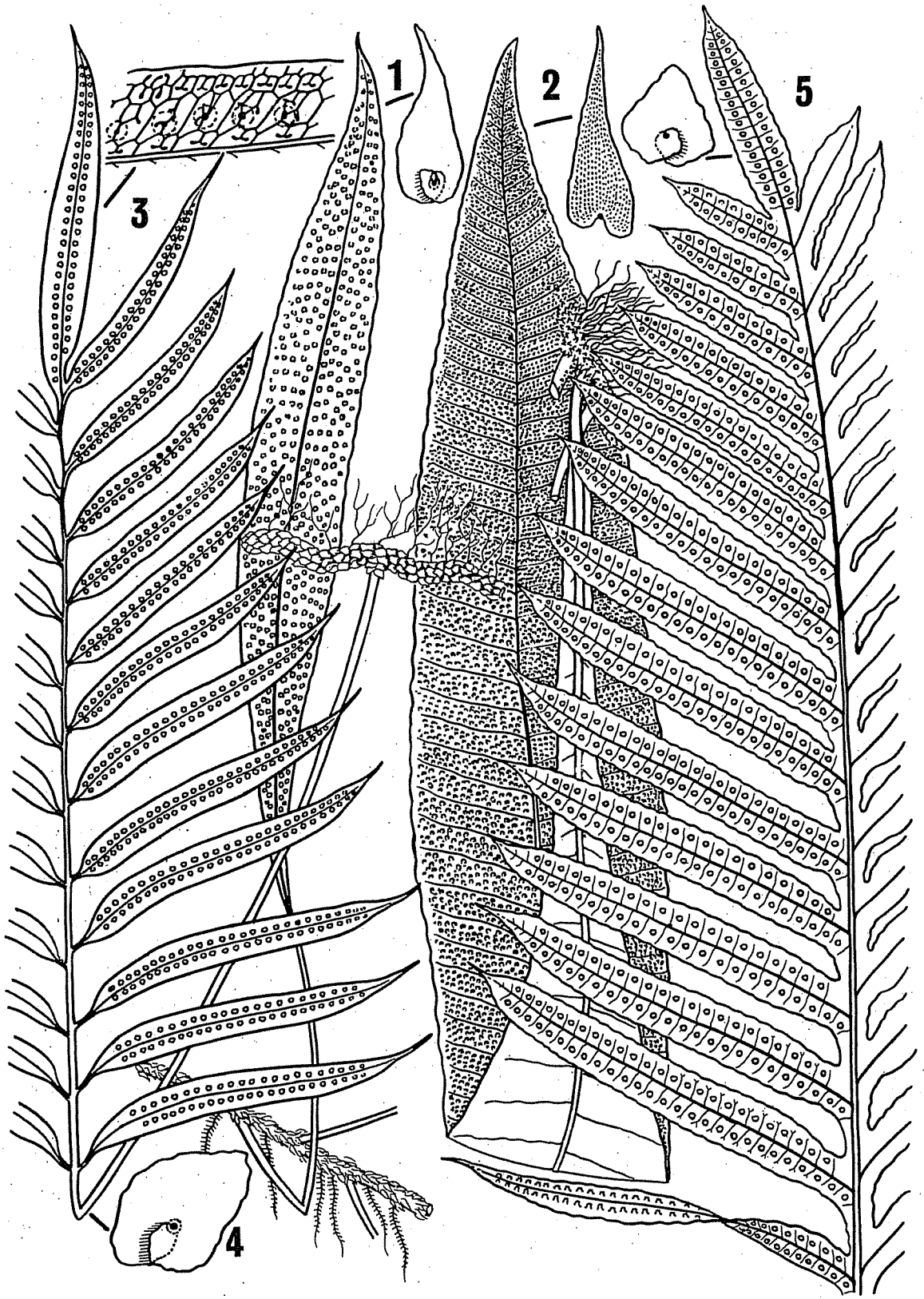

Figure 53. *Microsorium* spp. 1. *M. superficiale*; plant (x 0.5) and scale on rhizome, enlarged (right). 2. *M. membranaceum*; plant (x 0.5) and scale on rhizome, enlarged (right). 3 – 4: *M. cuspidatum*; 3. plant (x 0.5) and venation enlarged; 4. scale on rhizome, enlarged. 5. *M. rubidum*; upper portion of frond (x 0.5) and scale on rhizome, enlarged (left).

apical portion with longitudinal cells with toothed margin. *Stipes* up to 30 cm long, winged nearly to the base, not so distinct from the midrib of the basal part of laminae, stramineous, dark and scaly at base. *Laminae* narrowly oblong, acuminate to attenuate at apex, broadest at middle or lower portion, cuneately narrowing and broadly decurrent downwards to the wings of stipes, subentire or undulate at margin, 60 – 90 cm tall including stipes, or about 40 by 10 cm, not distinctly dimorphic but the soriferous fronds usually much taller with long stipes; lateral main veins distinct, the other veins visible, anastomosing to form copious areoles with included veinlets; papyraceous. *Sori* usually at junction of veinlets, with elongate receptacles, round or elongate, irregularly scattered on the fronds underneath.

T h a i l a n d.— PENINSULAR: Trang (Khao Chong).

D i s t r i b u t i o n.— Malesia throughout (type from Java).

E c o l o g y.— On moist rocks by streams or on rather dry slopes in dense evergreen forests at low altitudes.

5. Microsorium punctatum (Linn.) Copel., Univ. Calif. Publ. Bot. 16: 111. 1929; Ching, Bull. Fan Mem. Inst. Biol. 4: 307. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 483. 1941; Holtt., Rev. Fl. Malaya 2: 179. 1955; Dansk Bot. Ark. 20: 20. 1961; 23: 231. 1965; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958; Tagawa, J. Jap. Bot. 38: 327. 1963; Tagawa & K.Iwats., Southeast As. St. 3(3): 76. 1965; 5: 52. 1967; Acta Phytotax. Geobot. 23: 52. 1968.— *Acrostichum punctatum* Linn., Sp. Pl. ed. 2: 1524. 1763.— *Pleopeltis punctata* (Linn.) Bedd., Ferns Brit. Ind. Suppl.: 22. 1876; Handb.: 357. f. 201. 1883.— *Polypodium punctatum* (Linn.) Sw., Schrad. J. Bot. 1800(2): 21. 1801; Christ, Bot. Tidsskr. 24: 104. 1901; C.Chr., Bot. Tidsskr. 32: 348. 1916.

Rhizome creeping, 3 – 5 mm diam., dark or glaucous in surface, bearing fronds closely, scaly; scales narrowly oblong-subtriangular, gradually narrowing from ovate basal portion towards long-attenuate apex, concolorously dark greyish-brown, clathrate, the surface wall of constituent cells not transparent, margin distinctly toothed, up to 8 by 1.5 mm. *Stipes* not distinct from laminae, scaly at base, stramineous to greenish. *Laminae* narrowly oblong to lanceolate, gradually narrowing towards acute apex or moderately acute with not pointed apex, narrowing towards attenuate base and decurrent downwards to form wings of stipes sometimes nearly to the base, 40 – 80 cm long including stipes, 3 – 6 cm broad; midrib raised on both surfaces, other veins obscure, finely anastomosing to form copious areoles; subcoriaceous, the margin of fronds sometimes revoluted. *Sori* small, round, many, scattered on the whole under surface of fronds.

T h a i l a n d.— NORTHERN: Chiang Rai (Mae Kok), Chiang Mai (Fang, Doi Chiang Dao, Tin Tok, Mae Rim, Doi Inthanon), Lampang (Mae Ngao), Tak (Lan Sang, Doi Musoe), Phitsanulok (Salaeng Haeng, Thung Salaeng Luang); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradueng);

EASTERN: Chaiyaphum (Phu Khieo); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chon Buri (Si Racha, Hup Bon), Nakhon Ratchasima (Pak Thong Chai, Pak Chong), Chanthaburi (Takhamao Falls, Makham, Khao Kluea), Trat (Ban Saphan Hin, Ko Chang, Ko Kut); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai, Wangka, Sai Yok), Prachuap Khiri Khan (Bang Saphan); PENINSULAR: Ranong (Kra Buri, Khlong Nakha), Surat Thani (Ban Don), Phangnga (Khlong Nang Yon), Phuket, Nakhon Si Thammarat (Khao Luang, Thung Song), Trang (Khao Chong), Yala (Khao Khalakhiri, Bannang Sata).

D i s t r i b u t i o n.— Throughout the tropics of the Old World, W. Africa to Tahiti.

E c o l o g y.— On mossy rocks or tree-trunks usually in dry open places or in light shade, common at low to medium altitudes throughout Thailand.

V e r n a c u l a r.— Kraprok hang sing (กระปรอกหางสิงห์) (South-eastern); prue mai (ปรือไม้) (South-western); lin phi mai (ลิ้นผีไม้), hang nok wa (หางนกหว้า) (Peninsular); ai-ka bu-kong ka-waeng (ไอกาบุกงกะแวง) (Malay/Peninsular); Crested Fern.

6. Microsorium pteropus (Bl.) Copel., Univ. Calif. Publ. Bot. 16: 112. 1929; Ching, Bull. Fan Mem. Inst. Biol. 4: 312. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 484. 1941; Holtt., Rev. Fl. Malaya 2: 172. f. 80. 1955; Dansk Bot. Ark. 23: 230. 1965; Tagawa & K.Iwats., Southeast As. St. 3(3): 77. 1965; 5: 53. 1967.— *Polypodium pteropus* Bl., En. Pl. Jav. 2: add. 3. 1828, Fl. Jav. Fil.: 168. t. 76. 1829.— *Pleopeltis pteropus* (Bl.) Bedd., Handb.: 359. f. 203. 1883.

Rhizome long-creeping, 1 – 2 mm diam., bearing fronds rather closely, densely scaly; scales oblong-lanceolate, gradually narrowing towards apex, round at base, up to 5 by 1.5 mm, brown, distinctly clathrate, the cells rather regularly arranged longitudinally, the margin entire. *Stipes* 0.5 mm or so apart from the next ones, stramineous, with the scales like those on rhizome but smaller in size, up to 15 cm long, winged on upper portion. *Laminae* simple to trifoliate, simple laminae broadest at lower $\frac{1}{3}$ portion, narrowing towards attenuate base, decurrent downwards as wings of stipes, narrowing towards attenuately very long-acuminate apex, entire, up to 15 by 3.5 cm, the lateral lobes of trifoliate laminae various in size and form, rarely almost the same as the terminal lobes, usually narrower, terminal lobes like simple laminae; midrib raised on both surfaces, more or less minutely scaly; lateral main veins distinct beneath, the other veins hardly visible or distinct, anastomosing with a row of main areoles along both sides of midrib and many smaller areoles in irregular arrangement; thinly papyraceous to herbaceous, dark green to blackish in colour. *Sori* round to more or less elongate, many, irregularly scattered on the under surface of fronds.

T h a i l a n d.— NORTHERN: Chiang Rai (Mae Lao), Chiang Mai (Doi Chiang Dao, Doi Saket), Lampang (Mae Long), Tak, Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang); EASTERN: Buri Ram (Bu Khanun), Chaiyaphum; CENTRAL: Nakhon Nayok (Khao Yai), Saraburi (Muak Lek);

SOUTH-EASTERN: Chanthaburi (Pong Nam Ron); SOUTH-WESTERN: Ratchaburi, Kanchanaburi (Khao Ri Yai), Prachuap Khiri Khan (Huai Yang); PENINSULAR: Chumphon (Ban Tha Ngo), Ranong (Mueang Laen), Surat Thani (Ko Samui, Ban Don), Nakhon Si Thammarat (Khao Luang, Thap Chang, Khiriwong), Trang (Khao Chong), Satun (Bukit Racha Wang), Yala (Bannang Sata).

D i s t r i b u t i o n.— India to Malesia (type from Java), north to S. China and the Ryukyus.

E c o l o g y.— On wet rocks in stream-beds in dense gloomy forests at low to medium altitudes less than 800 m alt., usually in spraying water, not so rare throughout the country.

V e r n a c u l a r.— Kut hang nok kaling (กูดหางนกกะลิง) (Peninsular).

N o t e.— The lobation of fronds is various and there are colonies including only the simple form, i.e. var. *minor* (Bedd.) Ching, though this is hardly distinguished as a variety. The venation is rather peculiar: the main lateral veins form a row of main areoles including many smaller areoles, and at the outside of main areoles there are smaller ones with veins more distinct than those of included smaller areoles. The sori are sometimes elongate to form areoles, usually only in the main areoles. The size is much larger in some foreign plants, and the variation in size and form is comprehensive, though the habitat of this species is peculiar, usually in the stream-beds where will be wholly immersed when the level of water in the river will be a little higher.

7. Microsorium dilatatum (Bedd.) Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 143. 1960; Tagawa & K.Iwats., Southeast As. St. 5: 53. 1967.— *Pleopeltis dilatata* Bedd., Ferns Brit. Ind.: t. 122. 1866; Handb.: 367. f. 209. 1883, based on *Polypodium dilatatum* Wall. ex Hook., Sp. Fil. 5: 85. 1863, non Hoffm. 1796.— *Microsorium hancockii* (Bak.) Ching, Bull. Fan Mem. Inst. Biol. 4: 309. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 485. 1941; Holtt., Rev. Fl. Malaya 2: 174. f. 82. 1955.

Rhizome creeping, thick, more than 6 mm diam., dark, bearing fronds closely, scaly; scales oblong-subtriangular, gradually narrowing towards long-acuminate apex, round at base, up to 6 by 2 mm, brown to dark brown, clathrate, decaying from outside, round to oblong-ovate on older rhizome. *Stipes* (i.e. the portion below the first lobe) up to 30 cm long, distinctly winged nearly to the base, scaly at base. *Laminae* simple to pinnatifid with a few lobes, or pinnate with more than 10 pairs of lateral pinnae and winged rachis, about 50 by 35 cm, the lower lateral pinnae or lobes adnate at base, oblong to rarrowly oblong-lanceolate, caudate at apex, entire, up to 20 by 4 cm, the upper ones gradually becoming smaller, the terminal lobes oblong, gradually narrowing towards apex, undulate at margin, those of pinnate large fronds smaller; rachis and midrib raised, main lateral veins distinct, the other veins visible, copiously anastomosing; papyraceous, light green. *Sori* round, smaller, irregularly scattered on the lower surface, about 1.5 mm diam. at maturity.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Inthanon, Doi Khun Huai Pong), Mae Hong Son (Mae La Noi), Phrae (Mae Sai); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— It is rather difficult to distinguish *M. dilatatum* s. str. in Sri Lanka and Himalayas (type) to Malaya and Indochina from *M. hancockii* in China and southern edge of Japan to Taiwan, for in Thailand there are transitional forms from simple to hastate form to nearly pinnate form. Further study is highly necessary to investigate the status of specific difference for these two species.

E c o l o g y.— On muddy rocks usually near streams in deep shade at low to medium altitudes.

8. Microsorium cuspidatum (D.Don) Tagawa in Hara, Fl. East. Himal.: 495. 1966; Tagawa & K.Iwats., Southeast As. St. 5: 53. 1967.— *Polypodium cuspidatum* D.Don, Prodr. Fl. Nepal.: 2. 1825.— *Phymatodes lucida* (Roxb.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 61. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 475. 1941. Figure 53. 3–4.

Rhizome fleshy, creeping, 6–10 mm diam., bearing a few fronds remotely, densely scaly throughout; scales large, circular, attached to rhizome a little basal than central point, 5–8 mm in both directions, the central portion with larger cells, the cells becoming smaller towards margin, dark brown but paler towards margin, entire, more or less clathrate. *Stipes* about 35 cm long, stramineous, scaly at base. *Laminae* imparipinnate, oblong to oblong-subdeltoid, acute to moderately acute at apex, truncate to broadly cuneate at base, 40–55 by 35–45 cm; lateral pinnae (8–) 12–15 pairs, gradually becoming smaller from base towards apex, more or less ascending, linear-lanceolate or broader, up to 25 cm long, 1.5–3.5 cm broad, caudately acuminate at apex, subentire, round to cuneate at base, stalked; rachis like the stipes, costa raised, stramineous, main veins distinct, other veins hardly visible, copiously anastomosing with included veinlets; herbaceous to papyraceous. *Sori* round, about 3 mm diam. at maturity, arranging in one row at each side of costa, medial or a little costal, nearly superficial.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tham Yup), Chiang Mai; EASTERN: Chaiyaphum (Nam Phrom); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng).

D i s t r i b u t i o n.— Himalayas (type), SW. China, Upper Burma, Laos and N. Vietnam.

E c o l o g y.— On rather dry rocks or on tree-trunks in dense forests at medium altitudes.

V e r n a c u l a r.— Kut cham (กูดฉ่ำ) (Northern).

N o t e.— In nearly superficial sori and pinnate fronds, this is not quite identical with the species belonging to *Phymathodes,* though the close relationship to *M. nigrescens* is suggested by various authors.

9. Microsorium rubidum (Kunze) Copel., Gen. Fil.: 197. 1947; Tagawa & K.Iwats., Southeast As. St. 5: 53. 1967; Acta Phytotax. Geobot. 23: 53. 1968.— *Polypodium rubidum* Kunze, Bot. Zeit. 1848: 117.— *Pleopeltis longissima* (Bl.) Moore, Ind.: lxviii. 1857; Bedd., Handb.: 366. 1883.— *Phymatodes longissima* (Bl.) J.Sm., Cat. Cul. Ferns: 10. 1857; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 62. 1933; Tard & C.Chr. in Fl. Gén. I.-C. 7(2): 476. 1941; Holtt., Rev. Fl. Malaya 2: 191. 1955. Figure 53. 5.

Rhizome creeping, thick, 5 – 8 mm diam., bearing stipes remotely, dark on surface, scaly; scales oblong-subdeltoid, gradually narrowing towards apex, round at base, about 5 by 2.5 mm, irregularly toothed at margin, concolorously brown, more or less clathrate. *Stipes* thick, up to 1 cm diam. near base, up to 70 cm long, winged only on the upper portion. *Laminae* oblong, moderately acute at apex, up to 130 by 50 cm, pinnatisect with broadly winged rachis; lateral pinnae about 25 pairs, linear-lanceolate, caudately acuminate at apex, entire at margin, a little narrowing at base and decurrent to rachis, 30 by 3 cm at lower or middle ones, more or less ascending; costa distinctly raised, lateral main veins distinct, the other veins visible, copiously anastomosing; herbaceous to thinly papyraceous, dark green, brownish in dried condition. *Sori* in one row arranging medial at each side of costa, round, about 2 mm diam., distinctly immersed in hollow which are prominently raised on upper surface.

T h a i l a n d.— NORTHERN: Lampang (Mae Tha); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Yala (Bannang Sata).

D i s t r i b u t i o n.— India, Sri Lanka, throughout Malesia and Polynesia, north to Vietnam.

E c o l o g y.— On rather wet rocks along rivers in light shade at low altitudes.

V e r n a c u l a r.— Kraprok bai chaek (กระปรอกใบแฉก) (South-eastern).

10. Microsorium nigrescens (Bl.) Copel., Occ. Pap. B.P. Bishop Mus. 14: 74. 1938; Tagawa & K.Iwats., Southeast As. St. 3(3): 77. 1965; 5: 54. 1967; Acta Phytotax. Geobot. 23: 53. 1968.— *Polypodium nigrescens* Bl., En. Pl. Jav.: 126. 1828; Fl. Jav. Fil.: t. 70. 1829; Christ, Bot. Tidsskr. 24: 105. 1901; C.Chr., Bot. Tidsskr. 32: 348. 1916.— *Pleopeltis nigrescens* (Bl.) Carr. in Seem., Fl. Vit.: 368. 1873; Bedd., Handb.: 367. f. 208. 1883.— *Phymatodes nigrescens* (Bl.) J.Sm.; Ferns Br. For.: 94. 1866; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 473. 1941; Holtt., Rev. Fl. Malaya 2: 193. f. 95. 1955; Dansk Bot. Ark. 20: 21. 1961; 23: 231. 1965; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958.— *Microsorium alternifolium* (Willd.) Copel., Gen. Fil.: 197. 1947.— *Polypodium alternifolium* Willd., Sp. Pl. 5: 168. 1810.

Rhizome creeping, thick, about 1 cm diam., scaly; scales circular to oblong, round to moderately acute at apex, round at base, attached near the center, minutely hairy at margin, about 5 mm in both directions, brown, more or less

clathrate with thick internal cell-walls and not transparent surface walls, the internal wall gradually becoming thiner outwards. *Stipes* up to 50 cm long, stramineous, glabrous. *Laminae* pinnatisect nearly to rachis, subdeltoid to oblong, up to 80 by 40 cm; lateral pinnae longest at base, or the basalmost ones a little reduced, gradually becoming smaller upwards, up to 30 by 4.5 cm, more or less ascending, usually straight, caudately acuminate at apex, subentire and nearly parallel at margin, somewhat narrowing towards base, up to 12 pairs; veins all distinct, forming areoles; papyraceous. *Sori* round, in distinct hollow in one row at each side of costa, about 4 mm diam., distinctly raised on upper surface.

T h a i l a n d.— EASTERN: Chaiyaphum (Nam Phrom, Phu Khieo), Nakhon Ratchasima (Pak Thong Chai); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chanthaburi (Takhamao Falls, Khao Sabap, Khao Soi Dao), Trat (Ko Chang); SOUTH-WESTERN: Uthai Thani (Ban Rai), Kanchanaburi (Khao Ri Yai, Ban Ti Li), Prachuap Khiri Khan (Ban Huai Ta, Ban Sai Khao); PENINSULAR: Chumphon (Tha Ngo), Phangnga (Khao Katha Khwam, Khao Phra Mi), Nakhon Si Thammarat (Chawang, Khao Luang, Khiriwong), Trang (Khao Chong), Satun, Pattani, Narathiwat (Waeng, Bacho, Sungai Padi, Bacho Falls), Yala (Bannang Sata).

D i s t r i b u t i o n.— Sri Lanka, S. India, Vietnam, Cambodia, throughout Malesia (type from Java) and Polynesia.

E c o l o g y.— On rather dry rocks in mixed forests at low altitudes.

V e r n a c u l a r.— Ka-lo ra-wa (กาโลระวา) (Malay/Peninsular).

N o t e.— This is distinguished from the preceding species by smaller number of lobes, up to 10 pairs which are broader, 3–4.5 cm in breath, with raised main veins as well as with slightly undulate and crisped edges. Both of the above two species are variable to some extent in size and form of fronds, but they are still distinct from each other.

11. Microsorium scolopendria (Burm. f.) Copel., Occ. Pap. B.P. Bishop Mus. 14: 112. 1929; Tagawa & K.Iwats., Southeast As. St. 3(3): 77. 1965; 5: 54. 1967; Acta Phytotax. Geobot. 23: 53. 1968.— *Polypodium scolopendria* Burm.f., Fl. Ind.: 232. 1769.— *Phymatodes scolopendria* (Burm.f.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 63. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 473. 1941; Holtt., Rev. Fl. Malaya 2: 191. f. 94. 1955; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958.— *Pleopeltis phymatodes* (Linn.) Moore, Ind.: lxxviii. 1857; Bedd., Handb.: 366. 1883; E.Sm., J. Siam Soc. Nat. Hist. Suppl. 8: 6. 1929.

Rhizome long-creeping, dark in surface, about 5 mm diam., bearing fronds more than 1 cm apart, scaly; scales rather small, gradually narrowing from base towards long-acuminate apex, up to 3 by 0.7 mm, dark brown, clathrate, hairy at margin. *Stipes* up to 50 cm long, stramineous to pale castaneous. *Laminae* oblong-ovate to subdeltoid, pinnatifid with broadly winged rachis, up to 40 by 35 cm; lateral pinnae up to 6 pairs, the basal one the longest, up to 20 by 3 cm in fertile and 5 cm

broad in sterile ones, gradually narrowing towards apex, entire at margin, the upper ones gradually becoming smaller, the wings of rachis about the same as the pinnae in breadth; costae raised on both surfaces, veins hardly visible, anastomosing, with many included veinlets ending in raised point; coriaceous. *Sori* in two rather irregular rows at each side of midrib, round or elongate in deep hollows, about 3 mm in breadth, raised on upper surface.

T h a i l a n d.— SOUTH-EASTERN: Chon Buri (Si Racha), Prachin Buri (Ban Bueng Hills); CENTRAL: Krung Thep (Bangkok); PENINSULAR: Surat Thani (Ban Don, Ko Tao, Ko Samui), Phangnga (Takua Thung), Nakhon Si Thammarat (Khao Luang, Khiriwong, Thung Song), Songkhla (Ban Prakop), Trang, Narathiwat, Yala (Bannang Sata), Pattani (Ban Sai Khao).

D i s t r i b u t i o n.— Tropics of the Old World.

E c o l o g y.— On rather dry muddy rocks or terrestrial in light shade or in open places.

V e r n a c u l a r.— Yai phaek (ยายแพก) (Peninsular).

N o t e.— In the features of scales, this species is a little different from the preceding three, though identical in soral characters.

9. MYRMECOPHILA

(Christ) Nakai, Bot. Mag. Tokyo 43: 6. 1929.— *Lecanopteris* Reinw.; Copel., Gen. Fil.:205. 1947, p.p.— *Phymatodes* Presl; Holtt., Rev. Fl. Malaya 2: 188. 1955, p.p.

Rhizome creeping, fleshy, hollow and ant-inhabited, scaly; scales peltate, usually ovate, bi-coloured with dark central portion and pale edge, clathrate. Fronds in two rows on phyllopodes, simple to pinnate, leatherly, glabrous; veins anastomosing to form areoles with included veinlets. Sori round or oblong, usually sunk in cavities, in a single row at each side of midrib.

This is a genus close to *Microsorium* from which discriminative by the ant-inhabited rhizome bearing peltate bi-coloured scales. There is another genus with ant-inhabited rhizome, *Lecanopteris,* from which *Myrmecophila* is distinguished by the scaly rhizome and sori not in small pockets on the margin of pinnae. Half a dozen species are belonging to this genus from Southeast Asia and two of them are native to Thailand.

KEY TO THE SPECIES

1. Fronds simple; ant-inhabited rhizome 1 – 1.5 cm diam. **1. M. sinuosa**
1. Fronds pinnatifid with narrow pinnae; ant-inhabited rhizome large, 3 – 5 cm in thickness **2. M. crustacea**

1. Myrmecophila sinuosa (Wall. ex Hook.) Nakai ex H. Ito, J. Jap. Bot. 11: 98. 1935; Ching, Sunyatsenia 5: 259. 1940; Tagawa & K.Iwats., Southeast As. St. 3(3): 78. 1965; 5: 54. 1967.— *Polypodium sinuosum* Wall. ex Hook., Sp. Fil. 5: 61. t. 284. 1863; Christ, Bot. Tidsskr. 24: 105. 1901; C.Chr., Bot. Tidsskr. 32: 348. 1916.— *Phymatodes sinuosa* (Wall. ex Hook.) J.Sm., Ferns Br. For. ed. 2: 296. 1877; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 470. 1941; Holtt., Rev. Fl. Malaya 2: 190. 1955; Dansk Bot. Ark. 20: 21. 1961; Seidenf., Nat. Hist. Bull. Siam Soc. 19: 86. 1958.— *Pleopeltis sinuosa* (Wall. ex Hook.) Bedd., Ferns Br. Ind.: t. 8. 1865; Handb.: 349. f. 195. 1883.

Rhizome creeping, thick, 1–1.5 cm diam., hollow and ant-inhabited, bearing two rows of fronds usually about 1.5 cm apart on tall phyllopodes of more than 5 mm in height, densely scaly; scales circular, about 3 mm diam., attached at central point, central portion about 1 mm diam., dark brown, clathrate with thick internal walls, the margin white consisting in narrow cells. *Stipes* up to 5 cm long, winged on uppermost portion. *Laminae* simple, oblong to linear, round to moderately acute at apex, cuneate to broadly attenuate at base, up to 15 by 3.5 cm in sterile and 0.7–1.5 cm broad in fertile ones, subentire or dully waved at margin; midrib raised on both surfaces, veins visible, copiously anastomosing; papyraceous. *Sori* medial or submarginal, in one row at each side of midrib, round to oblong, about 3.5 mm broad at maturity, in distinct hollow which raised on upper surface.

Thailand.— EASTERN: Nakhon Ratchasima; SOUTH-EASTERN: Chanthaburi (Makham, Khao Sabap), Trat (Ban Saphan Hin, Khao Kuap, Ko Chang); PENINSULAR: Chumphon (Lang Suan), Krabi, Nakhon Si Thammarat (Khao Luang, Khiriwong), Trang, Satun (Tarutao, Adang).

Distribution.— Sumatra and Malaya (type) to New Hebrides and the Solomon Islands, north to Cambodia and Vietnam.

Ecology.— On tree-trunks in light shade or in open places usually in or near the village at low altitudes.

Vernacular.— Tan mangkon (ตาลมังกร) (South-western).

2. Myrmecophila crustacea (Copel.) Tagawa, Acta Phytotax. Geobot. 22: 190. 1967; Tagawa & K.Iwats., Acta Phytotax. Geobot. 24: 175. 1970.— *Lecanopteris crustacea* Copel., Univ. Cal. Publ. Bot. 12: 406. 1931.— *Phymatodes crustacea* (Copel.) Holtt., Rev. Fl. Malaya 2: 190. 1955.— *Polypodium lomarioides* Kunze sensu Bonap., Not. Pterid. 14: 64. 1923. Figure 54. 1–2.

Rhizome fleshy, swollen, hollow and ant-inhabited, 3–5 cm in thickness, scaly; scales circular, up to 3 mm diam., bi-coloured, clathrate. *Stipes* up to 20 cm long, scaly at base, glabrescent above. *Fronds* narrowly elliptic, up to 45 by 12 cm, pinnatifid; pinnae linear, up to 7 by 0.5 cm, broadest at apical $\frac{1}{4}$ portion, round at apex, subentire, decurrent at base and connected to the next by very narrow wings; papyraceous, glabrous; veins anastomosing, hardly visible. *Sori* large, oblong, up to 2 mm in length, in shallow hollow at each side of costae, raised on upper surface.

T h a i l a n d.— PENINSULAR: Ranong (Kapoe), Surat Thani (Ban Don).

D i s t r i b u t i o n.— Malaya, Sumatra (type) and Borneo.

E c o l o g y.— Epiphytic on tree-trunks or on rocks at low altitudes in Peninsular.

10. COLYSIS

Presl, Epim. Bot.: 146. 1849; Ching, Bull. Fan Mem. Inst. Biol. 4: 313. 1933; Copel., Gen. Fil.: 198. 1947.

Rhizome creeping, scaly; scales thin, clathrate, peltate. Fronds with distinct stipes, simple to pinnate, rarely dimorphic, articulate to rhizome; veins anastomosing to form irregularly arranged areoles with included veinlets; thin herbaceous. Sori linear, usually continuous, one between the adjacent lateral main veins, oblique to costae, naked, without peltate paraphyses.

This is a genus with gymnogrammoid sori derived from *Microsorium*, similar in appearance to *Selliguea* but different from the latter in the texture of fronds and the rhizome-scales. *Colysis* is the genus of the warm part of Asia and Africa, extending to Australia, comprising about 25 species. Seven of them are known in Thailand.

KEY TO THE SPECIES

1. Fronds simple, entire	
2. Sori more or less interrupted	
3. Sori round to shortly elongate; main veins not strongly raised beneath	**1. C. hemionitidea**
3. Sori only slightly broken; main veins raised beneath	**2. C. macrophylla**
2. Sori continuous throughout between main veins or seldom interrupted	
4. Fronds subdimorphic with contracted fertile fronds	**3. C. pedunculata**
4. Fertile fronds like sterile ones	**4. C. wui**
1. Fronds pinnatifid to pinnate	
5. Lateral pinnae up to 5 pairs	**5. C. pentaphylla**
5. Lateral pinnae more than 6 pairs	**6. C. pothifolia**

1. Colysis hemionitidea Presl, Epim. Bot.: 147. 1849; Ching, Bull. Fan Mem. Inst. Biol. 4: 320. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 494. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 54. 1967.— *Pleopeltis hemionitidea* (Presl) Moore, Ind.: 346. 1862; Bedd., Handb.: 358. f. 202. 1883.— *Colysis* sp.; Holtt., Dansk Bot. Ark. 20: 20. 1961.

Rhizome creeping, about 4 mm diam., scaly throughout; scales oblong-subtriangular, gradually narrowing from base towards long-acuminate apex, 3 by 0.7 mm, finely clathrate with larger longitudinal cells, slightly toothed at margin.

Figure 54. 1–2: *Myrmecophila crustacea*; 1. plant (x 0.5); 2. venation of fertile segment (above, x 3) and scale on rhizome (below, x 12.5). 3. *Colysis wui*; plant (x 0.5). 4–5: *C. pentaphylla*; 4. plant (x 0.5); 5. venation of fertile segment, enlarged. 6. *Leptochilus axillaris*; plant (x 0.5). 7. *L. decurrens*; plant (x 0.5).

Stipes not distinct from the lower part of laminae with decurrent laminae forming wings of stipes, wingless part up to only 3 cm long. *Laminae* oblong to oblong-lanceolate, broadest at middle portion of fronds, gradually narrowing towards acute apex, roundly narrowing and then broadly decurrent downwards forming broad wings of stipes, 35 – 85 by up to 8 cm; lateral main veins raised, about 8 mm apart at broadest portion, the veins distinct, forming areoles with included veinlets; herbaceous, dark green, brownish in dried condition. *Sori* round to shortly elongate, arranging in one usually regular row between adjacent main veins.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Inthanon), Mae Hong Son (Mae La Noi), Phitsanulok (Phu Miang), Phrae (Mae Sai), Tak (Ban Musoe); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

D i s t r i b u t i o n.— Himalayas (type) to S. China, Taiwan and the Ryukyus, south to N. Vietnam and the Philippines.

E c o l o g y.— On wet rocks usually in stream-beds in dense forests at 1000 – 1500 m alt.

V e r n a c u l a r.— Kut hang nok kaling (กูดหางนกกะลิง) (Northern).

2. Colysis macrophylla (Bl.) Presl, Epim. Bot.: 147. 1849; Holtt., Rev. Fl. Malaya 2: 160. f. 72. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 175. 1969.— *Grammitis macrophylla* Bl., En. Pl. Jav.: 119. 1828.— *Colysis acuminata* (Bak.) Holtt. sensu Tagawa & K. Iwats., Acta Phytotax. Geobot. 23: 53. 1968.

Rhizome creeping or climbing up, long, rather flat, about 4 mm in breadth, scaly; scales oblong-subtriangular, gradually narrowing towards long-tailed apex, 4 by 1.5 mm, dark brown, clathrate with smaller cells, irregular at margin. *Stipes* long in fertile fronds, up to 20 cm long, narrowly winged on upper half, indistinct in sterile fronds. *Sterile laminae* oblong-lanceolate, acuminate at apex, gradually narrowing downwards and decurrenting nearly towards the base of stipes, up to 40 by about 6 cm. *Fertile laminae* oblong with shortly acuminate apex, cuneate at base, about 20 by 8 cm; main lateral veins distinctly raised, dark, the other veins distinct, forming usually two rows of areoles between adjacent main veins; herbaceous, dark green, dark brown in dried condition. *Sori* extending from midrib nearly to the margin of fronds, occasionally broken.

T h a i l a n d.— PENINSULAR: Narathiwat (Sungai Padi), Yala (Khao Khalakhiri), Pattani (Ban Sai Khao).

D i s t r i b u t i o n.— Malesia (type from Java).

E c o l o g y.— On muddy rocks along streams in dense forests at 400 – 650 m alt.

3. Colysis pedunculata (Hook. & Grev.) Ching, Bull. Fan Mem. Inst. Biol. 4: 321. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 492. 1941; Holtt., Rev. Fl. Malaya 2:

160. f. 71. 1955; Dansk Bot. Ark. 23: 230. 1965; Tagawa & K.Iwats., Southeast As. St. 3(3): 76. 1965; 5: 55. 1967.— *Ceterach pedunculatum* Hook. & Grev., Ic. Fil.: t. 5. 1827.— *Gymnogramma hamiltoniana* Wall. ex Hook., Sp. Fil. 5: 161. 1864.— *Selliguea hamiltoniana* (Hook.) Bedd., Ferns Br. Ind.: t. 239. 1867; Handb.: 390. f. 226. 1883.

Rhizome long-creeping, very dark, bearing fronds usually 1–3 cm apart, scaly; scales narrowly subtriangular, gradually narrowing from base towards taperly acuminate apex, 2.5 by 0.7 mm, dark greyish-brown, clathrate, toothed at margin. *Fronds* dimorphic. *Sterile fronds*: stipes about 10 cm long, narrowly winged nearly to the base; laminae oblong, usually gradually narrowing towards acute to acuminate apex, round to cuneate at base, up to 35 by about 8.5 cm; main lateral veins distinct, up to 1.2 cm apart, the veins forming areoles with included veinlets; herbaceous, geen, dark in dried specimens. *Fertile fronds*: stipes up to 30 cm long, stramineous, wingless; laminae broadly oblong, broadest at middle portion, narrowing towards acute apex, round at base, up to 10 by 3.5 cm broad. *Sori* up to 4 mm broad, extending almost all the lower surface except on midrib and lateral main veins.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao); SOUTH-EASTERN: Chon Buri (Si Racha), Chanthaburi (Khao Soi Dao); PENINSULAR: Surat Thani (Ko Samui, Ban Don), Krabi (Khao Phanom Bencha), Nakhon Si Thammarat (Chawang), Trang (Khao Chong, Ko Talibong).

D i s t r i b u t i o n.— SE. Himalayas (type), SW. China (Yunnan), Vietnam to Malaya.

E c o l o g y.— On moist or damp rocks in stream-beds or in deep shade or climbing on basal tree-trunks in dense evergreen forests at low to medium altitudes.

V e r n a c u l a r.— Kraprok nom maeo (กระปรอกนมแมว) (South-eastern).

N o t e.— *Colysis fluviatilis* of Borneo is distinguished from this species by narrow fertile fronds of about 1 cm in breadth with oblique sori sometimes fusing along midrib. We have several collections at hands bearing the feature similar to this, but we observed in the fields that these plants were mixed with the typical form of this species within the same colony.

4. Colysis wui (C.Chr.) Ching, Bull. Fan Mem. Inst. Biol. 4: 322. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 494. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 55. 1967.— *Polypodium wui* C.Chr., Bull. Dept. Biol. Sun Yatsen Univ. 13: 17. 1933. Figure 54. 3.

Very close to the preceding species, differs only in: fertile laminae not so contracted, acuminate at apex; sori narrower, up to 1 mm broad, more than 1 mm apart from each other.

T h a i l a n d.— PENINSULAR: Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— China (Kwangtung and Kwangsi, type).

E c o l o g y.— On muddy rocks in dense evergreen forests at medium altitudes.

N o t e.— This is close to the preceding species, and there are some variations in the fertile fronds even among the plants not so many in number. We can arrange various degree of the contraction of the fertile fronds in this and the preceding species.

5. Colysis pentaphylla (Bak.) Ching, Bull. Fan Mem. Inst. Biol. 3: 332. 1933; Tagawa, J. Jap. Bot. 38: 328. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 55. 1967.— *Gymnogramma pentaphylla* Bak., Kew Bull. 1898: 233.— *Gymnopteris elliptica* (Thunb.) Bak. sensu Hoss., Beih. Bot. Centr. 28(2): 365. 1911.— *Colysis elliptica* (Thunb.) Ching sensu Holtt., Dansk Bot. Ark. 20: 19. 1961. Figure 54. 4–5.

Rhizome creeping, bearing fronds sparsely, about 5 mm diam., scaly; scales oblong-subtriangular, gradually narrowing from round base towards long-acuminate apex, irregularly minutely toothed at margin, or subentire in young stage, up to 8 by about 2 mm broad, concolorously brown, clathrate. *Stipes* stramineous, brown at base, sparsely scaly on lower portion, up to 40 cm long, terete. *Laminae* imparipinnate, broadly ovate-subdeltoid to circular in outline, 15–35 by 20–35 cm; lateral pinnae up to 5 pairs, nearly equal in size, or the upper one or two slightly reduced, narrowly lanceolate to oblong-lanceolate, broadest at middle portion, caudately acuminate at apex, narrowly cuneate towards base, about 20 by 3 cm broad, the base decurrent to form very narrow wing of rachis; veins more or less obscure, forming two rows of areoles between adjacent main veins; herbaceous. *Sori* linear; continuous along a line between two rows of areoles, sometimes lacking on $\frac{1}{4}$ part near margin.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Khun Huai Pong, Doi Suthep, Doi Inthanon), Phitsanulok (Thung Salaeng Luang, Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai).

D i s t r i b u t i o n.— SW. China (Yunnan, type) and Laos.

E c o l o g y.— On mountain-slopes usually in dense forests at high altitudes, rather rare.

N o t e.— The Phu Luang plants are typical of this species and the others resemble the following in some respects. This species is sometimes confused with the next, but distinguishable from it by a few pinnae (less than 5 pairs) which are usually oblanceolate, narrowing towards base, forming the outline of laminae ovate, the stipes much longer than laminae, and light green leaves, not easily becoming blackish in dried condition.

6. Colysis pothifolia (D.Don) Presl, Epim. Bot.: 148. 1849; Tagawa & K.Iwats., Southeast As. St. 5: 55. 1967.— *Hemionitis pothifolia* D.Don, Prodr. Fl. Nepal.: 13. 1825.— *Colysis elliptica* var. *pothifolia* (D.Don) Ching, Bull. Fan Mem. Inst.

Biol. 4: 334. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 498. 1941.— *Selliguea elliptica* (Thunb.) Bedd. sensu Bedd., Handb.: 392. 1883, p.p.

Rhizome usually thick, about 5 mm diam., sparsely bearing fronds, scaly; scales oblong-subtriangular, gradually narrowing from round base towards long-attenuate apex, irregularly minute toothed at margin, up to 5 by about 1.3 mm, concolorous, dark brown, clathrate. *Stipes* stramineous, about 50 cm long, terete. *Laminae* imparipinnate, broadly oblong, up to 50 by 35 cm; lateral pinnae 6 – 12 pairs, upper 2 or 3 reduced upwards, the others nearly equal in size, or the lowest ones slightly reduced, narrowly lanceolate, gradually narrowing towards acute apex, narrowly cuneate towards base, decurrent to rachis forming very narrow wing, up to 25 by 2.8 cm; veins visible, forming two rows of areoles between the adjacent main veins; herbaceous, dark green in living condition, brownish in dried specimens. *Sori* linear, continuous along the line between two rows of areoles, usually forming 45° to costa.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Inthanon), Lampang, Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang).

D i s t r i b u t i o n.— Himalaya (type) to S. China and Taiwan, extending north to SW. Japan and the Ryukyus, south to Indochina and the Philippines.

E c o l o g y.— On rocky mountain-slopes in dense evergreen forests at high altitudes (1100 – 1600 m), rather rare.

N o t e.— This is often reduced to a variety of *C. elliptica* of Japan and China. In SW. Japan both of them occur and are rather clearly distinguished from each other by the size of rhizome, subdimorphism of fronds in *C. elliptica*, numbers of lateral pinnae many in *C. pothifolia*, colour and the texture of fronds in addition to the difference in general size. Their specific difference is more easily rocognized in the fields than by the herbarium specimens.

11. LEPTOCHILUS

Kaulf., Enum.: 147. pl. 1. f. 10. 1824; Ching, Bull. Fan Mem. Inst. Biol. 4: 336. 1933; Copel., Gen. Fil.: 197. 1947.— *Paraleptochilus* Copel., Gen. Fil.: 198. 1947.

Terrestrial or on tree-trunks; rhizome long-creeping, scaly; scales dark, peltate, more or less clathrate. Fronds biserrate, articulate to rhizome, distinctly dimorphic. Sterile laminae simple to laciniate, herbaceous to subcoriaceous, glabrous, with copiously reticulate venation, usually blackish when dried. Fertile fronds prominently contracted, linear. Sori covering the whole under surface of linear fertile laminae except on midrib and at margin, without peltate paraphyses.

As described above this genus is close to *Colysis*, differing from it only in the distinctly dimorphic fronds. COPELAND (1947) recognized *Paraleptochilus* and *Dendroglossa* as distinct genera, and considered that these three genera are independently derived from *Microsorium* originated in different species:

Leptochilus s.str. from *Phymatodes*, *Paraleptocilus* from *M. zippelii*, and *Dendroglossa* from *Colysis*. We have at present no actual evidence to support his speculation, and here we follow the current opinion to treat *Leptochilus* in broader sense.

Thus circumscribed, *Leptochilus* is composed of a dozen species in tropical Asia, east to Polynesia. In Thailand following two are known.

KEY TO THE SPECIES

1. Lateral main veins indistinct	**1. L. axillaris**
1. Lateral main veins distinct nearly to the edge of fronds	**2. L. decurrens**

1. Leptochilus axillaris (Cav.) Kaulf., Enum. Fil.: 147. t. 1. f. 10. 1824; Ching, Bull. Fan Mem. Inst. Biol. 4: 346. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 499. 1941; Holtt., Rev. Fl. Malaya 2: 164. f. 75. 1955.— *Acrostichum axillare* Cav., Ann. Hist. Nat. 1:101. 1799.—*Gymnopteris variabilis* var. *axillaria* (Cav.) Bedd., Handb.: 430. 1883. Figure 54. 6.

Rhizome long-creeping on tree-trunks, more or less flattened, about 2.5 mm broad, sparsely scaly; scales small, up to 2 by about 0.5 mm, ovate with long tails, dark, clathrate, entire. *Stipes* usually more than 1.5 cm apart from each other, winged nearly to the base, 4–7 cm long but indistinct from the base of laminae. *Sterile laminae* simple, entire, lanceolate, broadest at middle portion, gradually narrowing towards both base and apex, acuminate at apex, attenuate at base, up to 35 by about 5.5 cm, herbaceous, glabrous, green to dark green; veins more or less visible, lateral main veins not distinct, forming copious anastomosis. *Fertile laminae* linear, up to 30 cm by 3 mm. *Sori* covering whole the under surface of linear fertile fronds.

T h a i l a n d.— NORTHERN: Chiang Rai, Chiang Mai (Mae Rim), Phrae (Mae Sai), Tak; SOUTH-WESTERN: Kanchanaburi (Wangka).

D i s t r i b u t i o n.— S. India, Himalayas, Indochina and Malesia (type from Luzon) to Polynesia.

E c o l o g y.— Epiphytic on tree-trunks in evergreen forests at medium altitudes.

2. Leptochilus decurrens Bl., En. Pl. Jav.: 206. 1828; Ching, Bull. Fan Mem. Inst. Biol. 4: 345. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 502. 1941; Holtt., Rev. Fl. Malaya 2: 164. f. 74. 1955; Tagawa, J. Jap. Bot. 38: 328. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 55. 1967.— *Acrostichum variabile* Hook., Sp. Fil. 5: 277. 1864; Hoss., Beih. Bot. Centr. 28(2): 363. 1911.— *Gymnopteris variabilis* (Hook.) Bedd., Ferns Br. Ind.: t. 272. 1868; Handb.: 429. f. 258. 1883. Figure 54. 7.

Rhizome long-creeping, up to 3 mm diam., bearing fronds more than 1 cm apart, scaly throughout; scales narrowly-subtriangular, gradually narrowing from base towards long-attenuate apex, up to 3 by 1 mm, distinctly clathrate, concolorously brown. *Fronds* dimorphic. *Sterile fronds*: stipes up to 15 cm long, more or less winged at least on the upper part, sparsely scaly at lower portion, stramineous; laminae oblong to oblong-lanceolate, broadest near base, round or broadly cuneate at base and decurrent downwards to form wings of stipes, gradually narrowing upwards and then caudately acuminate at apex, up to 30 by about 10 cm, entire or irregularly undulate at margin; midrib raised on both surfaces; main lateral veins distinct, the other veins visible, forming copious areoles with forked or branched included free veinlets; dark green, dark in dried condition. *Fertile fronds*: stipes up to 40 cm long, stramineous, wingless; laminae linear, up to 30 by 0.3 cm broad, wholly covered by sporangia except on the midrib.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Phacho), Chiang Mai (Doi Chiang Dao, Tintok, Doi Suthep, Doi Inthanon), Lamphun (Doi Khun Tan), Mae Hong Son (Doi Loi Bian, Ban Pasui), Phrae (Huai Hom Noi), Lampang (Mae Tha); NORTH-EASTERN: Phetchabun (Phu Miang); SOUTH-EASTERN: Chanthaburi (Khao Ram, Khao Soi Dao Tai); SOUTH-WESTERN: Uthai Thani (Noen Pradu), Kanchanaburi (Kha Thalai); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— S. India, Himalayas to S. China and Taiwan, Indochina, Malesia (type from Java) and Polynesia throughout.

E c o l o g y.— Terrestrial, on moist rocks or on basal tree-trunks usually in dense evergreen forests, rather common at medium to high altitudes throughout Thailand.

12. DRYNARIA

(Bory) J.Sm., J. Bot. 4: 60. 1841; Copel., Gen. Fil.: 203. 1947.

Rhizome creeping, scaly. Leaves in two kinds: nest-leaves (or scaly leaves) sessile, sterile, small, usually placed to cover the rhizome, becoming brown but persistent, usually humus-collecting; foliage-leaves pinnatifid to pinnate, stipes not distinctly jointed to rhizome but all pinnae jointed to rachis, in pinnatifid leaves abscission distinct at base and each side of lobes, veins anastomosing to form drynarioid venation (i.e. each lobe or pinna has very distinctly raised main veins which are connected by cross veins nearly at right angles to main veins forming main areoles; within the main areoles are small areoles, usually with free included veinlets). Sori round or elongate.

This and the following two genera form a natural group of ferns in the Polypodiaceae, though the generic classification of them is a subject of repeated discussions. We follow here to HOLTTUM (1955) and refer the group as a whole to a derivative of *Microsorium*. The soral structure and dimorphism of fronds will show a good example of character evolution independent from each other.

Thus defined, *Drynaria* contains more than 20 species in the tropics of the Old World, from Africa to Oceanea, northwards to China and the Ryukyus and southwards to Australia. In Thailand following seven species are collected and distinguished from each other as in the following key.

KEY TO THE SPECIES

1. Foliage-leaves lobed, pinnatifid or pinnatisect
 2. Sori many between adjacent main veins
  3. Sori dispersed in a few irregular rows between adjacent main veins
   4. Nest-leaves lobed to a half-way towards midribs; lobes of foliage-leaves not narrowing towards base **1. D. sparsisora**
   4. Nest-leaves nearly circular and subentire; lobes of foliage-leaves more or less narrowing towards base **2. D. bonii**
  3. Sori in one or two regular rows between adjacent main veins
   5. Sori placed on the whole lower surface of foliage-leaves, in two distinct rows close to main veins; lobes of nest-leaves rounded to moderately acute at apex **3. D. quercifolia**
   5. Sori often confined to the upper middle portion of the foliage-leaves, usually one in each main areoles, thus forming a single row between the adjacent main veins; lobes of nest-leaves acuminate at apex **4. D. fortunei**
 2. Sori one between adjacent main veins, thus in one row at each side of costa
  6. Nest-leaves present; lateral lobes of foliage-leaves 8 – 12 (– 16) pairs **5. D. propinqua**
  6. Nest-leaves wanting; lateral lobes of foliage-leaves 5 – 9 (– 11) pairs **6. D. parishii**
1. Foliage-leaves pinnate **7. D. rigidula**

1. Drynaria sparsisora (Desv.) Moore, Ind. Fil.: 348. 1862; C.Chr., Bot. Tidsskr. 32: 349. 1916; Holtt., Rev. Fl. Malaya 2: 183. f. 89. 1955; Dansk Bot. Ark. 23: 231. 1965; Tagawa & K.Iwats., Southeast As. St. 3(3): 78. 1965; 5: 58. 1967.— *Polypodium sparsisorum* Desv., Berl. Mag. 5: 315. 1811.— *Polypodium linnei* Bory, Ann. Sci. Nat. 5: 464. t. 12. 1825.— *Drynaria linnei* (Bory) Bedd., Ferns Brit. India: t. 315. 1869; Handb.: 343. 1883; Christ, Bot. Tidsskr. 24: 106. 1901.

Rhizome creeping, about 1.5 cm diam., densely covered with scales; scales oblong-ovate, acute at apex, round at base, peltate, toothed to fimbriate at margin, up to 3 by about 2 mm, bi-coloured with black brown central portion and brown margin, not so stiff. *Nest leaves* sessile, oval to ovate-oblong, 17 – 23 by 16 – 22 cm, lobed to a half-way between midrib and margin; lobes round at apex, entire, oblong-subdeltoid, up to 6 by 4 cm. *Foliage leaves*: stipes 12 – 18 cm long, narrowly winged almost to the base; laminae pinnatifid, oblong, acute at apex, 40 – 50 by 25 – 35 cm; lobes oblique, adnate to the neighbourings with laminae of less than 1 cm in breadth, oblong-lanceolate, caudately acuminate at apex, entire, up to 20 by 5 cm; veins raised on both surfaces, copiously anastomosing, 6 – 8 rows of areoles between the main veins, no included free veinlets; coriaceous; pale green, glabrous. *Sori* round or punctiform, on veins, irregularly placed on the lower surface of lobes.

T h a i l a n d.— EASTERN: Chaiyaphum (Chulaphorn Dam); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chanthaburi (Nong Bon), Trat (Ko Rang Yai, Ko Chang, Huai Raeng); PENINSULAR: Ranong (Ko Kut), Phangnga (Khao Phota

Luang Kaeo), Phuket (Ko Pu), Trang (Khao Chong), Satun, Narathiwat (Sungai Padi).

Distribution.— Malesia and Polynesia to tropical Australia.

Ecology.— On tree-trunks in dense evergreen forests or in light shade at low to medium altitudes.

Vernacular.— Kut hok (กูดฮอก) (Northern); phang-nga (พังงา) (Malay/Peninsular); wan ngu kwak (ว่านงูกวัก), wao (ว่าว) (Peninsular).

2. Drynaria bonii Christ, Not. Syst. 1: 186. 1910; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 517. f. 61. 1–2. 1941; Holtt., Dansk Bot. Ark. 20: 20. 1961; 23: 231. 1965; Tagawa, J.Jap. Bot. 38: 329. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 58. 1967. Plate II:3.

Rhizome creeping, tightly fixed on substrate, sometimes very flat, 2.5 cm wide, 5 mm thick, densely scaly; scales oval with long tails, peltate, round at base, up to 2.5 mm long with tails of about 2 mm in length, 1.5 mm broad, sharply toothed to fimbriate at margin, bi-coloured with black brown small central portion and brown margin. *Nest-leaves* many, imbricate, covering rhizome almost entirely, oval in outline, deeply cordate at base, subentire, 5–10 by 4.5–7 cm. *Foliage-leaves*: stipes stramineous, 10–25 cm long, narrowly winged almost to the base, scaly at base; laminae pinnatifid nearly to rachis, decurrent laminae less than 5 mm in breadth, 30–55 by 20–40 cm; lobes more or less ascending, oblanceolate or oblong-lanceolate, moderately acute to caudately acuminate, 10–22 by up to 3.8 cm, subentire, more or less narrowed towards base; veins distinct on both surfaces, finely anastomosing with 4–6 rows of areoles between main veins; chartaceous, light green, glabrous. *Sori* round or punctiform, in 2–4 irregular rows between main veins.

Thailand.— NORTHERN: Chiang Rai (Doi Tham Yup), Chiang Mai (Doi Suthep, Doi Saket, Mae Klang), Mae Hong Son, Lampang (Ngao, Mae Tha), Phrae (Mae Ban), Tak (Lan Sang, Ban Na), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng), Nong Khai; EASTERN: Chaiyaphum (Tat Ton), Nakhon Ratchasima (Pak Thong Chai); SOUTH-EASTERN: Prachin Buri (Bang Ban Hills, Khao Yai), Chon Buri (Si Racha, Khao Khieo); CENTRAL: Saraburi (Muak Lek), Sing Buri, Uthai Thani (Ban Rai); SOUTH-WESTERN: Prachuap Khiri Khan (Huai Yang), Kanchanaburi (Khao Nam Tok).

Distribution.— China (Kweichow) and Indochina (type).

Ecology.— On dry or muddy rocks and tree-trunks in light shade or in dense deciduous forests at low to medium altitudes, less than 1000 m, fairly common.

Note.— This is a species usually found in the deciduous forests at elevation lower than 1000 m alt. At the beginning of rainy season, the plants extend their nest-leaves, first green and soon turning brown, and then foliage-leaves with soriferous portion. In dry season, the foliage-leaves are all fallen off, remaining thick rhizome with brown nest-leaves over that. This is a handsome fern on rocks and tree-trunks usually along streams, especially in pale green colour in rainy season.

This may be a species allied to the preceding ones, from which specialized in the deciduous forests where the rainy and dry seasons are sharply distinguished. *D. involuta* of Malesia and *D. descansa* of the Philippines seem to be the other members of this genus closely related to this species.

3. Drynaria quercifolia (Linn.) J. Sm., J. Bot. 3: 398. 1841; Bedd., Handb.: 341. f. 191. 1883; E. Sm., J. Siam Soc. Nat. Hist. Suppl. 8: 6. 1929; C.Chr., Contr. U.S. Nat. Herb. 26: 335. 1931; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 518. 1941; Holtt., Rev. Fl. Malaya 2: 182. f. 88. 1955; Dansk Bot. Ark. 23: 231. 1965; Tagawa & K.Iwats., Southeast As. St. 3(3): 77. 1965; 5: 59. 1967.— *Polypodium quercifolium* Linn., Sp. Pl. 2: 1087. 1753. Plate III:4.

Rhizome creeping, about 1.5 cm diam., densely scaly; scales dark brown, gradually narrowing from base to tailed apex, up to 1.8 cm long, 1.3 mm broad, the margin paler and densely toothed. *Nest-leaves* sessile, ovate, up to 32 by about 20 cm, shallowly lobed; lobes close, 5 by 3 cm, rounded to moderately acute at apex, entire. *Foliage-leaves*: stipes about 25 cm long, stramineous, very narrowly winged throughout, densely scaly at base with those like rhizome-scales; laminae oblong to narrower, up to 80 by about 50 cm, deeply pinnatifid, continuous to the next ones by rather broad wings more than 1 cm in breadth; lobes ascending, gradually narrowing from base to acute or acuminate apex, entire and more or less crisped at margin; veins distinct on both surfaces, finely anastomosing with more than 10 rows of areoles between main veins; coriaceous, shining pale green, glabrous. *Sori* round or oblong, two rows between adjacent main veins.

T h a i l a n d.— NORTHERN: Chiang Rai, Chiang Mai (Doi Saket), Phitsanulok (Thung Salaeng Luang), Tak; NORTH-EASTERN: Nong Khai; SOUTH-EASTERN: Chanthaburi (Khao Sabap, Makham), Chon Buri (Si Racha, Ko Sichang), Trat (Ban Saphan Hin); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Wangka, Thung Kang Yang), Prachuap Khiri Khan (Huai Yang, Bang Saphan); PENINSULAR: Phangnga (Takua Thung), Krabi, Surat Thani (Ko Tao, Ban Don), Nakhon Si Thammarat (Khao Luang), Phuket (Ban Ma Phrao), Phatthalung (Ko Si Ko Ha), Trang, Satun, Yala (Bannang Sata).

D i s t r i b u t i o n.— Sri Lanka, India to S. China and Indochina, Malesia throughout to Fiji and tropical Australia.

E c o l o g y.— On rather dry rocks on hillsides in light shade or at edge of forests, fairly common at low altitudes.

V e r n a c u l a r.— Kratae tai mai (กระแตไต่ไม้) (Central); kut kha hok (กูดขาฮอก), chao-wa-na (เช้าวะนะ), phu-dong-khae (พุดองแคะ) (Karen/Northern); dao-ka-lo (เดากาโละ) (Malay/Peninsular); bai hu chang (ใบหูช้าง), sabai nang (สะใบนาง), hua wao (หัวว่าว) (South-western); sa-mong (สะโมง) (Suai/Surin).

4. Drynaria fortunei (Kunze ex Mett.) J. Sm. in Seem., Bot. Voy. Herald: 425.

1857; Bedd., Handb. Suppl.: 92. 1892; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 518. 1941; Tagawa, J. Jap. Bot. 38: 329. 1963.— *Polypodium fortunei* Kunze ex Mett., Abh. Senck. Naturf. Ges. 2: 121. t. 3. f. 42–45. 1857. Figure 55. 1.

Rhizome creeping, up to 1.2 cm diam., densely scaly throughout; scales narrow, gradually narrowing from peltate base towards attenuately tailed apex, up to 8 by about 1.4 mm, dark brown with paler margin, distinctly toothed at margin. *Nest-leaves* sessile, adnate, oval, up to 10 by 6.5 cm, lobed to a half-way between midrib and margin; lobes oblong-subdeltoid, acuminate at apex, entire, up to 1.5 cm broad. *Foliage-leaves*: stipes short, up to 10 cm long, narrowly winged throughout; laminae narrowly oblong, slightly narrowing from base to apex, up to 40 by 25 cm; lobed nearly to rachis, remaining narrow wings of rachis less than 5 mm in breadth, narrowly oblong from base towards moderately acute apex, entire but irregularly waved, up to 11 by 2.5 cm, the basal lobes the longest or reduced; costa and main veins minutely pubescent, main veins and cross veins distinct on both surfaces, the other veins less so, anastomosing with free included veinlets; chartaceous, glabrous. *Sori* dispersed from the upper central portion downwards, two rows of round sori or a single row of crescent sori between adjacent main veins.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Suthep).

D i s t r i b u t i o n.— S. China (type), Indochina and Taiwan.

E c o l o g y.— On the trunks of trees.

N o t e.— The smaller plants of this species take an appearance similar to *D. bonii,* but differs from the latter in: sori in one or two regular rows between main veins and the nest-leaves lobed to a half-way towards rachis, the lobes narrowly triangular with acuminate apex.

5. Drynaria propinqua (Wall. ex Mett.) J. Sm. ex Bedd., Ferns Brit. India: t. 160. 1866; Handb.: 339, f. 189. 1883; C.Chr., Contr. U.S. Nat. Herb. 26: 334. 1931; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 521. 1941; Holtt., Dansk Bot. Ark. 20: 20. 1961; Tagawa, J. Jap. Bot. 38: 329. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 59. 1967.— *Polypodium propinquum* Wall. ex Mett., Abh. Senck. Naturf. Ges. 2: 120. t. 3. f. 50. 1857.

Rhizome long-creeping, up to 1 cm diam., very densely scaly throughout; scales persistent, narrowing from round peltate base to long-tailed apex, about 8 by 1.5 mm, pale brown with dark center, the margin bearing long white downy hairs. *Nest-leaves* sessile, ovate, about 20 cm in both length and width, deeply lobed more than half a way to midribs; lobes narrowly subtriangular, acute at apex, entire, up to 7 by 2.5 cm, small scales with downy hairs more or less dense on main axes. *Foliage-leaves*: stipes stramineous, up to 15 cm long, narrowly winged at least on the upper part; laminae oblong to oblong-lanceolate, up to 40 by 25 cm, deeply lobed almost to rachis, remaining wings of rachis less than 2 mm in breadth; lobes 8–12 (–16) pairs, lanceolate, acute to acuminate at apex, slightly narrowing towards base,

more or less ascending, up to 15 by 2.5 cm, entire; veins distinct on both surfaces, anastomosing, 2–4 rows of anastomosis between main veins, with included free veinlets; papyraceous, light green. *Sori* round, one in each areole next posterior of costal one, one row along each side of costa, one between adjacent main veins, a little raised on upper surface.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Hua Mot, Doi Suthep, Bo Luang).

D i s t r i b u t i o n.— Himalayas (type), S. China, Burma, Laos, N. Vietnam and Java.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests at 1200–1700 m alt., locally abundant.

6. Drynaria parishii (Bedd.) Bedd., Ferns S.India Suppl.: 24. 1876; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 520. 1941; Tagawa, J. Jap. Bot. 38: 329. 1963; Tagawa & K.Iwats., Acta Phytotax. Geobot. 24: 175. 1970.— *Pleopeltis parishii* Bedd., Ferns Brit. India t. 125. 1866. Figure 55. 2–3.

Rhizome long-creeping, up to 1 cm diam., densely scaly throughout; scales persistent, narrowing from peltate base to attenuate apex, pale brown with still paler margin and dark central point, about 6 by 1.5 mm, marginate with long downy white hairs. *Nest-leaves* wanting. *Foliage-leaves*: stipes stramineous, 5–10 cm long on scaly phyllopodes, scaly at base with those like rhizome-scales, very narrowly winged almost to the base; laminae oblong, up to 25 by 20 cm, deeply lobed almost to rachis remaining very narrow wings of rachis less than 2 mm in breadth; lobes 5–9 (–11) pairs, oblanceolate, broadest usually at $\frac{1}{3}$ part from apex, slightly narrowing to base, moderately acute to acuminate at apex, subentire and more or less crisped at margin, up to 11 by about 2 cm, patent or slightly ascending; veins raised on lower surface, anastomosing, 3–5 rows of areoles between adjacent main veins, with included free veinlets; chartaceous, green to paler. *Sori* round, in one row on each side of costa, rather close to costa, one between main veins, raised on upper surface.

T h a i l a n d.— NORTHERN: Chiang Mai (Huai Tong, Doi Chiang Dao, Doi Suthep, Tin Tok, Bo Luang), Lamphun (Doi Khun Tan), Tak (Rahaeng, Khao Pha Wo, Doi Musoe); SOUTH-WESTERN: Kanchanaburi (Si Sawat, Khao Ri Yai).

D i s t r i b u t i o n.— Burma (Moulmein, type) and Vietnam.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests usually on ridges at 600–1300 m alt.

N o t e.— On the herbarium sheet of H.M. Smith's collection in US, CHRISTENSEN (1941) suggested that those might be *D. delavayi*, from which Thai plants are different in rhizome-scales, venation, number and form of lateral lobes. In Thailand, there is no evidence of *D. delavayi* which is common in SW. China.

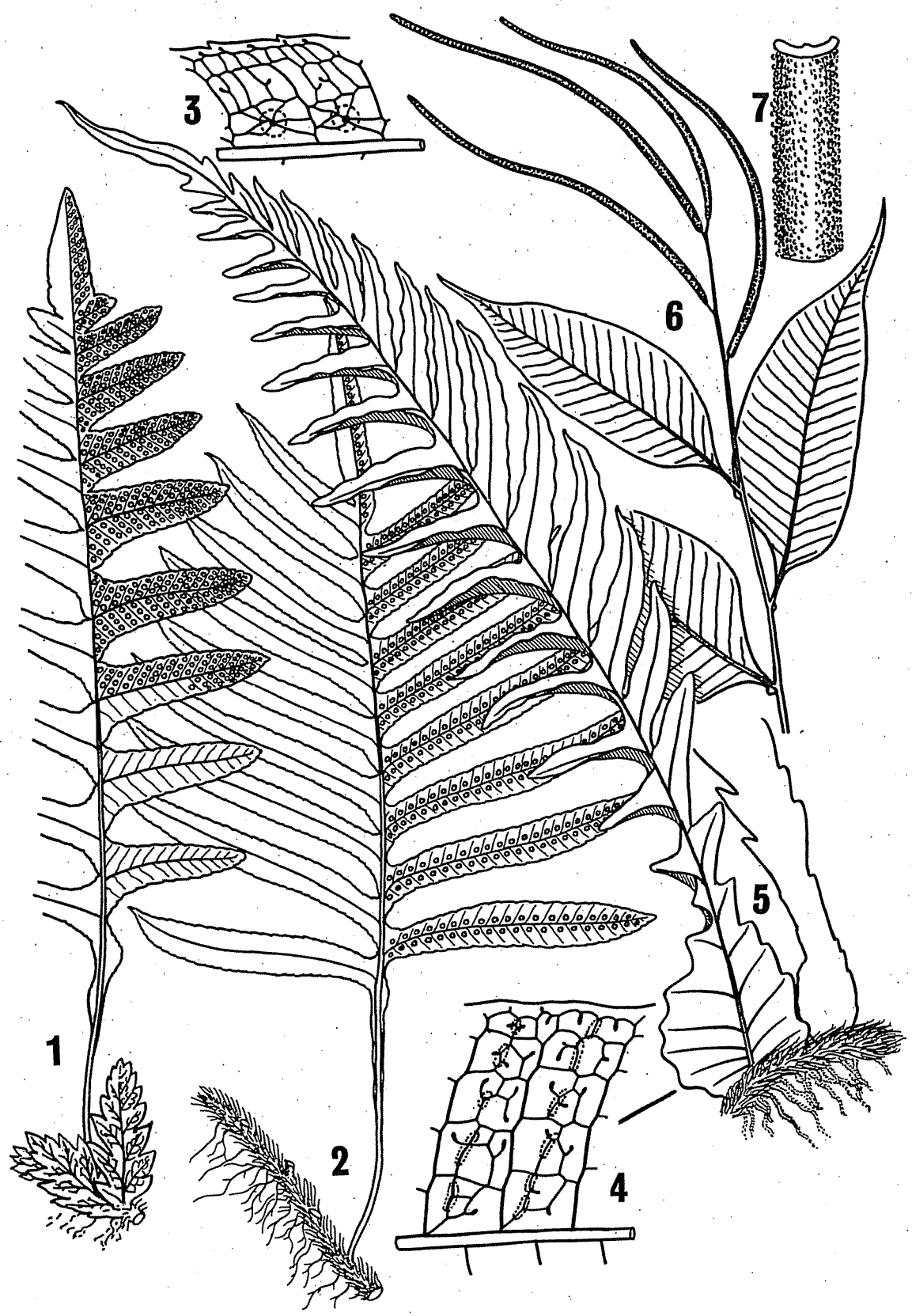

Figure 55. 1. *Drynaria fortunei*; plant (x 0.5). 2–3: *D. parishii*; 2. plant (x 0.5); 3. venation of pinna, enlarged. 4–5: *Aglaomorpha coronans*; 4. venation of pinna (x 2.5); 5. plant (x 0.2). 6–7: *Photinopteris acuminata*; 6. upper portion of fertile frond (x 0.5). 7. part of fertile segment enlarged.

7. Drynaria rigidula (Sw.) Bedd., Ferns Brit. India: t. 314. 1869; Handb.: 344. f. 192. 1883; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 521. 1941; Holtt., Rev. Fl. Malaya 2: 183. f. 90. 1955; Dansk Bot. Ark. 20: 20. 1961; 23: 231. 1965; Tagawa, J. Jap. Bot. 38: 330. 1963; Tagawa & K. Iwats., Southeast As. St. 5: 59. 1967.— *Polypodium rigidulum* Sw., Schrad. J. Bot. 1800(2): 26. 1801. Plate IV:5.

Rhizome creeping, about 6 mm diam., densely scaly throughout; scales gradually narrowing from peltate rounded base to apex, pale brown with dark basal point, up to 10 by 1.2 mm, sparsely hairy at margin with pale long downy hairs. *Nest-leaves* sessile, narrowly oblong-subdeltoid, round at base, acute at apex, up to 35 by about 10 cm, lobed to $\frac{1}{3}$ way towards midribs; lobes subtriangular, round at apex, entire, up to 3 by 2 cm. *Foliage-leaves*: stipes pale castaneous to purple, more or less densely downy hairy, up to 20 cm long, but usually very short, often bearing undeveloped pinnae at both sides of stipes; laminae pinnate, oblong-lanceolate, up to 100 by 30 cm; rachis pale purple, downy-hairy; lateral pinnae about 40 pairs, linear-lanceolate, up to 15 by 1.4 cm, sessile, subentire or serrate at margin, caudately acuminate at apex, unequally cuneate at base; costa pale stramineous, jointed to rachis; veins raised on both surfaces, anastomosing, 2 to 5 areoles between main veins. *Sori* round, close to costa, one row along each side of costa, one between main veins, raised on upper surface.

T h a i l a n d.— NORTHERN: Chiang Rai (Mae Kok), Chiang Mai (Mae Ho, Kong Kat, Ping Khong, Doi Suthep, Sop Aep, Doi Inthanon, Bo Luang), Phitsanulok (Thung Salaeng Luang), Tak; NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Sabap); SOUTH-WESTERN: Kanchanaburi (Wangka, Thung Kang Yang); PENINSULAR: Krabi (Ao Luek), Surat Thani (Ban Don), Yala (Betong).

D i s t r i b u t i o n.— Indochina, Malesia, Polynesia and tropical Australia, also in Burma [(Tavoy, KEENAN et al. 767 & 919 (E)].

E c o l o g y.— On tree-trunks or in muddy crevices of cliffs in some open places or in deciduous or mixed forests at medium altitudes, rather common throughout the country.

V e r n a c u l a r.— Kra prok lek (กระปรอกเล็ก), kra prok hua hin (กระปรอกหัวหิน), kut thang (กูดถัง), kut fuei (กูดเฟือย), kut mai (กูดไม้), kut om (กูดอ้อม), kut hang ma (กูดหางม้า) (Northern).

N o t e.— This species is different from the other species of *Drynaria* by pinnate fronds, impressed sori and having the paraphyses in sori. Sect. *Poronema* is prepared to accommodate this distinct species and shows its isolated position appropriately.

13. AGLAOMORPHA

Schott, Gen. Fil.: ad pl. 20. 1834; Copel., Gen. Fil.: 201. 1947.

Like *Drynaria*, but fronds in one form, partially dimorphic; upper part like foliage leaves, pinnatifid, lower part like nest-leaves, very broad at base. Sori small, round or variously spreading and united.

About a dozen species are known in tropical Asia, most abundantly in Malesia. According to the classification by COPELAND (1947), this genus is divided into four genera principally by the difference in soral structure. Only one species is known in Thailand.

Aglaomorpha coronans (Wall. ex Mett.) Copel., Univ. Calif. Publ. Bot. 16: 117. 1929; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 488. f. 57, 3–4. 1941; Holtt., Dansk Bot. Ark. 20: 21. 1961; Tagawa, J. Jap. Bot. 38: 328. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 57. 1967.— *Polypodium coronans* Wall. ex Mett., Abh. Senck. Naturf. Ges. 2: 121. t. 3. f. 40–41. 1857; Hoss., Beih. Bot. Centr. 28(2): 366. 1911.— *Drynaria coronans* (Wall. ex Mett.) J.Sm., J. Bot. 4: 61. 1841; Bedd., Handb.: 338. 1883.— *Pseudodrynaria coronans* (Wall. ex Mett.) Ching, Sunyatsenia 5: 262. 1940; Holtt., Dansk Bot. Ark. 23: 231. 1965.— *Polypodium conjugatum* Bak., Syn. Fil.: 366. 1868.— *Drynaria conjugata* (Bak.) Bedd., Ferns Brit. India correct. 1870.— *Aglaomorpha heraclea* (Kunze) Copel. sensu Holtt., Dansk Bot. Ark. 20: 21. 1961. Figure 55. 4–5.

A large epiphyte. *Rhizome* creeping, thick, usually more than 1.5 cm diam., densely scaly throughout; scales brown, linear, 10–15 by more than 0.5 mm, sharply toothed at margin. *Fronds* sessile, usually more than 1 m long, about 60 cm wide, lobed almost to rachis; lobes continuing with wings less than 1 cm broad; the base of fronds broadly rounded to cordate, up to 15 cm broad, subentire or shallowly lobed, brown, like the nest-leaves of *Drynaria*; lobes of the upper part of fronds ascending, usually more than a dozen pairs, linear-subtriangular, attenuately acuminate at apex, entire at margin, up to 40 by about 5 cm, every lobe falling at the abscission along rachis; veins raised on both surfaces, venation drynarioid, or with complicately reticulate, main areoles quadrangular, smaller areoles with free included veinlets; coriaceous, green, glabrous. *Sori* one, or very rarely two, row(s) between main veins, more or less elongate, or sometimes uniting longitudinally, but rarely continuous beyond cross veins.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Hua Mot, Doi Suthep, Huai Tong, Doi Inthanon), Lampang (Mae Tia), Phrae (Mae Sai), Tak (Huai Krasa, Doi Musoe), Phitsanulok (Thung Salaeng Luang); EASTERN: Chaiyaphum (Thung Kamang, Nam Phrom); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng), Prachin Buri (Khao Yai); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Song Tho); PENINSULAR: Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang), Trang (Khao Chong), Phangnga (Khao Phota Luang Kaeo).

D i s t r i b u t i o n.— Himalayas to S. China, Indochina, Taiwan and northwards to the Ryukyus; Khao Chong is the southernmost record of this species.

E c o l o g y.— On rather dry or mossy rocks or on tree-trunks in open places or in dense forests, not so rare at medium altitudes throughout Thailand.

V e r n a c u l a r.— Bai kut om (ใบกูดอ้อม) (Northern).

14. PHOTINOPTERIS

J. Sm., J. Bot. 3: 403. 1841; 4: 155. 1841; Copel., Gen. Fil.: 203. 1947.

Like *Drynaria* but differs from it in: fronds stipitate, pinnate; pinnae short stalked, jointed to rachis; upper fertile pinnae very narrow, elongate, entirely covered beneath with sporangia.

This is a monotypic genus apparently of a group of *Drynaria*, though lacking so-called nest-leaves. In the soral structure, this is similar to *Merinthosorus*, but this may be resulted from the parallel evolution of this particular character.

Photinopteris acuminata (Willd.) Mort., Contr. U.S. Nat. Herb. 38: 31. 1967.— *Acrostichum acuminatum* Willd., Sp. Pl. 5: 116. 1810.— *Lomaria speciosa* Bl., En. Pl. Jav.: 202. 1828.— *Photinopteris speciosa* (Bl.) Presl, Epim. Bot.: 264. 1849; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 502. f. 59, 3 – 4. 1941; Holtt., Rev. Fl. Malaya 2: 187. f. 93. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 58. 1967.— *Acrostichum rigidum* Wall. ex Hook. in Hook. & Bak., Syn. Fil.: 424. 1868.— *Photinopteris rigida* (Wall. ex Hook.) Bedd., Ferns Br. Ind.: t. 211. 1867; Handb.: 442. f. 269. 1883. Figure 55. 6 – 7.

Rhizome long-creeping, 7 – 10 mm diam., black or often glaucous or white on surface, densely scaly in young part; scales linear, gradually narrowing from base to apex, about 8 by 1 mm, brown with dark base, toothed at margin. *Stipes* very short, up to 5 cm long, though a basal few pairs of pinnae lacking or extremely reduced, thus becoming to 20 cm long below usual pinnae, stramineous or faintly purple. *Laminae* pinnate, up to 80 by about 30 cm; partially dimorphic; sterile pinnae in lower portion of fronds, 7 – 10 pairs, 5 – 8 cm apart from the next ones, distinctly stalked, articulated to rachis, oblong to oblong-ovate, acuminate at apex, equally cuneate at base, entire, up to 15 by 8 cm, the lower two or three pairs reduced, the upper ones gradually becoming smaller; veins more or less raised on both surfaces, venation drynarioid; coriaceous, green, paler below, glabrous; fertile pinnae in upper part of fronds, a few to several pairs, linear, up to 15 by less than 0.5 cm, stalked or nearly sessile. *Sporangia* covering the whole under surface of the fertile pinnae except on costa and on narrow marginal strands.

T h a i l a n d.— SOUTH-EASTERN: Prachin Buri (Khao Yai), Trat (Khao Kuap); PENINSULAR: Surat Thani (Ban Don), Nakhon Si Thammarat (Khao Luang), Satun.

D i s t r i b u t i o n.— Indochina and W. Malesia (Malaya, Sumatra to the Philippines, type).

E c o l o g y.— On muddy trunks of fallen trees or on living tree-trunks in dense evergreen forests, rather rare at low to medium altitudes in the Peninsula.

15. CHRISTIOPTERIS

Copel., Park. Fragm.: 1888. 1905; Gen. Fil.: 178. 1947.

Rhizome long-creeping, dictyostelic, scaly; rhizome-scales peltate, abruptly contracted into setaceous tails which look like bristles, or broadly lanceolate in one species. Stipes remote, articulate to rhizome. Fronds trilobate to pinnatifid, the margin entire, dimorphic. Sterile fronds coriaceous, glabrous; venation reticulate with branched included veinlets. Fertile fronds much contracted, acrostichoid. Sporangia covering the whole under surface, mixed with short simple paraphyses.

There are three species known in the Old World, and one of them is native to Thailand.

Christiopteris tricuspis (Hook.) Christ, J. Bot. France 21: 273. 1908; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 450. f. 52, 2. 1941; Holtt., Rev. Fl. Malaya 2: 211. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 24: 60. 1969.— *Acrostichum tricuspe* Hook., Sp. Fil. 5: 272. t. 304. 1864.— *Gymnopteris tricuspis* (Hook.) Bedd., Ferns Br. Ind.: t. 53. 1866; Handb.: 434. f. 263. 1883. Figure 56. 1–2.

Rhizome long-creeping, 2–4 mm diam., densely covered with scales; scales red-brown, peltate, up to 0.7 mm broad at basal portion and gradually or sometimes abruptly narrowing upwards as long tails like bristles, up to 10 mm long, sometimes clathrate to some extent with thick intermediate cell-walls or not, very sparsely short hairy at margin. *Stipes* pale to stramineous, glabrous except for the scaly base, about 30 cm long in those of sterile fronds, longer in fertile ones. *Sterile fronds* deeply tri-lobed (5-lobed in Malayan and Vietnamese plants), up to 30 cm both in length and width, round or slightly cordate at base, main lobes oblong with caudate apex, larger than the lateral ones, up to 30 by 7 cm; lateral lobes oblong to oblong-lanceolate, curved upwards; the edges of fronds thickened, entire or crisped; coriaceous, green on both surfaces but paler underneath; venation drynarioid, copiously reticulate with simple or branched included veinlets, not easily visible. *Fertile fronds* taller, lobes linear, up to 1.5 cm broad, longer than the sterile lobes, lower surface covered entirely with sporangia mixed with short, simple paraphyses.

T h a i l a n d.— CENTRAL: Nakhon Nayok (Khao Yai).

D i s t r i b u t i o n.— Sikkim (type), Vietnam and Malaya (Pahang).

E c o l o g y.— Epiphytic in evergreen forests along streams.

N o t e.— HOLTTUM (1955) observed the peltate scales on the under surface of young sterile fronds.

16. CRYPSINUS

Presl, Epim. Bot.: 123. 1849; Copel., Gen. Fil.: 205. 1947.

Epiphytic plants; rhizome long-creeping, scaly; scales gradually narrowing from peltate base to hairy apex, not or hardly clathrate. Stipes jointed to rhizome. Laminae simple, lobed or rarely pinnate, coriaceous or leatherly, glabrous, edges of lobes cartilagineous, more or less thickened; veins copiously anastomosing, areoles irregular, with included free veinlets. Sori round, one between adjacent main veins, in a single row at each side of costa, or scattered on the under surface of fronds, sometimes sunk in deep cavities; paraphyses only in some species, simple.

The structure and affinity of this genus were discussed by COPELAND (1947) who considered this as one of the most ancient groups of the Polypodiaceae with relation to *Microsorium* in the most ancestral forms.

Among ten species known in Thailand, five are the so-called Malesian elements found in Thailand only in the Peninsula. On the contrary, the other four belong to the Himalayan elements and unknown from the Peninsula. Another species is known in China (Kwangtung), N. Vietnam and N. Thailand. Generally, the species of *Crypsinus* are rather restricted in their distributional areas.

About forty species are known in warmer part of Asia, from N. India to New Guinea, northwards to Japan.

KEY TO THE SPECIES

1. Fronds simple, entire, lanceolate
 2. Fronds not dimorphic, more than 2.5 cm in breadth; main lateral veins raised
  3. Fronds narrowly oblong. Sori round, large, one between adjacent main veins **1. C. griffithianus**
  3. Fronds oblong-lanceolate. Sori many, in two rows between adjacent main veins **4. C. enervis**
 2. Fronds moderately dimorphic, up to 2 cm in breadth; main lateral veins not or indistinctly raised
  4. Sori at upper narrower portion of fertile fronds, not sunk in sharply defined cavities **2. C. rhynchophyllus**
  4. Sori not restricted to narrower apical portion, sunk in sharply defined cavities **3. C. stenophyllus**
1. Fronds deeply lobed
 5. Fronds distinctly dimorphic **5. C. trilobus**
 5. Fronds not dimorphic
  6. Fronds hairy throughout **8. C. hirsutus**
  6. Fronds glabrous
   7. Fronds tri-foliate, up to 10 cm long **6. C. cruciformis**
   7. Fronds with two or more pairs of lobes, usually more than 12 cm long
    8. Wings of rachis usually more than 5 mm in breadth; lobes entire at margin **7. C. oxylobus**
    8. Wings of rachis very narrow, usually less than 5 mm in breadth; lobes slightly toothed at margin
     9. Rhizome-scales black with dark brown edge, shining. Sori hardly raised on upper surface **9. C. ebenipes**
     9. Rhizome-scales dark chestnut-brown. Sori raised on upper surface **10. C. laciniatus**

1. Crypsinus griffithianus (Hook.) Copel., Gen. Fil.: 206. 1947; Tagawa, J. Jap. Bot. 38: 330. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 59. 1967.— *Polypodium griffithianum* Hook., Ic. Pl.: t. 951. 1854.— *Pleopeltis griffithiana* (Hook.) Moore, Ind.: lxxviii. 1857; Bedd., Handb.: 354. f. 199. 1883.— *Phymatodes griffithiana*

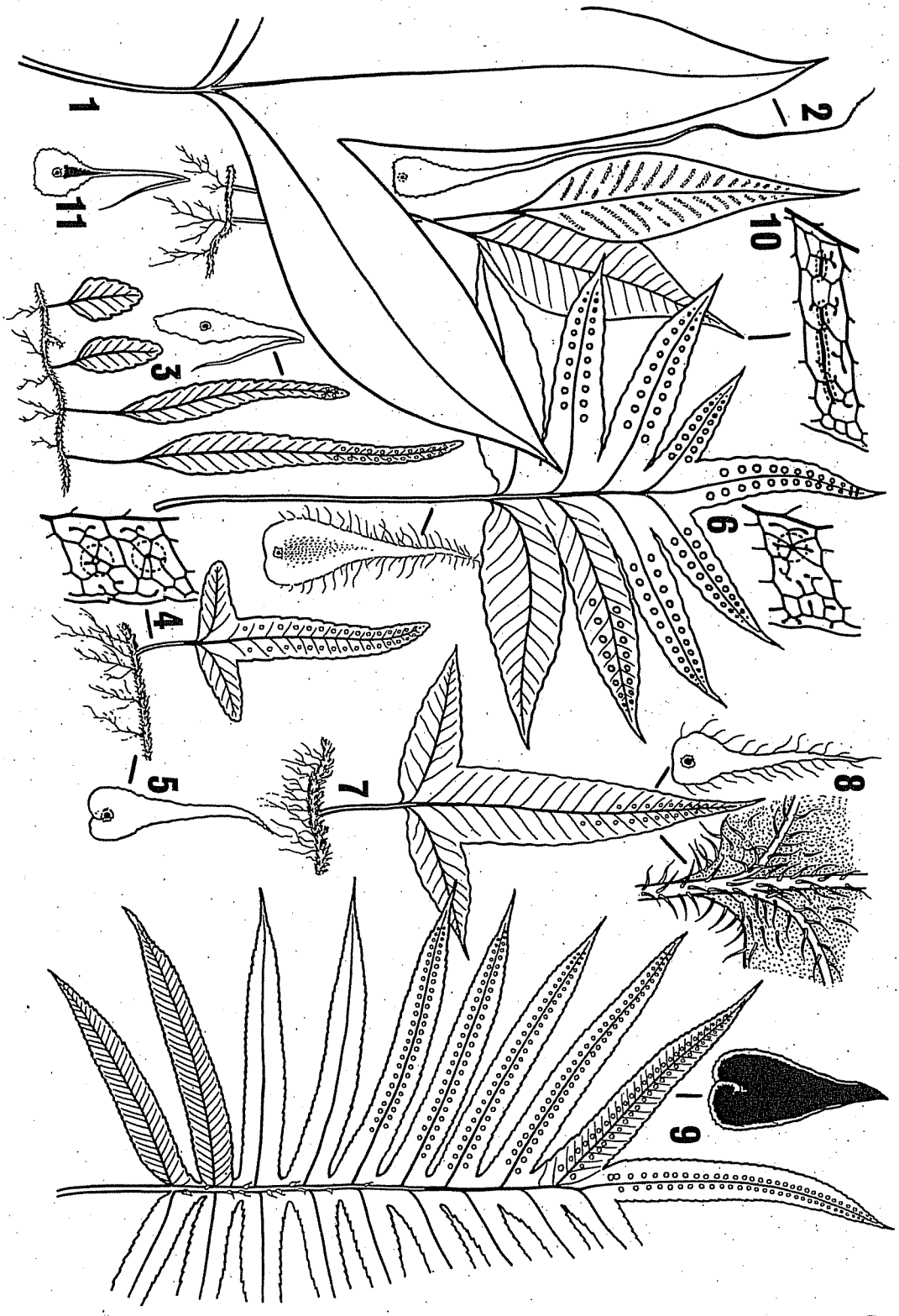

Figure 56. 1–2: *Christiopteris tricuspis*; 1. sterile leaf (x 0.5); 2. scale on rhizome enlarged. 3. *Crypsinus rhynchophyllus*; (x 0.5) and scale on rhizome enlarged (left). 4–5: *C. cruciformis*; 4. plant (x 0.5) and venation (left, x 2); 5. scale on rhizome, enlarged. 6. *C. oxylobus*; fertile leaf (x 0.3), venation (x 2) and scale on rhizome, enlarged (below). 7–8: *C. hirsutus*; 7. plant (x 0.5); 8. basal part of frond (right) and scale on rhizome enlarged. 9. *C. ebenipes*; fertile leaf (x 0.3) and scale on rhizome, enlarged. 10–11: *Selliguea heterocarpa*; 10. plant (x 0.3) and venation enlarged (x 2). 11. scale on rhizome enlarged.

(Hook.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 71. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 472. 1941.

Rhizome long-creeping, about 2 mm diam., densely covered with scales throughout; scales linear, moderately acute at base, gradually narrowing from the broadest peltate portion to long-tailed apex, about 6 by 1.2 mm, brown or paler, membraneous, entire. *Stipes* (2–)5–12 cm long, stramineous, scaly at base with those like on rhizome, very sparsely scaly upwards with linear hair-like scales. *Laminae* simple, narrowly oblong with gradually narrowing apical portion, cuneate to rounded at base, rather suddenly narrowing at caudately acuminate apex, (9–)15–25 by (2–)3.5–5.5 cm, entire or irregularly waved at margin; midrib distinctly raised beneath, like the upper part of stipes; main lateral veins forming angles of 55–75° to midrib, straight or forming zigzag curve, becoming obscure near the margin; the other veins hardly visible, forming irregular anastomosis with included free veinlets; papyraceous or stiff, green, glabrous. *Sori* one between adjacent main veins, thus in a single row, close to midrib, round, rather large, up to 4 mm diam.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Inthanon).

D i s t r i b u t i o n.— India (type), Upper Burma, SW. China and Vietnam.

E c o l o g y.— On mossy tree-trunks or on mossy limestone cliffs in dense evergreen forests, restricted to the highest parts of the higher mountains in Northern, not so common.

2. Crypsinus rhynchophyllus (Hook.) Copel., Gen. Fil.: 206. 1947; Holtt., Dansk Bot. Ark. 20: 21. 1961; Tagawa, J. Jap. Bot. 38: 330. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 59. 1967.— *Polypodium rhynchophyllum* Hook., Ic. Pl.: t. 954. 1854; C.Chr., Contr. U.S. Nat. Herb. 26: 334. 1931.— *Pleopeltis rhynchophylla* (Hook.) Moore, Ind.: lxxviii. 1857; Bedd., Handb.: 353. f. 198. 1883.— *Phymatodes rhynchophylla* (Hook.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 69. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 471. 1941. Figure 56. 3.

Rhizome long-creeping, about 1.2 mm diam., densely scaly throughout; scales ovate with long tails up to 5 by 1.2 mm, membraneous, entire at margin, light brown. *Fronds* in two forms: *Smaller sterile fronds* on short stipes of 5–20 mm in length, oval or ovate-oblong, round to moderately acute at both the base and apex, 2–3.5 by about 1.5 cm. *Larger soriferous fronds*: stipes 1.5–5 cm long, scaly at base, glabrescent upwards; laminae lanceolate, cuneate at base, broadest at $\frac{1}{5}$ – $\frac{1}{4}$ way from the base, narrowing at the soriferous portion of upper $\frac{1}{4}$ – $\frac{1}{2}$ part, acute to round at apex, 5–14 by 1.2–2 cm, the soriferous portion less than 1 cm in breadth; main lateral veins obscure at 1.5 cm inside the margin, other veinlets hardly visible, anastomosing to form irregular areoles with included free veinlets; coriaceous, green, paler beneath, glabrous. *Sori* one between adjacent main veins, a single row at each side of midrib, half-way or a little closer to midrib, round, up to 2.5 mm diam.

Thailand.— NORTHERN: Chiang Mai (Doi Suthep, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Khao Ri Yai).

Distribution.— N. India (type), Burma, SW. China, and Indochina; also in the Philippines, though Copeland considered the Philippines plants are distinct as *C. whitfordii.*

Ecology.— Not so rare in mossy forests; on mossy tree-trunks, or rarely on mossy rocks in dense evergreen forests at high altitudes (1200 – 1700 m).

Note.— This is another simple-fronded species, though the relationship between this and the preceding species seems to be not so close. This species seems to belong to the group of *C. hastatus* and close to *C. engleri* in China and Japan.

3. Crypsinus stenophyllus (Bl.) Holtt., Rev. Fl. Malaya 2: 199. f. 101. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 53. 1968.— *Polypodium stenophyllum* Bl., En. Pl. Jav.: 124. 1828.— *Pleopeltis stenophylla* (Bl.) Moore, Ind.: lxvii. 1857; Bedd., Handb.: 348. 1883.

Rhizome long-creeping, about 2 mm diam., sometimes a little glaucous but usually dark brown, densely scaly in younger portion; scales peltate, acute at basal edge, gradually narrowing towards attenuate apex, brown to dark brown in central portion, paler in the distal and marginal portions, those paler portions fallen off in the older scales, up to 7 by 1.2 mm. *Stipes* up to 7 cm long, stramineous or darker, indistinct from the decurrent base of fronds. *Laminae* simple, narrowly lanceolate, moderately acute to acute at apex, gradually narrowing and decurrent towards attenuate base, 6 – 15 by up to 1.2 cm, the sterile fronds sometimes shorter and broader, entire but cartilaginous and more or less involute at margin; midrib raised beneath, lateral main veins distinct on under surface, ascending, other veins obscure, anastomosing; chartaceous, glabrous. *Sori* one between main lateral veins, in a single row at medial position, round, about 2 mm diam., immersed in cavities which prominently extruded on upper surface of fronds.

Thailand.— PENINSULAR: Yala (Klong Chana, Gunong Ina, Khao Khalakhiri).

Distribution.— W. Malesia (Sumatra to the Philippines and Java, type), also recorded from Fiji.

Ecology.— Epiphytic in evergreen forests at 900 – 1200 m alt. in the southernmost part of Thailand.

4. Crypsinus enervis (Cav.) Copel., Gen. Fil.: 207. 1947; Holtt., Rev. Fl. Malaya 2: 199. f. 100. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 176. 1970.— *Polypodium enerve* Cav., Descr.: 245. 1802.

Rhizome long-creeping, 1.5 – 2 mm diam., densely scaly throughout; scales oblong with long tails, up to 5 by about 1 mm, round at base, gradually narrowing towards hairy tails, irregularly hairy at edges, brown, the central portion dark. *Stipes* stramineous, 5 – 8 cm long, scaly at base, glabrous above. *Laminae* oblong-lanceolate, round at base, broadest at basal $\frac{1}{6}$ portion and gradually narrowing towards attenuately acuminate apex, 10 – 22 by up to 4 cm; midrib and lateral main veins raised, straight; other veins invisible, copiously anastomosing with free included veinlets in areoles; coriaceous, glabrous, the edges entire, thickened and a little involved. *Sori* round, small, many, in two rather irregular rows between adjacent main veins, superficial.

T h a i l a n d.— PENINSULAR: Trang (Khao Soi Dao).

D i s t r i b u t i o n.— Malesia.

E c o l o g y.— Only once collected in Thailand on trees in evergreen forests at 800 m alt.

N o t e.— The description is drawn from the above specimens, but this is rather smaller in size. The size and form of fronds are variable to some extent, and the typical form is larger in Malesia.

5. Crypsinus trilobus (Houtt.) Copel., Gen. Fil.: 206. 1947; Holtt., Rev. Fl. Malaya 2: 197. f. 97. 1955; Tagawa & K.Iwats., Southeast As. St. 5:60. 1967; Acta Phytotax. Geobot. 23: 53. 1968.— *Polypodium trilobum* Houtt., Hist. Nat.: 14. 1783.— *Polypodium incurvatum* Bl., En. Pl. Jav.: 126. 1828.— *Pleopeltis incurvata* (Bl.) Moore, Gard. Chron. 1860: 1105; Bedd., Handb.: 364. f. 206. 1883.— *Polypodium triphyllum* Jacq., Coll. 2: 284. t. 22. f. 1. 1788.— *Phymatodes triphylla* (Jacq.) C.Chr. & Tard., Not. Syst. 2: 284. t. 22. 1941; in Fl. Gén. I.-C. 7(2): 470. f. 55, 4 – 5. 1941.

Rhizome long-creeping, 3 – 6 mm diam., not so densely scaly throughout; scales ovate, more or less imbricate, acuminate but not tailed at apex, rounded at base, 3 – 6 by 1.5 mm, pale brown, membraneous, subentire or uneven at margin. *Fronds* distinctly dimorphic. *Sterile fronds*: stipes 7 – 17 cm long, stramineous or dark purple, scaly on phyllopodes up to 4 mm in height, glabrescent upwards; laminae usually tri-lobed, rarely simple, 5-lobed or 7-lobed; simple laminae subdeltoid, round at base, gradually narrowing towards moderately acute apex, up to 10 by 7 cm; lobed laminae 10 – 20 by 13 – 25 cm, apical lobes like simple laminae, lateral lobes oblong to oblong-lanceolate, ascending, more or less falcate, caudately acuminate at apex, slightly narrowing at base in large ones, up to 12 by about 4.5 cm; rachis and costae distinctly raised beneath, main veins distinct on both surfaces, other veins hardly visible, anastomosing, areoles with included free veinlets; coriaceous, light green. *Fertile fronds* taller: stipes 25 – 35 cm long; laminae tri-lobed to pinnatisect (or pinnate) with up to 4 pairs of lateral lobes (or pinnae); rachis narrowly winged by the wings less than 5 mm in breadth, or wingless in lower parts; lobes (or pinnae) linear, acuminate at apex, entire, 7 – 14 by up to 0.8 cm, the basal ones the largest, smaller upwards. *Sori* in a single row at each side of costa, embedded in

deep rounded or oblong cavities up to 5 mm diam. and 2 mm in depth, prominently raised on upper surface.

T h a i l a n d.— PENINSULAR: Nakhon Si Thammarat (Khao Luang), Yala (Khao Khalakhiri).

D i s t r i b u t i o n.— Indochina, Malaya, Sumatra, Java, Borneo, and Philippines.

E c o l o g y.— On mossy trunks of fallen trees in clearing on ridges at medium or high altitudes.

V e r n a c u l a r.— Wan nok aen (ว่านนกแอ่น) (Peninsular).

6. Crypsinus cruciformis (Ching) Tagawa, Acta Phytotax. Geobot. 14: 193. 1952; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 48. 1968.— *Polypodium cruciforme* Ching, Sinensia 1: 47. 1930.— *Phymatodes cruciformis* (Ching) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 77. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 475. 1941.— *Polypodium hastatum* Thunb. sensu C.Chr., Contr. U.S. Nat. Herb. 26: 334. 1931. Figure 56. 4–5.

Rhizome long-creeping, about 1.5 mm diam., densely scaly throughout; scales light grey to pale brown, oblong with paler long tails, up to 4 by 1 mm, entire. *Stipes* 1–3 cm long, stramineous, densely scaly at low phyllopodes with those like rhizome-scales. *Laminae* tri-lobed or very rarely simple or 5-lobed, 4–10 by 3.5–8 cm; the terminal lobes large, gradually narrowing from base to moderately acute apex, up to 8 by 2 cm; lateral lobes patent or slightly ascending, oblong or subdeltoid, rounded at apex, up to 5 by 1.7 cm, entire at margin; midrib raised on both surfaces; main veins, or often main branches of them also, dark on upper surface, raised on both surfaces, not straight, the other veins hardly visible, anastomosing; papyraceous, light green, paler beneath, glabrous. *Sori* one between adjacent main veins, in a single row at half-way between midrib and margin of lobes, in round or elliptic shallow cavities up to 2 mm diam., raised on upper surface.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Nang Ka), Chiang Mai (Doi Suthep, Doi Hua Mot).

D i s t r i b u t i o n.— China (Kwangtung, type) and N. Vietnam.

E c o l o g y.— On mossy tree-trunks in evergreen forests on ridges at high altitudes, rather rare.

N o t e.— This is distinct from *C. hastatus* in nearly patent lateral lobes with round apex, subentire rhizome-scales, and in sori in hollowed cavities. *C. hastatus* of Japan and the adjacent regions is rather closely related to the following species, though appropriately compared and distinguished by CHING (1933).

7. Crypsinus oxylobus (Wall. ex Kunze) Sledge, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 145. 1960; Tagawa & K.Iwats., Southeast As. St. 5: 60. 1967.— *Polypodium oxylobum* Wall. ex Kunze, Linnaea 24: 255.1851; C.Chr., Contr. U.S. Nat. Herb.

26: 334. 1931.— *Phymatodes oxyloba* (Wall. ex Kunze) Presl ex Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 67. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 474. 1941.— *Pleopeltis hastata* (Thunb.) Bedd., Handb.: 362. f. 205. 1883; Suppl.: 96. 1892, excl. basion.— *Pleopeltis trifida* (D.Don) Bedd., Handb. Suppl.: 96. 1892.— *Crypsinus taeniatus* var. *palmatus* (Bl.) C.Chr. sensu Holtt., Dansk Bot. Ark. 23: 231. 1965. Figure 56. 6.

Rhizome long-creeping, about 3 mm diam., densely scaly throughout; scales gradually narrowing from round peltate base to long-tailed apex, about 5 by 1.3 mm, brown in broader basal portion, paler in narrow tails, toothed at margin. *Stipes* stramineous or brown, jointed to rhizome at low scaly phyllopodes, glabrous upwards, (5–)7–15(–20) cm long. *Laminae* lobed, with (1–)3–8 pairs of lateral lobes and a ternimal one, up to 30 by 25 cm; rachis brown beneath, paler on upper surface, winged with lobes 5–17 mm in breadth; lateral lobes usually longest at base, becoming smaller upwards, ascending, sometimes bending downwards, linear to oblong-subdeltoid, acute to acuminate at apex, up to 15 by 1.5–2.5(–4.5) cm, entire, terminal lobes longer; midrib raised on both surfaces, main veins distinct, ascending, more or less zigzag, the other veins obscure, reticulate, forming irregular areoles with included veinlets; papyraceous, deep green to paler, paler on lower surface, glabrous. *Sori* one between adjacent main veins, in a single row along both side of midrib, subcostular or medial, round, 3–4 mm diam., hardly raised on upper surface.

T h a i l a n d.— NORTHERN: Chiang Rai (Phu Langka, Doi Tung), Chiang Mai (Pong Pho, Doi Chiang Dao, Doi Suthep, Huai Kaeo, Doi Pha Hom Pok, Doi Hua Mot, Doi Inthanon), Lamphun (Doi Khun Tan), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng), Prachin Buri (Khao Yai); SOUTH-WESTERN: Ratchaburi (Khao Luang).

D i s t r i b u t i o n.— N. India (type), Upper Burma, SW. China (Yunnan & Szechuwan) and Indochina.

E c o l o g y.— Epiphytic commonly on mossy tree-trunks or on wet rocks in dense evergreen forests at 1000–2300 m alt.

V e r n a c u l a r.— Kut hom (กูดฮ่อม) (Northern).

N o t e.— In the mossy forests in Northern, this is a fairly common epiphyte on tree-trunks. The abundant collections of this species show a wide range of variation in frond form, especially in dissection and the form of lobes. A specimen from Doi Pha Hom Pok represents a variation in having densely toothed dark brown rhizome-scales, patent lower lateral lobes which are very broad, up to 4.5 cm in breadth, acuminate apex of lobes and usually very closely placed lobes with round sinus. In such diagnostic features as lobed fronds and entire margin of lobes, our collections are constant even in such variants, and the extreme forms are also occupied by numerous intermediate forms.

8. Crypsinus hirsutus Tagawa & K.Iwats., Acta Phytotax. Geobot. 24: 176. 1970. Figure 56. 7–8.

Rhizome creeping, 3–4 mm diam., more or less glaucous, densely scaly throughout; scales subulate, about 4 by 0.8 mm, dark brown, paler at edges, ciliate at margin; phyllopodes about 5 mm in height. *Stipes* stramineous, up to 12 cm long, densely hairy throughout. *Laminae* hastate or rarely with two lateral lobes on one side, up to 24 by 21 cm; lateral lobes ascending, slightly falcate, narrowly elliptic, gradually narrowing towards long-acuminate apex, up to 12 by 2–3 cm broad; apical lobes gradually narrowing towards long-acuminate apex, more or less constricted at base, up to 20 by 3.2 cm; midrib flat above, raised below, densely hairy; main veins raised on both surfaces, ascending 5–12 mm apart from the next ones; veins visible or hardly so, forming copious anastomosis in larger areoles and included smaller areoles with included free veinlets, apex of free veinlets often thickened and distinct; papyraceous, rather densely hirsute on both surfaces, subentire or undulate at margin, not toothed, narrowly margined with cartilaginous membrane; hairs small, coarse, unicellular or with a few cells in construction. *Sori* round, large, up to 3 mm diam., one between main veins, closer to midrib than to edges.

T h a i l a n d.— NORTHERN: Chiang Rai, Chiang Mai (Doi Chiang Dao, type), Phitsanulok (Phu Miang).

D i s t r i b u t i o n.— Endemic.

E c o l o g y.— Gregarious on rocks or rocky soil in exposed or comparatively dry places as well as in shaded or moist situations at 1000–1800 m alt.

9. Crypsinus ebenipes (Hook.) Copel., Gen. Fil.: 206. 1947; Tagawa & K.Iwats., Southeast As. St. 5: 60. 1967.— *Polypodium ebenipes* Hook., Sp. Fil. 5: 88. 1863.— *Pleopeltis ebenipes* (Hook.) Bedd., Handb.: 363. 1883.— *Phymatodes ebenipes* (Hook.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 86. 1933. Figure 56. 9.

Rhizome long-creeping, 3–5 mm diam., very densely scaly throughout; scales stiff, subdeltoid with round base, or narrower, 4–7 by about 2 mm, nearly black on central portion of abaxial surface, deep brown in other part, shining, with irregularly toothed thinner margin. *Stipes* jointed to rachis on distinct scaly phyllopodes, stramineous or brown, 7–14 cm long, sparsely scaly with those like rhizome-scales but smaller and more or less thinner. *Laminae* deeply pinnatifid, oblong, ovate, up to 17 cm both in length and breadth; rachis and costae distinctly raised on both surfaces, rarely scaly; lateral lobes 4–7 pairs, deeply lobed with wings of rachis 2–6 mm in breadth, basal 1–2 pairs deflexed, the others ascending, up to 9 by 1.5 cm, the margins parallel and gradually narrowing near the apex towards acuminate apex, shallowly serrate at margin; main veins distinct, 3–4 mm from each other, the other veins hardly visible, reticulate forming irregular anastomosis with included free veinlets; papyraceous. *Sori* one between adjacent main veins, in a single row at each side of costa, close to costae, round, up to 3 mm diam., hardly raised on upper surface.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Inthanon).

Distribution.— NE. India (type) and SW. China.

Ecology.— On mossy tree-trunks in dense mountain forests at ridge at about 2500 m alt.

Note.— This is a distinct large species common in Himalayas to SW. China but elsewhere only known on the highest part of Doi Inthanon, not recorded from Upper Burma nor from Tonkin.

10. Crypsinus laciniatus (Presl) Holtt., Rev. Fl. Malaya 2: 198. f. 98. 1955; Dansk Bot. Ark. 20: 21. 1961; Tagawa & K.Iwats., Southeast As. St. 5: 60. 1967.— *Phymatodes laciniata* Presl, Tent. Pterid.: 197. 1836, based on *Polypodium laciniatum* Bl., En. Pl. Jav.: 131. 1828, non Gmel. 1791.— *Pleopeltis laciniata* (Presl) Bedd., Handb. Suppl.: 97. 1897.

Rhizome long-creeping, about 5 mm diam., densely covered with scales throughout; scales gradually narrowing from rounded base to long-tailed apex, 5–7 by 1.2 mm, irregularly toothed at margin, brown, thin. *Stipes* jointed to rhizome on scaly phyllopodes, pale castaneous, a little polished, glabrous, 15–28 cm long. *Laminae* oval or oblong, up to 30 by 25 cm, deeply pinnatifid, the wings of rachis about 3 mm in breadth in the narrowest portion; lateral lobes 4–7 pairs, the basal pair deflexed, the other ascending, straight, lanceolate, more or less narrowing towards base, caudately acuminate at apex, shallowly serrate at margin, up to 13 by 1.5–2.5 cm; main veins distinct, 5–7 mm from each other, other veins obscure, reticulate, forming irregular anastomosis with included free veinlets; papyraceous to chartaceous, green. *Sori* one between adjacent main veins, in a single row at each side of costa, not so close to costa, round, up to 3 mm diam., raised on upper surface.

Thailand.— PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution.— W. Malesia (type from Java).

Ecology.— On mossy trunks of fallen trees in clearing at ridge at about 1500 m alt.

17. SELLIGUEA

Bory, Dict. Class. d'Hist. Nat. 6: 587. 1824; 17: pl. 41. 1839; Copel., Gen. Fil.: 209. 1947.

Rhizome long-creeping, rather thick, scaly throughout; scales usually hair-pointed, peltate, thin but firm, not clathrate, hardly bi-coloured. Fronds simple and entire, distinctly stipitate with stipes jointed to rhizome, coriaceous, rigid, brown or reddish when dried, glabrous; lateral main veins distinct, the other veins hardly visible, anastomosing to form copious networks with included free veinlets in areoles. Sori more or less sunk, usually linear, or interrupted, in a single row between adjacent main veins.

This has long been united with *Colysis* solely by the similar soral construction, though these two are decidedly different from each other in rhizome-scales and texture of fronds. The features distinguishing *Colysis* from *Selliguea* are just the same as those *Microsorium* from *Crypsinus*, and this fact suggests the parallel evolution of the former genera from the latter. In fact, *Colysis* is identical with *Microsorium* except for the soral features, and *Selliguea* with *Crypsinus* except for the same character. From some of the simple-fronded species of *Crypsinus*, *Selliguea* is sometimes difficult to be distinguished in the sterile condition.

Thus confined, the genus *Selliguea* contains some eight species in Malesia, extending north to Peninsular Thailand, Indochina, and S. China (Kwangtung), east to Polynesia. One of them is known in Thailand.

Selliguea heterocarpa Bl., Fl. Jav. Fil.: 125. t. 52. f. 1. 1828; Holtt., Rev. Fl. Malaya 2: 157. f. 69. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 53. 1968.— *Selliguea metteniana* var. *lateritium* (Bak.) Tard. & C.Chr., Not. Syst. 8: 197. 1937; in Fl. Gén. I.-C. 7(2): 490. f. 57, 1–2. 1941.— *Selliguea feei* Bory sensu Bedd., Handb.: 389. f. 225. 1883. Figure 56. 10–11.

Rhizome long-creeping, about 2 mm diam., densely scaly throughout; scales oblong-subtriangular with very long tail, dark brown, not clathrate, about 8 by 1 mm, fimbriate at basal margin, toothed at basal lateral margin, the tails filamentous. *Stipes* up to 12 cm long, fertile fronds usually taller, stramineous, scaly at base. *Laminae* simple, oblong to oblong-lanceolate, entire, gradually narrowing towards acuminate apex, rounded to cuneate at base, broadest at about basal $\frac{1}{4}$ way, up to 18 by 3.5 cm in fertile and up to 10 by 3.3 cm in sterile ones; leatherly, light green, more or less reddish in dried specimens; midrib and lateral main veins distinct, the other veins hardly visible, anastomosing with included free veinlets. *Sori* linear, in one row between adjacent lateral main veins, continuous or more or less interrupted, immersed to some extent and raised on upper surface.

T h a i l a n d.— PENINSULAR: Phangnga (Takua Pa, Khao Katha Khwam, Khao Phra Mi), Surat Thani (Ko Phangan), Nakhon Si Thammarat (Thung Song), Satun (Boriphat Falls), Yala (Khao Khalakhiri, Betong).

D i s t r i b u t i o n.— Indochina, Malaya, Sumatra, Java (type), Borneo, and the Philippines.

E c o l o g y.— On rocks or on tree-trunks usually by streams in not so dense evergreen forests at low altitudes.

N o t e.— The size and form of fronds are variable to some extent. Indochinese plants are all having narrower fronds and distinguished as a different variety, but our Thai materials accord well with W. Malesian plants.

18. ARTHROMERIS

(Moore) J.Sm., Hist. Fil.: 110. 1875; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 87. 1933; Copel., Gen. Fil.: 209. 1947.

Rhizome creeping, densely scaly; scales narrow, concolorous or obscurely bi-coloured, not clathrate. Stipes jointed to rhizome usually on short scaly phyllopodes. Fronds imparipinnate; lateral pinnae articulate to rachis, usually oblong-lanceolate, subentire or undulate at margin, marginated by more or less broad cartilaginous membrane; main lateral veins distinct, other veins obscure, forming copious anastomosis of the drynarioid venation; herbaceous to coriaceous, glabrous or hairy. Sori round in one regular row at each side of costa or scattered on the lower surface of fronds, naked, superficial, without paraphyses.

In the region from N. India to Taiwan and Luzon, eight species are recognized and four among them are collected in Thailand.

KEY TO THE SPECIES

1. Sori larger, solitary between adjacent main veins, thus arranging in one medial row at each side of costa
 2. Lateral pinnae cuneate to cordate at base, papyraceous to subcoriaceous, green to blue green on under surface **1. A. tatsienensis**
 2. Lateral pinnae cordate and amplexicaulous at base, herbaceous, glaucous on under surface **2. A. amplexifolia**

1. Sori smaller, two to three rows between adjacent main veins
 3. Rhizome-scales larger, 12 – 17 mm long **3. A. phuluangensis**
 3. Rhizome-scales smaller, less than 7 mm long **4. A. lehmanni**

1. Arthromeris tatsienensis (Franch. et Bureau ex Christ) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 93. 1933; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 111. f. 6. 1968.— *Polypodium tatsienense* Franch. et Bureau ex Christ, Bull. Soc. Bot. France 52. Mém. 1: 19. 1905.

Rhizome long-creeping, 4 – 7 mm diam., densely scaly throughout; scales narrowly subulate with long tails, up to 6 by 1.2 mm, irregularly toothed at margin, brown, indistinctly clathrate. *Stipes* 20 – 30 cm long, castaneous, densely scaly at base, glabrous upwards. *Laminae* imparipinnate, oblong, 20 – 33 by up to 23 cm; rachis castaneous, glabrous; lateral pinnae subopposite, 2 – 7 pairs, ascending, straight, sessile, oblong-lanceolate, caudately acute at apex, broadly cuneate to round or rarely subcordate at base, 8 – 15 by 1.5 – 3 cm, the edges subentire or undulate, margined with narrow cartilaginous membranes; terminal pinna larger, up to 16 by 3 cm, usually narrowing from base to apex; main veins 4 – 6 mm remote, veins anastomosing copiously with many included veinlets; subcoriaceous, green, glabrous. *Sori* at junction of reticulate veins, large, round or elliptic, 3 – 5 mm diam., in a single row at each side of costa, medial or a little closer to costa, superficial.

T h a i l a n d.— NORTHERN: Chiang Mai (Om Koi, Pha Mon), Lamphun (Doi Khun Tan).

D i s t r i b u t i o n.— SW. China (Szechuwan, type and Yunnan).

E c o l o g y.— Terrestrial on rather dry slopes along path in mixed forests at about 600 – 1400 m alt.

N o t e.— The identity of *A. tatsienensis* is still doubtful, for the specimens identified to this are usually considered as not fully grown. Our Thai materials were gathered on mountain-slopes, and the specimens of *A. wallichiana*, a close relative of our species, have been collected either on moist banks or on tree-trunks or on rocks.

2. Arthromeris amplexifolia (Christ) Ching, Contr. Inst. Biol. Nat. Acad. Peiping 2: 94. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 487. f. 56, 2–3. 1941; Tagawa, J. Jap. Bot. 38: 330. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 60. 1967.— *Polypodium amplexifolium* Christ, J. Bot. II. 1: 269. 1908. Figure 57. 1–2.

Rhizome long-creeping, about 5 mm diam., densely covered with scales throughout; scales narrowly subtriangular, gradually narrowing from peltate base to acuminate apex, up to 8 by 1.5 mm, white with pale brown base, minutely toothed at margin. *Stipes* stramineous to castaneous, densely scaly at base, glabrous upwards, 10–20 cm long. *Laminae* oblong in outline, 20–40 by up to 33 cm, imparipinnate; rachis pale castaneous, glabrous; lateral pinnae 2–7 pairs, subopposite, caudately acuminate at apex, deeply cordate and amplexicaulous at base, 8–18 by 1.5–3.5 cm, the edges subentire, margined with cartilaginous membrane; terminal pinna rounded to cordate at base, gradually narrowing upwards, up to 19 by 3.5 cm; main veins 5–8 mm remote, veins copiously anastomosing with many included veinlets; herbaceous, glabrous, light green, glaucous beneath. *Sori* at junction of several veinlets, round, 2–3 mm diam., medial, superficial.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Mae Ho, Doi Suthep); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— Vietnam (Tonkin, type), Laos.

E c o l o g y.— On mossy tree-trunks or muddy crevices of moist cliffs in dense evergreen forests at 800–1800 m alt.

3. Arthromeris phuluangensis Tagawa & K.Iwats., Acta Phytotax. Geobot. 22: 100. f. 4. 1967; Southeast As. St. 5: 61. 1967.

Rhizome long-creeping, about 6 mm diam., densely covered with scales; scales subulate, up to 17 mm long including the long tapering filiform portion 7 to 10 mm in length, about 2 mm broad entire but sparsely ciliolate towards the apex, whitish with brownish center. *Stipes* up to 25 cm long, glabrous, stramineous or pale brown. *Laminae* ovate-oblong in outline, up to 60 by 30 cm; rachis like the upper part of stipes; lateral pinnae 7–12 pairs, subopposite, the basal two or three pairs the largest, patent and straight or slightly undulate on the margin, margined with cartilaginous membrane, deeply cordate at sessile base, long-acuminate and caudately prolonged at apex, up to 25 by 3 cm, the upper ones smaller, usually up to 15 by 1.5 cm; terminal pinna like the middle lateral ones, sometimes slightly auricled at base, up to 18 by 2 cm; costae distinct on both surfaces, lateral main veins more than 45 pairs in larger pinnae, visible on both surfaces; thinly

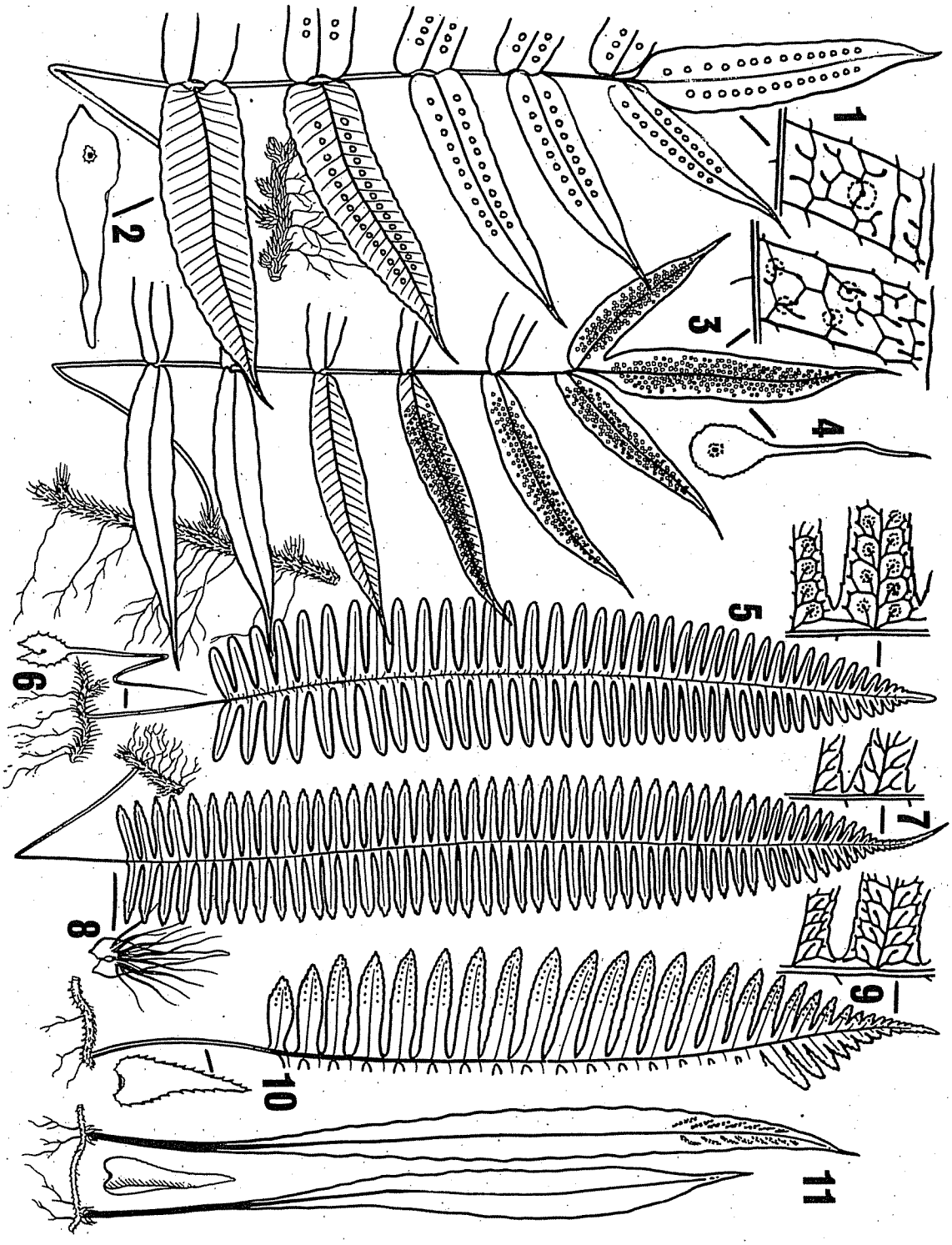

Figure 57. 1–2: *Arthromeris amplexifolia*; 1. plant (x 0.4) and venation (x 2.5); 2. scale on rhizome, enlarged. 3–4: *A. lehmanni*; 3. plant (x 0.4) and venation (above, x 2.5); 4. scale on rhizome. 5–6: *Polypodium garrettii*; 5. plant (x 0.4) and venation (above, x 1.5); 6. scale on rhizome, enlarged. 7–8: *P. manmeiense*; 7. plant (x 0.4) and venation (left, x 1.5). 8. scale on rhizome enlarged. 9–10: *P. microrhizoma*; 9. plant (x 0.4) and venation (left, natural size). 10. scale on rhizome, enlarged. 11. *Loxogramme duclouxii*; plant (x 0.4) and scale on rhizome, enlarged.

papyraceous. *Sori* in two rows between adjacent main veins, round, in several rows on each side of costae, up to 1 mm diam., superficial.

T h a i l a n d.— NORTHERN: Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang, type)

D i s t r i b u t i o n.— Endemic.

E c o l o g y.— On mossy tree-trunks or on mossy rocks in dense evergreen forests at ridge at 1500 – 1600 m alt.

N o t e.— This is a species close to the next one but differs distinctly in rhizome-scales. The plants are larger, with thicker rhizome and more lateral pinnae than *A. lehmanni*.

4. Arthromeris lehmanni (Mett.) Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 96. 1933; Tagawa & K.Iwats., Southeast As. St. 5: 60. 1967.— *Polypodium lehmanni* Mett., Abhandl. Senckenb. Naturf. Ges. 2: 117. t. 3. f. 35. 1857; C.Chr., Contr. U.S. Nat. Herb. 26: 334. 1931.— *Pleopeltis lehmanni* (Mett.) Bedd., Ferns Br. Ind.: t. 260. 1868; Handb.: 370. f. 211. 1883. Figure 57. 3 – 4.

Rhizome long-creeping, about 5 mm diam., dirty brown, densely scaly throughout; scales ovate-oblong with long tails, round at peltate base, up to 7 mm long including tails about 5 mm in length, 1.5 mm broad, nearly concolorously brown or more or less paler towards margin, minutely toothed at apical portion. *Stipes* stramineous or pale castaneous, 10 – 20 cm long, glabrous. *Laminae* oblong, up to 45 by 40 cm, imparipinnate; rachis like the upper part of stipes; lateral pinnae 3 – 9 pairs, patent or slightly ascending, straight, sessile, lanceolate, caudately acuminate at apex, cuneate to round at acroscopic and round to subtruncate at basiscopic bases, up to 20 by 3 cm, subentire to waved and more or less crisped at margin, marginate by cartilaginous membrane; terminal pinna larger, about 20 cm long, like the lateral ones; main veins 3 – 5 mm remote, veins anastomosing copiously, more or less visible; herbaceous, green, glabrous. *Sori* at junction of reticulate veins, two rows between adjacent main veins, 3 or 4 rows at each side of costa, round, up to 2 mm diam., superficial.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Nang Ka), Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon).

D i s t r i b u t i o n.— Himalayas (type from Bhutan) to Upper Burma, SW. China, Taiwan, and south to the Philippines (Luzon).

E c o l o g y.— On mossy tree-trunks or on mossy rocks in dense evergreen forests at high altitudes (1500 – 2400 m).

N o t e.— This is the species most widely distributed among this genus, but is confined to the highest part of Northern Thailand and is unknown from Indochina. Sori are round but sometimes become elliptic and united with the adjacent ones. All the Thai collections are uniform in having glabrous fronds and there is no specimen referable to *A. lungtauensis* which is recorded from Indochina.

19. POLYPODIUM

Linn., Sp. Pl. 2: 1082. 1753; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 31. 1933; Copel., Gen. Fil.: 180. 1947.— *Goniophlebium* (Bl.) Presl, Tent. Pterid.: 185. 1836; Copel., Gen. Fil.: 181. 1947.

Rhizome long-creeping, densely scaly; scales peltate, clathrate. Stipes articulate to rhizome at phyllopodes. Fronds deeply pinnatifid to pinnate, when pinnate pinnae jointed to rachis; lobes or pinnae shallowly toothed; veins free and once forked, or anastomosing to form regular areoles 1 to 4 rows at each side of costa, each areole including a single free veinlet running outwards towards margin. Sori on acroscopic branch of forked veins or terminal on the included free veins, usually in one row along costa, round; paraphyses known only to some species.

Formally all the species with naked round sori were included in this genus, but the natural relationships among them have been elucidated by the authors; and *Polypodium*, typified by *P. vulgare*, is now restricted to less than 100 species well in accordance with the diagnostic features given above. They are distributed throughout the surface of earth where the ferns are growing, the center of species being in tropical regions of the world. *Goniophlebium* has sometimes been separated from *Polypodium* by the jointed pinnae or by the anastomosing venation. Here, we follow to Ching (1933) and the others to consider *Polypodium* including *Goniophlebium*. In Thailand there are nine species confined in this genus.

Key to the species

1. Pinnae confluent at base (*Polypodium*)
 2. Veins all free **1. P. manmeiense**
 2. Veins anastomosing
  3. Fronds glabrous or hairy on costae and veins as well as very minutely scaly on various axes
   4. Pinnae very close; fronds oblong to oblong-lanceolate with distinct terminal pinnae; papyraceous to subcoriaceous **2. P. amoenum**
   4. Pinnae remote, costae more than 1.5 cm from the next ones; fronds narrowly lanceolate, without distinct terminal pinnae; herbaceous to softly papyraceous **3. P. microrhizoma**
  3. Fronds densely hairy on both surfaces **4. P. garrettii**
1. Pinnae, at least the lower ones, free, articulate to rachis (*Goniophlebium*)
 5. Pinnae hairy on both surfaces, gradually becoming smaller upwards forming no distinct terminal pinnae **5. P. beddomei**
 5. Pinnae glabrous or sparsely hairy on upper surface, terminal pinnae more or less distinct
  6. Sori superficial; base of pinnae deeply cordate **6. P. argutum**
  6. Sori more or less sunk in cavities; base of pinnae cuneate to subtruncate
   7. Rhizome glaucous. Sori without paraphysis
    8. Base of pinnae subtruncate to subcordate, sessile **7. P. subauriculatum**
    8. Base of pinnae cuneate, shortly stalked **9. P. persicifolium**
   7. Rhizome not glaucous. Sori rounded by dark strongly toothed scale-like paraphyses **8. P. verrucosum**

1. Polypodium manmeiense Christ, Bull. Herb. Boiss. 6: 870. 1898; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 41. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 535. 1941; Holtt., Dansk Bot. Ark. 20: 21. 1961; Tagawa & K.Iwats., Southeast As. St. 5: 56. 1967. Figure 57. 7–8.

Rhizome wide-creeping, about 1.5 mm diam., dark green to brown, densely covered with scales; scales narrowly subtriangular, acuminate at apex, entire, up to 3 by 1 mm, dark greyish-brown. *Stipes* stramineous, 3 – 12 cm long, densely scaly at base. *Laminae* deeply pinnatifid, usually decurrent to the next lobes by very narrow wings of rachis less than 1 mm in breadth in the lower part, narrowly oblong with rather suddenly narrowing acuminate apex, 10 – 25 by 3.5 – 6.5 cm; lobes up to 35 (in particular case more than 50) pairs, narrowly lanceolate, patent except more or less deflexed lower one or two pair(s), about 3 by 0.5 cm, acute to moderately acute at apex, incised to undulate at edge at least at distal portion, upper ones rather suddenly becoming smaller, the apex usually forming lobed terminal pinnae; costa 5 – 7 mm from the next one, raised on both surfaces, glabrous, stramineous to darker; veins forked, terminal of veinlets ending in elliptic hydathodes inside the margin of lobes; herbaceous, glabrous. *Sori* terminal or subterminal on acroscopic veinlets, medial, less than 1 mm diam., superficial or immersed in cavities.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Tung), Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang).

D i s t r i b u t i o n.— Sikkim, Upper Burma, SW. China (Yunnan, type) and Laos.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests at high altitudes (1300 – 2300 m).

V e r n a c u l a r.— Kut pha (กูดผา) (Northern).

N o t e.— This is an only representative in this country of the free veined *Polypodium* with pinnatisect plan of fronds. However, this can not be referred to an ally of *P. vulgare*, but to a group of *P. amoenum* with reticulate venation. The laminar surface of the lobes of this species is rather narrow and seems to admit no enough space to have reticulate venation. In fact there is rarely evidence of the irregular anastomosis in some broader portion of the lateral lobes.

2. Polypodium amoenum (J.Sm. ex Hook. et Grev.) Mett., Abhandl. Senckenb. Naturf. Ges. 2: 80. 1857; C.Chr., Contr. U.S. Nat. Herb. 26: 333. 1931; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 43. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 536. 1941; Tagawa, J. Jap. Bot. 38: 325. 1963; Tagawa & K.Iwats., Southeast As. St. 5: 56. 1967.— *Goniophlebium amoenum* J.Sm. ex Hook. et Grev., Gen. Fil.: t. 50. 1840; Bedd., Handb.: 317. f. 170. 1883.

Rhizome wide-creeping, about 5 mm diam., dark brown, densely scaly throughout; scales narrow with ovate peltate base, up to 5 by 2 mm, not so stiff, light brown to greyish, more or less clathrate. *Stipes* stramineous or faintly castaneous, 10 – 30 cm long, scaly at base, glabrescent upwards. *Laminae* somewhat variable in form and size, usually oblong to oblong-lanceolate, deeply pinnatifid with more or less distinct apical lobes, smaller ones subdeltoid, up to 50 by about

25 cm; rachis stramineous to castaneous, usually minutely scaly beneath or sometimes hairy; lobes up to 25 pairs, a few basal pairs a little shorter than the next above, deflexed, middle and lower ones patent, straight or slightly falcate, linear-lanceolate, acuminate at apex, up to 15 by 1.7 cm, continuous to the next ones by narrow wings of rachis more than 2 mm in breadth; costa more or less hairy on upper surface; veins forming a row of costal areoles or rarely an additional row, visible on both surfaces; papyraceous to subcoriaceous. *Sori* terminal on included veinlets in costal areoles, thus in a single row at each side of costa, about 1 mm diam., superficial or slightly sunken.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Chiang Dao, Doi Suthep, Doi Inthanon), Phitsanulok (Phu Miang); NORTH-EASTERN: Loei (Phu Luang); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

D i s t r i b u t i o n.— Himalayas (type) to Burma, S. China, Indochina and Taiwan.

E c o l o g y.— On mossy tree-trunks or on moist mossy rocks in dense evergreen forests, fairly common at high altitudes (1400–2300 m).

N o t e.— In form and size of the fronds, this is a species fairly variable. In deep gloomy places, the fronds become larger and thinner, usually green in colour. The type specimen is such a larger plant. In dryer places like those on the ridge, in contrary, the fronds are subdeltoid in outline, thicker and paler. The hairiness is also variable without any particular relation to the habitat, though the figures of Beddome are erroneous to draw hairs densely on laminar surface. Only a few specimens are sparsely hairy on upper surface of laminae, but nothing particular in the other characters.

3. Polypodium microrhizoma Clarke ex Bak. in Hook. et Bak., Syn. Fil. ed. 2: 511. 1874; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 47. 1933; Tagawa & K.Iwats., Southeast As. St. 5: 57. 1967.— *Goniophlebium microrhizoma* (Clarke ex Bak.) Bedd., Ferns Br. Ind. Suppl.: 21. t. 384. 1876; Handb.: 322. 1883. Figure 57. 9–10.

Rhizome wide-creeping, about 3 mm diam., dark brown to nearly black, densely covered with scales; scales narrowly ovoid with tails, up to 5 by 1 mm, pale brown to greyish-brown or darker, toothed at margin. *Stipes* 10–15 cm long, stramineous or faintly castaneous beneath, densely scaly at base, glabrescent upwards. *Laminae* deeply pinnatifid to pinnatisect, narrowly lanceolate, 35–45 by 10–13 cm; rachis stramineous and grooved on upper surface, castaneous beneath, glabrous, nearly wingless in the lowest portion; lateral lobes up to 35 pairs, basal ones not or very slightly deflexed, a little shorter than the next above, middle ones lanceolate, acute to acuminate at apex, toothed at margin, patent, straight, up to 6.5 by 1.2 cm; veins anastomosing to form a row of large costal areoles at each side of costa each containing a simple included vienlet, the other veins free; herbaceous or thinly papyraceous, green, glabrous. *Sori* round or elliptical, at terminal of the free included veinlets of costal areoles, more or less immersed.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Inthanon).

D i s t r i b u t i o n.— N. India (type), Upper Burma, SW. China (Yunnan & Szechuwan) and Taiwan.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests, rather rare on highest part at 2000–2300 m alt. in Northern region.

N o t e.— This is close to *P. amoenum* and rather difficult to discriminate from the latter variable species by diagnostic features in a few words. The plants of *P. microrhizoma* are glabrous throughout, but the upper surface of costae is more or less hairy in *P. amoenum*. At each side of rachis of *P. amoenum* is a row of narrow areoles, but in *P. microrhizoma* such an areole along rachis is rarely formed. The anastomosis of venation in *P. microrhizoma* is rather vague and sometimes the veins are not uniting at all. The outline of fronds, pinnation, texture and the size of fronds are different between these two species as noted in the key and description.

4. Polypodium garrettii C.H. Wright, Kew Bull. 1930: 174; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 49. 1933. Figure 57. 5–6.

Rhizome wide-creeping, 2.5–3 mm diam., dark brown to nearly black, densely covered with scales; scales thin, ovate with long tails, about 1 mm diam. with tails about 5 mm in length, irregularly toothed at margin, light brown, shining, clathrate. *Stipes* stramineous, 6–7 cm long, densely scaly at base, densely hairy upwards. *Laminae* linear-lanceolate, round at base, acuminate at apex, 25–50 by 6–12 cm, pinnatifid to pinnatisect; rachis stramineous, densely hairy throughout, scaly beneath; lobes up to 40 pairs, the upper ones gradually becoming smaller, the basal one or two pairs slightly deflexed, sometimes separated by a little longer ones next above or continuous with very narrow wing of rachis, middle lobes the largest, patent, straight, acute at apex, subentire or very slightly toothed at margin, narrowly oblong or gradually narrowing from base to apex, up to 6 by about 1 cm; veins reticulate to form a single row of large costal areoles along each side of costa, each areole containing a simple included veinlet, the other veins free, the apex a little inside the margin of lobes, hardly visible; rather thick, green, densely pubescent on both surfaces. *Sori* round, terminal on the included simple veinlets, thus in a single row along each side of costa, medial or closer to costa, up to 1.5 mm diam., superficial.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao, Doi Inthanon, type).

D i s t r i b u t i o n.— Endemic.

E c o l o g y.— On mossy tree-trunks in dense forests in limestone areas at 1000–1800 m alt.

N o t e.— In the character of fronds, this species is close to *P. wattii* in the Himalayas and N. Vietnam, but distinct from the nominal species in the features of

rhizome: in *P. wattii* rhizome is almost naked and glaucous, as this is sometimes referred to a variety of *P. niponicum*. Another close species is *P. transpianense* in Taiwan, which is distinguished by less densely scaly rhizome, little deflexed lowest lobes which are continuous to the next above with wings of rachis more than 1 mm in breadth, and usually two rows of areoles are at each side of costa. In spite of such apparent similarity to the species of the group of *P. niponicum*, *P. garrettii* seems to be a close ally of *P. amoenum*, from which it is different in the dense hairy surfaces of the fronds.

5. Polypodium beddomei Bak. in Hook. et Bak., Syn. Fil. ed. 2: 344. 1874, based on *Goniophlebium molle* Bedd., Ferns Brit. India: t. 206. 1867; Handb.: 322. f. 172. 1883; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 50. 1933; Tagawa & K.Iwats., Southeast As. St. 5: 57. 1967.

Rhizome long-creeping, about 4 mm diam., glaucous or dark brown in older part, densely scaly throughout; scales linear, toothed at margin, up to 8 by 1 mm, brown, shining, clathrate. *Stipes* 15–25 cm long, castaneous or paler, glabrescent. *Laminae* lanceolate, 30–45 by up to 20 cm, pinnate; rachis castaneous and scaly beneath, hairy throughout; pinnae up to 30 pairs, patent or slightly ascending, straight or slightly falcate, sessile, the base broadly cuneate to cordate in lower ones, adnate in upper ones, gradually narrowing from base to attenuate apex, up to 12 by 1.7 cm, serrate at margin; veins anastomosing to form 2 to 3 rows of areoles at each side of costa, each areole including a simple included free veinlet, other veins free, ending in hydathodes a little inside the apex of dentation, visible on both surfaces; herbaceous or thinner, densely hairy on both surfaces, pale green. *Sori* round, in a single row along each side of costa, closer to costae, about 1.2 mm diam., sunk in cavities which raised distinctly on upper surface.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Suthep, Doi Inthanon), Phitsanulok (Thung Salaeng Luang); NORTH-EASTERN: Loei (Phu Kradueng).

D i s t r i b u t i o n.— Burma (Tenasserim, type).

E c o l o g y.— On muddy rocks near streams in dense forests at 500–1200 m alt.

N o t e.— This is a rare species and the Thai specimens are all additional to the Tenasserim type. Beddome included Malay Peninsula in the area of this species, but we could not see any specimen referable to this from Malaya.

6. Polypodium argutum (J.Sm. ex Hook. et Grev.) Hook., Sp. Fil. 5: 32. 1863; C.Chr., Contr. U.S. Nat. Herb. 26: 333. 1931; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 51. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 537. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 57. 1967.— *Goniophlebium argutum* J.Sm. ex Hook. et Grev., Gen. Fil.: t. 51. 1840; Bedd., Handb.: 323. f. 174. 1883.

Rhizome long-creeping, 4–5 mm diam., dark brown or slightly glaucous, densely scaly at least at apex; scales narrowly subtriangular, about 3 by 0.8 mm, irregularly toothed at margin, light brown, clathrate. *Stipes* up to 20 cm long, stramineous or faintly castaneous, scaly at base, glabrous upwards. *Laminae* pinnate with distinct terminal pinnae, oblong-lanceolate, up to 50 by 20 cm; rachis like the upper part of stipes, minutely scaly and hairy; lateral pinnae up to 12 pairs, the basal one either reduced or the longest, the upper ones gradually becoming smaller upwards, slightly ascending, lower ones patent, straight or falcate, sessile, deeply cordate and more or less roundly auricled at base, attenuately acuminate at apex, serrate at margin, the lobes toothed, the larger pinnae up to 14 by 2 cm; terminal one usually longer, sometimes deeply lobed at basal portion, up to 16 cm long; veins anastomosing to form 2–3 rows of areoles at each side of costa, each costal areole containing a simple free veinlets, the other veins free, ending inside the margin of lobes, visible on both surfaces; herbaceous, glabrous or minutely scaly underneath. *Sori* terminal on included veinlets of costal areoles, up to 2 mm diam., superficial.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Suthep, Doi Hua Mot, Pha Mon, Doi Inthanon), Lampang; NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng), Phetchabun (Phu Miang); SOUTH-WESTERN: Kanchanaburi (Si Sawat, Khao Ri Yai).

D i s t r i b u t i o n.— Himalayas (type) to China, Indochina, Taiwan and the Philippines.

E c o l o g y.— On mossy tree-trunks or on moist mossy rocks in dense evergreen forests at high altitudes (1300–2200 m).

7. Polypodium subauriculatum Bl., En. Pl. Jav.: 133. 1828; Fl. Jav. Fil.: 177. t. 68. 1828; Ching, Contr. Inst. Bot. Nat. Acad. Peiping 2: 51. 1933; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 538. 1941; Holtt., Rev. Fl. Malaya 2: 207. f. 108. 1955; Dansk Bot. Ark. 20: 21. 1961; 23: 232. 1965; Tagawa & K. Iwats., Southeast As. St. 5: 57. 1967.— *Goniophlebium subauriculatum* (Bl.) Presl, Tent. Pterid.: 186. 1836, Bedd., Handb.: 323. f. 173. 1883.

Rhizome long-creeping, about 5 mm diam., distinctly glaucous, densely scaly; scales linear, about 5 by 0.7 mm, brown clathrate, toothed at margin. *Stipes* stramineous or brown, 15–25 cm long, densely scaly at base, minutely scaly upwards or glabrescent. *Laminae* imparipinnate, lanceolate, 40–70 by 20–25 cm; rachis pale brown, minutely scaly throughout; lateral pinnae 25–35 pairs, a few basal pairs usually a little shorter than the next above, deflexed or patent, middle ones the largest, subopposite, sessile, linear, subcordate or subtruncate roundly auricled on both sides at base, gradually narrowing from base to long-attenuate apex, serrate at margin, patent or slightly ascending, straight or a little falcate, up to 20 cm by 7–18 mm, upper pinnae gradually becoming smaller; terminal pinna not so large, 3–10 cm long, irregularly lobed at basal portion;

veins anastomosing to form 1 – 3 rows of areoles at each side of costa, more or less visible; herbaceous to subcoriaceous, deep green, glabrous. *Sori* terminal on simple included veinlets in costal areoles, in one row at each side of costa, costular, more than 1.5 mm diam., distinctly immersed and raised on the upper surface.

T h a i l a n d.— NORTHERN: Chiang Rai (Doi Pacho, Mae Lao, Pong Pa Phon), Chiang Mai (Fang, Doi Inthanon, Doi Chiang Dao, Doi Suthep), Mae Hong Son (Doi Pha Dam), Lampang (Doi Luang), Tak (Mae Sot); NORTH-EASTERN: Phetchabun (Phu Miang), Loei (Phu Luang, Phu Kradueng); SOUTH-EASTERN: Prachin Buri (Khao Yai), Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Kanchanaburi (Sai Yok, Khao Nam Tok).

D i s t r i b u t i o n.— NE. India, SW. China, Laos, Vietnam, Malesia throughout (type from Java) to Australia (Queensland); also in the Tenasserim.

E c o l o g y.— On tree-trunks or on mossy rocks in light shade or at edge of evergreen forests at 700 – 1400 m alt.

8. Polypodium verrucosum (Hook.) Wall. ex Hook., Gard. Ferns: t. 41. 1862; Holtt., Rev. Fl. Malaya 2: 206. f. 106. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 53. 1968.— *Marginaria verrucosa* Hook., Gen. Fil.: t. 14. 1838.— *Goniophlebium verrucosum* (Hook.) J.Sm. in Hook., Gen.: ad t. 51. 1840; Bedd., Handb.: 324. f. 175. 1883.

Similar to *P. subauriculatum* but differs in: rhizome 3 – 4 mm diam., dark brown, rarely glaucous, scaly throughout; pinnae very shortly stalked or subsessile, round to broadly cuneate and more or less unequal at base, larger, about 15 by 2.5 cm, subentire or minutely toothed at margin; sori sunk in deep cavities which appear on the upper surface more than 1 mm high, surrounded by dark paraphyses.

T h a i l a n d.— PENINSULAR: Nakhon Si Thammarat (Lan Saka), Surat Thani (Ban Don), Narathiwat (Waeng), Yala (Ban Chana, Khao Khalakhiri).

D i s t r i b u t i o n.— Malesia throughout, Sumatra to New Guinea.

E c o l o g y.— Epiphytic on tree-trunks in low altitudes.

9. Polypodium persicifolium Desv., Berl. Mag. 5: 316. 1811; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 537. 1941; Holtt., Rev. Fl. Malaya 2: 206. f. 107. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 57. 1967.— *Goniophlebium persicifolium* (Desv.) Bedd., Ferns Brit. India Correct.: 1870.

Rhizome creeping, 4 – 5 mm diam., dark brown, densely scaly; scales ovate with tails, up to 5 mm long including tails, 2 mm broad at base, brown, entire. *Stipes* stramineous or brownish in upper parts, 20 – 35 cm long, minutely scaly or glabrescent. *Laminae* pinnate with distinct terminal pinnae, oblong to lanceolate, up to 60 by 35

cm; lateral pinnae up to 20 pairs, ascending, more or less falcate, lower to middle ones larger, distinctly stalked, linear-lanceolate, cuneate at base, caudately acuminate at apex, up to 20 by about 2 cm, serrate at margin, upper pinnae gradually becoming smaller upwards; terminal pinna up to 15 cm long; veins anastomosing to form 2 or 3 rows of areoles at each side of costa; herbaceous, green, glabrous. *Sori* round to elliptic, terminal on simple included veinlets in costal areoles, in a single row at each side of costa, medial or costular, up to 2 mm diam., distinctly immersed.

T h a i l a n d.— SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Nakhon Si Thammarat (Khao Luang, Lan Saka), Trang (Khao Chong).

D i s t r i b u t i o n.— Vietnam, Malaya, Sumatra, Java, Celebes and Philippines.

E c o l o g y.— On mossy tree-trunks in light shade or in dense evergreen forests, not so common at 400 – 1500 m alt.

N o t e.— The base of pinnae is cuneate and distinctly stalked. In this feature this species is distinct among the genus *Polypodium* in our regions. The size of pinnae, especially their breadth, is variable according to the habitat of the plants concerned.

20. LOXOGRAMME

(Bl.) Presl, Tent. Pterid.: 214. pl. 9. f. 8. 1836; Copel., Gen. Fil.: 217. 1947.

Rhizome short or long-creeping, scaly; scales entire, thin, concolorous, clathrate. Fronds not distinctly articulate, monomorphic to dimorphic, simple and entire, usually oblanceolate in outline, coriaceous to fleshy, glabrous; main veins hardly distinct, veins all invisible, reticulate to form areoles without, or rarely with, included free veinlets. Sori elongate, usually oblique to midrib, superficial or slightly immersed, naked; spores globose or tetrahedral.

About forty species are known mainly in Malesia – Polynesian regions, northwards to Japan, one extending to C.America, a few in Africa. Owing to the simple morphological construction of plants, the specific classification has hardly been completed.

The systematic position of this genus remains rather doubtful. Copeland is of opinion to refer *Loxogramme* to Grammitidaceae on the basis of non-articulated stipes and globose, sometimes certainly tetrahedral, spores. Holttum and others still maintain this in Polypodiaceae by the vascular anatomy, rhizome scales, and venation. HOLTTUM (1955) suggests that lack of articulation causes the fleshy nature of fronds. Really the fronds of this genus are extremely curled up in dry weather, and it needs sometimes more than over-night to obtain the flat fronds even immersed in the water.

In Thailand seven species are recorded here.

KEY TO THE SPECIES

1. Rhizome short. Fronds close to fasciculate
 2. Midrib distinct on upper surface. Species in Peninsular — **1. L. avenia**
 2. Midrib not so distinctly raised on upper surface
  3. Midrib raised as keels below. Species in Peninsular — **3. L. scolopendrina**
  3. Midrib slightly raised below. Species in Northern — **2. L. involuta**
1. Rhizome creeping. Fronds not so close
 4. Fronds monomorphic, oblanceolate to narrower, more than 5 cm long
  5. Stipe-base purple to castaneous — **4. L. duclouxii**
  5. Stipes green to paler throughout or very faintly brown at base
   6. Rhizome more than 1.2 mm in diameter. Sori closer to midrib. Species in Northern — **5. L. chinensis**
   6. Rhizome less than 1.2 mm in diameter. Sori closer to margin of frond. Species in Peninsular — **6. L. subecostata**
 4. Fronds dimorphic, sterile fronds suborbicular, up to 1 cm long — **7. L. lankokiensis**

1. Loxogramme avenia (Bl.) Presl, Tent. Pterid.: 215. 1836; Bedd., Handb.: 393. f. 229. 1883; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 465. 1941; Holtt., Rev. Fl. Malaya 2: 167. f. 76. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 56. 1967; Acta Phytotax. Geobot. 23:53. 1968.— *Grammitis avenia* Bl., En. Pl. Jav.: 117. 1828.— *Loxogramme blumeana* Presl, Tent. Pterid.: 215. 1836.— *Loxogramme involuta* (D.Don) Presl sensu Holtt., Dansk Bot. Ark. 23: 230. 1965.

Rhizome short-creeping, more than 3 mm diam., bearing fronds closely, densely covered with scales near apex; scales dark brown, hardly clathrate, linear-lanceolate, narrowing towards hair-pointed apex, about 10 by 1.2 mm, entire. *Stipes* indistinct, dark castaneous, densely scaly at base. *Laminae* lanceolate, acuminate at apex, broadest at middle to upper $\frac{1}{3}$ portion, gradually narrowing downwards and decurrent at base to form wings, 15 – 50 by 1.5 – 6 cm, edges entire or a little recurved, green on upper surface, paler beneath; midrib distinctly raised on upper surface, hardly so beneath, pale green to brown; veins hardly visible on both surfaces, forming copious anastomosis; thick, leathery, fleshy. *Sori* linear, oblique, continuous from near midrib to the margin of fronds, forming angles of 20° – 35° to midribs, up to 6 cm by about 2 mm, a little immersed.

T h a i l a n d.— CENTRAL: Nakhon Nayok (Nang Rong Falls); SOUTH-EASTERN: Chanthaburi (Khao Sabap), Trat (Ko Chang); PENINSULAR: Chumphon (Ban Kraye), Phangnga (Takua Pa, Khao Katha Khwam), Trang (Khao Chong), Satun, Narathiwat (Waeng), Yala (Ban Chana).

D i s t r i b u t i o n.— W. Malesia (type from Java) and Indochina; also in Burma (Moulmein).

E c o l o g y.— On mossy tree-trunks or on muddy rocks in dense evergreen forests usually near streams at low altitudes lower than 300 m.

N o t e.— This species is distinct in short-creeping thick rhizome bearing larger fronds closely, less clathrate long rhizome-scales, with more or less crisped hair-pointed apex, more or less castaneous stipe or frond base, and midrib distinctly raised above but nearly flat on lower surface.

2. Loxogramme involuta (D.Don) Presl, Tent. Pterid.: 215. 1836; Bedd., Handb.; 393. f. 228. 1883; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 464. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 56. 1967.— *Grammitis involuta* D.Don, Prodr. Fl. Nepal.: 14. 1825.

Rhizome short, ascending to creeping, about 1.5 mm diam., bearing a tuft of fronds near apex, densely covered with scales or dark on older portion; scales subdeltoid with acuminate apex, up to 7 by 4 mm, thin but stiff, entire, greyish-brown, clathrate. *Stipes* indistinct, or very short with wings. *Laminae* caudately long-acuminate at apex, attenuate at base and decurrent to narrow wings of stipes nearly to the base, lanceolate, up to 35 by 4 cm, deep green on upper surface, paler beneath; midrib more or less raised beneath, usually flat on upper surface, stramineous or pale green; veins all obscure, anastomosing with free included veinlets; thick and fleshy, glabrous on both surfaces. *Sori* linear, to form angles of about 80° to midribs, continuous from near margin to near midrib, up to 3 cm long, about 1.5 mm broad, superficial.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Inthanon, Doi Chiang Dao, Khun Kong San, Doi Hua Mot), Tak (Khao Phra Wo, Mae Sot); NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng); EASTERN: Nakhon Ratchasima (Khao Yai).

D i s t r i b u t i o n.— India (type from Nepal), Upper Burma and Indochina.

E c o l o g y.— On mossy rocks or on mossy tree-trunks in dense evergreen forests at 900 – 1800 m alt.

N o t e.— The most reliable feature to distinguish this from *L. avenia* is found in rhizome-scales which are in *L. involuta* broader, up to 4 mm broad, greyish-brown and finely clathrate. In the former species the rhizome-scales are narrow, up to 1.2 mm broad, dark brown, and hardly clathrate. It is sometimes diagnosed to discriminate the above two whether the midribs are raised above or not, but this is constant only in *L. avenia*. The midribs of *L. involuta* are usually raised below but slightly, and either flat or raised on upper surface.

This species is common in Sikkim – Himalayan regions, and the records from Malesia seem to be mostly erroneous. We see no specimen from Malesia well match the Himalayan species. The Malesian plants named as *L. involuta* are often *L. scolopendrina*.

3. Loxogramme scolopendrina (Bory) Presl, Tent. Pterid.: 215. 1836; Holtt., Rev. Fl. Malaya 2: 168. f. 78. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 24: 177. 1970.— *Grammitis scolopendrina* Bory, Dup. Voy.: 257. pl. 30. f. 1. 1829.

Similar to *L. avenia* but differing in: rhizome-scales broader, about 1 mm broad, greyish-brown, clathrate, the apex hair-pointed but less crisped; stipes or frond-base green to stramineous, rarely castaneous; midrib nearly flat on upper surface, distinctly raised as prominent keels beneath; texture more fleshy. Also resemble *L. involuta*, but distinct from it in: more fleshy texture, larger size of fronds, and distinctly keeled midrib on the lower surface; rhizome-scales are similar to those of *L. involuta*, but narrower and composed of larger cells of less

numbers, and distinctly clathrate.

T h a i l a n d.— PENINSULAR: Satun (Thung Nui), Yala (Bannang Sata).

D i s t r i b u t i o n.— Malesia, eastwards to the Solomon Islands.

E c o l o g y.— On mossy tree-trunks or on rocks usually in dense evergreen forests at low altitudes up to 300 m.

4. Loxogramme duclouxii Christ, Bull. Acad. Géogr. Bot. 16: 140. 1907; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 177. 1970. Figure 57. 11.

Rhizome long-creeping, 1.5 – 3 mm diam., dark brown, densely covered with scales; scales thin but firm, fuscous-brown, ovate-oblong or narrower, subulate, entire, clathrate, up to 10 by 2 mm. *Fronds* remote, oblanceolate, broadest at middle to $\frac{1}{4}$ way from apex, acuminate at apex, up to 45 by 4 cm, the edges often involute, very gradually attenuate towards base and decurrent into narrow wings of indistinct, short stipes with castaneous base; midrib raised on upper surface, a little distinct and flattened beneath, pale green; veins invisible, anastomosing to form elongate areoles usually with included veinlets; coriaceous, thick and fleshy, deep green on upper surface, paler beneath, glabrous. *Sori* confined to the upper half of the fronds, usually close together and deeply overlapping with the next ones, oblique, up to 4 cm by about 2 mm, rather close to costa than to the margin of fronds, superficial.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao); NORTH-EASTERN: Loei (Phu Luang, Phu Paek), Phetchabun (Phu Miang).

D i s t r i b u t i o n.— Tibet, NE. India, SW. China (type), Korea (Quelpart), S. Japan to Taiwan.

E c o l o g y.— On mossy rocks in dense evergreen forests at 1400 – 1800 m alt.

5. Loxogramme chinensis Ching, Sinensia 1: 13. 1929; Tard. & C.Chr. in Fl. Gen. I.-C. 7(2): 466. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 56. 1967.— *Loxogramme lanceolata* (Sw.) Presl sensu Bedd., Handb.: 392. 1883, p.p.; Holtt., Dansk Bot. Ark. 20: 20. 1961.

Rhizome long-creeping, slender, about 1.5 mm diam., densely scaly throughout; scales ovate with rather broad tails, up to 3 mm long including tails about 2 mm in length, 0.8 mm broad, deeply cordate, entire, clathrate. *Stipes* indistinct, densely scaly at base, pale green, narrowly winged to the very base. *Laminae* linear-lanceolate, acuminate at apex, gradually narrowing and decurrent downwards to the wings of indistinct stipes, up to 20 by 1 cm, edges entire, more or less involute; midrib raised on both surfaces, dark; thick, coriaceous, fleshy, deep green on upper surface, paler beneath, glabrous. *Sori* nearly parallel to midrib or a little oblique, usually in a single row or often uniting with neighbouring to form linear coenosori, usually 5 – 10 by 1.5 mm, naked, superficial.

T h a i l a n d.— Chiang Rai (Phu Langka), Chiang Mai (Doi Chiang Dao, Doi Suthep, Doi Inthanon).

D i s t r i b u t i o n.— Assam, Bhutan, Upper Burma, S. & SW. China (type) and N. Vietnam.

E c o l o g y.— On mossy tree-trunks or on mossy rocks in dense evergreen forests at 1600–2200 m alt.

N o t e.— Chiang Dao plants are different from the typical ones in: rhizome rather short, fronds close to each other, scales fuscous-brown, broader, up to 1.2 mm broad; sori more oblique, sometimes overlapping to the next ones.

This is most close to *L. parallela* in Sri Lanka, S. India, W. Malesia to the Philippines, and differs from the latter in generally smaller size of plants, smaller, narrower and less clathrate rhizome-scales; green to stramineous stipes and costa; and more oblique sori. This is the species formerly called *L. lanceolata*, but from this African species *L. chinensis* is different just in the same way as *L. parallela*, summarized in SLEDGE, Bull. Brit. Mus. (Nat. Hist.) Bot. 2: 141. 1960. In Thailand this is known only in the northern mountains and different from *L. subecostata* in Peninsular in the distribution.

6. Loxogramme subecostata (Hook.) C.Chr., Gard. Bull. S.S. 4: 405. 1929; Holtt., Rev. Fl. Malaya 2: 169. f. 79. 1955; Tagawa & K.Iwats., Southeast As. St. 3(3): 76. 1965; 5: 56. 1967.— *Polypodium subecostatum* Hook., Sp. Fil. 5: 59. pl. 283 A. 1863.

Rhizome long-creeping, about 1 mm diam., dark brown to nearly black, densely scaly at apex; scales linear, dark brown, up to 5 by 0.2 mm. *Stipes* none or very short, scaly. *Laminae* attenuately acuminate at apex, gradually narrowing downwards and decurrent nearly to the base, up to 20 by 0.7–1.3 mm; midrib raised on upper surface, less distinct beneath, green on upper side and paler beneath; veins invisible, forming few series of irregular areoles; subcoriaceous, more or less fleshy, edges slightly involute, green on both surfaces. *Sori* slightly oblique, not overlapping each other, marginal, up to 1 cm by 1.2 mm, but variable in size, born in shallow hollow or superficial.

T h a i l a n d.— PENINSULAR: Trang (Khao Chong), Phatthalung (Khlong Hin Khao), Satun (Boriphat Falls).

D i s t r i b u t i o n.— Malaya, Sumatra and Borneo (type).

E c o l o g y.— On muddy rocks by streams in dense evergreen forests at low altitudes up to 400 m.

N o t e.— This is similar to *L. chinensis* in northern districts but different from it in long-creeping slender rhizome, brown scales; midrib not raised beneath; and irregularly oblique submarginal sori. The form and size of sori are variable to some extent, some being very short and nearly round.

7. Loxogramme lankokiensis (Rosenst.) C.Chr., Ind., Fil. Suppl. III: 125. 1934; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 464. 1941; Tagawa & K.Iwats., Acta Phytotax. Geobot. 24: 60. 1969.— *Polypodium lankokiense* Rosenst., Med. Rijks. Herb. 5: 31. 1917.—*Loxogramme microphylla* C.Chr., Dansk Bot. Ark. 6:48. pl. 3.f.6. 1929.

Rhizome long-creeping, slender, about 0.5 mm diam., densely scaly throughout; scales gradually narrowing from round base towards subulate apex, about 2 by up to 0.5 mm, entire, thin, brown, distinctly clathrate. *Fronds* remote, dimorphic. *Sterile fronds* orbicular, with stipes up to 2 mm long, about 1 cm long, nearly as long as wide, midrib visible only at the base, raised on upper surface, veins quite invisible; chartaceous. *Fertile fronds* with short stipes bearing narrow wings, oblanceolate, broadest at $\frac{1}{5} - \frac{1}{7}$ way from apex, acute at apex, attenuate towards base, about 3 cm long including indistinct stipes, up to 5 mm broad; midrib distinct on lower half, margin a little involved. *Sori* oblique, confluent with the next ones at maturity, up to 7 by 1 mm.

T h a i l a n d.— NORTH-EASTERN: Loei (Phu Kradueng).

D i s t r i b u t i o n.— N. Vietnam (Tonkin, type) and Laos.

E c o l o g y.— On stones in river-bed in hill evergreen forests at about 900 m alt.

N o t e.— This is a dwarf species of *Loxogramme* with dimorphic fronds. In appearance *L. lankokiensis* resemble *L. conferta* but distinct from the latter in moderately acute apex of fronds, shortly stalked frond; smaller size, and finely clathrate brown rhizome-scales.

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31. GRAMMITIDACEAE

As most of the species are small and epiphytic in dense mossy forests in the tropical countries, the collections are still insufficient and no reliable system has ever been made. Here we follow a current system enumerating seven genera from Thailand.

KEY TO THE GENERA

1. Sori round
 2. Fertile lobes or pinnae flat
  3. Sori superficial or almost so
   4. Fronds simple, entire or nearly so — **1. Grammitis**
   4. Fronds lobed more than halfway to midrib
    5. Each lobe or pinna with a simple or forked vein — **2. Xiphopteris**
    5. Each lobe or pinna with a main vein and pinnately arranged veinlets — **3. Ctenopteris**
  3. Sori immersed in soral cavities — **4. Prosaptia**
 2. Fertile lobes or pinnae folded, i.e. the young sori protected by the folded edges of lobes
  6. Basiscopic part of fertile lobes folded over sori — **5. Calymmodon**
  6. Both upper and lower margins of distal part of fertile lobes folded and meet above sori **6. Acrosorus**
1. Sori elongate along a deep groove parallel to the edge of fronds — **7. Scleroglossum**

1. GRAMMITIS

Sw., Schrad. J. Bot. 1801: 17; Copel., Gen. Fil.: 210. 1947; Phil. J. Sci. 80: 93. 1951.

Small epiphytic ferns. Rhizome short, creeping or suberect, bearing scales. Stipes short or indistinct, usually setose hairy. Fronds simple, entire or crenate to shallowly lobed, narrow, usually setose-hairy; veins simple of forked, usually ending in hydathodes on upper surface. Sori typically dorsal on the lowest acroscopic branch of forked veins, usually in a single row along both sides of midrib, round or elliptic, superficial or impressed.

About 150 species are known in the tropical areas throughout the world, usually on mossy tree-trunks in dense evergreen forests. In Thailand six species have been recorded and are distinguished from each other by the features summarized in the following key.

KEY TO THE SPECIES

1. Fronds more or less persistently hairy throughout with setose hairs
 2. Veins simple or forked
  3. Hairs all simple
   4. Hairs at most 2.3 mm long
    5. Veins distinct; plants densely hairy throughout — **1. G. hirtella**
    5. Veins hardly visible; hairs not so dense — **2. G. dorsipila**
   4. Hairs longer and dense — **3. G. bongorensis**
  3. Hairs at margin of fronds in stellate cluster — **4. G. jagoriana**
 2. Veins more than twice forked — **5. G. setosa**
1. Fronds quite glabrous, or very sparsely short-hairy when young — **6. G. adspersa**

1. Grammitis hirtella (Bl.) Tuyama, Bot. Mag. Tokyo 51: 125. 1937; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 523. 1941; Copel., Phil. J. Sci. 80: 226. f. 86. 1951; Holtt., Rev. Fl. Malaya 2: 216. f. 115. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 61. 1967.— *Polypodium hirtellum* Bl., En. Pl. Jav.: 122. 1828; Bedd., Handb.: 305. f. 159. 1883. Figure 58. 1–2.

Rhizome short, ascending or suberect, immersed in the mosses on tree-trunks, bearing fronds in tuft, sparsely scaly; scales oblong-lanceolate, up to 1.2 by 0.3 mm broad, thin, pale brown, usually only at the apex of rhizome, hidden under the stipe-bases. *Stipes* a few centimeters long, not distinct from the base of simple fronds, narrowly winged, densely hairy; hairs patent, 0.8–2.3 mm long, brown, setose. *Fronds* simple, commonly up to 10 cm by 5–8 mm, linear, acute to moderately acute at apex, gradually narrowing downwards, entire or more or less waved at margin, hairy throughout though sparsely with thin texture; veins simple in very narrow fronds but usually forked, the acroscopic branches shorter, basiscopic ones longer, both ending in hydathodes on the upper surface, hydathodes medial or submarginal. *Sori* dorsal on acroscopic branches of veins, costular or rarely medial, round or oblong and distinct from the neighbourings.

T h a i l a n d.— PENINSULAR: Krabi (Khao Phanom Bencha), Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— S. China to W. Malesia (type from Java).

E c o l o g y.— On mossy tree-trunks in dense evergreen forests with daily fog at medium or high altitudes; locally abundant.

N o t e.— On the mossy tree-trunks in the higher elevation of Khao Luang, this species is abundant and is represented by various forms and sizes, though no taxonomical distinction can be found between any two of them.

2. Grammitis dorsipila (Christ) C.Chr. & Tard., Not. Syst. 8: 179. 1939; in Fl. Gén. I.-C. 7(2): 524. 1941; Copel., Phil. J. Sci. 80: 234. f. 91. 1951; Tagawa & K.Iwats., Southeast As. St. 5: 61. 1967.— *Polypodium dorsipilum* Christ in Warb., Monsunia 1: 59. 1900.

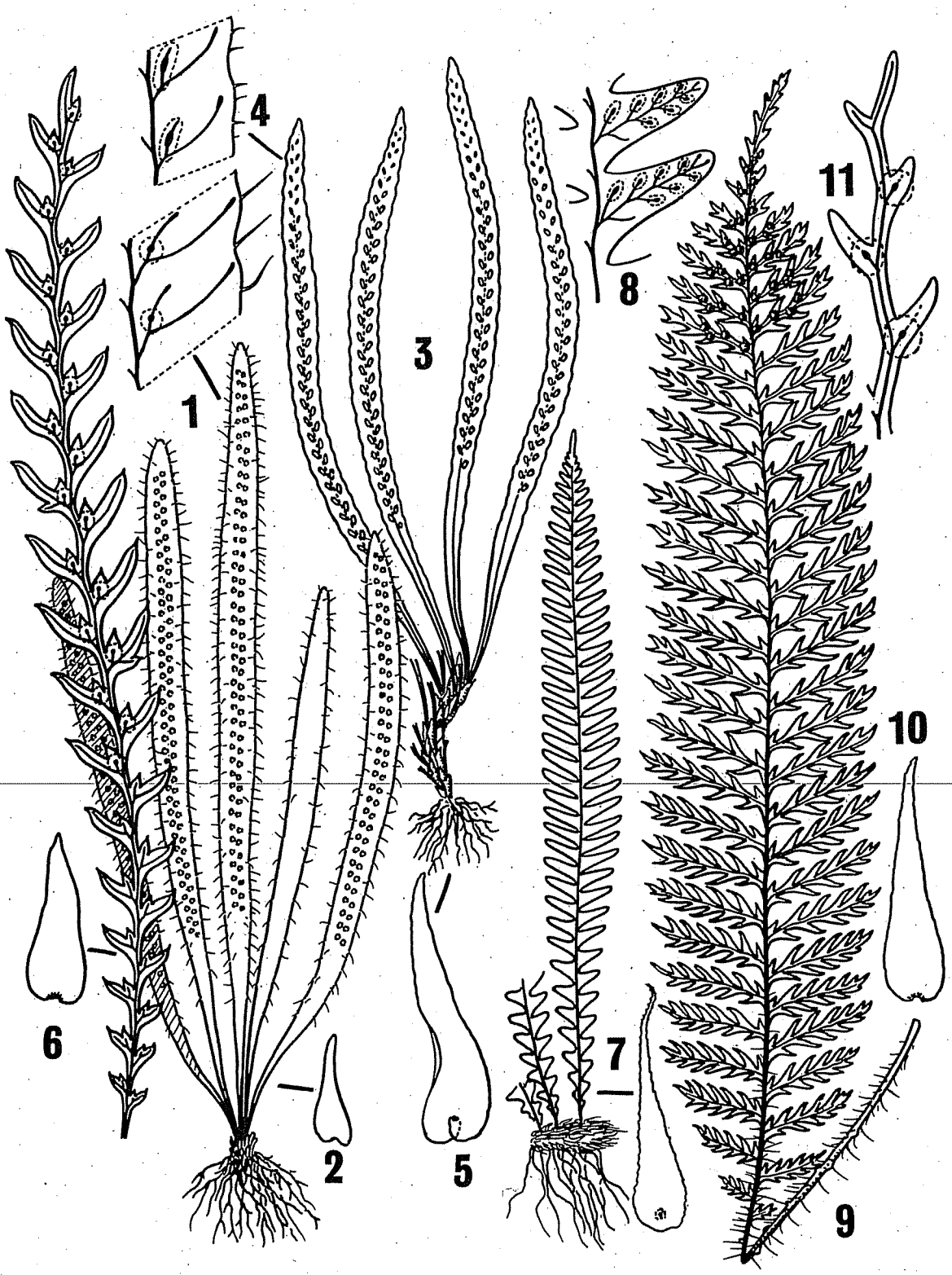

Figure 58. 1–2: *Grammitis hirtella*; 1. plant (below, natural size) and venation of fertile leaf (above, x 5); 2. scale on rhizome (x 15). 3–5: *G. adspersa*; 3. plant (natural size); 4. venation of fertile leaf (x 5); 5. scale on rhizome (x 9). 6. *Xiphopteris khaoluangensis* (drawn from holotype specimen); fertile leaf (x 2) and scale (x 15). 7–8: *Ctenopteris moultonii*; 7. plant (natural size) and scale on rhizome (x 13); 8. venation of fertile segment (x 4). 9–10: *C. tenuisecta*; 9. fertile frond (x 1.5); 10. scale on rhizome (x 10). 11. venation of fertile segment (x 4).

Rhizome short, creeping or ascending, slender, bearing several fronds in tuft, densely scaly; scales lanceolate, acute at apex, about 3 by 0.5 mm, entire, membraneous, pale brown. *Stipes* short, hardly distinct from the base of fronds, winged, sparsely scaly, hairy with shining brown setose patent hairs about 1 mm in length. *Fronds* simple, linear, moderately acute at apex, entire or slightly waved at margin, 3 – 7 cm by 2 – 6 mm, veins hardly visible, forked, the acroscopic branches short, ending in distinct hydathodes on upper surface; coarsely leathery, hairy throughout. *Sori* dorsal on short acroscopic branches of veins, costal to submarginal, round or oblong, not fusing to the neighbourings.

T h a i l a n d.— CENTRAL: Nakhon Nayok (Khao Yai); SOUTH-WESTERN: Prachuap Khiri Khan (Khao Luang); PENINSULAR: Phangnga (Khao Phota Luang Kaeo, Khao Katha Khwam).

D i s t r i b u t i o n.— S. Japan, Ryukyus, S. China (type) and Indochina.

E c o l o g y.— On mossy tree-trunks in light shade along rivers at medium altitudes; rather rare.

N o t e.— The collection from Khao Yai though in not so dense evergreen forests is immersed in deep mosses on tree-trunks. In Japan and the Ryukyus this is known on mossy tree-trunks in forests near the top of mountains where the fog occurs every day. By thick texture with hardly visible veins, this species is distinct among the species of this genus known in Thailand.

3. Grammitis bongorensis (Copel.) Copel., Phil. J. Sci. 80: 232. f. 90. 1951; Tagawa & K.Iwats., Southeast As. St. 5: 61. 1967.— *Polypodium bongorense* Copel., Phil. J. Sci. 38: 153. 1929, based on *P. brooksii* Copel., Phil. J. Sci. 12 C: 60. 1917, non C.Chr. 1913.

Rhizome short, creeping or subascending, bearing fronds closely, covered densely with scales; scales gradually narrowing from base towards acuminate apex, entire, about 2.5 by 0.8 mm, pale brown, membraneous. *Stipes* up to 1.5 mm long, very densely hairy with black setose hairs 2 mm in length. *Fronds* linear to very narrowly spathulate, gradually narrowing downwards, round or moderately acute at apex, entire and sometimes recurved at margin, up to 7 cm by 3 – 7 mm, very densely hairy throughout; hairs setose, nigrescent or dark brown, up to 3 mm long, very dense at margin, on both surfaces and in sorus as well; veins hardly visible, simple or forked, the acroscopic branches shorter; thinly leathery. *Sori* costular, in shallow cavities, round or elliptic.

T h a i l a n d.— NORTH-EASTERN: Loei (Phu Luang).

D i s t r i b u t i o n.— E. Malaysia (Sarawak, type).

E c o l o g y.— On moist mossy rocks by streams in dense evergreen forests at about 1200 m; only once collected, and abundant there.

N o t e.— This is the only species of *Grammitis* known in North-Eastern, and the habitat is distinct on moist mossy rocks, not on tree-trunks in mossy forests.

4. Grammitis jagoriana (Mett.) Tagawa, Acta Phytotax. Geobot. 10: 284. 1941; Copel., Phil. J. Sci. 80: 225. f. 85. 1951; Tagawa & K.Iwats., Southeast As. St. 5: 61. 1967.— *Polypodium jagorianum* Mett. ex Kuhn, Linnaea 36: 128. 1869.

Rhizome short, suberect, bearing several fronds in tuft, densely covered with scales; scales oblong-lanceolate, gradually narrowing towards acuminate apex, pale brown, thin, entire, up to 2.5 by 0.5 mm. *Stipes* up to 1.5 cm long, winged at the upper part, densely hairy with brown setose hairs up to 1 mm in length. *Fronds* linear, round at apex, entire or a little revolved at margin, gradually narrowing downwards to winged stipes, up to 6 cm by 2.5 – 4 mm; veins more or less distinct, rather close to each other, simple or forked, the basiscopic branches reaching nearly the margin; thinly leathery, hairy throughout; hairs shining brown, setose, 1 – 1.5 mm long, those at margin of fronds usually in stellate clusters. *Sori* in distinct cavities along midribs, elliptic, 1.5 mm long.

T h a i l a n d.— PENINSULAR: Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— Borneo, Philippines (type), Celebes and Taiwan.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests at high altitudes of Khao Luang, mixed with *G. setosa* and *G. hirtella*.

N o t e.— This species is collected only once in the mossy forests of Khao Luang, where this is growing in just the same habitat as *G. hirtella* and *G. setosa*. In the mountain forests, they are hardly distinguishable in appearance, though the hairs at margin of fronds are distinct in stellate clusters in this species. Soral cavities are variable in characteristics, and our Thai specimen has distinct ones. The veins are rather prominent on the upper surface of fronds and reaching nearly to the margin of fronds. When the margin is recurved, the edge takes an appearance as incised by the distinct unrecurved veins. This species is not known in Malaya, though highly probable also to be there.

5. Grammitis setosa Bl., En. Pl. Jav.: 116. 1828; Copel., Phil. J. Sci. 80: 241. f. 94. 1951; Tagawa & K.Iwats., Southeast As. St. 5: 61. 1967.

Rhizome short-creeping, bearing fronds closely, densely scaly; scales gradually narrowing towards long-tailed apex, up to 4 by 1 mm, pale brown, thin, entire. *Stipes* up to 3.5 cm long, dark, densely hairy with patent setose hairs up to 1 mm in length. *Fronds* linear-lanceolate, gradually narrowing towards both apex and base, subentire or waved at margin, up to 20 by 1 cm; veins usually twice forked or seemingly pinnate in larger fronds, hardly visible, ending in hydathodes on upper surface; papyraceous or thicker, hairy throughout, the hairs castaneous to darker, up to 2 mm in length. *Sori* dorsal at acroscopic branches of the first fork, costular, round, rarely fusing to the neighbouring ones.

T h a i l a n d.— SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

Distribution.— Malesia generally (type from Java), northwards to Taiwan, but unknown in Malaya and Indochina.

Ecology.— On mossy tree-trunks in dense evergreen forests on ridge of mountains at high altitudes where the daily mist previals.

Note.— This is a species of larger size, and is abundant in the above two localities. This is distinct from *G. hirtella* by twice or more forked veins. In some broad-leaved forms, the sori become irregular in arrangement, in more than one row at each side of midrib.

6. Grammitis adspersa Bl., Fl. Jav. Fil.: 115. t. 48. f. 2. 1828; Copel., Phil. J. Sci. 80: 214. f. 78. 1951; Holtt., Rev. Fl. Malaya 2: 214. f. 111. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 49. 1968.— *Polypodium adspersum* (Bl.) Bedd., Handb. Suppl.: 86. 1892, non Schrad. 1818.— *Polypodium subevenosum* Bak., Syn. Fil.: 320. 1867; Bedd., Handb.: 303. 1883.— *Grammitis subevenosa* (Bak.) C.Chr. & Tard., Not. Syst. 8: 179. 1939; in Fl. Gén. I.-C. 7(2): 523. 1941. Figure 58. 3–5.

Rhizome short, creeping, or ascending, bearing fronds in tuft, scaly; scales narrow, gradually narrowing towards apex, 2.5 by 0.3 mm, pale brown, thin. *Stipes* up to 1.5 cm long, densely short pubescent with caducous pubescences. *Fronds* linear, round or moderately acute at apex, gradually narrowing downwards and decurrent into wings of stipes, entire; veins forked, the ends not reaching the margin, ending in hydathodes on upper surface, thin but firm, glabrous or sparsely short-hairy. *Sori* in distinct cavities along midrib, rounded to oblong.

Thailand.— PENINSULAR: Phangnga (Khao Katha Khwam).

Distribution.— Malaya to the Philippines and Java (type).

Ecology.— On tree-trunks in evergreen forests at about 900 m; only once collected in Thailand.

Note.— There are a few species of *Grammitis* which have no hairs on the fronds. Usually, they are considered as primitive members, but they are better considered as the derivatives evolved in reduction as shown by the rare presence of short caducous hairs in young fronds.

2. XIPHOPTERIS

Kaulf., Jahrb. Pharm.: 35. 1820; Copel., Gen. Fil.: 214. 1947.

Small plants usually growing in the mats of mosses on tree-trunks. Rhizome short, erect, bearing numerous roots and a tuft of fronds, covered with scales; scales brown, small, membraneous. Stipes very short, hairy. Laminae linear, pinnatifid, pinnatisect or pinnate, lobes subtriangular to oblong, adnate; veins forked or rarely simple. Sori at terminal of short acroscopic branch of veins, one for each lobe, usually round, receptacles elongate.

This is a genus of about 50 species known in the mossy forests throughout the tropics; only 2 species have been recorded from Thailand. This genus is usually interpreted as an intermediate between simple-fronded *Grammitis* and pinnate *Ctenopteris*. *Acrosorus* and *Calymmodon* have the same structure of fronds, though they have evolved on the other lines changing in the soral construction.

KEY TO THE SPECIES

1. Fronds narrow, 3–5 mm wide; lobes subtriangular, moderately acute to round at apex, without distinct lobules **1. X. hieronymusii**
1. Fronds 6–10 mm wide; lobes oblong, moderately acute to acute at apex, falcate, usually with distinct lobules **2. X. khaoluangensis**

1. Xiphopteris hieronymusii (C.Chr.) Holtt., Rev. Fl. Malaya 2: 218. f. 118. 1955.— *Polypodium hieronymusii* C.Chr., Ind. Fil.: 533. 1906, based on *Polypodium sertularioides* J.Sm. ex Hieron., Hedwigia 44: 98. 1905, non Bak., 1876.

Rhizome short, erect, scaly at apex; scales narrow, acute to acuminate at apex, entire, about 2 mm long, membraneous, light brown. *Stipes* very short, castaneous or darker, narrowly winged, glabrescent. *Fronds* linear, attenuate towards both apex and base, up to 15 by 3–5 cm, deeply lobed almost to the rachis; rachis green or dark below, green above, sparsely hairy with short branched hairs; lobes subtriangular, upper edges forming nearly right angle to the rachis, sometimes with small basal acroscopic lobules in fertile lobes, moderately acute to acute at apex, entire; thinly leathery, glabrous; veins forked or rarely simple, basiscopic branches running to near the apex of lobes and the acroscopic ones to upper edges, forming elongate receptacles at apex. *Sori* round, in lobes.

T h a i l a n d.— PENINSULAR: Phangnga (Khao Phota Luang Kaeo), Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— Malaya (type) and Borneo.

E c o l o g y.— In the mats of mosses on trees in dense primitive forests at high altitudes of Khao Luang; fairly abundant.

N o t e.— Thai plants are not so typical for this species: in a frond of one plant in Khao Luang collections, we find the lobes abnormally long bearing branched veins and several sori. The occurrence of such peculiar form may suggest that the species here is not quite stable.

2. Xiphopteris khaoluangensis Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 177. f. 14. 1969.— *Xiphopteris* sp. aff. *X. hieronymusii*, Tagawa & K.Iwats., Southeast As. St. 5: 61. 1967; Acta Phytotax. Geobot. 23: 53. 1968. Figure 58.6.

Rhizome short, erect, bearing several fronds in tuft, scaly; scales ovate-lanceolate, acute, entire, about 2 by 0.6 mm, membraneous, light brown. *Stipes*

short, green or castaneous, narrowly winged to the base, glabrous. *Laminae* linear-lanceolate, widest at middle and gradually narrowing towards both ends, moderately acute at apex, 5–8 cm by 6–10 mm, deeply pinnatisect; rachis green or castaneous below, round and green above, minutely hairy on lower surface with usually pale, adpressed branched hairs about 0.3 mm in length; laminae entirely lobed to rachis, lobes erect-patent, oblong, moderately acute to acuminate, falcate, slightly curved and entire at lower edge, with a distinct lobule near acroscopic base, about 5 by 1.5 mm; lobules subtriangular, acute to acuminate, usually about 1 mm in both length and width; veins once forked, long basiscopic branch in lobe and short acroscopic branch in lobule; coarse to thinly leathery, glabrous. *Sori* at apex of short acroscopic branch of veins, usually at base of lobules, round, about 1.3 mm diam.

T h a i l a n d.— PENINSULAR: Nakhon Si Thammarat (Khao Luang, type), Yala (Gunong Ina).

D i s t r i b u t i o n.— Endemic.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests at ridge of high altitudes; rather rare.

3. CTENOPTERIS

Bl., Fl. Jav. Fil.: 2: 132. 1828; Copel., Gen. Fil.: 218. 1947.

Rhizome short, scaly. Fronds pinnate or rarely pinnatifid or bipinnate, the lower pinnae reduced, hairy usually with red setose hairs; veins pinnate in pinnae, not simple nor once forked. Sori one to several on a pinna, terminal on veins, usually superficial.

This is a genus of more than 200 species known mainly in the tropics throughout the world. Most of the species are epiphytic on mossy tree-trunks in evergreen forests, and small or mediocre in size. In Thailand four species are collected.

KEY TO THE SPECIES

1. Pinnae entire or very slightly lobed
 2. Stipes densely hairy with patent setose hairs — **1. C. mollicoma**
 2. Stipes rather sparsely hairy with very short stiff branched hairs — **2. C. moultonii**
1. Pinnae lobed more than $\frac{1}{5}$ way to costa
 2. Pinnae lobed $\frac{1}{5}$ to $\frac{1}{3}$ way to costa — **3. C. subfalcata**
 2. Pinnae deeply lobed nearly to costa, with one vein in each lobe — **4. C. tenuisecta**

1. Ctenopteris mollicoma (Nees & Bl.) Kunze, Bot. Zeit. 1846: 425; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 533. 1941; Holtt., Rev. Fl. Malaya 2: 226. f. 124. 1955; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 49. 1968.— *Polypodium mollicomum* Nees & Bl., Nova Acta 11: 121. t. 12. 1823.

Rhizome erect, sometimes standing up to 5 cm in height in the masses of mosses on tree-trunks, bearing fronds in tuft at apex, scaly; scales lanceolate, acute to acuminate at apex, 3.5 by 0.4 mm, entire, hairy at margin with setose castaneous hairs, bright brown, rather thick. *Stipes* up to 2 cm long, dark brown, densely covered with patent, setose, castaneous hairs about 2 mm in length. *Fronds* lanceolate, gradually narrowing towards both the apex and the base, up to 20 by 2 cm, deeply pinnatisect nearly to rachis; pinnae oblique, narrowly subtriangular, usually gradually narrowing towards round or moderately acute apex, entire, 1.2 cm long, 2.5 mm broad, the basiscopic base more or less decurrent to rachis; veins hardly visible, pinnate, veinlets simple, 6 – 10 in pairs; papyraceous, both surfaces rather densely hairy, hairs setose, castaneous, 1 – 2 mm long, those on upper surface shorter. *Sori* terminal at veinlets, round, sometimes touching to the next ones, medial.

T h a i l a n d.— PENINSULAR: Nakhon Si Thammarat (Khao Luang), Yala (Gunong Ina).

D i s t r i b u t i o n.— W. Malesia (type from Java).

E c o l o g y.— On mossy tree-trunks in dense evergreen forests on ridges at high altitudes, rather rare.

N o t e.— This is close to *G. brevivenosa* in Borneo, Sumatra and Malaya, and hardly discriminative in definition. The most important key character to distinguish them is the texture of fronds, which is rather difficult to describe in a few words. Our Thai materials have papyraceous lobes of fronds, though the hairs on under surface of fronds are longer as those on stipes in spite of the description in the key by HOLTTUM (1955).

2. Ctenopteris moultonii (Copel.) C.Chr. & Tard., Not. Syst. 8: 181. 1939; in Fl. Gén. I.-C. 7(2): 534. 1941; Holtt., Rev. Fl. Malaya 2: 229. f. 128. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 62. 1967.— *Polypodium moultoni* Copel., Phil. J. Sci. 10 C: 149. 1915. Figure 58. 7 – 8.

Rhizome short, creeping or oblique, bearing fronds closely, densely scaly; scales oblong-subtriangular, gradually narrowing from round base to acuminate apex, entire, about 2.5 cm by 0.5 mm. *Stipes* not distinct, dark castaneous, hairy with short stiff brown branched hairs. *Fronds* narrowly lanceolate, gradually attenuate towards both the apex and the base, larger ones 20 by 3 cm, commonly about 12 by 2 cm, deeply pinnatisect nearly to rachis; pinnae patent or ascending, up to 1.7 cm by 2.5 mm, round or moderately acute at apex, entire, the basiscopic base usually decurrent at base; veins pinnate, veinlets 4 – 10 pairs, hardly visible; thin but firm, hairy on rachis and at margin of pinnae; hairs short, setose, dark brown, branched. *Sori* round, distinct, costal.

T h a i l a n d.— PENINSULAR: Surat Thani (Ko Phangan), Phangnga (Khao Katha Khwam), Trang (Khao Chong), Satun (Ko Adang).

D i s t r i b u t i o n.— Cambodia, Malaya, Sumatra and Borneo (type).

E c o l o g y.— On moist tree-trunks in dense evergreen forests on ridges.

3. Ctenopteris subfalcata (Bl.) Kunze, Bot. Zeit. 6: 120. 1848; Tagawa & K.Iwats., Southeast As. St. 5: 62. 1967.— *Polypodium subfalcatum* Bl., En. Pl. Jav.: 130. 1828; Bedd., Handb.: 314. f. 168. 1883.— *Polypodium subminutum* v.A.v.Ros., Mal. Ferns: 598. 1909.— *Ctenopteris subminuta* (v.A.v.Ros.) Holtt., Rev. Fl. Malaya 2: 228. f. 127. 1955.

Rhizome short, erect, bearing a tuft of fronds at apex, scaly; scales thin, membraneous, light brown, up to 2 mm long. *Stipes* up to 1 cm long, indistinct, densely hairy with setose pale, patent hairs up to 2 mm in length. *Fronds* oblong-lanceolate, gradually narrowing towards both apex and base, up to 10 by 1.5 cm; pinnae ascending, narrow, round or moderately acute at apex, gross dentate about $\frac{1}{5}$ to $\frac{1}{3}$ way towards costa, up to 8 by 3 mm, the lobes round-subdeltoid, round to moderately acute at apex, each containing a veinlet; thinly herbaceous, densely hairy on both surfaces with long, pale setose hairs up to 2 mm in length. *Sori* round, one to each lobe, usually fusing with the next ones at maturity.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Pha Hom Pok, Doi Khun Huai Pong, Doi Suthep, Doi Inthanon); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— Sri Lanka, Himalayas, S. China, W. Malesia (type from Java) and Taiwan.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests usually on ridges at high altitudes.

N o t e.— Comparing with the materials from Sri Lanka and Malesia, our Thai plants are usually smaller in size and the lobing is deeper at margin of pinnae. Specimens from northern mountains are constant in the various taxonomic features, and are different from variable Malesian plants. We have not actually examined the Chinese materials in detail in the fields, but the plants in Himalaya, China and N. Thailand may be suggested here to belong a distinct species from *C. subfalcata* in Malesia.

4. Ctenopteris tenuisecta (Bl.) J.Sm., Hist. Fil.: 185. 1875; Holtt., Rev. Fl. Malaya 2: 226. f. 123. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 62. 1967.— *Polypodium tenuisectum* Bl., En. Pl. Jav.: 134. 1828. Figure 58. 9–10.

Rhizome short creeping, about 2.5 mm diam., bearing fronds closely, scaly; scales oblong-subtriangular, round to cordate at base, attenuate at apex, about 5 by 1.5 mm, entire at margin, brown. *Stipes* up to 3 cm long, dark brown to castaneous, densely hirsute with setose, patent castaneous hairs up to 1.5 mm in length. *Laminae* oblong-lanceolate, gradually narrowing downwards, acuminate at apex, up to 30 by 4 cm, deeply bipinnatisect; rachis narrowly winged, like stipes, densely hairy throughout; pinnae up to 40 pairs, narrowly oblong, up to 2.5 cm by 6 mm, the basal acroscopic lobes at junction between rachis and costa, the basal basiscopic lobes decurrent to rachis, lobed nearly to costa; lobes narrow, slightly falcate, oblique, 3 by 0.6 mm, rounded to moderately acute at apex, entire, each

containing a veinlet; papyraceous. *Sori* one at base of each lobe, round, up to 1 mm diam.

T h a i l a n d.— PENINSULAR: Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— Malaya, Sumatra, Java (type) to the Philippines and Taiwan, also in New Guinea and Samoa.

E c o l o g y.— On humus-rich floor of dense evergreen forests at about 1500 m alt. on Khao Luang, known only on this mountain in Thailand.

N o t e.— This and the allied species with bipinnatisect fronds are usually considered as the primitive species among the genus. It is rather difficult to know which is more primitive form among the Grammitid ferns, though the dwarf, simple-fronded species may usually be as the derivatives. This fact does not necessarily mean that the finely dissected species as this is primitive. In the case of this species, the firm axes of fronds with short-creeping rhizome may safely be suggested as a primitive form of *Ctenopteris*.

4. PROSAPTIA

Presl, Tent. Pterid.: 165. 1836; Copel., Gen. Fil.: 220. 1947.

Rhizome short-creeping or ascending, scaly. Fronds in tuft, pinnatifid with free venation. Sori round to elliptic, more or less sunk in cavities at margin or on lower surface of fronds.

This genus is distinguished from *Ctenopteris* by more or less distinct soral cavities, though the generic distinctness remains still doubtful. Thus defined, *Prosaptia* is a genus of about 15 species in the Old World tropics north to the Ryukyu Islands. There are six species known to Thailand.

KEY TO THE SPECIES

1. Mouth of soral cavities not opening towards the margin of lobes
2. Soral cavities without raised edges
3. Fronds lobed, with wings of rachis about 2 mm in breadth — **1. P. khasyana**
3. Fronds pinnate, with pinnae attached by broad base — **6. P. celebica**
2. Soral cavities with raised edges — **2. P. obliquata**
1. Mouth of soral cavities opening towards the margin of lobes
4. Sori marginal. Fronds lobed almost to midrib — **3. P. contigua**
4. Mouth of soral cavities within the margin of lobes
5. Fronds lobed to a wing 2 – 3 mm in width on each side of midrib — **4. P. alata**
5. Fronds lobed to less than 1 mm from midrib — **5. P. leysii**

1. Prosaptia khasyana (Hook.) C.Chr. & Tard., Not. Syst. 8: 180. 1939; in Fl. Gén. I.-C. 7(2): 531. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 62. 1967.— *Polypodium khasyanum* Hook., Ic. Pl.: t. 949. 1854; Bedd., Handb.: 308. 1883.— *Ctenopteris khasyana* (Hook.) Holtt., Rev. Fl. Malaya 2: 233. f. 134. 1955; Dansk Bot. Ark. 20: 21. 1961; 23: 232. 1965.

Rhizome short, ascending, bearing a tuft of fronds at apex, scaly; scales oblong-subdeltoid, about 3 by 1.2 mm, pale brown, pubescent at margin. *Stipes* very stout, castaneous, densely pubescent. *Laminae* narrowly lanceolate, gradually narrowing towards both ends, 20 – 40 by up to 3 cm, deeply lobed to midrib with a wing 1 – 2 mm in breadth at each side; lobes oblique, oblong-subtriangular, moderately acute at apex, entire, the lower ones gradually reducing in length, the upper ones gradually becoming smaller upwards, the middle largest ones 1.4 by 0.5 mm; thinly leathery, veins simple, the lowest basiscopic ones usually running directly from midrib, the upper surface glabrous or very sparsely hairy, the margin and lower surface hairy, marginal hairs sometimes in tuft, setose, dark brown. *Sori* terminal at veins, round to subelliptic, medial or nearly so, sunk in cavities without prominent edges.

T h a i l a n d.— NORTH-EASTERN: Loei (Phu Luang, Phu Kradueng, Phu Lom Lo); SOUTH-EASTERN: Prachin Buri (Khao Yai); SOUTH-WESTERN: Prachuap Khiri Khan (Khao Luang); PENINSULAR: Krabi (Phanom Bencha), Phangnga (Khao Bang To).

D i s t r i b u t i o n.— Himalayas (type) to W. Malesia, also in S. China (Hainan).

E c o l o g y.— On muddy cliffs along streams in dense evergreen forests at medium altitudes (1100 – 1500 m).

2. Prosaptia obliquata (Bl.) Mett., Reise Oest. Freg. Nov. Bot. 1: 214. 1870; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 529. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 63. 1967.— *Polypodium obliquatum* Bl., En. Pl. Jav.: 128. 1828; Fl. Jav. Fil.: 181. t. 85 B. 1829; Bedd., Handb.: 311. f. 166. 1883.— *Ctenopteris obliquata* (Bl.) Copel. Phil. J. Sci. 81: 111. 1953; Holtt., Rev. Fl. Malaya 2: 221. f. 129. 1955.

Rhizome short, creeping to ascending, bearing fronds in tuft, scaly; scales narrowly subtriangular, up to 4 by 1 mm, long-acuminate at apex, clathrate with thick internal walls and transparent surfaces, densely hairy at margin with setose dark brown hairs, thinly leathery. *Stipes* up to 3 cm long, pale brown, densely hairy. *Laminae* linear-lanceolate, gradually narrowing towards both ends, up to 40 by 4 cm wide, deeply lobed nearly to midrib, the wings less than 0.5 mm in breadth at both sides of midrib; middle lobes slightly ascending, gradually narrowing from base towards acuminate apex, up to 2.2 cm by 3 mm, the lower ones gradually shorter and the upper ones becoming smaller upwards; thinly leathery to papyraceous; veins simple or rarely forked, hairy at margin of lobes with short, setose brown hairs. *Sori* terminal at veins, oblong, oblique, medial or submarginal, immersed with distinctly raised edges.

T h a i l a n d.— PENINSULAR: Krabi (Phanom Bencha), Phangnga (Khao Phota Luang Kaeo), Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— Tropics of Asia, from S. India and Sri Lanka to New Guinea (type from Java).

E c o l o g y.— On mossy tree-trunks in dense evergreen forests at medium

or high altitudes, rather rare but locally abundant.

N o t e.— According to some authors, the species with superficial sori are referred to *Ctenitis*, including in *Prosaptia* only the members with marginal sori. We are still not sure whether *Prosaptia* in this delimitation is a distinct genus or not, and pending the conclusion for more detailed revisional work.

3. Prosaptia contigua (Forst.) Presl, Tent. Pterid.: 166. 1936; Bedd., Handb.: 56. f. 28. 1883; Tagawa & K.Iwats., Southeast As. St. 5: 63. 1967; Acta Phytotax. Geobot. 23: 53. 1968.— *Trichomanes contiguum* Forst., Prodr.: 84. 1786.— *Ctenopteris contigua* (Forst.) Holtt., Rev. Fl. Malaya 2: 230. f. 130. 1955.

Rhizome short-creeping, bearing, fronds closely, densely scaly; scales subtriangular, attenuate at apex, about 3 by 1.7 mm, thin, more or less clathrate, hairy at margin with dark brown, short setose hairs. *Stipes* short, dark brown, rather densely setose hairy. *Laminae* linear-lanceolate, gradually narrowing towards both ends, up to 30 by 2.5 cm, deeply lobed nearly to midrib with a wing less than 1 mm in breadth at each side; middle largest lobes slightly ascending, narrowly subtriangular, straight or slightly falcate, entire, up to 1.5 cm by 4 mm; thinly leathery, veins simple, sparsely hairy at margin. *Sori* in cup-shaped cavities at margin of apical portion of lobes, opening towards margin, about 1 mm diam.

T h a i l a n d.— PENINSULAR: Chumphon (Khao Nom Sao), Surat Thani (Khao Nong), Nakhon Si Thammarat (Khao Luang), Yala (Gunong Ina).

D i s t r i b u t i o n.— Tropics of Asia, Sri Lanka, S.India, Sumatra to Polynesia.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests at high altitudes, rather rare.

N o t e.— Except in the difference in soral character, this and the preceding species are quite similar, and this species is abundant on Khao Luang completely mixed with the preceding one.

4. Prosaptia alata (Bl.) Christ, Ann. Jard. Bot. Buit. II. 5: 127. 1905; Tagawa & K.Iwats., Southeast As. St. 5: 63. 1967; Acta Phytotax. Geobot. 23: 53. 1968.— *Davallia alata* Bl., En. Pl. Jav.: 230. 1828.— *Ctenopteris alata* (Bl.) Holtt., Rev. Fl. Malaya 2: 232. f. 131. 1955. Figure 59. 1–3.

Rhizome short, subascending to suberect, bearing a few fronds in tuft, scaly; scales narrow, up to 4 by 0.7 mm, gradually narrowing towards attenuate apex, subclathrate with darker internal walls, setose hairy at margin, pale brown. *Stipes* very short, castaneous or darker, hairy. *Laminae* narrowly lanceolate, gradually narrowing towards both ends, moderately acute to acuminate at apex, deeply lobed to midrib with a wing 0.7–1.5 mm in breadth at each side of midrib, up to 20 by 2 cm; middle lobes subpatent to slightly ascending, round to moderately acute at apex, entire, up to 1 cm by 3.5 mm; thinly leathery, sparsely hairy at margin, veins

simple, hidden. *Sori* terminal on veinlets, 1 – 3 on a lobe usually on apical position, submarginal, cup-shaped with the mouth opening towards margin.

T h a i l a n d.— PENINSULAR: Chumphon (Khao Nom Sao), Surat Thani (Ko Phangan), Trang (Khao Chong), Yala (Khao Khalakhiri).

D i s t r i b u t i o n.— Tropics of Asia, Sri Lanka to Polynesia (type from Java).

E c o l o g y.— On mossy tree-trunks in dense evergreen forests or in light forests by streams at low to medium altitudes.

5. Prosaptia leysii (Bak.) Ching, Bull. Fan Mem. Inst. Biol. 10: 242. 1941; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 53. 1968.— *Polypodium leysii* Bak., J. Bot. 1879: 66.— *Ctenopteris leysii* (Bak.) Holtt., Rev. Fl. Malaya 2: 232. f. 132. 1955.

Vegetative structures like those of *P. obliquata*, differing only in: narrower and thinner pinnae; sori submarginal, very like those of the preceding species.

T h a i l a n d.— PENINSULAR: Yala (Betong).

D i s t r i b u t i o n.— W. Malesia (type from Sulu Archipelago).

E c o l o g y.— On mossy tree-trunks at low altitudes; known by only one collection.

6. Prosaptia celebica (Bl.) Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 61. 1969.— *Polypodium celebicum* Bl., En. Pl. Jav.: 127. 1828.— *Ctenopteris celebica* (Bl.) Copel., Univ. Calif. Publ. Bot. 18: 225. 1942; Holtt., Rev. Fl. Malaya 2: 233. f. 133. 1955.

Similar to *C. obliquata*, differing from it in: stipes densely hairy; hairs fine, spreading, 1 – 1.6 mm in length; soral cavities not so prominently raised at edge, open and elliptic.

T h a i l a n d.— PENINSULAR: Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— Malesia (type from Java).

E c o l o g y.— Epiphytic in evergreen forests at 1000 – 1740 m alt.

5. CALYMMODON

Presl, Tent. Pterid.: 203. 1836; Copel., Gen. Fil.: 215. 1947.

Small plants. Rhizome short, creeping or suberect, with a tuft of fronds at apex, scaly. Laminae narrow, hairy, lobed almost to midrib, each lobe with a simple vein. Sori on upper lobes, one to each lobe, folded at basiscopic portion to protect young sori.

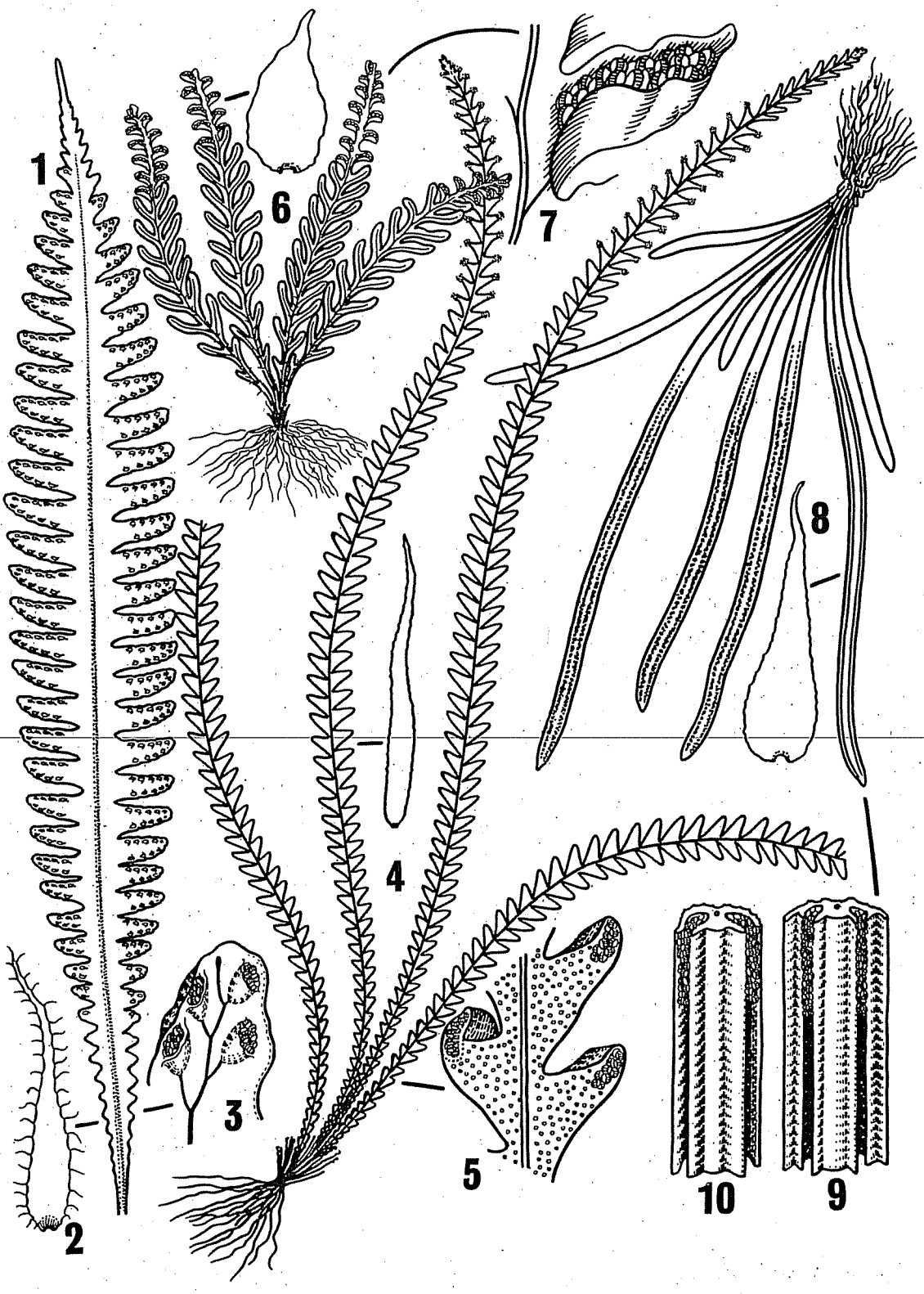

Figure 59. 1–3: *Prosaptia alata*; 1. fertile frond (natural size); 2. scale on rhizome (x 13); 3. fertile segment, enlarged. 4–5: *Acrosorus triangularis*; 4. plant (natural size) and scale on rhizome (x 13); 5. part of fertile leaf (x 8). 6–7: *Calymmodon asiaticus*; 6. plant (x 2) and scale on rhizome (x 30); 7. fertile pinna enlarged (x 20). 8–9: *Scleroglossum pusillum*; 8. plant (natural size) and scale on rhizome (x 13); 9. part of fertile leaf (x 5). 10. *S. minus*; part of fertile leaf (x 5).

More than a dozen of species are known in the tropics of Asia and Oceania, Sri Lanka and Samoa, and north to Taiwan, but the specific boundaries are still not clear. In Thailand two species are recorded in the Peninsula.

KEY TO THE SPECIES

1. Epiphytic on mossy tree-trunks. Fronds more than 3 cm by 3 – 6 mm; sterile lobes more than 1 mm broad **1. C. cucullatus**
1. On wet mossy rocks. Fronds less than 2 cm by 2 – 4 mm; sterile lobes less than 0.8 mm broad **2. C. asiaticus**

1. Calymmodon cucullatus (Nees & Bl.) Presl, Tent. Pterid.: 204. 1836; Copel., Phil. J. Sci. 34: 261. 1927; Holtt., Rev. Fl. Malaya 2: 220. f. 120. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 62. 1967; Acta Phytotax. Geobot. 23: 53. 1968. — *Polypodium cucullatum* Nees & Bl., Nova Acta 1: 121. 1828; Bedd., Handb.: 307. f. 161. 1883.

Rhizome short, suberect, bearing many fronds in tuft, scaly; scales brown, not clathrate, about 3 by 0.8 mm, narrowly oblong, rather suddenly narrowed at acuminate apex, entire at margin, glabrous. *Stipes* very short, dark brown, winged. *Laminae* linear, up to 5 cm by 5 – 8 mm, lobed almost to midrib with a wing less than 0.3 mm broad at each side; sterile lobes oblong, round to moderately acute at apex, entire at margin, up to 4 by 1.5 mm; thin, veins simple, distinct, very sparsely hairy with pale soft hairs; fertile lobes on upper part of fronds. *Sori* solitary, naked but protected by folded basiscopic half of the fertile lobes, thus the fertile lobes bilabiate in appearance.

T h a i l a n d.— PENINSULAR: Chumphon (Khao Nom Sao), Nakhon Si Thammarat (Khao Luang), Phangnga (Khao Katha Khwam), Yala (Gunong Ina).

D i s t r i b u t i o n.— Palaeotropics (type from Java), Sri Lanka and Sumatra to Australia.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests on ridges at high altitudes, rather rare.

N o t e.— The above description is drawn from Thai collections, but the typical form of this species is much larger in size, up to 20 by 1 cm, though the size and form of sterile lobes are much variable.

2. Calymmodon asiaticus Copel., Phil. J. Sci. 38: 154. 1929; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 526. 1941; Tagawa & K.Iwats., Southeast As. St. 5: 62. 1967. Figure 59. 6 – 7.

Rhizome short, suberect, bearing several fronds in tuft at apex, sparsely scaly; scales thin, brown, not clathrate, oblong-lanceolate, up to 2 by 0.7 mm. *Stipes*

indistinct, very short, green or brownish, winged to the very base, hairy with pale setose hairs up to 0.3 mm in length. *Laminae* narrowly lanceolate, gradually narrowing towards both ends, 1.5–3.5 by up to 0.5 cm wide, deeply lobed to midrib with a wing less than 0.2 mm broad on each side; sterile lobes oblong, ascending, round to moderately acute at apex, entire, up to 2.5 by 0.7 mm; thinly leathery, veins simple, hardly visible, glabrous or nearly so except for hairy midrib; fertile lobes at upper parts of fronds, 2–7 pairs. *Sori* solitary, the basiscopic half of fertile lobes folded to protect young sori, thus the fertile lobes appearing bivalvate.

Thailand.— PENINSULAR: Nakhon Si Thammarat (Khao Luang), Trang (Khao Soi Dao).

Distribution.— Vietnam (type).

Ecology.— On muddy rocks in spraying stream-beds in gloomy dense forests at medium altitudes (600–900 m), rather rare.

6. ACROSORUS

Copel., Phil. J. Sci. 1. Suppl.: 158. 1906; Gen. Fil.: 216. 1947.

Rhizome short, bearing a rosette of fronds at apex, scaly. Fronds narrow, deeply lobed, each lobe with a single vein; texture leathery or fleshy; stipes and midrib short hairy; fertile lobes on upper parts of fronds. Sori solitary, protected when young by the two edges of the distal half of lobe being reflexed and meeting over it.

The soral construction seems apparently to be derived in parallel with *Calymmodon*, probably from different origin. *Calymmodon* is similar to *Xiphopteris* at least in the vegetative features and seems to be evolved from the latter by the folding of the fertile lobes. *Acrosorus* is, on the contrary, comparable with simpler forms of *Prosaptia*, especially in their fleshy fronds and a little sunk sori enclosed by the distal ends of lobes. Some six species are credited to this genus in Malesian and Polynesian regions, and only one of them has been collected in Thailand.

Acrosorus triangularis (Scort. ex Bedd.) Copel., Phil. J. Sci. 3 C: 347. 1909; Holtt., Rev. Fl. Malaya 2: 222. f. 122. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 62. 1967; Acta Phytotax. Geobot. 23: 53. 1968.— *Polypodium triangulare* Scort. ex Bedd., J. Bot. 25: 324. t. 278. f. 1. 1887; Handb. Suppl.: 87. 1892. Figure 59. 4–5.

Rhizome short, suberect, bearing fronds in tuft, usually also with old fronds, scaly; scales linear, up to 5 by 0.4 mm, brown or bright brown, with 3–6 rows of longitudinal cells, entire. *Stipes* indistinct, green to brown, winged to the very base. *Laminae* linear, up to 20 cm by 7 mm, gradually narrowing towards both apex and base, deeply lobed almost to midrib; sterile lobes subtriangular, the acroscopic edges almost straight, nearly rectangular to midrib, the basiscopic edges almost straight or slightly curved, forming about 45° to midrib, the apex moderately acute,

3 – 4 mm in both length and width; thinly leathery, glabrous or nearly so except on midrib, veins hardly visible, simple; fertile lobes at middle or apical portion of fronds, sometimes mixed with sterile ones, each bearing a sorus, both edges of the distal half reflexed and meeting over sorus and protected it when young.

T h a i l a n d.— PENINSULAR: Surat Thani (Khao Nong), Nakhon Si Thammarat (Khao Luang), Yala (Gunong Ina).

D i s t r i b u t i o n.— Malaya (type), Borneo and the Philippines.

E c o l o g y.— On mossy tree-trunks in dense evergreen forests on ridges at medium or high altitudes, rather common.

N o t e.— *A. streptophyllus* is another species common in Malaya and Borneo, and *A. triangularis* was once reduced to the former by Christensen. These two are, however, easily distinguished by the size of fronds, texture and the soral construction: *A. streptophyllus* has the fronds 5 – 20 cm by 3 – 5 mm, of more thinly leathery texture and the sori not sunk in the lobes.

7. SCLEROGLOSSUM

v.A.v.Ros., Bull. Jard. Bot. Buit. II. 7: 37. 1912; Copel., Gen. Fil.: 213. 1947.

Rhizome short, bearing a rosette of fronds, scaly. Fronds simple, narrow, entire, glabrous or setose hairy, leathery in texture; veins hardly visible, usually once forked. Sori sunk in marginal or submarginal grooves, naked.

Several species are known in Malesian and Polynesian regions, though the specific boundary is still obscure. Two of them occur in Thailand.

KEY TO THE SPECIES

1. Grooves of sori medial. Stipes glabrous	**1. S. pusillum**
1. Grooves of sori almost marginal. Stipes with stellate hairs	**2. S. minus**

1. Scleroglossum pusillum (Bl.) v.A.v.Ros., Bull. Jard. Bot. Buit. II. 7: 39. pl. 5. f. 1 – 2. 1912; C.Chr., Dansk Bot. Ark. 6(3): 27. 1929; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 524. f. 39, 4 – 5. 1941; Holtt., Rev. Fl. Malaya 2: 234. f. 135. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 63. 1967; Acta Phytotax. Geobot. 23: 53. 1968.— *Vittaria pusilla* Bl., En. Pl. Jav.: 199. 1828. Figure 59. 8 – 9.

Rhizome short, suberect, bearing a tuft of fronds at apex, scaly; scales narrow, gradually narrowing from base towards acuminate apex, up to 4 by 0.8 mm, pale brown, entire. *Stipes* very short, indistinct, dark brown, glabrous. *Laminae* simple, linear, moderately acute at apex, up to 10 cm by 3.5 mm; leathery, glabrous. *Soral grooves* submarginal, opening towards margin, in apical to middle portion.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Suthep); SOUTH-EASTERN: Trat (Khao Kuap, Tha Kum); PENINSULAR: Nakhon Si Thammarat (Khao Luang), Yala (Gunong Ina).

D i s t r i b u t i o n.— Malesia throughout (type from Java).

E c o l o g y.— On tree-trunks in dense mossy forests at high altitudes, rather rare.

2. Scleroglossum minus (Fée) C.Chr., Dansk Bot. Ark. 6(3): 29. 1929; Holtt., Rev. Fl. Malaya 2: 236. 1955; Tagawa & K.Iwats., Southeast As. St. 5: 63. 1967.— *Vittaria minor* Fée, 3^{me} Mem. 23. pl. 4. f. 2. 1852. Figure 59. 10.

Rhizome short, ascending, bearing a tuft of fronds, scaly; scales thin, brown, gradually narrowing from base towards apex, up to 4 by 0.8 mm. *Stipes* indistinct, dark, winged to the base, sparsely stellate hairy. *Laminae* simple, linear, up to 8 cm by 4 mm; leathery, sparsely hairy. *Soral grooves* medial, at middle or somewhat marginal between midrib and margin of fronds.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Inthanon, Khun Mae Tuen), Phitsanulok (Thung Salaeng Luang, Phu Miang); NORTH-EASTERN: Loei (Phu Luang); PENINSULAR: Nakhon Si Thammarat (Khao Luang).

D i s t r i b u t i o n.— Malaya, Borneo, and the Philippines (type).

E c o l o g y.— On mossy tree-trunks in dense evergreen or deciduous forests at medium or high altitudes throughout Thailand but rather rare.

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32. MARSILEACEAE

This water fern family is comparable with the Schizaeaceae, though true affinity is still obscure.

MARSILEA

Linn., Sp. Pl. 2: 1099. 1753; Gen. Pl.: 485. 1754; Copel., Gen. Fil.: 230. 1947.

Rhizome long-creeping. Fronds with usually floating four leaflets; leaflets commonly obovate, with round apex and cuneate base; veins dichotomously branching, forming irregular areoles without included veinlets; heterosporous, bearing mega- and micro-sporangia in sporocarps borne near the base of stipes.

In paddy fields or in streams as well as in ponds, the plants of this family are rather common throughout Thailand, but all of them are at present referred to a single species.

Marsilea crenata Presl, Rel. Haenk. 1: 84. t. 12. f. 13. 1825; Holtt., Rev. Fl. Malaya 2: 619. 1955; Dansk Bot. Ark. 20: 35. 1961; Tagawa & K.Iwats., Southeast As. St. 5: 112. 1967.— *Marsilea* sp. aff. *M. polycarpa* Hook. & Grev., Ic. Fil.: t. 160. 1829; Holtt., Dansk Bot. Ark. 20: 35. 1961. Figure 60. 1 – 3.

Rhizome slender, long-creeping, irregularly branching, bearing pale brown hairs. *Stipes* rather close, green, stramineous or pale brown, darker towards base, 2 – 3 cm long in exposed place, or 6 – 18 cm long in immersed plants, hairy or glabrescent. *Leaflets* fan-shaped, round and subentire to undulate at apex, broadly cuneate at base, 0.5 – 2 cm both in length and in breadth, glabrous, or hairy at margin when young. *Sporocarps* one to several on short stalks placed at base of stipes, oblong, 2 – 5 mm long, covered with caducous hairs.

T h a i l a n d.— NORTHERN: Chiang Mai (Fang, Chiang Dao, Ban Pong Yaeng, Ban Mae Kon, Ban Yang, Ban Kao, Chom Thong), Phitsanulok; EASTERN: Chaiyaphum (Thung Kramang); NORTH-EASTERN: Khon Kaen (Chum Phae), Phetchabun (Wichian Buri); CENTRAL: Krung Thep (Bangkok); SOUTH-WESTERN: Kanchanaburi (Sai Yok); PENINSULAR: Krabi (Tambon Khao Phanom).

D i s t r i b u t i o n.— W. Malesia (type from the Philippines), north to the Ryukyus.

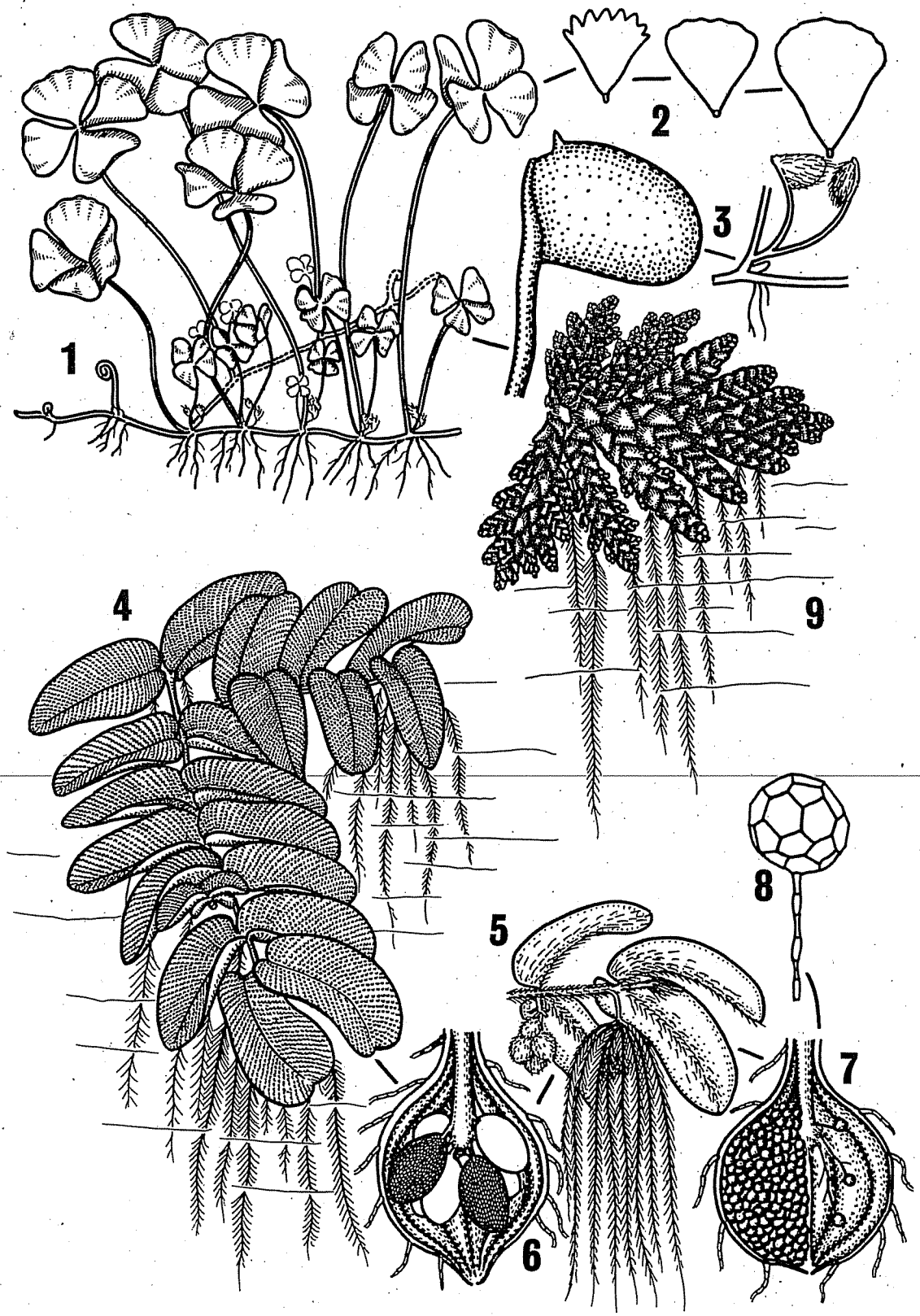

Figure 60. 1–3: *Marsilea crenata*; 1. plant (x 0.6); 2. various types of leaflet (x 1.5); 3. branching of sporocarp stalk (x 25) and sporocarp enlarged (x 15, hairs omitted). 4–8: *Salvinia natans*; 4. plant (x 2.5); 5. ventral view of plant, showing sporocarp-bearing segment (x 2.5); 6. sporocarp with female sporangia (x 20); 7. sporocarp with male sporangia (x 13); 8. male sporangium (x 75). 9. *Azolla pinnata*; plant (x 4).

E c o l o g y.— In paddy fields, in grooves, in streamlets, in ponds or in marshy places, usually in open sunny places, rather common throughout the country at low or medium altitudes, lower than 1000 m.

V e r n a c u l a r.— Phak linpi (ผักลิ้นปี่) (Peninsular); phak waen (ผักแว่น) (Northern, Central); nu-to (หนูเต๊าะ) (Karen/Northern).

N o t e.— This species has not yet been well defined as in the case of the other species of this genus. According to the number and position of the sporocarps, the species are distinguished, though we can not surely discriminate the species only by this feature. HOLTTUM (1955) recorded *M. polycarpa* which is distinguishable by having more numbers of sporocarps attached higher than the base of stipe. It should be further observed in the fields, for the variation of such a feature found in sporocarps is comparatively high, especially according to the condition of water level.

33. SALVINIACEAE

A water fern family with floating small plants includes a single genus consisting in some ten species known in all the warmer regions of the world.

SALVINIA

Adans., Fam. Pl. 2: 15. 1763; Copel., Gen. Fil.: 232. 1947.

Small floating ferns. Rhizome short-creeping, hairy, bearing the leaves in whorls of three rows, two simple and entire, green, floating, the third submerged, branching and growing downwards. Sori on submerged leaves, enclosed entirely by indusia; mega- and micro-sporangia in different sori.

Among about ten known species, two are native to Thailand.

KEY TO THE SPECIES

1. Lobes horizontal, oblong, pilose on upper surface **1. S. natans**
1. Lobes with sides curved upwards and inwards to meet at edges, triangular, papillate on upper surface **2. S. cucullata**

1. Salvinia natans (Linn.) All., Fl. Pedem. 2: 289. 1785; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 542. f. 64. 7. 1941 – 51; Tagawa & K.Iwats., Acta Phytotax. Geobot. 23: 50. 1968.— *Marsilea natans* Linn., Sp. Pl. 2: 1099. 1753. Figure 60. 4 – 8.

Stems branching irregularly, hairy. *Floating leaves* herbaceous, elliptic or narrowly so, 1 – 2 by 0.3 – 0.6 cm, shortly stalked; upper surface covered with dense short projections bearing several prickle-like hairs at apex, lower surface bearing downy hairs. *Sori* crowded at base of submerged leaves, spherical, covered with soft hairs.

Thailand.— SOUTH-WESTERN: Ratchaburi (Chom Bueng).

Distribution.— C. Europe (type from Italy), N. India, China, Japan, N. Vietnam and Java.

Ecology.— Floating in water pool in open places.

Vernacular.— Khrai (ไคร้) (South-western); nae bai makham (แหนใบ-มะขาม) (Central).

N o t e.— This species is collected only once in Thailand, but expected to be more commonly in Northern. According to the artificial condition for the irrigation system, distribution of the water plants is always changeable.

2. Salvinia cucullata Roxb. ex Bory in Bél., Voy. Bot. 2: 6. 1833; Tard. & C.Chr. in Fl. Gén. I.-C. 7(2): 543. 1941; Holtt., Rev. Fl. Malaya 2: 621. 1955; Dansk Bot. Ark. 20: 35. 1961; Tagawa & K.Iwats., Southeast As. St. 3(3): 89. 1965; 5: 112. 1967.

Floating leaves thick but soft, 1.2 – 1.8 cm long, wider than long, with sides curved upwardly and inwardly to meet the edges; upper surface covered with dense short projections bearing setae; lower surface with a few downy hairs. *Sori* many on various branches of the submerged leaves.

T h a i l a n d.— NORTHERN: Chiang Mai; CENTRAL: Pathum Thani, Phra Nakhon (Bangkhen); SOUTH-WESTERN: Prachuap Khiri Khan (Sam Roi Yot); PENINSULAR: Surat Thani (Huai Mut).

D i s t r i b u t i o n.— India (type), Indochina, Malaya to Sumatra.

E c o l o g y.— Floating on water in open places.

V e r n a c u l a r.— Chok hu nu (จอกหูหนู) (Central).

N o t e.— This species is represented by the herbarium specimens only by several collections but rather common in central plane and the other parts of Thailand. The water plants can be carried by men among the roots of the other plants and grow actively when they find the suitable habitat. This species seems to become common throughout Thailand only recently, by getting appropriate habitats by the improvement of the irrigation system for paddy fields, and also by making new creeks along highways.

34. AZOLLACEAE

This tiny water fern consists in a single genus of half a dozen species ranging all over the world.

AZOLLA

Lamk., Ency. 1: 343. 1783; Copel., Gen. Fil.: 232. 1947.

Rhizome short-creeping, branching alternately, with many submerged roots, hairy. Fronds bilobed. Sori near the base of submerged lobes, enclosed by indusia; a megasporangium or numerous microsporangia in each sori.

There are two species recorded from Thailand, though the specific boundary is still obscure.

1. Azolla pinnata R.Br., Prodr. Fl. N. Holl.: 167. 1810; Holtt., Rev. Fl. Malaya 2: 622. 1955; Dansk Bot. Ark. 20: 35. 1961; Tagawa & K.Iwats., Southeast As. St. 5: 113. 1967. Figure 60. 9.

Stems densely pinnate, forming triangular outline for the whole plants, 1 – 3 cm long. *Leaves* less than 1 mm long, purplish to reddish in old ones; upper surface densely papillose, with semitransparent cartilaginous membrane at margin. *Roots* up to 5 cm long, bearing root-hairs.

T h a i l a n d.— NORTHERN: Chiang Mai, Kamphaeng Phet; CENTRAL: Phra Nakhon (Bangkhen); SOUTH-EASTERN: Chanthaburi (Phriu Waterfall); PENINSULAR: Surat Thani (Huai Mut).

D i s t r i b u t i o n.— Palaeotropics (type from Australia).

E c o l o g y.— Floating on canals or on paddy fields usually in sunny places at low altitudes.

V e r n a c u l a r.— Nae daeng (แหนแดง) (Central).

2. Azolla caroliniana Willd., Sp. Pl. 5: 541. 1810; Holtt., Dansk Bot. Ark. 20: 35. 1961.

Plants smaller, up to about 2 by 1 cm. *Leaves* less than 1 mm long, green to purplish in old ones; upper surface papillose. *Roots* up to 5 cm long, bearing fine root-hairs.

T h a i l a n d.— NORTHERN: Phayao.

D i s t r i b u t i o n.— American tropics (type from N. America), dispersed to the tropics throughout the world and the range being dubious at present.

E c o l o g y.— Floating in water hole.

V e r n a c u l a r.— Nae daeng (แหนแดง) (Northern).

N o t e.— We are not certain to place this material in this species, though no further identification is possible at present. It is highly necessary to revise all the *Azolla* species and no conclusion can be given at present for the identification of this water fern.

GLOSSARY

Acrophyll: In some genera of Lomariopsidaceae, there are two distinct kinds of leaves: those near the grounds are bathyphyll (bottom leaf) and are usually more divided; adult leaves are acrophyll (top leaf) and are at some distance above the ground.

Acrostichoid: Sporangia do not form any sori and are spread all over the under surface of laminae; like *Acrostichum*.

Aerophore: There are distinct pale spots along the stipe and they are usually air-transparing; or, special projections are at base of pinna-rachis or costae of pinnae.

Anadromic: The basal basiscopic pinnules are placed anterior (more distal) than basal acroscopic pinnules, and/or the same sequence is found in the further branching of axis; controversy to catadromic.

Annulus: A row of specialized cells of sporangium; septae are thick-walled and elastic to be spore bursting at maturity.

Articulated hair: Hairs seem to be articulated; internal cell-walls, or septae, are thick and dark, instead of the other walls thin and transparent; when dried the cells are flattened but the septae are standing unsquashed.

Bathyphyll: Cf. acrophyll.

Catadromic: Cf. anadromic.

Caudex: The short stem bearing radial fronds, or erect or ascending rhizome.

Chaetopteroid: Ferns bearing only the hairs but no scales. Cf. lepidopteroid.

Coenosori: Many sori gathering to form a single unit.

Dryanaroid venation: Fide venation pattern.

Elator: The special accessaries attached to the spores of *Equisetum*.

Eusporangiate: Sporangium initial consists of several epidermal cells which divide periclinally nearly at the same time. Sporangium has its wall a few cells thick.

Exospore: Descriptive term for the exine of the spores of *Ophioglossum*.

False veins: The vein-like strands visible on the surface of laminae but having no vascular strands; known in *Selaginella*, *Angiopteris*, *Davallia*, *Vittaria*, some Hymenophyllaceae, and the others, and they are not the same in their morphology; often called pseudoveins.

Goniopteroid venation: Fide venation pattern.

Lepidopteroid: Ferns bearing scales, either with or without any hairs. Cf. chaetopteroid.

Leptosporangiate: Sporangium initial cell is a single epidermal cell which divides periclinally to form apical and basal cells. From apical cell is developed a sporangium of which wall is one-cell thick. Cf. eusporangiate.

Ligule: A small projection at adaxial base of microphyll in heterosporous Microphyllophyta (Selaginellaceae, Isoetaceae); its function is not known.

Marginales: The ferns whoes sori develop from the margin of leaves, or at terminal of veins. Cf. Superficiales.

Megaphyll: Most common leaf of land plants, usually multinervate; believed to be derived by metamorphosis from a telome truss. Cf. microphyll.

Meniscioid venation: Fide venation pattern.

Microphyll: Leaf of Microphyllophyta (Lycopodiaceae, Selaginellaceae, Isoetaceae), usually small and uninervate, often lacking leaf gap; believed to be formed as a development of enation. Cf. megaphyll.

Monostichous: Sporangia are arranged in one row in Schizaeaceae. Cf. polystichous.

Nest leaf: Humus accumulating form of dimorphous leaves; often colorless and round to ovate, like in Drynarioid ferns.

Paraphysis: Hair- or scale-like sterile structure found in sori, usually derived by the sterilization of the sporangium initials.

Petiole: Fide stipe.

Phyllomophore: Stalk-like structure below the division of leafy and cone-bearing portions in Ophioglossaceae.

Phyllopodium: Base of stipe which has specially enlarged structure; distinct in *Hypodematium*, several Polypodiaceous genera, and the others.

Polystichous: Sporangia are arranged in more than one rows in Schizaeaceae. Cf. monostichous.

Rhizome: Stem creeping on or underground, usually prostrate and root-like in appearance.

Rhizophore: A special root-bearing structure found in heterosporous Microphyllophyta (Selaginellaceae, Isoetaceae), having the nature of either leaf or root.

Sagenoid venation: Fide venation pattern.

Sinus membrane: Semi-transparent callous membrane at the bottom of sinus between adjacent lobes in Thelypteridaceae.

Sinus teeth: Usually small projections found at or near the bottom of sinus between adjacent lobes.

Sorophore: Cone-like structure, or specialized sporangia-bearing lobes of Schizaeaceae.

Sphenophyll: Whorled leaf of Arthrophyta (Equisetaceae); believed to be a derivative of megaphyll.

Stipe: Leaf-stalk, or axial portion of leaf below laminae.

Stipular leaflet: In the leaves of Gleicheniaceae, one pair of leaflets present at the base of each fork; not homologous with stipule but seemingly alike.

Superficiales: The ferns of which sori develop on the under surface of leaf, or dorsal on veins. Cf. Marginales.

Synangium: Sporangia walls become confluent during development and each sporangium is a loculus in a compact structure named synangium; known in fern allies and *Marattia*.

Trophophyll: Vegetative part of dimorphous leaves; when the leaves are dimorphic, vegetative leaf not sporophyll is trophophyll; in partially dimorphic leaf of Ophioglossaceae, leafy but not spore bearing portion is trophophyll.

Velum: Thin, transparent structure covering sporangium in Isoetaceae.

Venation pattern: According to the phenetic patterns, different typifications are made for reticulate venation. *Drynarioid*: veins reticulate to form various orders of irregularly formed areoles with a variety of included veinlets. *Goniopteroid*: opposite veinlets of the adjacent vein groups meet to form parallelogramme reticulation. *Meniscioid*: more rows of parallelogramme reticulation with

continuous conjugated veinlets, an elaboration of Goniopteroid. *Sagenoid*: with one type of irregular areoles usually without included veinlets.

Vernation: Order of unfolding from leaf-buds; in most ferns vernation is circinate but in Ophioglossaceae and Salviniaceae it is erect.

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Additions and Corrections

Since the publication of the first instalment in 1979, variety of contributions have been made on the ferns of Thailand and its neighbouring areas. The necessary changes and additions to ever published parts are enumerated here in accordance with the Flora format.

6. OPHIOGLOSSACEAE

Generic classification of this family was revised by KATO (1987). According to his system *Botrychium lanuginosum* should be **Japanobotrychium lanuginosum** (Wall. ex Hook. et Grev.) Nishida ex Tagawa, J. Jap. Bot. 33: 201. 1958.

Ref. KATO, M. 1987. A phylogenetic classification of Ophioglossaceae. Gard. Bull. Sing. 40: 1 – 14.

12. HYMENOPHYLLACEAE

Generic classification of this family was revised by IWATSUKI (1984) and a full list of continental Asiatic species, including those from Thailand, was given in IWATSUKI (1985).

KEY TO THE GENERA

1. Involucres bilabiate throughout or to the middle; receptacles included or extruded
 2. Rhizome long-creeping, filiform or wiry, nearly glabrous or sparsely with brown hairs; false veinlets absent **1. Hymenophyllum**
 2. Rhizome creeping with dense blackish hairs; false veinlets present **2. Crepidomanes**
1. Involucres tubular with a truncate or dilated apex; receptacles long extruded
 3. Venation anadromous; fronds mediocre to larger, pinnately decompound; false veinlets absent
  4. Rhizome long-creeping, or short but slender; plants epiphytic or saxicolous, rarely terrestrial **2. Crepidomanes**
  4. Rhizome erect, or creeping but short and thick; plants terrestrial, or rarely epiphytic **4. Cephalomanes**
 3. Venation catadromous, sori epitactic; fronds generally smaller; false veinlets present **3. Trichomanes**

1. HYMENOPHYLLUM

Syn.: *Mecodium* and *Meringium*.

KEY TO THE SPECIES

1. Receptacles included; involucres bivalvate, deeply cleft
 2. Margin of lobes entire
  3. All axes glabrous
   4. Involucre triangular to subdeltoid, longer than wide
    5. Wings of stipe and rachis flat or undulate
     6. Lips of involucre entire, or at most slightly crenate **1. H. polyanthos**
     6. Lips of involucre toothed **2. H. productum**
    5. Wings of stipe and rachis crisped
     7. Fronds 4 – 7 cm long; receptacles filiform to clavate **3. H. javanicum**
     7. Fronds 2 – 4 cm long; receptacles columnar **4. H. riukiuense**
   4. Involucre distinctly wider than long **5. H. badium**
  3. Stipes, rachis, and pinna-rachis persistently hairly **6. H. exsertum**
 2. Margin of lobes toothed **7. H. barbatum**
1. Receptacles extruded; involucres cleft to halfway
 8. Rachis terete in basal portion, wings of upper part of rachis, if any, narrow and flat
  9. Fronds lanceolate to ovate; lips entire **8. H. serrulatum**
  9. Fronds deltoid, long-stipitate; lips denticulate
   10. Internal cell walls thin; lips acute **9. H. bontocense**
   10. Internal cell walls thick and pitted; lips moderately acute **10. H. holochilum**
 8. Rachis winged throughout, wings more or less crisped
  11. Fronds more than 1 cm long; wings more or less crisped; ultimate segments crisped
   12. Fronds 3 – 8 cm long; wings somewhat crisped; ultimate segments denticulate and crisped but usually flat **11. H. denticulatum**
   12. Fronds 1 – 2(– 3.5) cm long; wings strongly crisped; ultimate segments sharply toothed and conspicuously crisped, not in a plane **12. H. acanthoides**
  11. Fronds at most 1 cm long; wings not crisped; ultimate segments denticulate, flat **13. H. blandum**

1. Hymenophyllum polyanthos (Sw.) Sw., Schrad. J. Bot. 1800 (2): 102. 1801.— *Mecodium polyanthos* (Sw.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 70. 1979.

2. Hymenophyllum productum Kunze, Bot. Zeit. 6: 305. 1848.— *Mecodium productum* (Kunze) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 71. 1979.

3. Hymenophyllum javanicum Spr., Syst. Veg. 4: 132, 1827.— *Mecodium javanicum* (Spr.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 71. 1979.

4. Hymenophyllum riukiuense Christ, Ann. Cons. Jard. Bot. Genéve 4: 208. 1900.— *Mecodium riukiuense* (Christ) Copel.; Tagawa & K. Iwats. Fl. Thail. 3(1): 72. 1979.

5. Hymenophyllum badium Hook. & Grev., Ic. Fil.: t. 76. 1828.— *Mecodium badium* (Hook. & Grev.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 72. 1979.

6. Hymenophyllum exsertum Wall. ex Hook., Sp. Fil. 1:109, pl. 38A, 1844.— *Mecodium exsertum* (Wall. ex Hook.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 73. 1979.

7. Hymenophyllum barbatum (van den Bosch) Bak.

8. Hymenophyllum serrulatum (Presl) C. Chr., Ind. Fil.: 367. 1905.— *Meringium meyenianum* Presl; Tagawa & K. Iwats., Fl. Thail. 3(1): 76. 1979.

9. Hymenophyllum bontocense Copel., Phil. J. Sci. 64: 33. 1937.— *Meringium bontocense* (Copel.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 76. 1979.

10. Hymenophyllum holochilum (van den Bosch) C. Chr., Ind. Fil.: 362. 1905.— *Meringium holochilum* (van den Bosch) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 77. 1979.

11. Hymenophyllum denticulatum Sw., Schrad. J. Bot. 1800(2): 100. 1801.— *Meringium denticulatum* (Sw.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 77. 1979.

12. Hymenophyllum acanthoides (van den Bosch) Rosenst., Bull. Jard. Bot. Btzg. II. 2: 25. 1911.— *Meringium acanthoides* (van den Bosch) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 78. 1979.

13. Hymenophyllum blandum Racib., Pterid. Btzg.: 20. 1898.— *Meringium blandum* (Racib.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 78. 1979.

2. CREPIDOMANES

Syn.: *Microtrichomanes*, *Gonocormus*, *Trichomanes* s. Tagawa & K. Iwats., *Pleuromanes*, *Reediella*, and *Microgonium* p.p.

KEY TO THE SPECIES

1. Hairy axial pads covering the under surface of laminae (Subgen. *Pleuromanes*) **1. C. pallidum**
1. Hairy axial pads wanting
2. False veinlets wanting
3. Marginal cells not especially elongate nor thick-walled
4. Fronds flabellate to pinnate, glabrous at margin (Subgen. *Maiora*)
5. Rhizome very slender; axes proliferous, or not so in dry habitat **2. C. minutum**
5. Rhizome more than 1 mm diam.; axes not proliferous
6. Fronds linear to lanceolate, simply pinnate to bipinnate **3. C. auriculatum**
6. Fronds oblong to oblong ovate, tripinnate or more compound
7. Fronds well spaced; wings of axes of pinnules broader than segments **4. C. birmanicum**
7. Fronds close together; wings of axes of pinnules narrower than segments **5. C. maximum**
4. Fronds digitate, hairy at margin (Subgen. *Microtrichomanes*) **15. C. digitatum**
3. Marginal cells elongate and thick-walled (Subgen. *Crepidum*) **6. C. humile**
2. False veinlets present (Subgen. *Crepidomanes*)
8. Fronds minute, less than 6 mm long including stipes, simple, forked or at most with three segments **7. C. parvifolium**
8. Fronds usually more than 6 mm long, with more than four segments
9. Submarginal false veinlets distinct, continuous or interrupted, oblique striae absent or a few
10. Fronds smaller, less than 2 cm long
11. Marginal laminar cells in one row; segments narrower, up to 0.7 mm broad **8. C. kurzii**
11. Marginal laminar cells in two rows; segments usually 1 – 1.2 mm broad **9. C. latemarginale**
10. Fronds normally larger, the soriferous fronds usually more than 3 cm long
12. Mouth of involucres bilateral
13. Segments commonly more than 0.7 mm broad **10. C. bipunctatum**
13. Segments proportionately narrower, less than 0.7 mm broad **11. C. brevipes**
12. Mouth of involucres dilated **13. C. christii**

9. Submarginal false veinlets absent, oblique striae many or a few
14. Fronds pinnate; involucres variable in form, usually less than thrice as long as broad **12. C. latealatum**
14. Fronds subdigitate; involucres long, about 4 times as long as the diameter **14. C. megistostomum**

1. Crepidomanes pallidum (Bl.) K. Iwats., Acta Phytotax. Geobot. 35: 174. 1984.— *Pleuromanes pallidum* (Bl.) Presl; Tagawa & K. Iwats., Fl. Thail. 3(1): 86. 1979.

2. Crepidomanes minutum (Bl.) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 524. 1985.— *Gonocormus saxifragoides* (Presl) van den Bosch; Tagawa & K. Iwats., Fl. Thail. 3(1): 80. 1979.— *G. prolifer* (Bl.) Prantl; Tagawa & K. Iwats., l.c. 81. 1979.— *G. siamensis* Tagawa & K. Iwats.; Tagawa & K. Iwats., l.c. 81. 1979.

3. Crepidomanes auriculatum (Bl.) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 528. 1985.— *Trichomanes auriculatum* Bl.; Tagawa & Iwats., Fl. Thail. 3(1): 83. 1979.

4. Crepidomanes birmanicum (Bedd.) K. Iwats., J. Fac. Sci. U. Tokyo III. 13:530. 1985.— *Trichomanes birmanicum* Bedd.; Tagawa & K. Iwats., Fl. Thail. 3(1): 84. 1979.

5. Crepidomanes maximum (Bl.) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 531. 1985.— *Trichomanes maximum* Bl.; Tagawa & K. Iwats., Fl. Thail. 3(1): 83. 1979.

6. Crepidomanes humile (Forst.) van den Bosch, Hymen. Jav. 16. pl. 11. 1861.— *Reediella humilis* (Forst.) Pichi-Ser.; Tagawa & K. Iwats., Fl. Thail. 3(1): 87. 1979.

7. Crepidomanes parvifolium (Bak.) K. Iwats., J. Fac. Sci. U. Tokyo III. 13:535. 1985.— *Microgonium parvifolium* (Bak.) Tagawa & K. Iwats., Fl. Thail. 3(1): 93. 1979.

8. Crepidomanes kurzii (Bedd.) Tagawa & K. Iwats.

9. Crepidomanes latemarginale (Eaton) Copel.

10. Crepidomanes bipunctatum (Poir.) Copel.; K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 536. 1985. Syn. *C. bilabiatum* (Nees & Bl.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 90. 1979.

11. Crepidomanes brevipes (Presl) Copel.

12. Crepidomanes latealatum (van den Bosch) Copel.

13. Crepidomanes christii (Copel.) Copel.

14. Crepidomanes megistostomum (Copel.) Copel.

15. Crepidomanes digitatum (Sw.) K. Iwats., Acta Phytotax. Geobot. 35: 175. 1984.— *Microtrichomanes digitatum* (Sw.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 79. 1979.

3. TRICHOMANES

Syn.: *Microgonium* and *Didymoglossum*

KEY TO THE SPECIES

1. Margin of fronds not setiferous
 2. Submarginal false veinlets absent
  3. Fronds orbicular or roundly oblong, up to 8 mm long, usually with a single sorus for each frond **1. T. motleyi**
  3. Fronds oblong, broadest at or below the middle portion, usually more than 1.2 cm long **2. T. sublimbatum**
 2. Submarginal false veinlets continuous **3. T. bimarginatum**
1. Margin of fronds setiferous **4. T. exiguum**

1. Trichomanes motleyi van den Bosch, Ned. Kruid. Arch. 5: 145. 1861.— *Microgonium motleyi* van den Bosch; Tagawa & K. Iwats., Fl. Thail. 3(1): 94. 1979.

2. Trichomanes sublimbatum K. Muell., Bot. Zeit. 12: 737. 1854.— *Microgonium sublimbatum* (K. Muell.) van den Bosch; Tagawa & K. Iwats., Fl. Thail. 3(1): 94. 1979.

3. Trichomanes bimarginatum van den Bosch, Ned. Kruid. Arch. 5: 143. 1861.— *Microgonium bimarginatum* van den Bosch; Tagawa & K. Iwats., Fl. Thail. 3(1): 95. 1979.

4. Trichomanes exiguum (Bedd.) Bak., Syn. Fil.: 464. 1874.— *Didymoglossum exiguum* (Bedd.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 96. 1979.

4. CEPHALOMANES

Syn.: *Callistopteris*, *Macroglena*, and *Selenodesmium*

KEY TO THE SPECIES

1. Laminar expansion of ultimate segments more than several rows of cells
 2. Caudex short, erect, with fasciculate fronds (Subgen. *Callistopteris*) **1. C. apiifolium**
 2. Rhizome short-creeping (Subgen. *Pachychaetum*) **4. C. obscurum**
  3. Lower part of rachis and stipe terete; mouth of involucres hardly dilated var. **obscurum**
  3. Rachis and at least upper part of stipes winged; mouth of involucres more or less dilated var. **siamensis**
1. Laminar expansion at each side of costae of ultimate segments 0–4 cells broad (Subgen. *Macroglena*)
 4. Ultimate segments very narrow, setaceous, placed not in one plane; laminar cells obsolete, or only one row at each side of costa **2. C. meifolium**
 4. Ultimate segments broader, not setaceous, placed in one plane; laminar cells 2–4 rows at each side of costa **3. C. gemmatum**

1. **Cephalomanes apiifolium** (Presl) K. Iwats., Acta Phytotax. Geobot. 35: 176. 1984.— *Callistopteris apiifolia* (Presl) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 85. 1979.

2. **Cephalomanes meifolium** (Bory ex Willd.) K. Iwats., Acta Phytotax. Geobot. 35: 177. 1984.— *Macroglena meifolia* (Bory) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 98. 1979.

3. **Cephalomanes gemmatum** (J. Smith ex Bak.) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 547. 1985.— *Macroglena gemmata* (J. Sm.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 98. 1979.

4. **Cephalomanes obscurum** (Bl.) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 547. 1985.— *Selenodesmium obscurum* (Bl.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(1): 99. 1979.

var. **siamense** (Christ) K. Iwats., J. Fac. Sci. U. Tokyo III. 13: 548. 1985.— *Trichomanes siamense* Christ, Bot. Tidsskr. 24: 103. 1901.

T h a i l a n d.— SOUTH-EASTERN: Trat (Ko Chang, type).

D i s t r i b u t i o n.— China (Kwangsi, Kwangtung, Hainan), Cambodge, and the Ryukyus.

E c o l o g y.— Terrestrial on wet sandy ground or in muddy crevices of wet rocks usually near stream in deep shade.

Ref. IWATSUKI, K. 1984. Studies in the systematics of filmy ferns VII. A scheme of classification based chiefly on the Asiatic species. Acta Phytotax. Geobot. 35: 165–179.

IWATSUKI, K. 1985. The Hymenophyllaceae of Asia, excluding Malesia. J. Fac. Sci. U. Tokyo III. 13: 501–551.

17. DAVALLIACEAE

Generic classification of this family was revised by KATO (1985).

KEY TO THE GENERA

1. Sori exindusiate; rachis not raised on adaxial side **1. Gymnogrammitis**
1. Sori indusiate
 2. Rhizome scaly, bearing no hairs; rachis raised on adaxial side; sori not terminal at vein-endings
  3. Fronds bearing multicellular articulated hairs; pinnules catadromous **2. Davallodes**
  3. Fronds glabrous; pinnules anadromous
   4. Fronds herbaceous; scales basifixed with cordate base **3. Araiostegia**
   4. Fronds thick, coriaceous; scales peltate
    5. Indusia usually large, long or short cup-shaped, attached by base and sides of various length **4. Davallia**
    5. Indusia firm, shell-shaped, attached by base and hardly by sides **5. Pachypleuria**
 2. Rhizome scaly as well as hairy **6. Leucostegia**

1. GYMNOGRAMMITIS

Griff., Ic. Pl. As.: pl. 129. f. 1. 1849.— *Araiostegia* Copel.; Tagawa & K. Iwats., Fl. Thail. 3(2): 150. 1985, p.p.

Rhizome long-creeping, densely scaly; scales basally attached, concolorously brown. Stipes articulated to rhizome, scaly at base. Lamina oblong, tripinnate to quadripinnatifid, thin, glabrous; rachis-grooves decurrent to those of costae and costules. Sori round, dorsal on veinlets, one for each segment, exindusiate.

A single species is known from Himalayas, SW. China, Hainan, and Tonkin, also collected from N. Thailand.

Gymnogrammitis dareiformis (Hook.) Ching ex Tard. & C. Chr. in Fl. Gén. I.-C. 7(2): 117. f.14, 1–2. 1939.— *Araiostegia dareiformis* (Hook.) Copel.; Tagawa & K. Iwats., Fl. Thail. 3(2): 151. 1985.

2. ARAIOSTEGIA

Copel.; Tagawa & K. Iwats., Fl. Thail. 3(2): 150. 1985, excl. syn. *Gymnogrammitis* Griff.

4. DAVALLIA

Add.: **Davallia heterophylla** J.E. Smith, Mem. Acad. Turin 5: 415. 1793.— *Humata heterophylla* (J.E. Smith) Desv., Prodr.: 323. 1825; Tagawa & K. Iwats., Fl. Thail. 3(2): 168 (1985).

5. PACHYPLEURIA

Presl, Epim.: 98. 1851; Kato, J. Fac. Sci. Univ. Tokyo III. 13: 567. 1985.— *Davallia* sect. *Pachypleuria* Presl, Tent. Pterid.: 128. 1836.

Humata (non Cav.) p.p. sensu auct.; Tagawa & K. Iwats., Fl. Thail. 3(2): 164. 1985.

Among five species listed up by TAGAWA & K. IWATS. (1985) under *Humata*, *H. heterophylla* is transferred to *Davallia*, and the other four are renamed under *Pachypleuria*.

1. **Pachypleuria vestita** (Bl.) Presl, Epim.: 261. 1849.— *Humata vestita* (Bl.) Moore; Tagawa & K. Iwats., Fl. Thail. 3(2): 165. 1985.

2. **Pachypleuria repens** (Linn. f.) M. Kato, J. Fac. Sci. Univ. Tokyo III. 13: 573. 1985.— *Humata repens* (Linn. f.) Diels; Tagawa & K. Iwats., Fl. Thail. 3(2): 166. 1985.

3. **Pachypleuria pectinata** (Smith) Presl, Epim.: 98. 1849.— *Humata pectinata* (Smith) Desv.; Tagawa & K. Iwats., Fl. Thail. 3(2): 167. 1985.

4. Pachypleuria angustata (Hook. & Grev.) Presl, Epim.: 98. 1849.— *Humata angustata* (Hook. & Grev.) J. Smith; Tagawa & K. Iwats., Fl. Thail. 3(2): 167. 1985.

Ref. KATO, M. 1985. A systematic study of the genera of the fern family Davalliaceae. J. Fac. Sci. Univ. Tokyo III. 13: 553–573.

19. PARKERIACEAE

A part of the genus *Cheilanthes* of Thailand was revised under a separate genus *Aleuritopteris* by WU (1983). *Cheilanthes* is thus known by 10 species in Thailand. The revised key to the species and the enumeration of additional species are:

KEY TO THE SPECIES

1. Lower surface of lamina not powdery (Subgen. *Cheilanthes*)
 2. Lamina usually more than 5 cm long
  3. Stipes and rachis glabrous or scaly
   4. Lamina tripinnate, subdeltoid in outline **1. C. tenuifolia**
   4. Lamina bipinnate, linear-lanceolate in outline **2. C. belangeri**
  3. Stipes and rachis densely pubescent throughout **3. C. fragilis**
 2. Lamina delicate, up to 2.5 by 1.5 cm **4. C. delicatula**
1. Lower surface of lamina covered with waxy powder (Subgen. *Aleuritopteris*)
 5. Lamina oblong-lanceolate to deltoid-oblong, 2–3(–4) times longer than broad; stipe shorter than or equal to lamina
  6. Lower pinnae distinctly stalked **5. C. siamensis**
  6. Pinnae all sessile or short-stipitate
   7. Lower surface of costa and veins scaly **6. C. rufa**
   7. Costa and veins not scaly, stipes and rachis sparsely scaly
    8. Scales on stipe-base ovate-subulate, rufo-brown, sometimes glandular at margin **8. C. krameri**
    8. Scales on stipe-base lanceolate, thin, blackish in centre and brownish at marginal portion, not glandular
     9. Indusium deeply lacerate and fimbriate **7. C. pseudofarinosa**
     9. Indusium not or slightly lacerate **9. C. formosana**
 5. Lamina pentagonal to ovate-pentagonal, almost equal in length and width; stipe 2–3 times longer than lamina **10. C. pseudoargentea**

1. Cheilanthes tenuifolia (Burm. f.) Sw.

2. Cheilanthes belangeri (Bory) C. Chr.

3. Cheilanthes fragilis Hook.

4. Cheilanthes delicatula Tagawa & K. Iwats.

5. Cheilanthes siamensis (S. K. Wu) K. Iwats., **comb. nov.**— *Aleuritopteris siamensis* S. K. Wu, Mem. Fac. Sci. Kyoto Univ. Biol. 8: 152. f.1, 3a. 1983.— *Cheilanthes farinosa* (Forssk.) Kaulf. sens. Tagawa & K. Iwats., Fl. Thail. 3(2): 203. 1985, p.p.

Rhizome short, suberect, scaly; scales narrowly lanceolate, brownish, pubescent. *Stipe* castaneous, polished, 20 – 30 cm long, glabrous with scaly base. *Lamina* oblong-lanceolate to deltoid-oblong, acuminate at apex, 20 – 40 by 15 – 25 cm, bipinnate-tripinnatifid; lateral pinnae 7 – 11 pairs, largest ones 7 – 18 by 3 – 7 cm, oblong-lanceolate, long acuminate at apex, with stalks 10 – 15 mm in length; ultimate segments oblong-lanceolate, about 4 mm broad, acute, waved at margin; chartaceous, creamy farinose on lower surface of lamina. *Sori* terminal on veinlets, protected by reflexed marginal flaps.

T h a i l a n d.— NORTHERN: Lampang (Huai Thak, type).

D i s t r i b u t i o n.— Endemic.

E c o l o g y.— On limestone cliff at 350 – 500 m alt.

6. Cheilanthes rufa D. Don; S. K. Wu, Mem. Fac. Sci. Kyoto Univ. Biol. 8:153. 1983.— *Cheilanthes subrufa* Bak. sensu Tagawa & K. Iwats., Fl. Thail. 3(2): 204. 1985.

7. Cheilanthes pseudofarinosa (Ching & S. K. Wu) K. Iwats., comb. nov.— *Aleuritopteris pseudofarinosa* Ching & S. K. Wu, Acta Phytotax. Sin. 19: 72. 1981; S. K. Wu, Mem. Fac. Sci. Kyoto Univ. Biol. 8: 153. 1983.— *Cheilanthes farinosa* (Forssk.) Kaulf. sensu Tagawa & K. Iwats., Fl. Thail. 3(2): 203. 1985, p.p.

Rhizome short, scaly at apex; scales linear-lanceolate, dark in the centre and light brown at marginal portion. *Stipe* castaneous, scaly at base. *Frond* oblong-subtriangular. Indusia broad, interrupted, fimbriate.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Suthep).

D i s t r i b u t i o n.— Nepal, India, China (S. of Yangtze River, type from Yunnan), and the Philippines.

E c o l o g y.— On rather dry rocks in light shade in mixed deciduous forests.

8. Cheilanthes krameri Fr. & Sav., Enum. Pl. Jap. 2: 212, 619. 1879.— *Aleuritopteris krameri* (Fr. & Sav.) Ching, Hongk. Nat. 10: 202. 1941; S. K. Wu, Mem. Fac. Sci. Kyoto Univ. Biol. 8: 154. 1983.— *Cheilanthes farinosa* (Forssk.) Kaulf. sensu Tagawa & K. Iwats., Fl. Thail. 3(2): 203. 1985, p.p.

Rhizome short, ascending, scaly; scales linear-lanceolate, dark brown, membranous. *Stipe* longer than laminae; scales ovate-subulate, rufo-brown, sometimes glandular at margin. *Frond* 5 – 8 by 3 – 4 cm, bipinnatifid; lower pinnae with short stalk, basiscopic side wider than acroscopic side. *Sori* at margin of lobes, interrupted, protected by reflexed margin of lobes.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao), Lamphun (Doi Khun Tan), Tak (Lan Sang); EASTERN: Nakhon Ratchasima (Khao Yai).

D i s t r i b u t i o n.— Japan and Taiwan.

E c o l o g y.— On rocks in light shade at medium or high altitutes.

9. Cheilanthes formosana Hayata, Enum. Pl. Formos. 5: 612. 1906.— *Aleuritopteris formosana* (Hayata) Tagawa, Acta Phytotax. Geobot. 14: 191. 1952; S. K. Wu, Mem. Fac. Sci. Kyoto Univ. Biol. 8: 155. 1983.— *Cheilanthes farinosa* (Forssk.) Kaulf. sensu Tagawa & K. Iwats., Fl. Thail. 3(2): 203. 1985, p.p.

Rhizome short, ascending, scaly. *Stipe* 5 – 12 cm long, dark purplish to castaneous, polished, scaly at base; scales lanceolate, thin, blackish in centre and brownish at marginal portion. *Frond* bipinnate, 5 – 10 cm long, oblong to lanceolate, covered with white or yellow waxy powder on lower surface. Indusia free, not or slightly lacerate at margin.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Inthanon), Lamphun (Doi Khun Tan), Mae Sariang (Mae La Noi).

D i s t r i b u t i o n.— Taiwan.

E c o l o g y.— On rocks in light shade in mixed deciduous forests at medium altitude.

10. Cheilanthes pseudoargentea (S. K. Wu) K. Iwats., comb. nov.— *Aleuritopteris pseudoargentea* S. K. Wu, Mem. Fac. Sci. Kyoto Univ. Biol. 8: 155. f. 2, 3b. 1983.— *Cheilanthes farinosa* (Forssk.) Kaulf. sensu Tagawa & K. Iwats., Fl. Thail. 3(2): 203. 1985, p.p.

Rhizome short, erect, scaly; scales linear-lanceolate, bi-coloured, dense. *Stipe* castaneous, about 30 cm long, scaly at lower portion. *Frond* pentagonous to ovate-deltoid, about 17 by 15 cm, acuminate at apex, bipinnate-tripinnatifid; lowest pinnae largest, 10 by 6 cm, sessile to subadnate; pinnules 5 – 8 pairs, lanceolate, acuminate, 5 by 1.5 cm, adnate at base; ultimate segments oblong, 6 by 1.5 mm; firm chartaceous, glabrous, covered with white waxy substances on the lower surface. *Sori* confluent at maturity; indusia membranous.

T h a i l a n d.— NORTHERN: Chiang Mai (Doi Chiang Dao, type).

D i s t r i b u t i o n.— Endemic.

E c o l o g y.— On calcareous rocks on cliffy mountain ridge near summit, 1900 – 2100 m alt.

Ref. WU, Su-Kung. 1983. Note on *Aleuritopteris* Fée in Thailand. Mem. Fac. Sci. Kyoto Univ. Biol. 8: 151 – 156.

22. ASPLENIACEAE

The *Asplenium unilaterale* complex was revised by MURAKAMI & HATANAKA (1988) and Thai plants ever identified as *A. unilaterale* was determined as:

18. Asplenium apogamus Murakami et Hatanaka, J. Fac. Sci. U. Tokyo III. 14: 193. f. 6 (1988).— *Asplenium unilaterale* (non Lamk.) sensu Tagawa & K. Iwatsu., Fl. Thail. 3(2): 277.

25. DRYOPTERIDACEAE

Subfamily Dryopterioideae

7. DRYOPTERIS

Dedy Darnaedi made an intensive biosystematic study on *D. sparsa* complex. Along with this study, a facultative rheophyte of this species complex was described:

2. Dryopteris rheophila Mitsuta ex Darnaedi, Kato et K. Iwats., J. Jap. Bot. 64: 1989.

Rhizome erect; rhizome scales persistent, dull brown, ovate, up to 7 by 4 mm. *Stipe* 10–40 cm long; fronds oblong-lanceolate to narrowly deltoid-ovate, bipinnate to obscurely tripinnatifid, 17–43 by 7–18 cm; pinnae inserted at angles less than 50 to rachis, middle pinnae oblong, broadest at base, acuminate towards apex, 5–11 by 2–3 cm; pinnules oblong, unequally cuneate at base, obtuse at apex, shallowly lobed, each lobe with a short sharp tooth. *Sori* medial on acroscopic veinlets, distributed throughout lamina; chromosome number n = 82, 2n = 164 (tetraploid); reproduction sexual.

T h a i l a n d.— NORTH-EASTERN: Loei (Phu Kradueng, type).

D i s t r i b u t i o n.— Endemic.

E c o l o g y.— On sandstone boulders in streamlet at 1000–1200 m alt.

Subfamily Tectarioideae

The whole Old World species are now under revision by Professor HOLTTUM. There are several amendments already proposed.

8. CTENITIS

Ctenitis manilensis is transferred to *Tectaria* sect. *Sagenia*, and *C. mannii* is:

2. Ctenitis subobscura (Christ) Holttum, Fern Gaz. 12: 320. 1984; Blumea 31: 23. 1985.— *Phegopteris subobscura* Christ, Bull. Herb. Boiss. 6: 836. 1898.— *Ctenitis mannii* sensu Tagawa & K. Iwats., Fl. Thail. 3(3): 357. 1988.

D i s t r i b u t i o n.— Malesia.

10. TECTARIA

3. Tectaria christii Copel., Phil. J. Sci. 2 Bot.: 416. 1907; Holtt., Kew Bull. 43: 488. 1988.— *Tectaria coadnata* sensu Tagawa & K. Iwats., Fl. Thail. 3(3): 367. 1988.

5. Tectaria impressa (Fée) Holtt., Kew Bull. 43: 483. 1988.— *Phlebigonium impressum* Fée, Gen. Fil.: 314. 1852.— *Tectaria variolosa* (Wall. ex Hook.) C. Chr.; Tagawa & K. Iwats., Fl. Thail. 3(3): 368.

26. Tectaria manilensis (Presl) Holtt., Ind. Fern J. 1: 36. 1984; Kew Bull. 43: 478. 1988.— *Lastrea manilensis* Presl, Epim.: 39. 1851.— *Ctenitis manilensis* (Presl) Holtt.; Tagawa & K. Iwats., Fl. Thail. 3(3): 358. 1988.

27. ATHYRIACEAE

2. DEPARIA

1. Deparia subfluvialis (Hayata) M. Kato, J. Fac. Sci. U. Tokyo III. 13: 389. f.11. 1984.— *Dryopteris subfluvialis* Hayata, Ic. Pl. Formos. 5: 288. f. 113. 1915.— *Deparia boryana* sensu Tagawa & K. Iwats., Fl. Thail. 3(3): 440. 1988.

Distribution.— S. and SW. China, Taiwan, and Luzon; also recorded from the Himalayas.

2. Deparia petersenii (Kunze) M. Kato, Bot. Mag. Tokyo 90:37. 1977; J. Fac. Sci. U. Tokyo III. 13: 420. f. 38. 1984.— *Asplenium petersenii* Kunze, Anal. Pterid.: 24. 1837.— *Deparia japonica* sensu Tagawa & K. Iwats., Fl. Thail. 3(3): 440. 1988.

Distribution.— Himalayas to E. Australia and New Zealand.

Ref. KATO, M. 1984. A taxonomic study of the Athyrioid fern genus *Deparia* with main reference to the Pacific species. J. Fac. Sci. U. Tokyo III. 13: 375 – 430.

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(Synonyms in *italics*)

CORRECTIONS

There occurred errors in the Flora of Thailand Volume Three Part Three and Volume Five Part One through the Production Manager's misunderstanding thus the name of the Assistant Editor and in the Editorial Board should be Bertel Hansen, Copenhagen instead of Ivan Nielsen, Aarhus.

FLORA OF THAILAND

Index of families treated

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Volume 2 Part 4 : Cannabidaceae, Casuarinaceae, Ebenaceae, Elaeocarpaceae, Hippocastanaceae, Irvingiaceae, Nyssaceae, Simaroubaceae, Symplocaceae. Oct. 1981, 184 p., 81 figs.

Volume 3 Part 1 : Cyatheaceae, Dennstaedtiaceae, Dicksoniaceae, Equisetaceae, Gleicheniaceae, Hymenophyllaceae, Isoetaceae, Lycopodiaceae, Marattiaceae, Ophioglossaceae, Osmundaceae, Plagiogyriaceae, Psilotaceae, Schizaeaceae, Selaginellaceae. June 1979, 128 p., 9 figs.

Volume 3 Part 2 : Aspleniaceae, Davalliaceae, Lindsaeaceae, Oleandraceae, Parkeriaceae, Pteridaceae, Vittariaceae. Nov. 1985, 168 p., 14 figs.

Volume 3 Part 3 : Athyriaceae, Blechnaceae, Dryopteridaceae, Lomariopsidaceae, Thelypteridaceae. June 1988, 170 p., 25 figs.

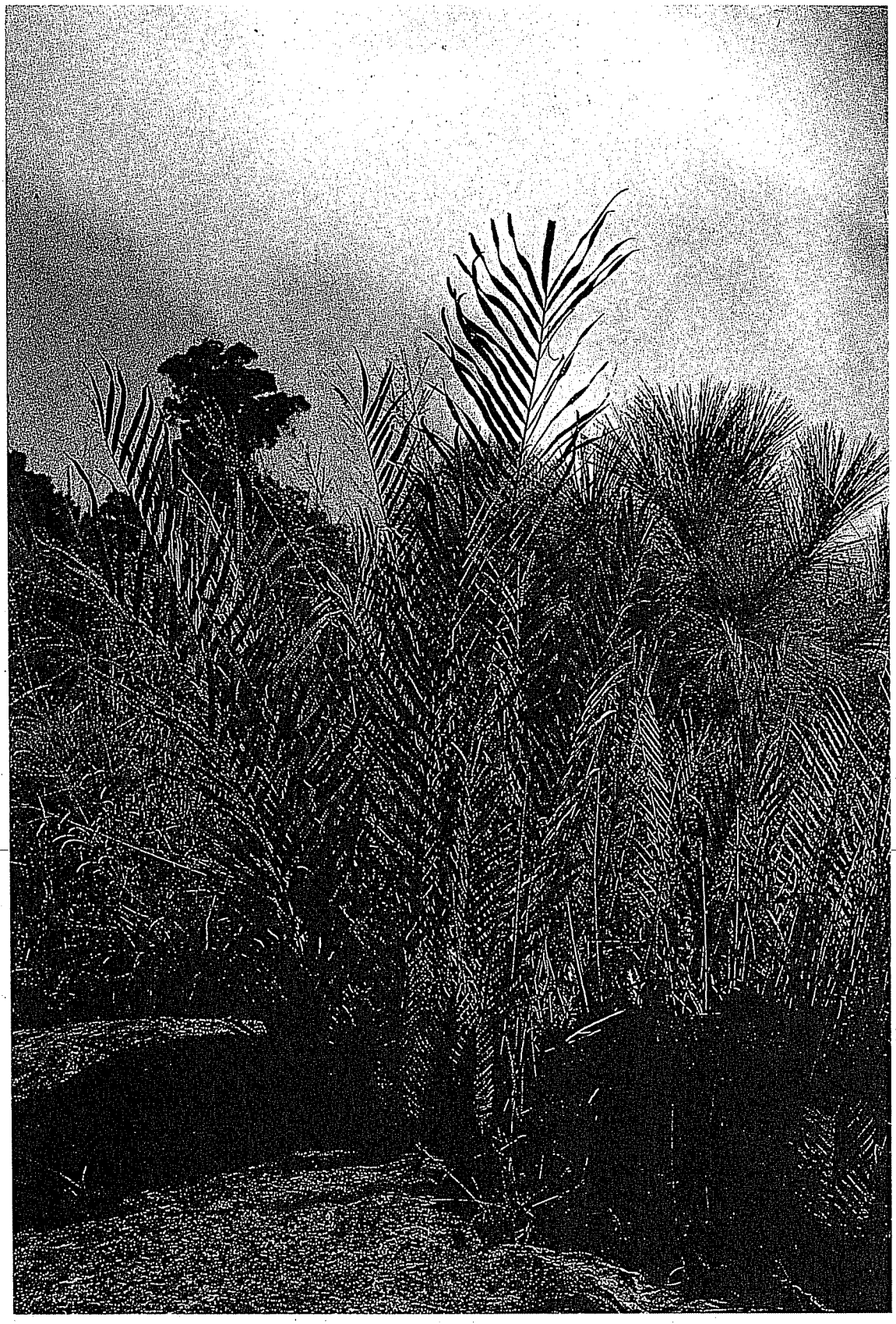
Volume 3 Part 4: Azollaceae, Cheiropleuriaceae, Dipteridaceae, Grammitidaceae, Marsileaceae, Polypodiaceae, Salviniaceae. Sept. 1989, 160 p., 12 figs., 4 coloured plates.

Volume 4 Part 1 : Leguminosae-Caesalpinioideae. March 1984, 130 p., 31 figs., 4 coloured plates.

Volume 4 Part 2 : Leguminosae-Mimosoideae. Dec. 1985, 92 p., 23 figs., 4 coloured plates.

Volume 5 Part 1 : Aristolochiaceae, Bignoniaceae, Droseraceae, Epacridaceae, Gentianaceae, Opiliaceae, Philydraceae, Proteaceae, Salicaceae, Thismiaceae, Valerianaceae, Xyridaceae. Dec. 1987. 138 p., 41 figs., 8 coloured plates.

1. *Platycerium holttumii* Jonch. & Hennipm.
Photo : T. Smitinand; Khao Yai National Park, Nakhon Ratchasima; Mar. 1983.



5. *Drynaria rigidula* (Sw.) Bedd.
Photo : T. Smitinand; Phu Kradueng, Loei; Nov. 1976.

FLORISTIC REGIONS AND PROVINCES OF THAILAND

I. *N* (NORTHERN)
- 1 Mae Hong Son
- 2 Chiang Mai
- 3 Chiang Rai
- 4 Phayao
- 5 Nan
- 6 Lamphun
- 7 Lampang
- 8 Phrae
- 9 Uttaradit
- 10 Tak
- 11 Sukhothai
- 12 Phitsanulok
- 13 Kamphaeng Phet
- 14 Phichit
- 15 Nakhon Sawan

II. *NE* (NORTH-EASTERN)
- 16 Phetchabun
- 17 Loei
- 18 Udon Thani
- 19 Nong Khai
- 20 Sakon Nakhon
- 21 Nakhon Phanom
- 22 Kalasin
- 23 Maha Sarakham
- 24 Khon Kaen

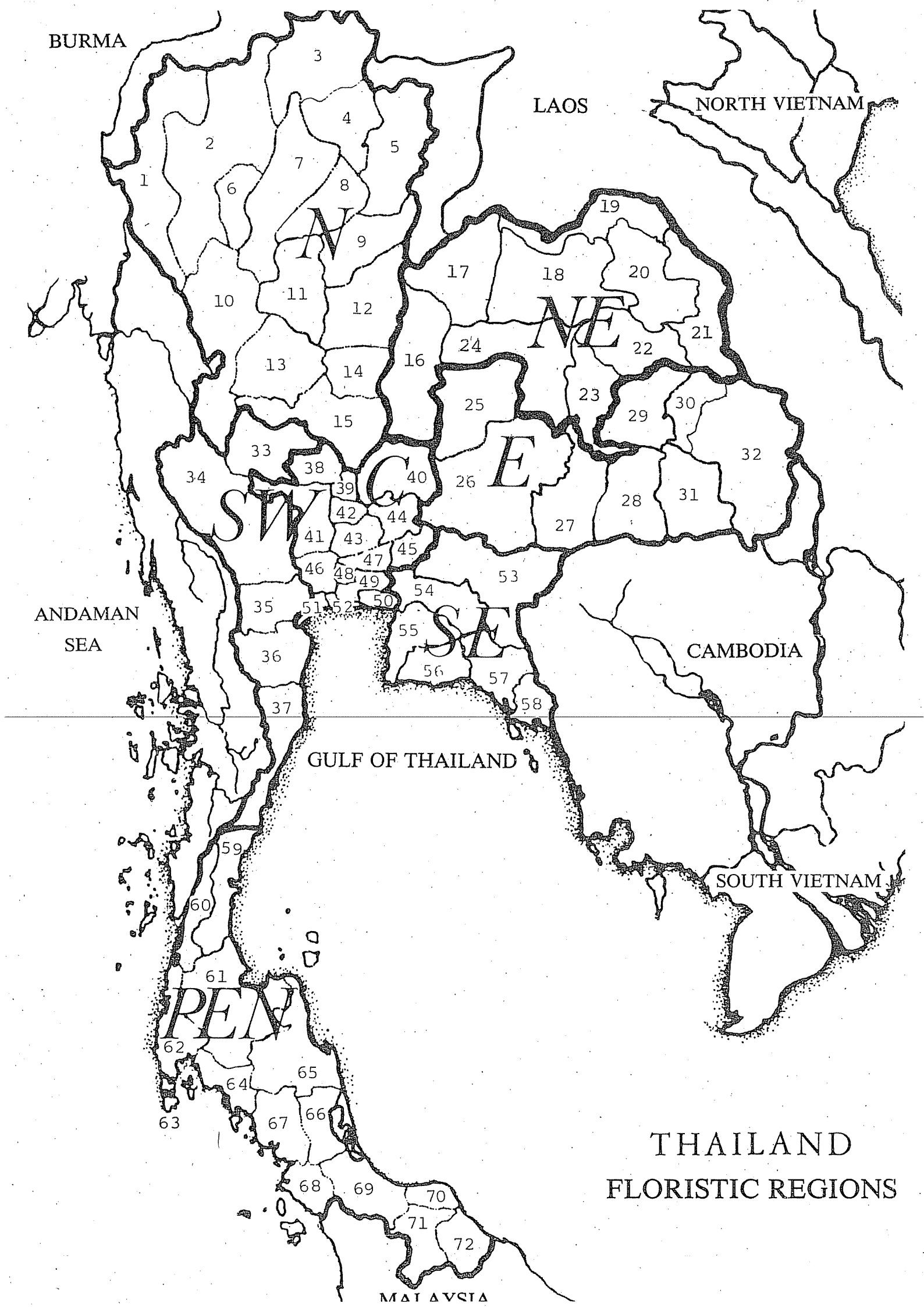
III. *E* (EASTERN)
- 25 Chaiyaphum
- 26 Nakhon Ratchasima
- 27 Buri Ram
- 28 Surin
- 29 Roi Et
- 30 Yasothon
- 31 Si Sa Ket
- 32 Ubon Ratchathani

IV. *SW* (SOUTH-WESTERN)
- 33 Uthai Thani
- 34 Kanchanaburi
- 35 Ratchaburi
- 36 Phetchaburi
- 37 Prachuap Khiri Khan

V. *C* (CENTRAL)
- 38 Chai Nat
- 39 Sing Buri
- 40 Lop Buri
- 41 Suphan Buri
- 42 Ang Thong
- 43 Phra Nakhon Si Ayutthaya
- 44 Saraburi
- 45 Nakhon Nayok
- 46 Nakhon Pathom
- 47 Pathum Thani
- 48 Nonthaburi
- 49 Krung Thep Maha Nakhon (Bangkok)
- 50 Samut Prakan
- 51 Samut Songkhram
- 52 Samut Sakhon

VI. *SE* (SOUTH-EASTERN)
- 53 Prachin Buri
- 54 Chachoengsao
- 55 Chon Buri
- 56 Rayong
- 57 Chanthaburi
- 58 Trat

VII. *PEN* (PENINSULAR)
- 59 Chumphon
- 60 Ranong
- 61 Surat Thani
- 62 Phangnga
- 63 Phuket
- 64 Krabi
- 65 Nakhon Si Thammarat
- 66 Phatthalung
- 67 Trang
- 68 Satun
- 69 Songkhla
- 70 Pattani
- 71 Yala
- 72 Narathiwat



THAILAND
FLORISTIC REGIONS