

TAXONOMIC REVISION OF THE POLYPODIACEOUS GENERA OF INDIA *PYRROSIA* MIRBEL

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ABSTRACT

Twenty two species of genus *Pyrrosia* are described from India. In addition, two more species are doubtfully (*P. ceylanica*, *P. angustata*) recorded from South Indian mountains. Majority of the species are met with in the Himalayas from Garhwal to Bhutan. So far no species is recorded from Central as well as Western India. *Pyrrosia acrostichoides* and *P. gardneri* are restricted to Southern India. Quite a many of the species look alike but can be segregated on the basis of rhizome scales and hairs on the lamina as well as the spores. This is particularly true of the species belonging to *P. stictica*, *P. mollis*, *P. mannii*, *P. nayariana* and *P. gardneri* groups.

INTRODUCTION

The present work is in continuation of earlier work from this laboratory on the taxonomy of family Polypodiaceae (cf. Bir & Devi, 1968; Bir & Satija, 1981; Bir & Trikha, 1968a, b, 1969, 1974; Bir *et al.*, 1974). During the execution of work herbarium specimens from PUN*, PAN, CAL, BLAT and LWG were examined. To the Directors/Officer-In-Charge we are thankful for giving the materials for study. In addition, observations were based on the basis of field study carried out by S. S. Bir and C. K. Satija in the Himalayas, Central Indian and South Indian mountains during the last two decades or so.

Pyrrosia Mirbel, the common tropical epiphyte, is very well represented in Indian forests. As currently understood, it is a genus belonging to family Polypodiaceae. The genus as circumscribed by Ching (1935) was established by Mirbel, C. B. as early as 1803 (in Hist. Nat. Veg. 5 : 91. 1803 et. Hist. Nat. Plant 4 : 70. 1803). Till about the middle

of 19th century, the generic name was more or less overlooked by most of the pteridologists and the members were referred to either *Niphobolus* Kaulf. or *Cyclophorus* Desv. The use of present name was revived by Farwell (1931).

An excellent monograph dealing with morphology and taxonomy of the group was given by Giesenhagen (1901). Later, Ching (1935) described 40 species from the mainland of Asia and its neighbouring islands. Mehra & Bir (1964) gave the checklist of 13 species from Darjeeling and Sikkim Himalayas whereas Nayar & Chandra (1965) dealt with the morphology and taxonomy of 14 species grouped under six groups, namely, *Obovata*, *Varia*, *Heteractis*, *Nayariana*, *Mannii* and *Flocculosa*.

A perusal of Indian literature on the taxonomy and systematics of ferns reveals that even presently the genus is not properly understood and quite often members are referred to *Cyclophorus* (cf. Chowdhury, 1973). Even today, we do not have any authentic taxonomic account of the different

*Here as well as elsewhere abbreviations according to Holmergen & Keuken (1974).

species of the genus from India. Therefore, the present work was taken up.

PYRROSIA Mirbel

Pyrrosia Mirbel, Hist. Nat. Veg. 5 : 91. 1803; Hist. Nat. Plant. 4 : 70. 1803; Ching, Bull. Chinese Bot. Soc. 1 : 36-72. 1935; Copeland, Gen. Fil. 192-194. 1947 incl. synonymous taxa.

Rhizome short, wide-creeping, dictyostelic, covered with elongated hair-like scales; fronds uniform or dimorphic, simple, entire, fleshy, coriaceous, matted with woolly or cottony tomentum on under surface, clothed on both surfaces with stellate hairs (usually of two types), deciduous on upper surface; venation obscure, variously anastomosing with included veinlets, hydathodes may or may not be present, when present distinct and punctate on the upper surface; sori minute, globose, cyclose or elliptic, often irregularly placed, covering almost entire surface, often crowded or confluent, superficial or immersed, buried among dense stellate pubescens; sporangia with long stalk, intermixed with stellate paraphyses, annulus 11-30 celled; spores bilateral, monoletic, smooth or rough, hyaline or discoloured and non-perisporiate.

It is typified by *P. chinensis* Mirbel [= *P. lingua* (Thunb.) Farwell] and is represented by 100 species which are distributed from New Zealand to the Maritime Province of Siberia and from Africa to Polynesia but are most abundant in south-east Asia (cf. Ching, 1935; Copeland, 1947).

Ching (1935) reported this genus to be similar to *Phymatodes* sect. [*Phymatopsis* (J. Sm.)] but can easily be distinguished because of its compyloneuroid venation and persistent stellate hairs. Nayar & Chandra (1965) reported it to be closely related to *Platynerium* on one hand and *Drymoglossum* on the other and placed it under family Platyceriaceae as suggested by Nayar (1961). Its identity from the above two genera is clearly distinct because *Platynerium* is characterised by dichotomously divided leaves, unspecialised foliar hairs and complex reticulate venation and *Drymoglossum* in its irregular reticulate venation with the areolae including one or more variously directed veinlets.

Bir & Trikha (1979) while giving a tentative evolutionary scheme of polypodiaceous genera showed that this genus may be an offshoot of *Dipteris* and placed it in-between *Paraleptochilus* (= *Leptochilus*) and *Loxogramme*.

KEY TO THE SPECIES

1. Rhizome widely creeping, fronds far apart (2-4 cm):
 2. Fronds dimorphous, fertile, linear-elongate to lanceolate much longer than sterile, of different shape:
 3. Sporangial paraphyses monomorphic with narrowly lanceolate arms ... 1. *P. adnascens*
 3. Sporangial paraphyses dimorphous, brown with long needle-like arms and white soft with frizzy arms:
 4. Sterile lamina ovate, orbiculate, cordate or round at the base; texture carnose-coriaceous, sori small circular, scattered on lamina ... 2. *P. nummularifolia*
 4. Sterile lamina obovate or spathulate, cuneate towards base; texture carnose-papyraceous; sori crowded, acrostichoid at maturity ... 3. *P. obovata*
 2. Fronds monomorphic:
 3. Main lateral veins indistinct; tomentum on lamina under surface deciduous at maturity (lamina subnaked or glabrous on under surface):
 4. Rhizome scales dimorphous, (i) large lanceolate with acuminate, non-glandular apex, (ii) small ovate or orbicular, apex glandular ... 4. *P. lanceolata*
 4. Rhizome scales uniform; venation hidden:
 5. Rhizome scales linear-lanceolate, apex with deciduous glandular hair, margin hairy ... 5. *P. nuda*
 5. Rhizome scales lanceolate to ovate-lanceolate to shield-shaped, apex glandular, margin entire or somewhat serrate ... 6. *P. varia*

5. Rhizome scales lanceolate, non-setaceous with obtuse and non-glandular apex ... 7. *P. acrostichoides*
5. Rhizome scales linear, setaceous ... 8. *P. laevis*
3. Main lateral veins distinct; tomentum on lamina under surface persistent at maturity:
 4. Lamina lanceolate to narrowly ovate-lanceolate, approximately 3 cm broad, cuneate or decurrent at the base ... 9. *P. lingua*
 4. Lamina oblong or oblong-lanceolate or oblong-ovate more than 3 cm broad, rotundo-cuneate at the base ... 10. *P. heteracta*
 4. Lamina ovate to ovate-lanceolate, more than 4 cm broad, cuneate at the base ... 11. *P. pannosa*
1. Rhizome shortly creeping; fronds subcaespitose or approximate (not more than $\frac{1}{2}$ cm apart); indumentum dimorphous:
 2. Rhizome scales bicolorous, lanceolate to ovate-lanceolate, atratous:
 3. Sporangial paraphyses dimorphous with crisped arms ... 12. *P. stictica*
 3. Sporangial paraphyses without crisped arms:
 4. Lamina linear-lanceolate to lanceolate or oblanceolate about 0.5-1.5 cm broad, with ferruginous tomentum underneath ... 13. *P. mollis*
 4. Lamina linear-elongate, about 2-4 mm broad, lower surface covered with dense nearly white tomentum ... 14. *P. stenophylla*
 4. Lamina broadly lanceolate, more than 2 cm broad with acute or acuminate apex, ferruginous dimorphous tomentum underneath, upper stellate hairs with lanceolate arms:
 5. Fronds sessile, adaxial groove distinct, base attenuate long; sori indistinct scattered upto $\frac{3}{4}$ of the lamina ... 15. *P. beddomeana*
 5. Fronds stipitate, stipe 2.5-10 cm long, gradually tapering below and decurrent at the base, sori up to $\frac{3}{4}$ or $\frac{1}{2}$ of the lamina ... 16. *P. stigmosa*
 2. Rhizome scales concolorous, linear-lanceolate to lanceolate or subulate:
 3. Margin of the rhizome scales dentate with teeth pointing backwards ... 17. *P. nayariana*
 3. Margin of the rhizome scales smooth with or without hairs:
 4. Spores verrucose, plano-convex ... 18. *P. mannii*
 4. Spores smooth, plano- to concavo-convex:
 5. Rhizome thin (1.5-3.0 mm); lamina texture carnosae-coriaceous; sori 2-4 rows on either side of mid-rib ... 19. *P. gardneri*
 5. Rhizome thick ($\frac{1}{2}$ -1 cm), lamina texture coriaceous; sori in many rows usually half-way down ... 20. *P. flocculosa*
 3. Margin of the rhizome scales eroded or somewhat serrate:
 4. Upper surface pitted with hydathodes, lower surface with white-subfurfuraceous tomentum; venation more or less compyloneuroid ... 21. *P. subfurfuracea*
 4. Upper surface devoid of hydathodes, lower surface with ferruginous tomentum; venation approaching venatio-drynarii ... 22. *P. boothii*

1. ***Pyrrosia adnascens*** (Sw.) Ching, Bull. Chinese Bot. Soc. 1 : 45. 1935; Holtt. Fl. Malaya 2 : 144. 1954; Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15 : 161. 1964; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117 : 48. 1965; Nayar & Kaur, Companion Bedd. Handb. 80. 1974; Dhir, Bibliotheca Pteridological 1 : 118. 1980.

Polypodium adnascens Sw., Syn. Fil. 25. 222. t. 2. 1806; type from Malabar, India; Hook. & Bak., Syn. Fil. 341. 1874; Hope, Journ. Bombay nat. Hist. Soc. 14 : 720-740. 1902-1903.

Cyclophorus adnascens (Sw.) Desv., Berl. Mag. 5 : 300. t. 811; C. Chr., Index Fil. 197. 1905 (cum synonyms excl. *Niphobolus caudatus* Kaulf.); Chowdhury*, PFUGP 72. 1973.

Polypodium heterophyllum Thunb., Fl. Jav. 18. 1825 (non Linn. 1753).

Niphobolus adnascens (Sw.) Bedd., Ferns South India t. 183. 1864.

N. carnosus Hook., J. Bot. 355. 1857.

N. pertusus Hook., J. Bot. 355. 1857.

Cyclophorus pustulosus Christ, Leconite, Not. Syst. 1 : 187. 1910; C. Chr., Index Fil. Suppl. 1 : 22. 1912.

Rhizome slender, widely creeping, profusely branched, densely paleaceous towards the apex, possessing tuft of wiry roots on under-surface, thin, 1.5-2.0 mm thick; paleae of two types, light to dark brown, margin hyaline, laminae dark-brown in the centre, large

*The Pteridophyte Flora of the Upper Gangetic Plain.

palae $3.0-5.0 \times 0.5-1.0$ mm in size, linear-lanceolate to lanceolate with long acuminate apex terminated by glandular hairs, margin with long protruding hairs, smaller palae $1.0-2.0 \times 0.5-1.0$ mm, shield-shaped with apex acuminate to acute, terminated by two glandular cells, hairy towards anterior side; fronds distant, dimorphic; stipes short, variable in form and size, $0.2-0.8$ cm in sterile and $0.5-2.8$ cm in fertile forms, adaxial groove prominent; sterile lamina $2.3-3.9 \times 0.6-1.4$ cm, lanceolate or obovate with usually acute seldom obtuse apex, decurrent at the base, fertile lamina $7.0-18.0 \times 0.5-1.2$ cm, lanceolate or linear-elongate with acuminate apex and margin rolling towards upper side on drying; texture coriaceous with upper surface glossy and lower encovered with numerous stellate hairs; venation compyloneuroid, hidden, main vein protruding on adaxial surface and forming a groove on abaxial surface, areoles in 4-5 rows on each side of midrib, each areole with 2-3 tertiary veinlets club-shaped at the apices; sori small circular, present on anterior one half or more than half of lamina; sporangial paraphyses monomorphous with long, white, narrowly lanceolate arms, $210-345 \mu\text{m}$; annulus 17-20 celled; spores oval, plano-convex to convex, pale yellow to yellow, exine verrucose with tubercle like thickenings in the centre, $61-84 \times 38-72 \mu\text{m}$ (Figs. 1, 21-24).

Growing as lithophyte or as an epiphyte on mossy substratum. Met with in eastern Himalayas (Darjeeling: Teesta, 150 m; Manjitar, 300 m; Badamtam, 750 m; Sikkim: Dickchu, 600 m; Andheri Khola, 900 m; Garo hills: Tura peak, 1,190 m; Jaintia hills: Jorain, 1,000 m; Khasi hills: Mawswai, 306 m), western Himalayas (Garhwal, 900-1,200 m; Almora: Kaptok; Sarju Valley, 1,050 m; Ramganga Valley; Happy Valley) and South India (Trivendrum, Shevaroy hills and Vishakhapatnam, sea level to 1,375 m).

Distribution: India, Ceylon, Malay-Peninsula, China, Tonkin and Formosa.

This polymorphic species is characterised

by its dimorphic fronds which easily distinguish it from its allied species *Pyrrosia lanceolata*. Sometimes some of the sterile fronds are intermediate between sterile and fertile fronds. Sori are restricted to upper $1/3$ or $1/2$ portion of lamina.

Specimens examined: EASTERN HIMALAYAS: Darjeeling: S. K. Malhotra, Aug., 1954 (PAN); 1,000 m, S. S. Bir, Aug., 1954 (PAN); Manjitar-Teesta Road, S. K. Malhotra 842, Aug., 1954 (PAN). SOUTH INDIA: Kerala: Trivendrum; sea level, S. P. Khullar, 10 June, 1965 (PAN); Madras: Shevaroy hills, 1,375 m, J. Ghatak, June, 1963 (CAL); Andhra Pradesh: Vishakhapatnam Dt., 950 m, N. P. Balakrishnan, Aug., 1960 (CAL).

2. *P. nummularifolia* (Sw.) Ching. Bull. Chinese Bot. Soc. 1: 47. 1935; Holtt., Fl. Malaya 2: 144. Fig. 59. 1954; Mehra & Bir. Res. Bull. Panjab Univ. Sci. (n.s.) 15: 161. 1964; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117: 73-76. 1965; Nayar & Kaur, Companion Bedd. Handb. 81. 1974.

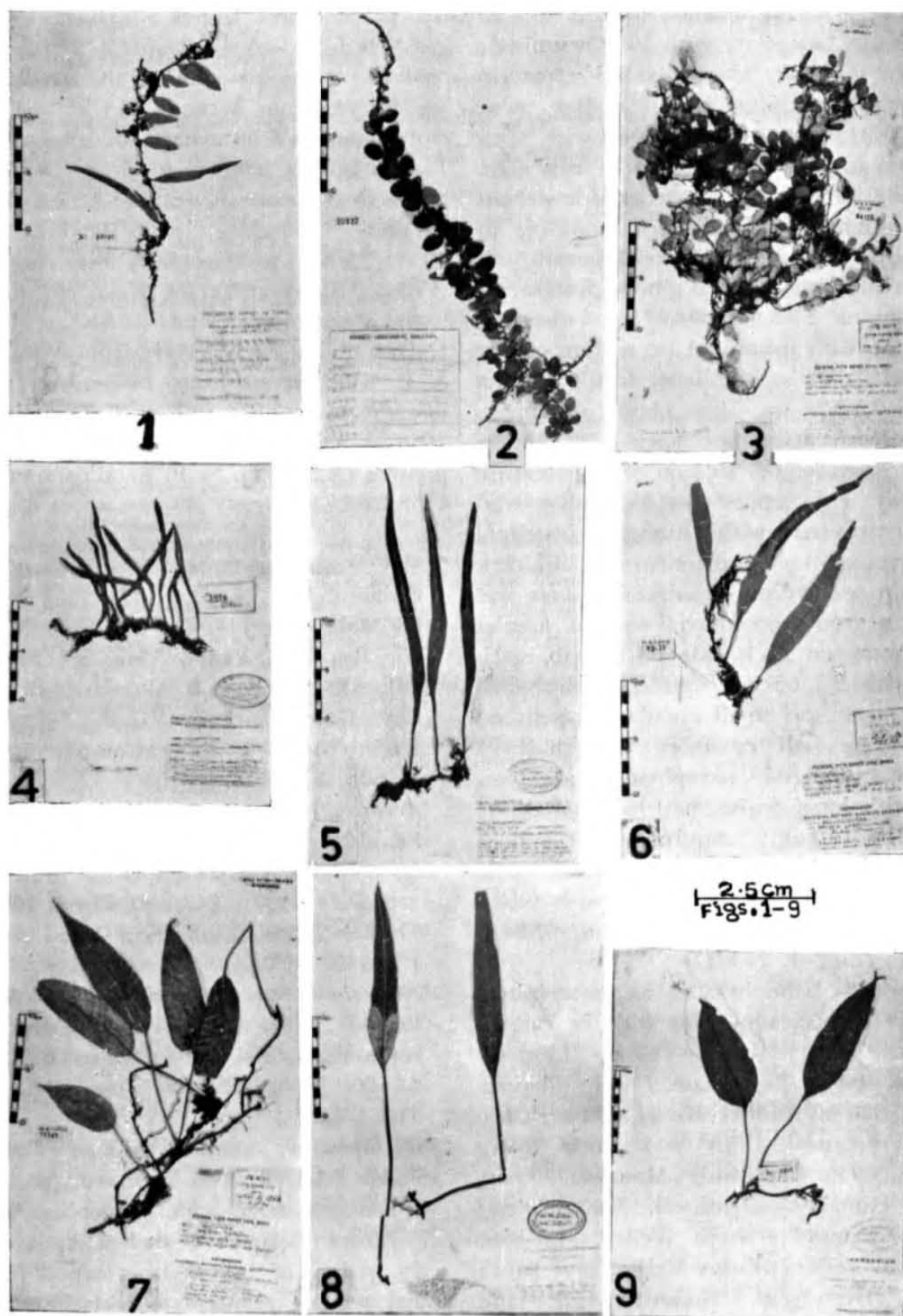
Acrostichum nummularifolium Sw., Syn. Fil. 191. 419. t. 2. Fig. 1. 1806.

Polypodium nummularifolium Mett., Farn-gatt. Poly. 123. n. 247. t. 3. Fig. 9, 10. 1857; Clarke, Trans. Linn. Soc. Lond. II. Bot. 1: 553. 1880.

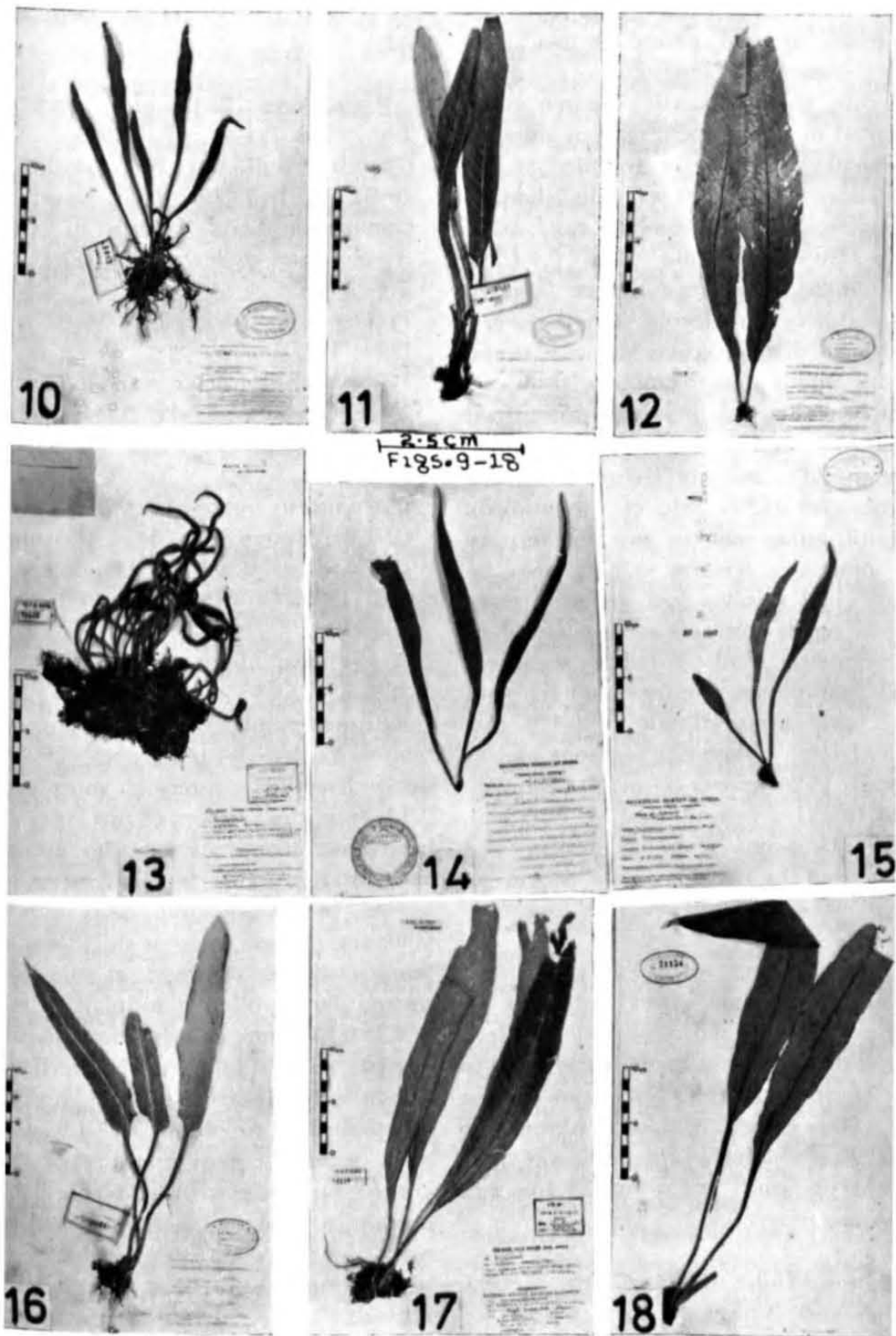
Niphobolus nummularifolius J. Sm., J. Bot. 3: 396. 1841; Bedd., Ferns South India 62. t. 186. 1863; Ferns Brit. India t. 320. 1869; Handb. Ferns Brit. India 334. 1883.

Cyclophorus nummularifolius C. Chr., Index Fil. 200. 1905. cum syn. (partim).

Rhizome slender, widely creeping, filiform, $0.75-1.0$ mm, sparsely branched, apex densely scaly, paleae of two distinct types, (i) large linear to linear-lanceolate with long acuminate, acicular, non-glandular apex, margin fringed with long stiff acicular hairs, $2.0-5.0 \times 0.25-0.50$ mm; (ii) small, ovate to shield-shaped with glandular apex and smooth



Figs. 1-9 : Photographs of different species of *Pyrrostia* Mirbel: 1. *P. adnascens* (Sw.) Ching; 2. *P. nummularifolia* (Sw.) Ching; 3. *P. obvata* (Bl.) Ching; 4. *P. lanceolata* (L.) Farwell; 5. *P. nuda* (Gies.) Ching; 6. *P. varia* (Kaulf.) Ching; 7. *P. lingua* (Thbg.) Ching; 8. *P. heteracta* (Mett.) Ching; 9. *P. pannosa* (Mett. ex Kuhn) Ching.



Figs. 10-18 : Photographs of different species of *Pyrrisia* Mirbel : 10. *P. mollis* (Kre.) Ching; 11. *P. beddomeana* (Gies.) Ching; 12. *P. stigmosa* (Sw.) Ching; 13. *P. nayariana* Ching ex Chandra; 14. *P. mannii* (Gies.) Ching; 15. *P. gardneri* (Mett.) Sledge; 16. *P. flocculosa* (Don) Ching; 17. *P. subfurfuracea* (Hook.) Ching; 18. *P. boothii* (Hook.) Ching.

margin, $1.0-1.5 \times 0.25-0.50$ mm; fronds dimorphic sub-sessile, sparsely placed in two alternate rows; stipe $0.1-0.7$ cm in sterile, $1.2-1.7$ cm in fertile fronds; sterile lamina ovate with rounded or acute apex, margin smooth, entire, orbiculate, cordate or rounded at the base, $0.9-2.6 \times 0.4-1.4$ cm; fertile lamina linear-elongate, oblong-lanceolate to lanceolate with obtuse or acute apex, $2.4-4.7 \times 0.5-0.7$ cm, margin entire; upper surface glossy at maturity and devoid of hydathodes, lower surface densely covered with loose ferruginous woolly tomentum; texture carnose-coriaceous, blackish-brown to dull-brown on drying; venation completely hidden, usually with three rows of irregular trapeziform areolae on either side of the mid-rib, areolae with either one or no free tertiary veinlets, sometimes tertiary veinlets may be lateral, marginal veinlets free, venation more irregular in fertile lamina; sori restricted to tertiary veinlets, small, circular, scattered; sporangial paraphyses dimorphous, (i) with long stalk and arms straight, $390-870$ μ m, (ii) with frizzy ribbon-like cottony arms; annulus cells 18-24; spores yellow to yellowish-brown to blackish brown, oval to elliptical, convex to plano-convex, exine hyaline and surface covered by thick, brown ridges or verrucae, $65-99 \times 38-65$ μ m (Figs. 2, 25-29).

This rare pendent, somewhat fleshy fern with dimorphic fronds grows either as an epiphyte or on large moss covered boulders. It is met with in the eastern Himalayas up to 900 m from Bhutan to Manipur (West Bengal: Darjeeling; Sikkim; Bhutan to Manipur: Assam; Meghalaya: Khasya hills). Also found in South India in the low hill forests (Anamallays).

Distribution: India, Cochin-China, Malaya, Philippines and Burma.

Specimens examined: EASTERN HIMALAYAS: Assam: Kamang, Wonne Basti, North of Bechom river, A. S. Rao, Nov..

1970 (CAL); Khasya, D. W. Deb, June 1961 (CAL).

3. **P. obovata** (Bl.) Ching, Bull. Chinese Bot. Soc. 1: 47. 1935; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117: 73-76. 1965; Nayar & Kaur, Companion Bedd. Handb. 81. 1974.

Acrostichum obovatum Bl., Fl. J. 35. t. 11. Fig. 3. 1828.

Polypodium obovatum Mett., Farngatt. Poly. 124. 1857.

P. nummularifolius var. *obovatus* (Sp.) Mett., Farngatt. Poly. 124. 1857; Clarke, Trans. Linn. Soc. Lond. II. Bot. 1: 554. 1880.

Cyclophorus nummularifolius var. *obovatus* C. Chr., Index Fil. 201. 1905 cum syn.

C. obovatus V.A.V.R., Handb. Mal. Ferns 685. 1909. C. Chr., Index Fil. Suppl. III. 65. 1934.

Niphobolus obovatus Kze., Bot. Zeit. 6: 120. 1848.

Rhizome slender, widely creeping, profusely branched, densely paleaceous, covered with small, irregular clusters of short roots, thin, $0.5-1.5$ mm thick; scales of two types, (i) linear-lanceolate, acuminate, acicular non-glandular apex margin with few stiff acicular, thick-walled protruding out hairs, $2.0-4.0 \times 0.25-0.50$ mm, (ii) few ovate or shield-shaped scales, margin entire, crowned at the apex with unicellular, swollen glandular hairs, $0.5-0.10 \times 0.25-0.50$ mm; fronds dimorphic sparsely placed; stipe $0.1-0.8$ cm in sterile and $0.7-1.2$ cm in fertile fronds; sterile lamina obovate or spatulate to oblong, $0.7-1.9 \times 0.7-1.2$ cm, apex rounded, margin entire or faintly recurved on under-surface; fertile lamina lanceolate to oblong-lanceolate, with rounded apex, $1.5-3.2 \times 0.4-0.6$ cm, gradually attenuate or cuneate at the base, margin slightly recurved; upper surface glossy without hydathodes, stellate-shaped hairs covering lower surface, texture carnose-papyraceous; venation obscure except for mid-rib which is slightly raised on the basal region, areolate

in four rows on each side, each areola with usually two rarely one or even no tertiary free veinlet; sori small, crowded and circular becoming acrostichoid at maturity; sporangial paraphyses of two types, (i) with long acicular, straight arms, $345-1170\ \mu\text{m}$, (ii) with frizzy very long ribbon-like coiled arms with rounded apices; annulus 17-20 celled; spores pale to golden yellow, oval to elliptical, plano-convex to convex, exine thick, bearing hyaline, thick, irregular spines and small verrucae here and there, $61-106 \times 49-65\ \mu\text{m}$ (Figs. 3, 30-33).

This species with dimorphic fronds grows as a lithophyte on moist shady rocks in eastern Himalayas (Assam: N. Cachar hills, Lu-shai and Khasya hills).

Distribution: India extending to Java and Tonkin.

This species is very closely allied to *P. nummularifolia* but differs in:

- (i) Sterile lamina obovate to oblong with rounded apex in *P. obovata* while in *P. nummularifolia* sterile leaves are ovate with acute or rounded apex.
- (ii) Lamina carnose-papyraceous in *P. obovata* and carnose-coriaceous in *P. nummularifolia*.
- (iii) Spores in *P. obovata* show thick irregular spines of exine which are absent in *P. nummularifolia*.

Specimens examined: EASTERN HIMALAYAS: Assam: North-Cachar hills, S. Chandra (LWG).

4. *P. lanceolata* (L.) Farwell, Amer. Midland. Naturalist 12: 245. 1931. (type from Ceylon); Sledge, Bull. Brit. Mus. (nat. Hist.) Bot. Ser. 2 (5): 133. 1960; Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15: 161. 1964; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117: 58-60. 1965; Bir & Vasudeva, J. Bombay nat. Hist. Soc. 68: 192. 1971; Nayar & Kaur, Companion Bedd. Handb. 80. 1974.

Acrostichum lanceolatum L., Spec. Plant. 2: 1067. 1753.

Niphobolus lanceolatus Trim., J. Linn. Soc. (Bot.) 24: 15. 1886.

N. adnascens Bedd., Ferns South India t. 184. 1863; Handb. Ferns Brit. India 325. t. 176. 1883 (pro parte), non Kaulf. 1824.

Cyclophorus lanceolatus Alston, J. Bot. 102. 1931; C. Chr., Index Fil. Suppl. 3: 65. 1934.

C. spissus Desv., Berl. Mag. 5: 301. 1811; C. Chr., Index Fil. 201. 1905, cum Syn.

C. giesenhagenii C. Chr., Index Fil. 199. 1905.

Polypodium adnascens Pt. auctt. Hook. & Bak., Syn. Fil. 349. 1867; Clarke, Trans. Linn. Soc. Lond. II. Bot. 1: 552. 1880 (pro parte).

P. partusum Hook., Exot. Fl. 2: t. 162. 1825 (pro parte).

Rhizome slender, widely creeping, thin 1-1.5 mm across densely paleaceous at apices, attached to the substratum by irregular clusters of black thin roots; scales light to dark brown of the two distinct types, (i) with large lanceolate $2.0-6.0 \times 0.25-0.50\ \text{mm}$, apex acuminate, non-glandular margin covered with long, tortuous, thin-walled, crowded hairs, (ii) small ovate to shield-shaped scales, hardly 1 mm long, apex acute or tending to be acuminate, margin more or less smooth, sometimes hairy only towards apex; fronds small uniform, distant or sometimes sparsely placed; stipe 0.4-1.5 cm; lamina linear-elongate to lanceolate or rarely oblanceolate, apex acute or acuminate, margin entire, reflexed, with narrowly or broadly cuneate base, $2.0-8.5 \times 0.2-0.9\ \text{cm}$; upper surface glossy and devoid of hydathodes, lower surface green, when mature covered with few stellate hairs, texture herbaceous, brittle when turgid; venation compyloneuroid, main lateral veins inconspicuous, areolae in 5-6 series between costa and the margin, each areola with 2-3 free tertiary veinlets, rarely anastomosing; sori small, circular, immersed, restricted to anterior half of the lamina; sporangial paraphyses with lanceolate, acute or obtuse arms, $150-270\ \mu\text{m}$ long; annulus

14-19 celled; spores yellow, oval to elliptical, convex to plano-convex, somewhat tuberculated, exine even irregular, $42-61 \times 27-42 \mu\text{m}$ (Figs. 4, 34-37).

Growing commonly both as an epiphyte as well as lithophyte or forming mats on the walls at lower elevations between 75-900 m in eastern Himalayas (Darjeeling: 165 m; near Teesta, 150 m; Siliguri, 75 m; Manjitar, 300 m. Sikkim State: Dickchu, 600 m; Andheri Khola, 900 m). Rare at higher elevations (Lebong forest, 1500 m). It is quite common in the south Indian mountains, going up to 1,200 m.

Distribution: India, Bhutan, China (Yunnan Province), Ceylon (type locality), Siam, Polynesia, Japan, Formosa, Tonkin, Fiji, Mascareen Islands and Cameroon Mountains.

It is characterised by narrowly linear-lanceolate, shortly stipitate fronds which are flavescent on drying. These are glabrous above and densely paleate and shortly pubescent underneath (sub-naked at maturity). The pubescence consists of stellate hairs with short-broad arms. The sterile fronds may be shorter than the fertile ones but the fronds are never dimorphic as in case of *Pyrrosia adnascens* which is comparatively much less common in the Himalayas and south Indian mountains. Sori are usually confined to the upper half portion. According to Mehra & Bir (1964) Clarke's (1880) and Beddome's (1883) *P. adnascens* is partly *P. lanceolata* and partly *P. nuda*. Specimens of this fern from Himalayas as well as south India are generally placed under *P. adnascens*.

Specimens examined: EASTERN HIMALAYAS: Darjeeling: Lebong, 165 m, S. K. Malhotra, Sept., 1953 (PAN); Darjeeling: July, 1955 (PAN); Near Teesta, 150 m, C. K. Trikha 1014, Sept., 1970 (PUN).

5. *P. nuda* (Gies.) Ching, Bull. Chinese Bot. Soc. 1: 70. 1935 (incl. syn.); Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15: 162. 1964.

Niphobolus nudus Gies., Farngatt. *Niphobolus* 146. 1901.

N. adnascens Bedd., Handb. Ferns Brit. India 325. 1880 (pro parte).

Polypodium adnascens Clarke, Trans. Linn. Soc. Lond. II Bot. 1: 552. 1880 (pro parte).

Cyclophorus nudus C. Chr., Index Fil. 200. 1905.

Rhizome slender, widely creeping, branched, densely paleaceous at the apex, thin, 2-4 mm thick; scales pale-yellow to yellowish brown, bicolorous, linear-lanceolate, apex acuminate to acute with deciduous glandular two-celled hair, margin hyaline, with long protruding hairs, luminae yellowish brown, $1.0-3.0 \times 0.25-0.50 \text{ mm}$; fronds uniform, sparsed; stipes 1-4 cm long, rather flattened forming a prominent dorsal median adaxial groove; lamina $8.0-13.0 \times 0.5-1.2 \text{ cm}$, linear-lanceolate to lanceolate, apex acuminate or acute or may be round, margin entire to faintly recurved; upper surface glossy and devoid of hydathodes, green and hairy on undersurface, sub-naked at maturity, texture herbaceous; venation compyloneuroid, hidden, main lateral veins inconspicuous, 4-7 areolae between costa and the margin, each areola with 2-4 free tertiary veinlets; sori large, circular, restricted to anterior half of lamina; sporangial paraphyses stellate with arms of variable size, may be $28-57 \mu\text{m}$ or $106-146 \mu\text{m}$ with long stalk; annulus 15-30 celled; spores light-yellow, oval to elliptical, convex to plano-convex, somewhat tuberculated, $53-76 \times 34-57 \mu\text{m}$ (Figs. 5, 38-43).

Growing as an epiphyte as well as lithophyte. Extremely common at low altitudes and abundant on exposed rocks. Met with in eastern Himalayas (Darjeeling: Teesta, 150 m; Sikkim; Jaintia hills: Jowai, 1350 m; Khasi hills: Barapani, 1,000 m) and South India (Kodaikanal: Falls view, 600 m).

Distribution: India, Burma, Ceylon, Malay Peninsula, China (Yunnan Province), Fiji, Mascareen Islands and Cameroon Mountains.

Pyrrosia nuda is closely allied to *P. lanceolata* but both can be separated as follows:

(i) *P. lanceolata* is characterised by the presence of two types of scales, (a) large lanceolate to ovate-lanceolate, (b) small shield-shaped whereas *P. nuda* possesses only linear to linear-lanceolate scales. (ii) Sporangial paraphyses are with short stalk in *P. lanceolata* and with long stalk in *P. nuda*.

This species has often been dealt under *P. adnascens* by early English Botanists.

Specimens examined : EASTERN HIMALAYAS : Darjeeling: Teesta, 150 m, S. S. Bir 842, June, 1963 (PAN). SOUTH INDIA : Kodaikanal: Falls view, 600 m, S. M. Vasudeva 132, Nov., 1966 (PUN).

6. *P. varia* (Kaulf.) Farwell, Amer. Midland Naturalist 12 : 302. 1931; Holtt., Fl. Malaya 2 : 146. 1954; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117 : 87-89. 1965; Nayar & Kaur, Companion Bedd. Handb. 80. 1974.

Niphobolus varius Kaulf., Enum. Fil. 125. 1824; Gies., Farngatt. *Niphobolus* 208. 1901.

N. adnascens Sw. (in part), Bedd. Handb., Ferns Brit. India 325. 1883.

Cyclophorus varius Gaud., Freyc. Voy. Bot. 364. 1827; C. Chr., Index Fil. 201. 1905 cum syn.; Bonap., Notes Pterid. t. 7. 126. 1918.

Rhizome long-creeping, branched, densely paleaceous at the apices, thin, 2-3 mm thick; scales appressed to the rhizome, dark brown in the centre and hyaline onwards, scales of variable size and shape, lanceolate to elongate-lanceolate to ovate-lanceolate to shield-shaped, apex acuminate to acute, terminating into either one or two globose glandular cells, peltate, shield-shaped hardly 1 mm in size, other types $3.0-5.0 \times 0.5-1.0$ mm, margin entire to somewhat serrate or with large acicular protruding out hairs; fronds distant, arranged in two rows; stipes 1.5-3.5 cm, cylindrical; lamina lanceolate to elongate-lanceolate, $9.1-19.1 \times 1.4-2.0$ cm, fertile laminae slightly longer than sterile ones, apex acute or acuminate, cuneate at the base, margin reflexed, texture herbaceous, upper surface

glossy and devoid of hydathodes lower surface dull-brown, covered with deciduous stellate hairs; venation compyloneuroid and hidden, lateral veins indistinct, 4-6 areolae on both sides of midrib, usually 3-6 unbranched, tertiary free veinlets within each areola, tertiary veinlets often branched or dividing the main areola; sori numerous, large, circular, close, restricted to anterior one-half to two-third of lamina and generally punctate; sporangial paraphyses monomorphous, stellate with long stalk and straight, lanceolate, blunt arms, $135-270 \mu\text{m}$; annulus cells 14-16; spores golden yellow to brown oval, planoconvex, strikingly verrucose with tubercle-like thickenings, $60-80 \times 42-53 \mu\text{m}$ (Figs. 6, 44-47).

This species is growing chiefly on trees in less exposed conditions than its allied species *P. adnascens* and is met with up to an elevation of 300 m in the eastern Himalayas (hill ranges of Assam).

Distribution : India, Malesia-Polynesia,

This fern is closely allied to *P. adnascens* but can be easily distinguished as follows :

(i) The dimorphic fronds are of variable shape and size in *P. adnascens* whereas almost monomorphic fronds of *P. varia* only differ in size.

(ii) Rhizome scales in *P. varia* are of three different types-lanceolate, ovate-lanceolate or shield-shaped, margin either entire or only with protruding out hairs at about $1/2$ of the scales whereas in *P. adnascens* scales are of two types—lanceolate to subulate or shield-shaped with either eroded margin or throughout with long, protruding acicular hairs.

Specimens examined : EASTERN HIMALAYAS : Assam : Amlari, P. Chandra & party 83035, Nov., 1963 (LWG).

7. *P. acrostichoides* (Forst.) Ching, Bull. Chinese Bot. Soc. 1 : 69. 1935.

Polypodium acrostichoides Forst., Prod. 81. 1786; Hook., Spec. Fil. 5 : 44. 1863.

Niphobolus acrostichoides Bedd., Ferns

Brit. India t. 81. 1869; Handb. Ferns Brit. India 327. 1880.

Cyclophorus acrostichoides (Forst.) Presl., Epim. 130. 1840; C. Chr., Index Fil. 197. 1905.

C. induratus Christ., J. Bot. d. France 21. 238. 271. 1908; C. Chr., Index Fil. Suppl. 1. 22. 1912.

Rhizome slender, wide-creeping, branched, younger portion squarrose; scales monomorphic, large, bright ferruginous, lanceolate; stipes 2.3-8.4 cm long, furnished at the base with obtuse scales; fronds hard, far apart, elongate-lanceolate or lanceolate, obtuse, 30-60 × 1.0-2.3 cm, sterile fronds generally the broadest; texture coriaceous, glabrous above, beneath whitish or tanny, stellate tomentose (tomentum very deciduous), dull-green on both sides; areolae 5-7 between costa and the margin, each with 3-6 veinlets, free and simple or variously forked and anastomosing; sori rather small, prominent, very compact, generally occupying the upper part of the frond, arranged in 6-8 oblique very close series between the costules (Figs. 19, 48-49).

Distribution : South India, Burma, Ceylon and Malesia-Polynesia.

This distinct and well-known fern is included on the basis of Ching (1935). It is characterised by long-creeping rhizome being clad in imbricately orbicular-ovate, shortly ciliate scales, attached by large black centre and uniform linear paper-like fronds which finally become naked above and sparsely clothed underneath in uniform, mealy-white stellate hairs with short broad arms.

8. *P. laevis* (J. Smith) Ching, Bull. Chinese Bot. Soc. 1: 52. 1935; Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15 : 162. 1964; Nayar & Kaur, Companion Bedd. Handb. 80. 1974.

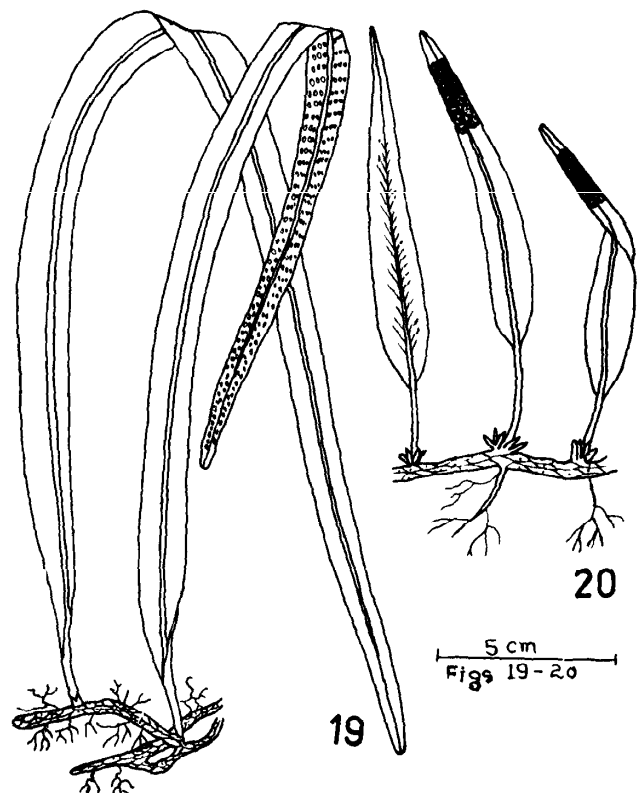
Nipholobolus laevis J. Smith Bedd., Ferns, Brit. India t. 161. 1866 and Handb. Ferns Brit. India 325. 1883.

Polypodium laeve Mett. ex Kuhn, Linnaea 36. 139. 1869.

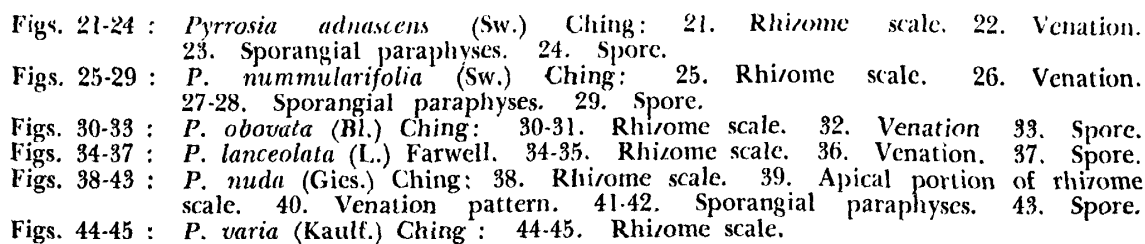
P. jaintense Clarke, Trans. Linn. Soc. Lond. II. Bot. 1: 552. Pl. 82. Fig. 4. 1880.

Cyclophorus laevis C. Chr., Index Fil. 199. 1905. cum syn. Sikkim: Khasya hills, Jaintia, type locality (cf. Ching, 1935).

Rhizome slender, wide-creeping, thin, 1-3 mm, clothed with linear-setaceous scales; stipes distant, somewhat hairy, 1.2-5.0 cm long, furnished with a tuft of scales at the base; fronds linear-lanceolate, much narrowed towards the base, 6.3-15.0 × 0.6-2.0 cm, glabrous above, hairy with stellate pubescence beneath, sub-naked at maturity, texture coriaceous; venation obscure, lateral veins indistinct, areolae in 3 series between costa and the margin with one, two or three clavate veinlets in each which are variously directed, free or rarely joined to the base of areola above; sori large, partially sunk in the tomentum, confined to apex of the frond, or



Figs. 19-20 : Habit sketch of *Pyrrosia acrostichoides* (Forst.) Ching and *P. laevis* (J. Smith) Ching respectively.



scattered or covering nearly all the under surface (Figs. 20, 50-51).

Recorded from eastern Himalayas by Beddome (1892) from Jarain (Jaintia — Khasya hills) at an elevation of 1,050 m.

Distribution : India and Tibbet.

This little fern is very distinct in having (i) distinctly petiolate fronds similar to *Lepisorus clatharatus* (Clarke) Ching, (ii) texture papyraceous, venation rather indistinct on both sides and (iii) indumentum on under surface densely felted with dark-brown stellate hairs with long needle-like arms.

9. *P. lingua* (Thbg.) Ching, Bull. Chinese Bot. Soc. 1 : 60. 1935; Farwell, Amer. Midland Naturalist 12 : 302. 1931; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117 : 60-63. 1965; Bedd., Ferns South India 81. 1970 (reprint).

Acrostichum lingua Thbg., Fl. Jap. 330. t. 33. 1784.

Niphobolus heteractis (Mett.) Bedd., Handb. Ferns Brit. India 327. 1883 (pro parte).

N. petiolosus Christ, Bull. Soc. Bot. d. France 52. Mem. 1 : 24. 1905 (non Diels. 1900).

Cyclophorus lingua (Thbg.) Desv., Prod. 224. 1827; C. Chr., Index Fil. 199. 1905. cum syn.

C. taiwanensis C. Chr., Index Fil. 201. 1905.

C. martini C. Chr., Index Fil. 199. 1905.

C. bodinieri C. Chr., Index Suppl. II. 1916.

Polypodium lingua Sw., Syn. Fil. 29. 1806; Hook. & Bak., Syn. Fil. 350. 1867 (partim);

Christ, Bull. Herb. Boiss. 7 : 5. 1899.

P. taiwanense Christ, Warb., Monsunia 1 : 60. 1901.

Rhizome widely creeping, slender, thin, 2.0-3.0 mm in diameter; scales brown, ovate to ovate-lanceolate, highly variable in size, acute to acuminate apex, non-glandular, margin hyaline, dark brown in the centre, 1.0-3.0 × 0.5-1.0 mm; fronds sparsely arranged; stipe 18.5-21.0 cm, with inconspicuous median dorsal groove, densely paleaceous at

the base; paleae yellow to light-brown, lanceolate to ovate-lanceolate, apex acute, non-glandular, margin somewhat less hairy than rhizome paleae, recurved, rounded at the base, 5.0-6.0 × 1.0-1.5 mm; lamina lanceolate to ovate-lanceolate, acute, margin slightly in-rolled, cuneate or decurrent at the base, 19.0-20.5 × 2.7-3.5 cm; texture stiff and leathery, upper surface brown and glossy, slightly punctate, lower surface brownish grey with a layer of greenish white tomentum; venation compyloneuroid, lateral veins indistinct, areolae in four to many rows, each areola with 2-4 tertiary veinlets with clavate apices, may be branched or sometimes dividing the areola into two, apices may be recurved; sori large, circular or evenly confluent, compact, covering the whole lamina; sporangial paraphyses with arms lanceolate, 140-280 μm, long stalked; annulus cells 15-21; spores yellow to brown, oval to elliptic, planoconvex to convex, verrucose, verrucae sub-globose and sparsed, 49-61 × 30-46 μm (Figs. 7, 52-55).

Met with in eastern Himalayas (Sikkim and Bhutan, 1,200-1,800 m; Khasya, 1,200-1,500 m).

Distribution : India, Japan, Formosa and Tonkin.

Characterised by acute lamina covered with monomorphous tomentum and sori slightly punctate on upper side.

Specimens examined : JAPAN : Prof. Nagasaki, Mt. Tara-dake, T. Harada, July 1936 (PAN).

10. *P. heteractis* (Mett.) Ching. Bull. Chinese Bot. Soc. 1 : 57. 1935 (as *heteractis*); Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15 : 163. 1964; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117 : 54-58. 1965; Nayar & Kaur, Companion Bedd. Handb. 80. 1974.

Polypodium heteractis Mett., Kuhn, Linnaea, 36 : 140, 1869; Clarke, Trans. Linn. Soc. Lond., II. Bot. 1 : 553. 1880.

Niphobolus heteractis J. Smith, Ferns Brit.

and Fore. ed. 2: 296. 1877; Bedd. Handb. Ferns Brit. India 327. 1883.

P. lingua Bedd., Ferns Brit. India Suppl. 22 t. 385. 1876 (non Spring 1827).

Cyclophorus heteractis (Mett.) C. Chr., Index Fil. 199. 1905, cum syn.

Rhizome slender, widely creeping, thin, 1.5-2.5 mm across, profusely branched, densely scaly, scales often abundant at the apices; scales broadly ovate to ovate-lanceolate to linear-lanceolate, golden yellow to golden brown, $2.0-6.0 \times 0.5-1.5$ mm, may be smooth or hairy, hairs only towards the apices, apical hairs non-glandular, may be coiled or sometimes bifurcated, hairs tortuous long, thin walled, fronds distant; stipes 4.5-6.0 cm, adaxial groove distinct, sparsely covered with scales and stellate hairs, scales brown lanceolate, wider than rhizome scales; lamina oblong to oblong-lanceolate to oblong-ovate with long acuminate apex, broadly rotundocuneate or rounded at the base, $8.0-15.0 \times 3.1-4.0$ cm, upper surface glossy with few small scattered hydathodes, lower surface clothed with light-brown felt of dimorphous, persistent stellate hairs, texture coriaceous; lateral main veins distinct on either side, areolae 8-9 in series between the costa and the margin, each areola including two to three veinlets, generally forked, more or less anastomosing; sori rather large, only scattered to free veinlets, often slightly elongated, either present all over or $2/3$ of the lamina, appearing postulate like at maturity due to bursting out of acutely stellate hairs; sporangial paraphyses of two types, (i) with acutely or obtusely lanceolate straight arms $135-315 \mu\text{m}$, (ii) with straight lanceolate and twisted frizzled arms in two circles; annulus 16-19 celled; spores yellow to light-brown, oval to elliptical, convex to planoconvex, verrucose, verrucae subglobose, $38-84 \times 34-61 \mu\text{m}$ (Figs. 8, 56-59).

This species is growing epiphytically as well as terrestrially near the ravines. It is represented in eastern Himalayas (North Sikkim, 1,200-1,800 m; Darjeeling, 2,100 m;

Lapchoo, 3,000 m; Khasya, 1,500 m; Assam: Jawai).

Distribution: India, Ceylon, Burma and Bhutan.

It is characterised by (i) lamina oblong to oblong-lanceolate to oblong-ovate, (ii) dimorphous stellate hairs and (iii) rhizome scales ovate to ovate-lanceolate to lanceolate. This species is closely allied to *Pyrrosia lingua* but differs in having broader oblong-lanceolate fronds with long acuminate apex, filamentous hairs radiating around the scales and somewhat different habit.

Specimens examined: EASTERN HIMALAYAS: Assam: Jawai, S. Chandra & party 94149, April, 1964 (LWG); Darjeeling: Near Lapchoo, 3,000 m, C. K. Trikha 1017, Aug., 1970 (PUN).

11. *P. pannosa* (Mett. ex Kuhn) Ching, Bull. Chinese Bot. Soc. 1: 58. 1935; Sledge, Bull. Brit. Mus. (nat. Hist.) Bot. Ser. 2 (5): 135. 1960; Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15: 164. 1964; Nayar & Kaur, Companion Bedd. Handb. 80. 1974; Dhir, Bibliotheca Pteridologica 1: 117. 1980.

Polypodium pannosum Mett. ex Kuhn, Linnaea 36: 141. 1869; Hook. & Bak., Syn. Fil. ed. 2: 512. 1874.

Niphobolus pannosus (Mett.) Bedd., Ferns Brit. India Suppl. 22. 1876 and Handb. Ferns Brit. India 328. t. 177. 1883.

N. lingua Bedd., Ferns South India t. 240. 1863-1865 (non Spring, 1827).

Cyclophorus pannosus (Mett.) C. Chr., Index Fil. 200. 1905.

Rhizome widely creeping, slender, thin, 1.0-2.5 mm in diameter, branched, clothed with clusters of wiry roots, closely appressed, ovate to lanceolate with acute or obtuse apex either terminating into a non-glandular hair or numerous hairs $1.0-6.0 \times 0.5-1.0$ mm; fronds distant; stipe 7.0-12.5 cm long, cylindrical, densely scaly, scales ovate to ovate-lanceolate, apex acute, rarely forked, cuncate at the base, $12.0-17.5 \times 4.0-5.5$ cm; tex-

ture coriaceous, glabrous above, beneath densely matted with stellate hairs, hydathodes present; venation compyloneuroid, main lateral veins distinct, areolae in about 5-7 rows, each areola with 1-4 simple, free or anastomosing tertiary veinlets; sori small, in definite rows, bursting out like a postule at maturity, about 6-25 in transverse rows, 4-6 in parallel rows; sporangial paraphyses stellate with both straight and frizzy arms, straight arms 135-210 μm ; annulus 20-24 celled; spores pale yellow to yellow, ovoid to elliptical or irregular in shape, convex to plano-convex, exine thick, verrucose, 49-72 $\times$ 38-57 μm (Figs. 9, 60-62).

Commonly growing as a lithophyte or rarely as an epiphyte in eastern Himalayas (north Sikkim : Tung, 1,500 m) and western Himalayas (Nainital : Bhimtal, 1,350 m).

Distribution : India and Ceylon.

It is characterised by creeping rhizome densely clothed with brown scales.

Specimen examined : EASTERN HIMALAYAS : N. Sikkim : Tung, 1,500 m, S. S. Bir 1080, July, 1958 (PAN).

12. *P. stictica* (Kze.) Holtt., Novit. Bot. Inst. Bot. Univ. Carol. Prague 31. 1968; Verma & Khullar, Brit. Fern Gaz. 12 (2) : 91. 1980; Bir & Vasudeva, J. Bombay nat. Hist. Soc. 76 : 558. 1980. *Niphobolus sticticus* Kze., Linn. 24 : 257. 1851.

Polypodium sticticum Mett., Poly. 128. n. 260. 1857.

Cyclophorus sticticus C. Chr., Index Fil. 201. 1905.

Rhizome short-creeping, thin, 1.0-2.5 mm in diameter, paleaceous, thickly covered with dark-brown wiry roots; scales light to dark-brown, ovate to ovate-lanceolate, firmbriate, apex acute, non-glandular, rounded at the base, margin hairy, 3.0-7.0 $\times$ 0.25-0.50 mm; fronds aggregate; stipe 2-7 cm, densely covered by stellate hairs; lamina lanceolate with acute or acuminate apex, margin entire, gradually attenuate at the base, 7.0-16.0 $\times$

1.0-2.0 cm, wholly tomentose with ferruginous woolly stellate hairs; texture carnoscoriaceous; venation obscure, lateral veins indistinct, 10 to many parallelogrammoid areolae on each side of mid-rib, each areola with 2-5 tertiary veinlets which are generally free, may be forked or seldom anastomosing; sori scattered, in irregular rows, copious, sunken among tomentum when young, sporangial paraphyses dimorphous with crisped arms, (i) with straight, needle-like arms, 84-152 μm , (ii) with ribbon-like coiled frizzy arms; annulus 14-29 celled; spores pale yellow to yellow, oval to elliptical, planoconvex to convex, exine slightly verrucose, 76-91 $\times$ 46-72 μm (Figs. 63-67).

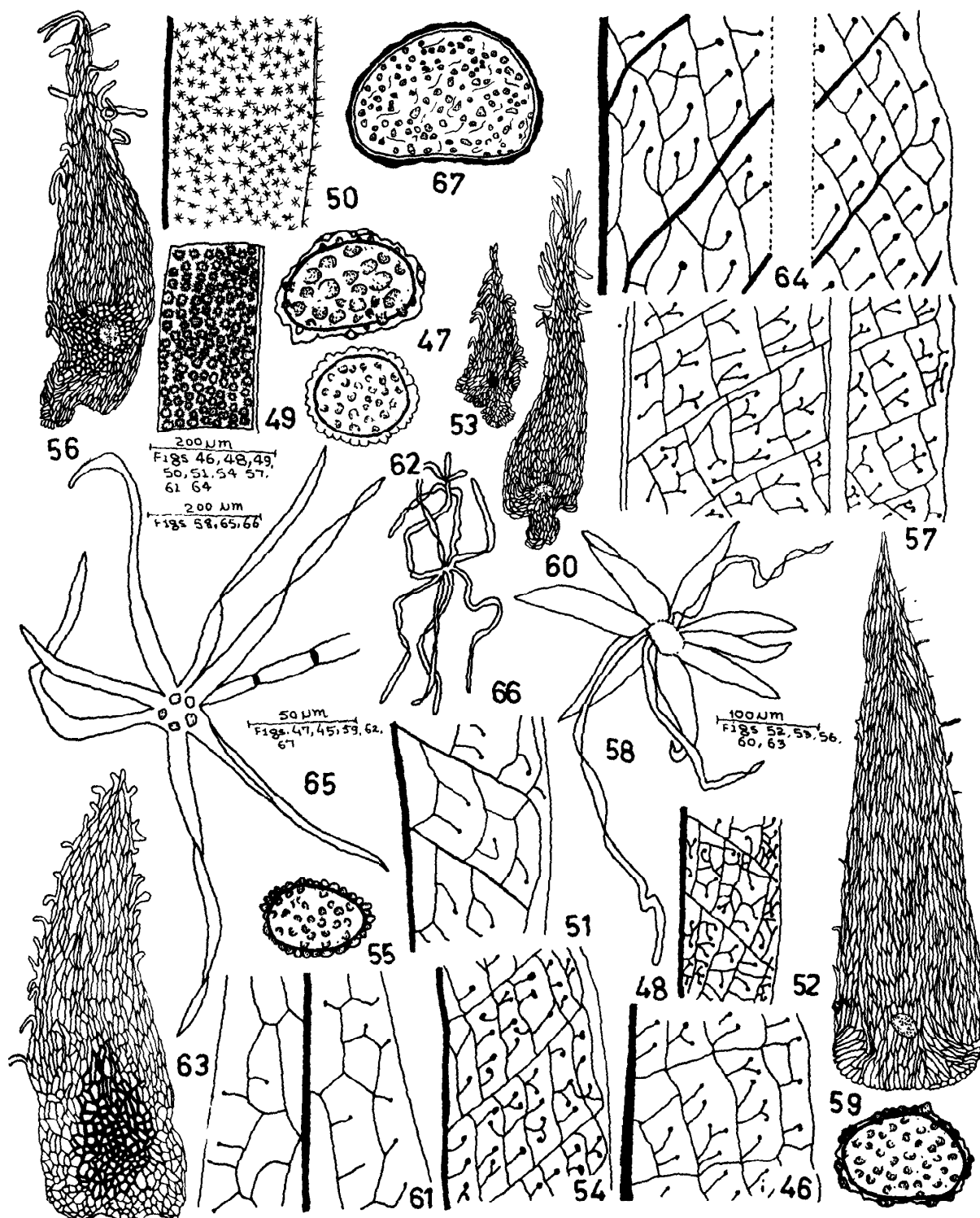
This fern grows as lithophyte as well as an epiphyte in moist shady and even open places in north western Himalayas (Nainital) and South India (Nilgiris-type locality, Kodaikanal : Silver Cascade, 1,800 m: Perumalmalai).

Distribution : India, China and Philipines.

Ching (1935) and Sledge (1960) treat the present species as a synonym of *Pyrrosia mollis*. Although closely related to that species it is distinguished by its crisped arms of stellate hairs.

Specimens examined : SOUTH INDIA : Kodaikanal : Near Silver Cascade, 1,800 m, S. M. Vasudeva 75, Sept., 1970 (PUN); Perumalmalai, S. M. Vasudeva 1184, Jan., 1975 (PUN).

13. *P. mollis* (Kze.) Ching, Bull. Chinese Bot. Soc. 1 : 53. 1935 (incl. syn.); Sledge, Bull. Brit. Mus. (nat. Hist.) Bot. Ser. 2 (5) : 134. 1960; Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15 : 163. 1964 cum syn. pro parte; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117 : 67-70. 1965; Bir & Vasudeva, J. Bombay nat. Hist. Soc. 68 : 192. 1971; Nayar & Kaur, Companion Bedd. Handb. 81. 1974; Dhir, Bibliotheca Pteridologica 1 : 116. 1980. *Niphobolus mollis* Kze., Bot. Zeit. 121. 1848.



- Figs. 46-47 : *P. vniia* (Kaulf.) Ching : 46. Venation. 47. Spore.
 Figs. 48-49 : *P. acrostichoides* (Forst.) Ching : 48, 49. Venation
 Figs. 50-51 : *P. laevis* (J. Smith) Ching : 50, 51. Venation.
 Figs. 52-55 : *P. lingua* (Thbg.) Ching : 52, 53. Rhizome scale. 54. Venation. 55. Spore.
 Figs. 56-59 : *P. heteracta* (Mett.) Ching : 56. Rhizome scale. 57. Venation. 58. Sporangial paraphyses. 59. Spore.
 Figs. 60-62 : *P. pannosa* (Mett. ex Kuhn) Ching : 60. Rhizome scale. 61. Venation. 62. Spore.
 Figs. 63-67 : *P. stricta* (Kze.) Holtt. : 63. Rhizome scale. 64. Venation. 65, 66. Sporangial paraphyses. 67. Spore.

N. fissus Bedd., Ferns Brit. India II. 1870; Handb. Ferns Brit. India 330. t. 179. 1883 (non-Blume, 1828).

N. porosus Bedd., Ferns South India t. 183. 1863.

Polypodium fissum Hook. & Bak., Syn. Fil. 351. 1874; Clarke, Trans. Linn. Soc. Lond. II. Bot. 1 : 554. 1880 (non *Nipholobolus fissus* Bl.); Hope, J. Bombay nat. Hist. Soc. 14 : 720. 1902-1903.

Cyclophorus porosus Presl., Epim. Bot. 130. 1849; C. Chr., Index Fil. 200. 1905. cum syn. (excl. *Nipholobolus mannii* Gies.); Suppl. 111 : 65. 1934.

C. mollis Presl., Epim. Bot. 131. 1849; C. Chr., Index Fil. 199. 1950 (cum syn.).

Rhizome short-creeping, caudex slender, thin, 2-3 mm in diameter, covered with dark-brown wiry roots, apex densely paleaceous, paleae lanceolate, bicolorous, atratous, luminae thick and dark-brown in the centre, margin with numerous fringed protruding out hairs, apex acuminate to acute or obtuse with small glandular deciduous hairs in the centre, 1.0-3.0 × 0.25-1.0 mm; fronds rather aggregate; stipes subcaespitose; lamina oblanceolate, linear-lanceolate to lanceolate, acute or finely acuminate, gradually attenuate at the base, margin entire, 15-23 × 0.5-1.5 cm; texture carnose-coriaceous; upper surface glossy, dull-green on drying, studded with hydathodes, lower surface wholly tomentose with ferruginous woolly stellate hairs; venation obscure, lateral veins distinct, veins punctate and forming parallelogrammoid areolae, areolae in 4-6 series on each side with 2-3 clavate, rarely forked tertiary veinlets; sori scattered in irregular rows, superficial, sunken along tomentum when young; sporangial paraphyse dimorphous, (i) upper with straight long acicular pointed arms 210-450 μ m, (ii) lower with frizzy arms and blunt apices; annulus 20-24 celled; spores light-yellow, oval to elliptical or irregular, planoconvex to convex, exine verrucose, very distinct,

yellow pigments in the centre, 80-103 × 46-57 μ m (Figs. 10, 68-70).

A common lithophyte growing on rocks boulders. Seldom growing as an epiphyte. It is found in association with *Pyrrosia mannii* in eastern Himalayas and with *P. flocculosa* in western Himalayas. Met within eastern Himalayas (Darjeeling: Lebong forest, 1,500 m; Pashupathi Phatak; Rangaroon, 1,500 m; Sikkim State: Karponang, 3,000 m; Mangan, 1,200 m; Kameng District: Diomara south of bridge on hill slopes; Rupa surroundings; Khasi hills: Shillong, 1,500 m), western Himalayas (Garhwal: Gobindghat, 1,800 m; Almora: Jageshwar, 1,800 m; Nainital; Ranikhet, 1,800 m; Dhobi Khud, 1,800 m; Kaladhuggi Road, 300-900 m; Kulu Valley: Naggar, 2,200 m; Kandi Pass, 1,700 m; J & K: Poonch, 1,500 m) and south India (western Ghats and Nilgiris).

Distribution : India, Burma, Java, Malaya and China (Yunnan Province).

It is characterised by its bicolorous, atratous, fimbriate and lanceolate scales. Lamina shape is highly variable, may be oblanceolate, linear-lanceolate or lanceolate. Under surface of lamina is thickly covered by ferruginous dimorphous tomentum.

Specimens examined : WESTERN HIMALAYAS: Nainital: Ranikhet, 1,800 m, P. Chandra Pande 16, Oct., 1970 (PUN); Dhobi Khud, 1,800 m, C. K. Trikha 1083, July, 1971 (PUN); Kaladhungi Road, 300-900 m, K. K. Dhir 3101, Sept., 1965 (PAN); Kulu Valley: Naggar 2,200 m, S. S. Bir, Oct., 1965 (PAN); Kandi Pass, 1,700 m, S. S. Bir, Sept., 1955 (PAN); J & K: Poonch, 1,500 m, Harvender Kirn 1486, Dec., 1973 (PUN). EASTERN HIMALAYAS: Darjeeling: S. K. Malhotra, Sept., 1953 (PAN); Lebong forest, S. S. Bir 750 July, 1957 (PAN); Pashupathy Phatak in Sinann, R. D. Dixit 52409, May, 1975 (CAL); Sikkim State: Karponang, 3,000 m, S. K. Malhotra, Sept.,

1955 (PAN); Kameng District : Doimara south of Bridge on hill slopes, A. S. Rao 56468, Feb., 1974 (CAL); Rupa surroundings, 1,800 m, J. Joseph 40407, Sept., 1974 (CAL).

14. *P. stenophylla* (Bedd.) Ching, Bull. Chinese Bot. Soc. 1 : 55. 1935; Nayar & Kaur, Companion Bedd. Handb. Ferns Brit. India 81, 1974.

Niphobolus fissus var. *stenophyllus* Bedd. Handb. Ferns Brit. India Suppl. 92. 1892. *N. stenophyllus* Gies., Farngatt. *Niphobolus* 131. 1901.

Polypodium fissum var. *floccigerum* Clarke, Trans. Linn. Soc. Lond. II. Bot. 1 : 554, 1880.

Cyclophorus stenophyllus C. Chr., Index Fil. 201. 1905.

It is closely allied to *Pyrrosia mollis* but distinct in having very narrowly linear fronds, 20-40 cm long and only 2-4 mm broad. The hairs on under surface of lamina are dense, mealy-white, dimorphous, the lower ones whitish woolly with frizzy arms, the upper ones sparse, brown, consisting of needle like arms.

Recorded by Beddome (1892) from Khasya (Manipur : Mao, 1,800 m) and Ching (1935) from Bhutan.

Distribution : India and Bhutan.

The Khasyan specimens of the present species had been referred to *P. floccigera* (Bl.) Ching which is a common fern of Malesia-Polynesia and Philippines.

15. *P. beddomeana* (Gies.) Ching, Bull. Chinese Bot. Soc. 1 : 68. 1935 (incl. syn.); Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15 : 164. 1964.

Niphobolus beddomeanus Gies. Farngatt. *Niphobolus* 101. 1901.

N. costatus Bedd., Ferns Brit. India t. 120. 1866.

N. stigmosus Bedd., Handb. Ferns Brit. India 328. 1883 (pro parte).

Cyclophorus beddomeana C. Chr., Index Fil. 198. 1905. cum syn.; Stewart, Ann.

Vol. Royal Bot. Gard., Calcutta 170. 1942. *Polypodium stigmosum* Clarke, Trans. Linn. Soc. Lond. II. Bot. 1 : 553. 1880; Hook. & Bak., Syn. Fil. 350. 1867. (pro parte).

Rhizome rather short-creeping, slender, thin, 2-4 mm thick, clothed with tuft of wiry roots; scales ferruginous, part atratous, ovate-lanceolate to lanceolate, attached with auricled base, apex long-acuminate with a deciduous glandular cell, dark in the centre, margin entire, 4.0-9.0 × 0.25-1.0 mm; fronds closely aggregated, generally sessile, sub-caespitose stipes, 0.75-7.0 cm, adaxial groove distinct; lamina oblanceolate to broadly lanceolate, apex acuminate or acute, gradually attenuate towards the base, margin entire or wavy, 11.0-65.0 × 1.0-6.4 cm; upper surface glabrous and dark-brown on drying, lower surface ferruginous tomentose beneath; venation compyloneuroid, main lateral veins distinct, costules distinct on lower side, areolae in 4 to many series on each side of the midrib, each areola with 2 to many tertiary veinlets which are either free or irregularly anastomosing; sori very minute, immersed, arranged in numerous compact or closely placed lines between the costules and in equally compact series, transverse to them, up to 3/4 of lamina; sporangial intermixed with stellate, short, thick, lanceolate, 135-225 µm and frizzy armed paraphyses; annulus 11-15 celled; spores orange to yellow, subglobose, convex to planoconvex to concavoconvex, exine smooth, 49-65 × 30-46 µm (Figs. 11, 71-74).

Very frequently met with on rocks or stony walls or growing epiphytically, usually on tree trunks of *Ficus elastica* at low elevations in eastern Himalayas (Darjeeling : Teesta, 150 m; Teesta Valley Tea State, 800 m; Manjitar, 300 m; way to Peshok, 1,000 m; Garo hills; Tura Peak 1,075 m; Khasi hills; Shillong, 1,830 m), western Himalayas (Kumaon : Baram, Geori, 1,200 m; Nainital : Bhimtal, 1,400 m) and Orissa (Mazpada, 682 m).

Distribution : India, Tibet, and China (Yunnan Province).

This fern is characterised by (i) fronds bases long attenuate (lamina gradually decurrent along the stipe until near the base) and (ii) dimorphic hairs on the under-surface of the fronds, upper stellate hairs with lanceolate arms and lower woolly hairs with frizzy silky arms. It is distinct from *Pyrrosia stigmosa* in its oblanceolate, sessile fronds gradually decurrent along the stipe until near the base.

Specimens examined : EASTERN HIMALAYAS : Darjeeling : Manjitar-Teesta Road, S. K. Malhotra 835, Aug., 1957 (PAN); Near Peshoke, 2,400 m, C. K. Trikha 1011, Aug., 1970 (PUN); Teesta Valley Tea Estate, 800 m, R. D. Dixit, Feb., 1976 (CAL). WESTERN HIMALAYAS : Nainital : Bhimtal, 1,400 m. S. S. Bir, Sept., 1967 (PUN); Kumaon : Baram, Geori, 1,200 m, U. C. Bhattacharyya, April, 1962 (CAL). ORISSA : Majipada, 682 m, G.V.S. Rao 30444, Dec., 1962 (CAL).

16. *P. stigmosa* (SW.) Ching, Bull. Chinese Bot. Soc. 1 : 67. 1935; Mehra, Ferns Mussoorie, Panjab Univ. Bot. Publ. Lahore (W. Pakistan) pp. 27. 1939; Holtt., Fl. Malaya 2 : 148. 1954; Mehra & Bir. Res. Bull. Panjab Univ. Sci. (n.s.) 15 : 164. 1964; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117 : 80. 1965; Nayar & Kaur, Companion Bedd. Handb. 80. 1974; Dhir, Bibliotheca Pteridologica 1 : 118. 1980.

Polypodium stigosus Sw., Schrad. J. 1800^a : 21. 1801; Clarke, Trans. Linn. Soc. Lond. II. Bot. 1 : 553. 1801 (pro parte; Hope, Bombay nat. Hist. Soc. 14 : 720-749. 1902-1903).

Cyclophorus stigosus C. Chr., Index Fil. 201. 1905 (cum syn.); Chowdhury, PFUGP. 73. 1973.

Niphobolus stigosus Bedd., Handb. Ferns Brit. India 328. t. 178. 1883 (pro parte).

Rhizome short-creeping, stout, rather flattened dorso-ventrally, thick, 5-9 mm across, rufous paleaceous, thickly covered with dark-brown wiry roots; scales brown, subulate to linear-lanceolate or lanceolate, long acuminate apex, margin smooth eroded at the base, cells of the luminae rather thick, dark brown or black in the centre, peltate, 7.0-8.0 × 1.0-1.5 mm, fronds subaggregated, stipitate; stipes subcaespitose, 2.5-10.0 cm long, densely paleaceous at the base; lamina lanceolate to broadly lanceolate, acuminate, gradually attenuate or may be decurrent at the stipe, firm with crisped margin, 20.0-84.0 × 2.2-8.5 cm, upper surface yellowish-green, lower dark-green texture subcoriaceous, glabrous above, beneath densely stellate ferruginous tomentose; venation distinct, elevated on the lower side, areolae in about 10-13 series on each side, each areola including many veinlets which are branched or variously anastomosing, sori immersed, circular, arranged in compact series between the costules and the equally compact series transverse to them, upto $\frac{1}{2}$ or $\frac{2}{3}$ or lamina; sporangial paraphyses of two distinct types (i) with stellate, straight, lanceolate acuminate arms, 150-355 μ m (ii) with frizzy, long, very much coiled arms, few with two rings of arms, upper straight and lower frizzy; annulus 12-16 celled; spores yellowish brown, oval to globose, planoconvex to concavoconvex, smooth or slightly verrucose-granulose, verrucae small and sparsed, 46-65 × 27-46 μ m (Figs. 12, 75-77).

This fern may be growing both epiphytically as well as lithophytically on rock crevices or on stone embankments at low altitudes. Met with in the Himalayas from Garhwal to Bhutan, Khasya hills and Paras-nath hills (Garhwal, 1,200 m; Almora : Sarju Valley, 900-1,500 m; Kapkot; Bageshwar, 900 m; Darjeeling : Manjitar Road, 2,000 m; Teesta, 150 m; way to Manjitar, 300 m; Peshok, 2,400 m; Kameng; Badamtam-Manjitar-Teesta Road; Teesta-Siliguri

road; Teesta-Kalimpong road; Sikkim State: Singhik, 1,200 m) and south India (Vizagapattam: Golcondah hills).

Distribution: India, Burma, Malesia, northwards to Cochin-China, Indonesia and New Guinea.

It is characterised by long stipitate fronds and is very confusing with *Pyrrosia beddomeana* and *P. subfurfuracea* but can easily be distinguished as follows:

- (i) lamina is lanceolate to oblanceolate in *P. beddomeana* and elongate-lanceolate to oblanceolate in *P. subfurfuracea* whereas in *P. stigmosa* lamina is lanceolate to broadly lanceolate,
- (ii) rhizome scales are with deciduous apical glandular cell in *P. beddomeana* and *P. subfurfuracea* and non-glandular apex in *P. stigmosa*.

Specimens examined: EASTERN HIMALAYAS: Darjeeling: Manjitar road, 2,000 m, S. K. Malhotra, Aug., 1958 (PAN); Teesta, 150 m, S. S. Bir, Sept., 1963 (PAN); way to Manjitar, 300 m, C. K. Trikha 1918, Aug., 1970 (PAN); Peshok, 2,400 m, C. K. Trikha 1012, Aug., 1970 (PUN); Takdah to Teesta road, R. D. Dixit 52787, May, 1975 (CAL); Kameng, A. S. Rao 56434, Feb., 1974 (CAL); North Sikkim: Singhik, 1,200 m, S. S. Bir, July, 1938 (PAN).

17. *P. nayariana* Ching ex Chandra, Amer. Fern J. 54 (2) 62. 1964; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117: 70. 1965.

Rhizome short-creeping, thin, about 2.5-3.0 mm across, hard and sparsely branched, densely covered by dark brown roots; paleae dark brown lanceolate, apex long acuminate, sometimes with glandular hair, seldom a lateral glandular hair present, laminac uniformly brown, margin dentate, most of the teeth pointing backwards, 3.0-5.0 × 0.5-1.5 μ m; fronds approximate, uniform, sometimes subsessile; stipes 0.3-0.9 cm; lamina linear to linear-lanceolate, broader in the middle or slightly above, apex acuminate or sharp,

acute, margin entire, recurved, 14.7-21.7 × 0.25-0.5 cm, texture subcoriaceous, upper surface glossy and covered with small pitted hydathodes, numerous stellate hairs on lower surface; venation hidden, compyloneuroid, midrib forming a groove on upper surface towards the apex and prominent blunt ridge on the lower surface, lateral veins indistinct, 1-4 rows of areolae on each side, each areola with 1-2 unbranched tertiary veinlets; sori circular, up to 2/3 of lamina, protruding out of the placentum; sporangial paraphyses of three distinct types (i) with straight arms, 135-360 μ m long, (ii) with frizzy long, ribbon-like coiled arms, (iii) with both straight and frizzy arms on upper and lower circles respectively; annulus cells 19-21; spores yellow, round to oval to elliptical, convex to plano-convex; exine slightly verrucose 65-87 × 42-57 μ m (Figs. 13, 78-81).

A rare species of north eastern India collected by P. Chandra from Imphal and J. G. Srivastava & K. M. Balapure from Morch road, Manipur as an epiphyte.

Distribution: India (Eastern Himalayas).

This endemic species is characterised by

- (i) sporangial paraphyses of either straight or frizzy or with both straight and frizzy arms,
- (ii) lamina linear to linear-lanceolate, broader in the middle,
- (iii) midrib forming a groove on the upper surface towards the apex.

Specimens examined: EASTERN HIMALAYAS: Manipur: Imphal-Morch road, J. G. Srivastava and K. M. Balapure, April, 1962 (LWG).

18. *P. mannii* (Gies.) Ching, Bull. Chinese Bot. Soc. 1: 55. 1935 (incl. syn.); Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15: 163. 1964; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117: 63-66. 1965; Nayar & Kaur, Companion Bedd. Handb. 81. 1974; Dhir, Bibliotheca Pteridological 116. 1980.

Niphobolus mannii Gies., Farngett. *Niphobolus* 107. 1901.

N. fissus Hook., Spec. Fil. 5 : 48. 1863 and Syn. Fil. 351. 1867; Bedd., Handb. Ferns Brit. India 330. 1883 (pro parte). *Cyclophorus porosus* C. Chr., Index Fil. 200. 1905 (pro parte); Stewart, Ann. Bot. Royal Bot. Gard. Calcutta 170. 1938.

Rhizome stout, short-creeping, branched, thin, 2-3 mm across, densely paleaceous, clothed with numerous wiry roots; scales pale yellow to brown, concolorous, linear-lanceolate to subulate with long acuminate apex terminating into uniseriate, globose, deciduous glandular hair, margin smooth, $5-8 \times 0.75-1.00$ mm; fronds aggregate; stipe 2-4 cm long, woody, dorsoventrally flattened, hairy; lamina lanceolate to linear-lanceolate, finely acuminate, gradually attenuate at the base, margin quite entire or rarely irregular, $22.0-40.0 \times 1.0-2.0$ cm; texture subcoriaceous, lower surface wholly tomentose with deep ferruginous stellate hairs, depressed punctate, the dots corresponding with the sori; venation obscure, almost similar to *P. mollis*, areolae parallelogrammoid and in 10-13 series on each side of midrib, each areola with 2-4 free, clavate tertiary veinlets, rarely forked; sori small, circular, usually irregularly scattered on the general surface, seldom arranged in series, covered with foliar indumentum when young; sporangial paraphyses stellate with straight or frizzy arms, straight arms $330-525 \mu\text{m}$; annulus cells 20-27; spores pale yellow to yellow, elliptical, planoconvex, exine verrucose and rather thin, verrucae small and subcircular, $42.0-68.0 \times 27.0-38.0 \mu\text{m}$ (Figs. 14, 82-84).

Commonly growing in the Himalayas between 1,800-2,700 m as an epiphyte intermixed with *Pyrrosia mollis*. Met with in the eastern region (Sikkim: Mangan, 1,200-1,300 m; Darjeeling: Lebong forest, 1,500 m; Karponang, 2,700 m; Rangaroon, 2,400 m; Khasya and Jaintia hills: Mawphlang, 1,500 m; Shillong, 1,500 m), and western region (Nainital: along Mangoli-Kaladhungi

road, 1,200 m). It is also reported from western ghats in south India.

Distribution : India, Ceylon and Malaya.

Species is closely allied to *P. mollis* but differs in scales which are concolorous smooth in *P. mannii* and bicolorous fimbriate in *P. mollis*.

Specimens examined : EASTERN HIMALAYAS : North Sikkim: Mangan, 1,300 m, S. S. Bir 1025, July, 1958 (PAN); Darjeeling: Rangaroon, 2,400 m, C. K. Trikha 1015, July, 1970 (PUN); Khasya and Jaintia hills: Mawphlang, 1,500 m, G. Panigrahi, Feb., 1960 (CAL).

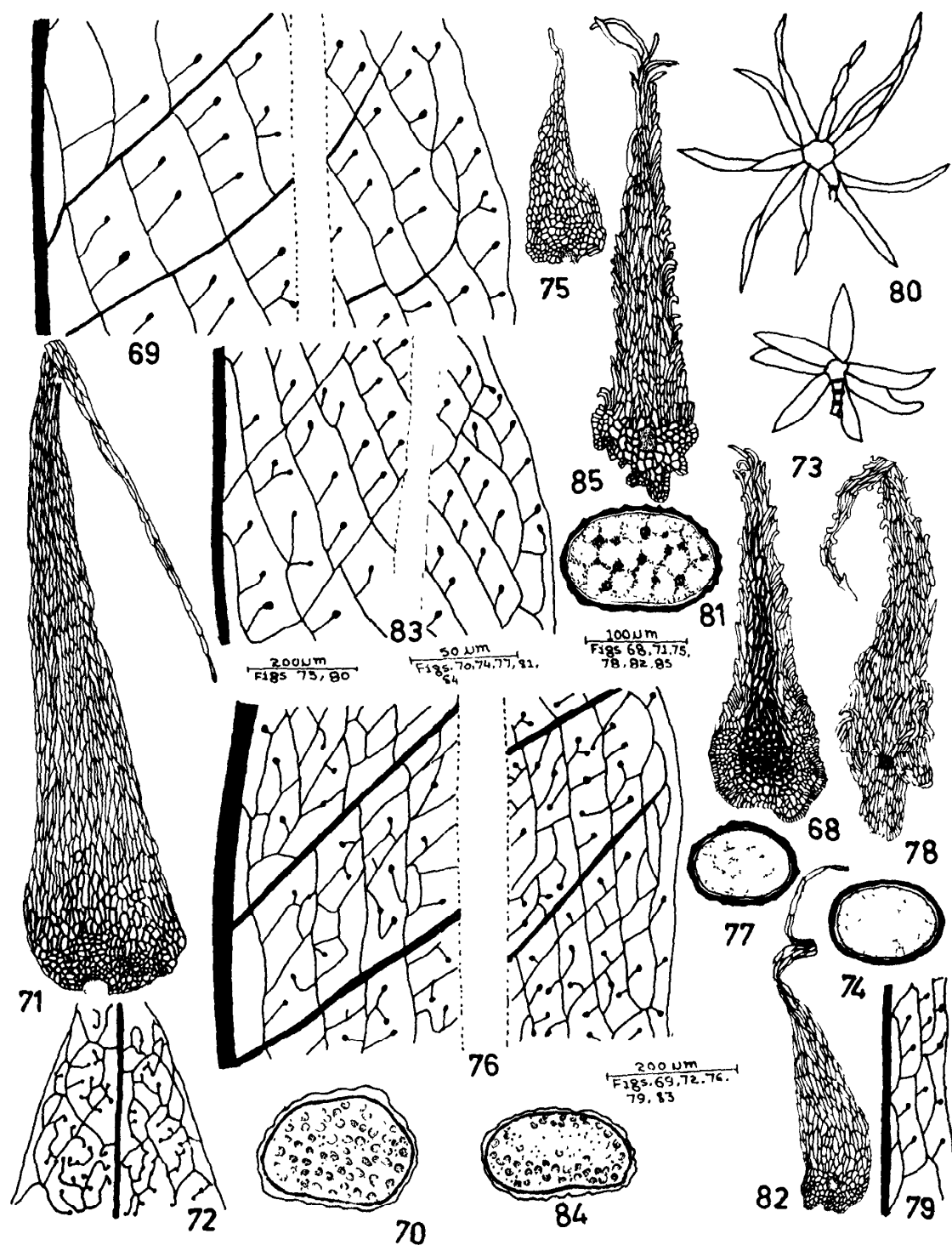
19. *P. gardneri* (Mett.) Sledge, Bull. Brit. Mus. (nat. Hist.) Bot. Ser. 2 (5) : 134. 1960; Nayar & Kaur, Companion Bedd. Handb. 81. 1974.

Polypodium gardneri Mett., Pol. 129. n. 263. 1857; Hook., Sp. Fil. V : 51. 1863; Hook. & Bak., Syn. Fil. 352. 1874.

Niphobolus gardneri Kze., J. Sm., Cat. Cult. Ferns 12. 1857; Bedd., Ferns South India t. 241. 1863 and Handb. Ferns Brit. India 331. t. 181. 1883.

Cyclophorus gardneri (Kze.) C. Chr., Index Fil. 99. 1905.

Rhizome short-creeping, covered with a tuft of wiry roots, thin, 1.5-3.0 mm in diameter, apices, densely scaly; scale ferruginous, appressed, lanceolate to linear-lanceolate, apex obtuse or acute with numerous protruding out hairs or with uniseriate, acicular, non-glandular hairs, few cells in the middle dark brown, margin light yellow to hyaline, smooth, with very small protruding out hairs, $2.0-4.0 \times 0.5-1.0$ mm; fronds approximate; stipes 2.5-7.0 cm long, dorsoventrally flattened, densely paleaceous at the base, paleae slightly broader than rhizome scales; lamina lanceolate, oblanceolate to ovate-lanceolate with acute or obtuse acuminate apex, gradually attenuate at the base, $5.5-23.5 \times 0.5-2.2$ cm, margin smooth or reflexed upwards; texture carnose-coriaceous, upper surface glabrous, lower surface densely



Figs. 68-70 : *Pyrrosia mollis* (Kze.) Ching : 68. Rhizome scale. 69. Venation. 70. Spore.
 Figs. 71-74 : *P. beddomeana* (Gies.) Ching : 71. Rhizome scale. 72. Venation. 73. Sporangial
 paraphyses. 74. Spore.
 Figs. 75-77 : *P. stigmosa* (Sw.) Ching : 75. Rhizome scale. 76. Venation. 77. Spore.
 Figs. 78-81 : *P. nayariana* Ching ex Chandra : 78. Rhizome scale. 79. Venation.
 80. Sporangial paraphyses. 81. Spore.
 Figs. 82-84 : *P. mannii* (Gies.) Ching : 82. Rhizome scale. 83. Venation. 84. Spore.
 Fig. 85 : *P. gardneri* (Mett.) Sledge : 85. Rhizome scale.

clothed with a compact, firm, ferruginous stellate tomentum; venation compyloneuroid, lateral veins distinct, costae and costules slightly elevated beneath, areolae about 6-7 between the costa and the margin, each areola generally with 2 rarely 4 tertiary simple veinlets with clavate apices, rarely forked or anastomosing; sori in 2-4 parallel rows along the costa, small, circular and superficial; sporangial paraphyses may be either with 10-11 straight arms (285-480 μm) or with frizzy ribbon-like coiled arms; annulus 21-27 celled; spores yellow, oval to elliptical, planoconvex to concavoconvex, exine rather thin, smooth, 61.0-87.0 $\times$ 38.0 μm (Figs. 15, 85-87).

Growing both as lithophyte as well as an epiphyte. Restricted only to South India (Tamil Nadu: Salem District: Balmadies Estate-Yercaud, 1,667 m; Bauxite hills-Yercaud, 1,240 m and Anamallay hills, 5,000 m).

Distribution : India and Ceylon.

Characterised by fronds oblanceolate to lanceolate to ovate-lanceolate, lateral veins distinct, sori in regular rows, spores smooth with comparatively thin exine.

Specimens examined : SOUTH INDIA: Tamil Nadu: Salem District, Balmadies Estate-Yercaud, 1,667 m, K. Subramanyam 6587, Sept., 1958 (CAL); Bauxite hills, Yercaud, 1,240 m. J. Ghatak, G. 60, March, 1962 (CAL).

20. *P. flocculosa* (Don) Ching. Bull. Chinese Bot. Soc. 1 : 66. 1935; Mehra, Ferns Mussoorie, Panjab Univ. Bot. Publ. pp. 26. 1939; Loyal & Verma, J. Bombay nat. Hist. Soc. 57 : 488. 1960; Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15: 164. 1964; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117 : 51-54. 1965; Bir & Shukla, Nova Hedwigia 21 : 196. 1971; Nayar & Kaur, Companion Bedd. Handb. 81. 1974; Dhir, Bibliotheca Pteridologica 1 : 117. 1980.

Polypodium flocculosum Don, Prod. Fl. Nepal 1. 1825; Hook. & Bak., Syn. Fil. 351. 1867; Clarke, Trans. Linn. Soc. Lond. II. Bot. 1 : 554. 1880; Hope, J. Bombay nat. Hist. Soc. 14: 720-749. 1902-1903. *Niphobolus detergibilis* Hook., Spec. Fil. 5 : 49. 1964. *N. flocculosus* Bedd., Ferns Brit. India t. 162, 1866 and Handb. Ferns Brit. India 331. t. 180. 1883.

Cyclophorus flocculosus (Don) C. Chr., Index Fil. 199. 1905 (cum syn.); Chowdhury, PFUGP. 73. 1973.

Rhizome short-creeping, thick, paleaceous, densely covered with numerous wiry roots, 5-10 mm across; scales yellow to golden brown, linear-lanceolate to subulate with much broader base and long acuminate, acicular apex and smooth margin, 2.5-6.0 $\times$ 0.5-1.0 mm; fronds approximate, in two closely placed rows; stipes thick, aggregate, stout, with prominent adaxial groove, 3.0-16.0 cm; lamina lanceolate to oblong-lanceolate, apex acute, acuminate or rarely obtuse, subsinuate at the margin, moderately attenuate, decurrent or cuneate at the base, 5.5-32.0 $\times$ 1.0-4.0 cm; texture coriaceous, lower surface covered with thick indumentum of stellate hairs; venation immersed, costules distinct, 5-16 between costa and the margin with 3-5 usually unbranched tertiary veinlets in each, generally free rarely anastomosing from the top of the areola; sori small, circular, slightly elevated above the tomentum, arranged in many regular rows between the costules, rarely sunken; sporangial paraphyses dimorphic, (i) dark brown with needle-like straight arms, (ii) with frizzy ribbon-like coiled arms; annulus 17-23 celled; spores pale yellow to light brown, globose to oval, plano- to concavo-convex, smooth exine thickened with uneven surface, 76-95 $\times$ 42-53 μm (Figs. 16, 88-90).

A common epiphyte of the low hills met with in eastern Himalays (Darjeeling, 1,200 m; Teesta, 150 m; Siliguri, 75 m; North Sikkim; Singhik, 1,200 m; Garo hills : Tura, 750 m; Jaintia hills : Jowai, 1,200 m; Khasi hills :

Shillong. 1,850 m) and western Himalayas (Kumaun : Ashote, 1,800 m; Dafia Dhurm, 2,200 m; Nainital : Khurpatal, 1,800 m; Kathgodam, 500 m; Bhimtal, 1,200 m; Mangoli, 1,500 m; Sattal, 1,500 m; Hanuman gari, 1,900 m; Way to Jeolikot, 1,500 m; Mussoorie, 2,100 m; Dehradun : Shahastradhara, 500 m; Nalapani; Dharamsala : Near K. B., 1,350 m; Simla : Gooma, 2,000 m).

Distribution : India, Nepal, Burma and Tonkin.

Species is characterised by oblong-lanceolate fronds with attenuate to decurrent or rarely cuneate base. Hairs are dimorphous, upper layer dense brown with needle like arms and lower layer of woolly ones.

Specimens examined : EASTERN HIMALAYAS : Darjeeling, S. K. Malhotra, Aug., 1964 (PAN); North Sikkim : Singhik, 1,200 m, S. S. Bir 1089, July, 1958 (PAN). WESTERN HIMALAYAS : Nainital : Khurpatal, 1,800 m, S. P. Khullar 170, Sept., 1957 (PAN); Hanuman gari, 1,900 m, C. K. Trikha 1085, July, 1971 (PUN); Way to Jeolikot, 1,500 m, C. K. Trikha 1080, Aug., 1971 (PUN); Way to Khurpatal, 1,600 m, C. K. Trikha 1084, July, 1971 (PUN); Kumaon, Ashote, 1,800 m, V. C. Bhattacharyya, April, 1962 (CAL); Dafia Dhurm, 2,200 m, C. M. Arora, Aug., 1972 (CAL); Mussoorie : S. K. Malhotra, Aug., 1949 (PAN); 2,100 m, S. S. Bir, July, 1975 (PUN); Dehradun : Shahastradhara, 500 m, S. M. Vasudeva 4440, Sept., 1975 (PUN); Dharmasala : Near K. B., 1,350 m, Puran Singh 39, April, 1972 (PAN); Simla : Gooma, 2,000 m, S. S. Bir 1483, Sept., 1960 (PAN).

21. *P. subfurfuracea* (Hook.) Ching, Bull. Chinese Bot. Soc. 1 : 68. 1935; Mehra & Bir, Res. Bull. Panjab Univ. Sci. (n.s.) 15 : 165. 1964; Nayar & Chandra, Bull. nat. Bot. Gard. Lucknow, India 117 : 83-87. 1965; Nayar & Kaur, Companion Bedd. Handb. 80. 1974.

Polypodium subfurfuraceum Hook., Spec.

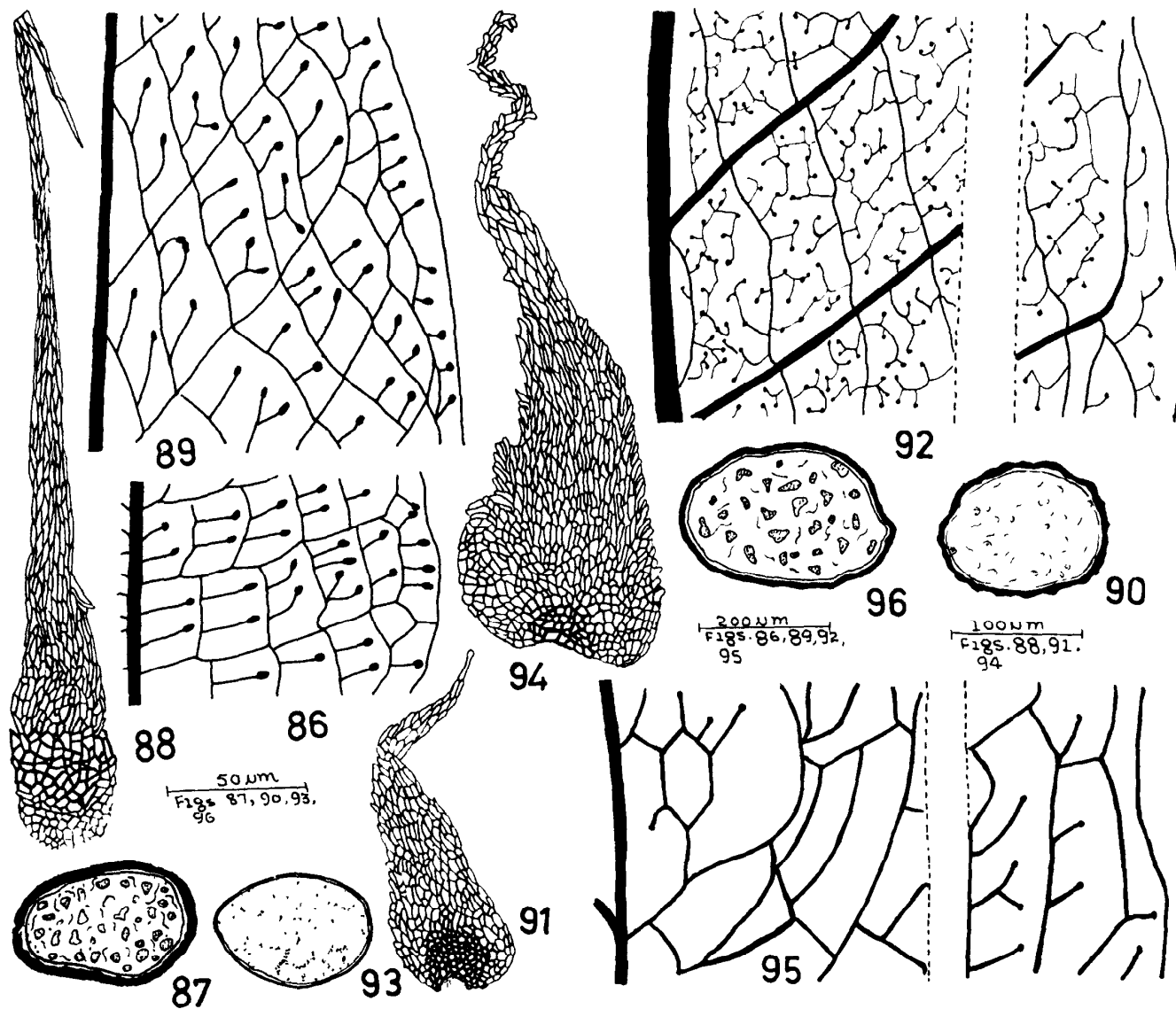
Fil. 5. 52. 1863, Syn. Fil. 351. 1867; Clarke, Trans. Linn. Soc. Lond. II. Bot. 1 : 553. 1880.

Niphobolus subfurfuraceus Bedd., Ferns Brit. India t. 259. 1868; Handb. Ferns Brit. India 329. 1883.

Cyclophorus subfurfuraceus C. Chr., Index Fil. 201. 1905, cum syn.

Rhizome short-creeping, with numerous wiry roots, densely paleaceous at the apex, thin, about 2-3 mm across scales ferruginous, basally attached, bases more or less auricled, linear-lanceolate to ovate-lanceolate to lanceolate, with long, uniseriate acuminate apex, terminating into small globose glandular cell, margin entire to somewhat serrate, 1.5-5.0 × 1.0-1.5 mm; fronds aggregate or sub-aggregate; stipe 6.0-8.0 cm long, sub-cylindrical, with prominent adaxial groove, scaly at the base; scales similar to rhizome scales; lamina broad-lanceolate to elongate-lanceolate to oblanceolate, gradually attenuate towards the base, acute or slightly acuminate, 28.0-40.0 × 3.5-5.5 cm; texture stiff and leathery, upper surface green, glabrous, with pitted hydathodes, lower surface with minute, thin, firm, close, persistent white coloured tomentum so that it appears subfurfuraceous or pannose; lateral veins distinct, veinlets irregular, 15-20 trapeziform areolae, 8-10 in a series between the costa and the margin, each areola with 8-9 tertiary veinlets which are usually free or branched or anastomosing; veinlets soriferous, sori rather small, forming as many arched series between the costules as there are number of areolae, compital; sporangial paraphyses of two types (i) with stellate lanceolate and 120-125 μ m, (ii) with long, narrow, frizzy arms; annulus 13-18 celled; spores oval to elliptical, plano-convex to convex, exine smooth, light yellow to yellow, containing oil globules, 49-61 × 34-42 μ m (Figs. 17, 91-93).

It is growing intermixed with *Pyrrosia stigmosa* usually as lithophyte in eastern Himalayas (Sikkim State; Assam: Mishmee; Lushai hills; Bhutan).



Figs. 86-87 : *P. gardneri* (Mett.) Sledge : 86. Venation. 87. Spore.
 Figs. 88-90 : *P. flocculosa* (Don) Ching : 88. Rhizome scale. 89. Venation. 90. Spore.
 Figs. 91-93 : *P. subfurfuracea* (Hook.) Ching : 91. Rhizome scale. 92. Venation. 93. Spore.
 Figs. 94-96 : *P. boothii* (Hook.) Ching : 94. Rhizome scale. 95. Venation. 96. Spore.

Distribution : India, Bhutan and China (Yunnan Province).

This is the largest species of the genus with lamina up to 100 cm long and 8-10 cm broad and gradually decurrent along the stipe, 10-14 cm long; further it is characterised by persistent thin, firm, close, subfurfuraceous or pannose, dimorphous indumentum on lower side of lamina.

Specimens examined : EASTERN HIMALAYAS: Assam: Aizal, Lushai hills, P. Chandra & Party 81158, Oct., 1963 (LWG).

22. *P. boothii* (Hook.) Ching, Bull. Chinese Bot. Soc. 1: 66. 1935; Nayar & Kaur, Companion Bedd. Handb. 81. 1974. *Polypodium boothii* Hook., Spec. Fil. V. 53. 1863; Clarke, Trans. Linn. Soc. Lond. II. Bot. 1: 555. 1880.

Niphobolus boothii Bedd., Ferns Brit. India t. 258. 1866; Handb. Ferns Brit. India 333. t. 183. 1883.

Rhizome short-creeping, thick, 6-8 mm across, densely paleaceous; scales lanceolate to ovate-lanceolate, peltate, non-clathrate, 2.0-5.0 × 0.5-1.5 mm, ferruginous with long acuminate apex, margin eroded or somewhat serrate; fronds aggregate; stipes 14-17 cm, stout, covered with imbricating ferruginous lanceolate scales only at the base; lamina lanceolate or ovate-lanceolate with obtuse or obtuse-acuminate apex, moderately attenuate at the base, margin somewhat irregular, 25.0-33.2 × 5.1-5.5 cm; texture subcoriaceous, glabrous and lower surface covered with mass of ferruginous stellate tomentum; venation obscure, irregular, approaching venatio-drynarii, with free included 10-12 veinlets which are branched or anastomosing; sori minute, irregular, sunken covered with ferruginous tomentum; sporangial paraphyses of two distinct types, (i) with straight acuminate arms 345-510 μ m, (ii) with ribbon-like coiled long frizzy arms, annulus 15-24 celled; spores yellow to brown, oval to elliptical, plano- to concavo-convex,

slightly verrucose-granulose, 68-87 × 38-49 μ m (Figs. 18, 94-96).

It grows both epiphytically as well as lithophytically in eastern Himalayas (Sikkim).

Distribution : India and Bhutan.

It is characterised by numerous ferruginous stellate tomentum on the lower surface of lamina, covering minute, irregular sori. It is closely allied to *Pyrrosia subfurfuracea* in its general appearance but clearly distinct because of :

- (i) fronds moderately attenuate at the base,
- (ii) venation obscure, irregular, approaching venatio-drynarii and
- (iii) tomentum beneath ferruginous.

In *P. subfurfuracea* the fronds are much more attenuate at the base, venation is compyloneuroid and the tomentum underneath is white.

Specimens examined : EASTERN HIMALAYAS: Sikkim, P. L. Levinge, Oct., 1883 (CAL).

DOUBTFUL RECORDS

1. *Pyrrosia angustata* (Sw.) Ching, Bull. Chinese Bot. Soc. 1: 49. 1935; Holtt., Fl. Malaya II. Fig. 58. 143. 1954; Nayar & Kaur, Companion Bedd. Handb. 86. 1974. *Polypodium angustatum* Sw., Syn. 27. 224. 1806; Clarke, Trans. Linn. Soc. Lond. II. Bot. 1: 559. 1880.

Niphobolus angustatus Spr., Syst. 4: 44. 1827; Hook., Spec. Fil. 5: 43. 1863; Bedd., Ferns South India t. 185. 1863. *Pleopeltus macrosora* Presl., Tent. 193. 1836.

P. angustata (Sw.) Bedd. Handb. Ferns Brit. India 351. 1883.

Cyclophorus micraster Copel., Univ. Cal. Publ. Bot. 12: 405. 1941.

C. angustatus (Sw.) Desv., Berl. Mag. 5: 300. 1811; C. Chr., Index Fil. 198. 1905.

Rhizome slender, long-creeping, thin, about 2 mm in diameter, scaly throughout; scales narrow, tapering gradually to a slender acute apex, peltate base nearly black, rest very thin, almost white, edges entire, 4-6 mm long; stipe 1-10 cm long; fronds dimorphous, sterile fronds spatulate to lanceolate, apex rather shortly acuminate or blunt, base cuneate but not long decurrent, 12.25 × 2.5-4.5 cm; fertile fronds to about 40 cm long, usually bearing sori in apical half, sometimes almost to the base, the sterile basal part often about as wide as in sterile fronds, the sorus bearing part always narrower, commonly 1.0-1.5 cm wide; texture rather thinly fleshy, upper surface glabrous, shiny, shining when young, lower surface stellate hairy often showing the oblique main veins distinctly and smaller veins indistinctly; sori large, round, globose or round, somewhat elongated obliquely or parallel to the midrib 5-9 mm in length, in a single row between the midrib and the edge, sunk in shallow hollows which appear as raised areas on the upper surface; sporangial paraphyses in two layers, upper layer brown long needle-like, armed, loose, soon rubbed off and under layer whitish, in a close felt on the surface.

Distribution : Malesia-Polynesia.

This very distinct species is characterised by the presence of large, subglobose, oval, partially sunk sori present in a single row on either side of the midrib.

According to Beddome (1892) it had been collected from south India (Nilgiris—Tranquebar?) but very rare. Beddome's illustration in ferns of south India (t. 185. 1863) is based on Johnston's specimen and he himself had not found it. According to Ching (1935) the species is confined to Malesian-Polynesian region and is not met with in India.

2. *P. ceylanica* (Gies.) Sledge, Bull. Brit. Mus. (nat. Hist.) Bot. Ser. 2 (5): 133-134. 1960.

Niphobolus ceylanicus Gies., Farnh. 1901.

Niphobolus 216. 1901.

This fern is closely allied to *Pyrrosia lanceolata* but markedly differs in having long attenuate rhizome scales with smooth margin. The characteristic scale margin ciliations of *P. lanceolata* are absent here. According to Sledge (1960) there is a specimen in Kew Herbarium from south India marked "on trees Courg, Coll. Viscount Gough 3242/105". We have not come across any specimen of this fern in Indian herbaria nor could we find it in Palni and Nilgiri hills.

REFERENCES

- BEDDOME, R. H. Hand book to the Ferns of British India, Ceylon and Malay Peninsula, with supplement. Calcutta. 1892.
- BIR, S. S. AND K. DEVI. Taxonomic revision of Polypodiaceous genera of India-II: *Phymatodes* Presl. Bull. bot. Surv. India 10: 196-217. 1968.
- AND C. K. SATIJA. *Lepisorus kasyapii* in western Himalayas. Amer. Fern Journ. 71(2): 53-56. 1981.
- AND C. K. TRIKHA. Taxonomic revision of the Polypodiaceous genera of India-I: *Microsorium* Link. Bull. Bot. Surv. India 10: 133-148. 1968a.
- AND — Taxonomic revision of the Polypodiaceous genera of India-III: *Pleopeltis*. Amer. Fern Journ. 58: 119-125. 1968b.
- AND — Taxonomic revision of the Polypodiaceous genera of India-IV: *Polypodium lineare* complex and allied species. Bull. Bot. Surv. India 11: 260-276. 1969 (1971).
- AND — Taxonomic revision of the Polypodiaceous genera of India-VI: *Lepisorus excavatus* group. Amer. Fern Journ. 64: 49-73. 1974.
- AND — The Polypodioid ferns: their classification, characteristics and evolution. New Botanist (New Delhi) 5: 25-32. 1979.
- AND S. M. VASUDEVA. Ecological and phytogeographical distribution of Pteridophytic flora of Pachmarhi hills (Central India). Journ. Ind. Bot. Soc. 51: 209-284. 1972.
- AND — Systematic account of Pteridophytes of Pachmarhi hills (Central India). Plant Science 5: 71-86. 1973.
- , C. K. TRIKHA AND S. M. VASUDEVA. Taxonomic revision of Polypodiaceous genera of India-V: *Polypodium* Linn. and *Goniophlebium* (Bl.) Presl. New Botanist (New Delhi). 1 (3 & 4): 142-159. 1974.
- AND S. C. VERMA. Ferns of Mount Abu. Res. Bull. Punjab Univ. (n.s.) 15: 187-202. 1963.

- CHING, R. C. On genus *Pyrrosia* Mirbel from the mainland of Asia including Japan and Formosa. *Bull. Chinese Bot. Soc.* 1: 36-72. 1935.
- CHOWDHURY, N. P. The Pteridophyte Flora of the upper Gangetic Plain. New Delhi. 1973.
- COPELAND, E. B. 'Genera Filicum'. Chronica Botanica Co. Waltham, Mass. U.S.A.
- FARWELL, O. A. Fern notes. II. Ferns in herbarium of Parke, Devis & Company. *Amer. Midl. Naturlist* 12: 233-311. 1931.
- GIESENHAGEN, K. Die Farngattungen *Niphobolus* Ein Monographie, Jena.
- HOLMGREN, P. K. AND W. KEUKEN, 'Index Herbariorum' Pt. 1. Ed 6. *Reg. Veg.* 92 : 1-397. 1974.
- MEHRA, P. N. AND S. S. BIR. Pteridophytic flora of Darjeeling and Sikkim Himalayas. *Res. Bull. Punjab Univ.* (n.s.) 15 : 69-182. 1964.
- MITTAL, P. L. Fern and fern allies of Rajasthan-II. A systematic account of ferns and fern allies of Rajasthan with special reference to new records. *Journ. Bombay nat. Hist. Soc.* 66 (1): 31-42. 1968a.
- Fern and fern allies of Rajasthan-II. Hitherto unrecorded species of *Ophioglossum* from Rajasthan. *Bull. Bot. Surv. India* 10: 171-175. 1968b.
- NAYAR, B. K. Studies in Polypodiaceae-VII. *Pyrrosia* Mirbel. *Journ. Ind. Bot. Soc.* 40: 168-186. 1961.
- AND S. CHANDRA. Ferns of India-XV: *Pyrrosia*. *Bull. nat. Bot. Gard. Lucknow, India* 117: 1-98. 1965.
- SHARMA, B. D. AND D. R. BOHRA. Year round Pteridophytic flora of Mount Abu. *Geobios* 4: 102-103. 1977.
- SLIDGE, W. A. The Polypodiaceae and Grammitidaceae of Ceylon. *Bull. Brit. Mus. (nat. Hist.) Bot. Ser.* 2(5): 133-158. 1960.