STUDIES IN INDIAN PTERIDOPHYTES

IV. The Family Ophioglossaceae in India

by G. Panigrahi *and* R. D. Dixit, *Botanical Survey of India, Allahabad*

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The family Ophioglossaceae seems to be the most primitive living family of the class Filicopsida. This paper presents our findings regarding the number of Indian taxa and their nomenclature and furnishes description together with notes on the habitat of each taxon. Illustration of the habit of the plants, venation of the frond/tropophyll, diagrams of the spores, are provided for facilitating their identification, both in the field and in herbaria. The family is represented in India by three genera, viz. *Botrychium* 6 spp. and 1 var., *Helminthostachys* 1 sp. and *Ophioglossum* 10 spp., with 3 vars. and 2 formas. Of these, *Botrychium multifidum* (Gmel.) Rupr. ssp. *multifidum*, *Ophioglossum gramineum* Willd. var. *majus* (v.A. v.R.) Wief., *O. reticulatum* f. *dilatatum* (Miq.) Wief. are reported here as new records for India. The report of the occurrence of *O. pendulum* Linn. f. *pendulum* in India may be treated as doubtful, as we have seen no specimen collected with certainty from any Indian locality.

Introduction

The Ophioglossaceae represents perhaps the most primitive living family of the class Filicopsida and belongs to the subclass Ophioglossidae. It includes three genera, viz. *Botrychium* 23–36 spp., *Helminthostachys* 1 sp., *Ophioglossum* 28–54 spp., according to estimates of competent pteridologists. Copeland (1947) recognizes *Rhizoglossum* with 1 sp. as the 4th genus and Pichi-Sermolli (1959), *Cheiroglossa* with 2 spp. as the 5th genus of the family. These genera have many characters in common and constitute a well-defined natural group representing the best example of simple morphological development.

For reasons not yet clearly understood, the Ophioglossaceae have not been preserved in the rock strata; consequently, there is no fossil record to help us in determining the phylogeny of the group. Cytology also affords no clue to phylogeny because of high number of chromosomes, viz. 631 bivalents and 10 fragments in *Ophioglossum reticulatum* Linn. (cf. Abraham and Ninan 1954), indicating high grade of polyploidy. Although the affinity of the Ophioglossidae has been visualized from time to time with the Psilopsida on the basis of its marked primitiveness, with the Lycopodiidae, on the morphological nature of the fertile spike, with 'ancestors most nearly represented, among the surviving plants by *Anthoceros*', Pichi-Sermolli (1959) rules out

such hypotheses as 'misleading', 'groundless' and 'rash', respectively. He agrees with Bower (1923–28) that Ophioglossidae 'appear to have terminated as a blind evolutionary series and they stand today as an imperfectly modernized relic of the Paleozoic flora'. Pichi-Sermolli (1959) who considers *Helminthostachys* as an isolated genus, probably more ancient than the other two genera, recommends further investigation to establish the relative primitiveness between *Botrychium* and *Ophioglossum* since the former, which is more primitive in its sporophytic characters, has more advanced gametophytes than the latter.

Since the family Ophioglossaceae is a very old one, it has had time to become exceedingly widespread. These are scattered with remarkable uniformity almost in the same form throughout the habitable world, viz. *Ophioglossum* and *Botrychium*. Clausen (1938) considers its ancient lineage and extreme conservatism practically unparalleled in the other fern groups. *Helminthostachys*, of course, is not so widespread and occurs from India to Formosa and New Caledonia. *Rhizoglossum* is a very little fern confined to South Africa and *Cheiroglossa*, with two species, range from the American tropics to Florida, Indonesia, Madagascar and Seychelles Islands.

Considering that the leaf-cutting, pubescence, size and habit are not fundamental characters for recognition of species, Clausen (1938) tried to discover another key feature of taxonomic value, but was finally forced to recognize species on the basis of such characters as above. Although Clausen (1938) and Wieffering (1964) agree regarding the unsatisfactory nature of these taxonomic criteria used for delimitation of species, the latter recognized a fewer number of species and accords varietal status to some of the species of Clausen.

After Beddome's (1883, 1892) monumental work on Indian ferns, the systematic studies in the family Ophioglossaceae, mainly of the genus *Ophioglossum*, has received the attention of Indian botanists. Reference to the studies on the subject made by Hope (1903), d'Almeida (1922), Blatter and d'Almeida (1922), Chakravarty (1951), Balkrishnan *et al.* (1960), Mahabale (1962) and Mital (1968), however, shows complete lack of agreement between them regarding the number of taxa, their nomenclature, characteristic morphological features and the species distribution in India. In his comprehensive treatment of the genus *Ophioglossum* in India, Mahabale (1962) outlines the taxonomic history of the genus from the time of Bauhin (1620) up to the time of Clausen (1938). Basing his studies on the gross morphology, and anatomy of the sporophyte, and ornamentation of the spores, he recognizes occurrence of 10 spp. of *Ophiolgossum* in India.

Bearing in mind the observations made by Clausen (1938), Pichi-Sermolli (1954), Nishida (1959) and Wieffering (1964), on the nomenclature and description of the taxa and their distribution, and in pursuance of the scheme for

bringing out an illustrated manual on the fern flora of India, we have had the occasion to re-examine all the specimens of this family of ferns deposited in various herbaria of the Botanical Survey of India. This paper presents our findings regarding the number of Indian taxa and their nomenclature and furnishes description and notes on the habitat of each taxon. Illustration of the habit of the plant and venation system in the frond/tropophyll and diagrams of the spores are provided for facilitating identification of these taxa in the field and in herbaria.

Data presented in Table I would help to focus the attention of the reader on the differences in nomenclature that exist between our treatment of the genus *Ophioglossum* and that of Mahabale (1962). While we confirm that 10 spp. recorded by Mahabale (1962) occur in India, we recognize the existence of 14 taxa therein, instead of 10.

TABLE I

	Present treatment	Mahabale's (1962) treatment
1.	*O. costatum* R. Br.	*O. fibrosum* Schum.
2.	*O. gramineum* Willd. var. *gramineum*	+
2(*a*)	*O. gramineum* Willd. var. *majus* (v.A. v.R.) Wief.	—
3.	*O. lusitanicum* Linn.	+
4.	*O. thermale* Kumarov var. *nipponicum* (Miyabe et Kudo) Nishida	*O. japonicum* Thunb.
5.	*O. nudicaule* Linn. f.	+
5(*a*)	*O. nudicaule* Linn. f. var. *macrorrhizum* (Kze.) Clausen	—
6.	*O. polyphyllum* A. Br. apud Seubert	*O. aitchisoni* d'Almeida
7.	*O. vulgatum* Linn.	+
8.	*O. reticulatum* Linn. f. *reticulatum*	+
8(*a*)	*O. reticulatum* Linn. f. *complicatum* (Miq.) Wief.	—
8(*b*)	*O. reticulatum* Linn. f. *dilatatum* (Miq.) Wief.	—
9.	*O. petiolatum* Hooker	*O. pedunculosum* Prantl
10.	*O. pendulum* Linn. f. *pendulum*	+

+ = Taxa with the same nomenclature as in the present paper.
— = Taxa not dealt with by Mahabale.

SYSTEMATIC ACCOUNT

Order: Ophioglossales
Family: Ophioglossaceae

Ophioglossaceae (R. Br.) Kaulfuss, *Wesen Farrenkr*, 119 (1827).
Synonym: Ophioglossaceae R. Br., *Prodr. Fl. Nov. Holl.*, 163 (1810) (as a tribus).
Type: **Ophioglossum** Linn., *Sp. Pl.*, **2**, 1063 (1753).

Perennial herbs, terrestrial or epiphytic, but not growing in water; rhizome subterranean, short, fleshy, not scaly, erect or creeping, with a cluster of

stout fibrous roots and bearing at the apex a fertile spike/sporophyll and one to several sterile blades/tropophylls, the latter enclosing a leaf bud in its sheathing base; the leaves erect or pendant (not circinate); venation free or netted; the lamina stalked or sessile, simple, lobed or variously decompound, the fertile segments simple, racemose or paniculate but always representing segment of a typically partly sterile frond and bearing sporangia, embedded, in or seated upon a stalked spike which is usually erect; the sporangium without any annulus and opening by a longitudinal or transverse slit and, thus, bivalvate; spores numerous per sporangium, trilete and circular; the gametophytes subterranean, tuberous, micorrhizic and without chlorophyll.

A family of three distinct genera, viz. *Botrychium*, *Helminthostachys* and *Ophioglossum*, all of which are widely distributed in almost all the continents (*see* Clausen 1938; Copeland 1947; Holttum 1954).

Key to the Genera

A. Venation free, both the sterile and fertile segments compound (rarely simple); spike simple, racemose or paniculate bearing distinct sessile or stalked sporangia.
B. Sterile segment pinnate or decompound, the fertile segment pinnate with several spreading branches; sporangium dehiscing by a transverse slit ..... I. *Botrychium*
B. Sterile segment palmate with several separate leaflets; fertile segment compact with many short branches; sporangia dehiscing by a longitudinal slit ..... II. *Helminthostachys*
A. Venation reticulate; sterile and fertile segments simple, entire (or with few lobes); spike simple, terete, erect or pendulous; sporangia half-embedded in two lateral rows ..... III. *Ophioglossum*

I. **Botrychium** Swartz

Botrychium Swartz, *Journ. für di Botanik*, **2**, 110 (1800).
Type species: *Botrychium lunaria* (Linn.) Swartz, *Journ. für di Botanik*, **2**, 110 (1800).
Osmunda lunaria Linn., *Sp. Pl.*, **2**, 1064 (1753). (*B. lunaria* was described by Fuchs in 1542 as *Lunaria minor*).

A genus of 36 spp. (Christensen 1905) or 23 spp. (Clausen 1938) represented in all the major geographical regions of the earth; of these, 6 spp. occur in India.

Clausen (1938) recognizes three subgenera in *Botrychium*, viz. *Sceptridium*, *Eubotrychium* and *Osmundopteris*, they are distinguished from each other as follows:

Key

I. Sterile blades oblong to broadly deltoid, variable in texture but rarely membranous. Bud hairy or smooth, completely enclosed by the sheathing base of the stalk.

II. Sterile blades rather large, ternately decompound, long-stalked to sessile, usually inserted towards the base of the plant, at times arising rather higher up; the buds commonly hairy, rarely almost glabrous	A. subgenus: *Sceptridium*
II. Sterile blades usually small, pinnately or palmately divided, rarely simple, sessile or short-stalked, parting from the common stalk at various heights. Buds glabrous	B. subgenus: *Eubotrychium*
I. Sterile blades large, deltoid, much divided *with membranous texture*. Bud hairy, *partially exposed* by the sheathing base of the stalk which is open on one side	C. subgenus: *Osmundopteris*

A. Subgenus **Sceptridium** (Lyon) Clausen, *Mem. Torrey bot. Club*, **19** (2), 24 (1938).
Sceptridium Lyon, *Bot. Gaz.*, **40**, 457 (1905).
Type: *Botrychium obliquum* Muhl. (*Sceptridium* = sceptre-like fertile fronds).

This subgenus of ternate evergreen grape ferns, comprising 12 spp. in the world flora, is further divided into three sections with four spp. each, viz. *Multifidae*, *Biternatae* and *Elongatae*. Of these, three spp., viz. *B. multifidum* and *B. ternatum* of the *Multifidae* section and *B. daucifolium* of the *Elongatae* section, occur in India.

Key to the sections and species of the subgenus Sceptridium *occurring in India*

A. Sterile pinnules of about the same size and shape; the chief terminal divisions not elongate	Section *Multifidae*
B. Fronds with *compact* sterile pinnules *coriaceous* in texture, crenate with slightly hyaline margins and with obtuse or round apex, but the ultimate segments may be acutish	*B. multifidum*
B. Fronds with relatively lax sterile pinnules which are membranous in texture, sharply serrate, without any hyaline margins and with acutish apex	*B. ternatum*
A. Sterile pinnules are not of the same size and shape but with the chief terminal divisions usually elongate and little divided.... Sterile blades usually inserted medianly, the ultimate divisions more or less sharply toothed, the fertile segment either equalling or somewhat exceeding the sterile segment	Section *Elongatae* *B. daucifolium*

Section: **Multifidae** Clausen, *Mem. Torrey bot. Club*, **19** (2), 26 (1938).

Botrychium multifidum (Gmel.) Rupr., *Beitr. Zur. Pflanzenkunde des Russ. Reiches*, **11**, 40 (1859); Clausen, *Mem. Torrey bot. Club*, **19** (2), 30 (1938); Panigrahi & Dixit, *Bull. bot. Surv. India*, **9** (1–4), 286-287 (1967). Ssp. **multifidum**.

Basinym: *Osmunda multifida* Gmel., *Nov. Comment, Acad. Petrop*, **12**, 517 (1768).

Synonyms: *Botrychium multifidum* var. *dichotomum* Farwell, *Rep. Mich. Acad. Sci.*, **18**, 87 (1916).

B. multifidum var. *simplicus* Farwell in papers *Mich. Acad. Sci.*, Art and Letters, **3**, 89 (1924).

Sceptridium multifidum (Gmelin) Nishida var. *multifidum* ex Tagawa, *J. Jap. Bot.*, **33**, 200 (1958).

Plant up to 22 cm high (Fig. 1); common stalk up to 15 mm long; sterile stalk up to 3·7 cm long; blade 6·5 × 8 cm, i.e. broader than long, pinnules crowded or sometimes imbricate, coriaceous in texture, crenate with slightly

FIGS. 1–5. 1, *Botrychium multifidum*; 2–4, *B. ternatum*, variation in biotypes; 5, *B. daucifolium*.

hyaline margins and with obtuse or round apex, but the ultimate segments may be acutish; veins forked (Fig. 15); fertile stalk 16·5 cm long, fruiting spike paniculate, 3 cm long; spores trilete with circular *amb.*, triangular in polar view, 25–30 μ in diameter and with verrucose exine (Fig. 16).

Fertile: August.

Distribution in India: Sikkim—Lachung Valley (Lachen), *Gammie* 650 (CAL) at 2745 m alt.

Earlier records: It is widely distributed in Northern Europe and Asia (China—Yunan); North America and eastern British Columbia, but nowhere common (cf. Clausen 1938). According to Nishida (1966), Himalayan plants reported by Beddome (1892) under *Botrychium ternatum* should represent this species.

B. ternatum (Thunb.) Swartz, *Schrad. Journ. für di Botanik*, **2**, 111 (1800); Clausen, *Mem. Torrey bot. Club*, **19** (2), 42 (1938); Bedd., Handb. Fern Brit. India in suppl., 110 (1892); Hope, *J. Bomb. nat. Hist. Soc.*, **15**, 108 (1903).

Basinym: *Osmunda ternata* Thunb., Flora Japonica, p. 329, Pl. 32 (1784).

Synonym: *Sceptridium ternatum* (Thunb.) Lyon, *Bot. Gaz.*, **40**, 458 (1905).

Growing in meadows and on humus-covered soil in moist shady situations, between 1500 and 3300 m from Simla to North-East Frontier Agency (NEFA). Plants 18–75 cm high (Figs. 2–4); common stalk 1–5 cm long; sterile stalk 4–20 cm long; sterile blade deltoid, tripinnate to quadripinnatifid, stalk of the pinnae 0·5–2 cm long and with ultimate segments 2–6 × 3–4 mm, apex acutish, veins simple or forked (Fig. 17); fertile stalk 13–21 cm long, fruiting spike, deltoid, profusely compound, 3–16 cm long; spores trilete with circular *amb.*, triangular in polar view, 25–30 μ in diameter and with verrucose exine (Figs. 18, 19).

Fertile: August to November.

Distribution in India (based on herbarium sheets consulted by authors, only a few specimens of different herbaria* are cited as authority for distribution): NEFA—Kameng district: Senge, *Joseph* 40162B (ASSAM). SIKKIM—Gassing to Ratong river, *Anderson* 1412 (CAL); Yoksun, *Clarke* 25196 (CAL); *Comminghan s.n.* (CAL). UTTAR PRADESH—Garhwal; Bissone hill, *Mackinnon s.n.* (CAL); Mussoorie, *Mackinnon s.n.* (CAL); Ukhimath forest; Ghangaria; Simla, *Blanford s.n.* (CAL); Naini Tal, Bhawali, *Champeon* 3 (CAL). Abundant.

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* The abbreviations cited for Indian herbaria are:

BSA	..	Central Circle, Botanical Survey, Allahabad.
ASSAM	..	Eastern Circle, Botanical Survey, Shillong.
BSD	..	Northern Circle, Botanical Survey, Dehra Dun.
BSMH	..	Southern Circle, Botanical Survey and Madras Herbarium, Coimbatore.
CAL	..	Central National Herbarium, Calcutta.
BSI	..	Western Circle, Botanical Survey, Poona.

Earlier records: Ranging from Northern Japan, south and west through Korea and the uplands of Southern China to the Himalayas including Darjeeling, Simla and Sikkim in India (cf. Clausen 1938).

Section: **Elongatae** Clausen, *Mem. Torrey bot. Club*, **19** (2), 48 (1938).
This section is characterized by decidedly elongate penultimate segments of the sterile blade.

B. daucifolium Wall. in Hooker et Greville, *Ic. Fil.*, Pl. 161 (1829); Clausen, *Mem. Torrey bot. Club*, **19** (2), 60 (1938); Bedd., Handb. Ferns Brit. India, 469, t. 294 (1883).
Synonyms: *Botrychium subcarnosum* Wall., List, No. 49 (1828) (*nomen nudum*).
Sceptridium ducifolium (Wall.) Lyon in *Bot. Gaz.*, **40**, 457 (1905).
S. daucifolium (Wall.) Lyon var. *parvum* (v.A. v.R.) Nishida in *J. Jap. Bot.*, **41**, 319 (1966).

Growing amidst grasses in moist shady situations, on hill slopes, between 1000 and 3000 m alt. plants stout, 25–60 cm high, hairy to glabrescent with lax pinnules; rhizome small erect, rarely creeping, and normally one but sometimes two fronds arise from the same rhizome (Fig. 5). Common stalk 11–32 cm long, sterile stalk 1–7·5 cm long; sterile blade usually inserted medianly or somewhat above (in younger plants, the sterile blade seems to be very much higher up), deltoid, tripinnatifid to tripinnate, 12–22 × 16–36 cm, i.e. broader than long, texture subcoriaceous, penultimate segments elongate, acute, ultimate segments oblong, blunt or acutish, coarsely to finely toothed margin, veins simple or forked (Fig. 20); fertile segment sometimes exceeding the sterile segment at maturity by about 10 cm; fertile stalk 4·5–15 cm long; fruiting spike paniculate, 6–19 cm long; spores trilete with circular *amb.*, triangular in polar view, *ca.* 30 μ in diameter and with spinulose exine (Figs. 21-22).

Fertile: March to November.

Distribution in India: NEFA—Siang district: Pangu to Minguing (ASSAM). ASSAM—Khasi hills, *Clarke* 18730 (CAL); Nunkhlow, *Biermann s.n.* (CAL); Daphla hills, *Lister s.n.* (CAL). SIKKIM—*G. King s.n.* (CAL); *J. D. H. s.n.* (CAL). NEPAL—*Maries s.n.* (CAL). ORISSA—Gurguria to Jenabil (ASSAM). MADRAS—Pulney hills, *Beddome s.n.* (CAL); Tirunevelly; Upper Godaiyar, *Henry* 17426 (BSMH); Tinnevelly: Sengaltheri, *s.l.* 14552 (CAL). KERALA—Travancore: Udambanshola, *Meebol s.n.* (BSMH).

Earlier records: Throughout the mountain regions of India up to 2400 m elevation, Burma, Southern China, Ceylon, Java, Borneo, the Philippines and Fiji (cf. Clausen 1938).

Nishida (1966) treats some Nepal plants under *Sceptridium daucifolium* var. *parvum* (v.A. v.R.) Nishida and describes it as plants 10–20 cm in height, sterile frond 5–10 cm long, 5–11 cm wide, bipinnately compound, pinnules subentire, minutely serrate or sometimes slightly lobed and with fertile frond once pinnate, 5–8 cm long, etc., and reports it as new to the Himalayas. We find no justification for this separate varietal treatment.

B. Subgenus **Eubotrychium** (Milde) Clausen, *Mem. Torrey bot. Club*, **19** (2), 60 (1938).
Botrychium, § I, *Eubotrychium*, (*a*) *Affinia* Milde, *Verh. Zool. bot. Ges. Wien.*, **19**, 96 (1869).
Botrychium, section *Eubotrychium* (Milde) Prantl in *Berichte Deutsch. bot. Ges.*, **1**, 348 (1883).

The subgenus *Eubotrychium* consists of two sections, (*a*) *Lanceolatae* 1 sp., (*b*) *Lunariae* 5 spp., in the world flora. Of these, *B. lunaria* only, of the *Lunariae* section, occurs in India.

Section: **Lunariae** Clausen, *Mem. Torrey bot. Club*, **19** (2), 61 (1938).

Key to the Indian forms

A. Sterile blade coriaceous, with the flabellate divisions often imbricate and slightly crenate or undulate. ..... *B. lunaria* var. *lunaria*
A. Sterile blade membranous, with the flabellate or oblong divisions rather remote and more deeply incised ..... *B. lunaria* var. *onondaganse*

Recognition of *Botrychium lunaria* (Linn.) Sw. var. *onondaganse* (Underwood) House in India, as distinct from the type variety, is based on the authority of Clausen (1938, p. 62), but a more critical mind may not consider such treatment convincing since the membranous or leathery nature would largely depend upon the grassy, moist, shady or rocky nature of the substratum on which plants grow, and since the spores also are not of much use in separating the two varieties. However, the shape, cutting and arrangement of sterile divisions on the rachis (Figs. 6, 7), together with the texture, have weighed with us in separating the specimens of *B. lunaria*, available in Indian herbaria, to two distinct varieties, as detailed below.

B. lunaria (Linn.) Swartz., *Schrad. Journ. für di Botanik*, **2**, 110 (1800); Clausen, *Mem. Torrey bot. Club*, **19** (2), 62 (1938); Bedd., Handb. Ferns Brit. India, 469, f. 293 (1883), and in suppl., 110 (1892).
var. **lunaria** (Moonwort).
Basinym: *Osmunda lunaria* Linn., *Sp. Pl.*, **2**, 1064 (1753).
Synonyms: *Botrychium lunatum* Gray, *A natural arrangement of British plants*, **2**, 19 (1821).
B. racemosum (Fuchs) Bubani, *Fl. Pyr.*, **4**, 438 (1901).

Growing on grassy slopes of hills between 3000 and 3500 m altitude. Rhizome small, enclosed by brown sheaths and bearing stoutish branched roots, which are fleshy when fresh but brittle when dry. Plants 7–23 cm high (Fig. 6); common stalk 3–8 cm long, erect, smooth which is cylindrical, hollow and succulent. Vernation of both the fertile and sterile segments erect. Fronds solitary, 6–17 cm long, firm and fleshy; sterile branch 6 × 2 cm, pinnate, oblong, pinnae commonly sessile, flabellate and often overlapping; veins flabellately forked (Fig. 23). Fertile branch clasped by the

FIGS. 6–14. 6, *B. lunaria* var. *lunaria*; 7, *B. lunaria* var. *onandaganse*; 8–12, *B. lanuginosum* var. *lanuginosum*. 8, a glabrescent plant; 9, a pilose plant; 10, rhizome bearing two fronds; 11, rhizome crowned with brown leafy stipular sheaths; 12, sterile pinnules bearing sporangia. 13-14, *B. virginianum* var. *virginianum*. 13, a plant in which fertile stalk not exceeding the sterile blade; 14, a plant with usually long-stalked spike, exceeding the sterile blade.

FIGS. 6–14.

sterile one before unfolding. Fertile stalk 1–8 cm long; fruiting spike racemose or paniculate 0·5–6 cm long; sporangia sessile, circular, brown, arranged in two rows on the dorsal face of the spike. Spores (Figs. 25, 26) trilete, sometimes the triradiate mark forked at the ends (Figs. 24), 28–33 μ in diameter and with reticulate exine.

Fertile: June to July.

Distribution in India: NEPAL—above Ramgaon, *Stainton* and *Williams* 3340 (CAL). SIKKIM: Zemn Valley, *Smith* and *Cave* 1116 (CAL). UTTAR PRADESH (North-West Himalayas)—Tehri-Garhwal: Nag Tiba *s.n.* (CAL); near Deoband Forest Bungalow, *Miss Oliver s.n.* (CAL). MADRAS—Shevaroi hills, *Perrottet* 510 (CAL).

Earlier records: North India, Sikkim, in the arctic and cold temperate zone, extending to South Europe; Afghanistan, the United States, Greenland, Japan, Patagonia, New Zealand, Southern Australia and Tasmania.

New record for South India.

B. lunaria (Linn.) Swartz var. **onondaganse** (Underwood) House, *Bull. N.Y. State Mus.*, Nos. 243-244, p. 47 (1923); Clausen, *Mem. Torrey bot. Club*, **19** (2), 66-67 (1938); Bedd., Handb Ferns Brit. India, 469, f. 293 (1883).

Basinym: *Botrychium onondaganse* Underwood, *Bull. Torrey bot. Club*, **30**, 47 (1903).

Synonym: *Botrychium lunaria* f. *onondaganse* (Underwood) Clute, *Fern Bull.*, **14**, 80 (1906).

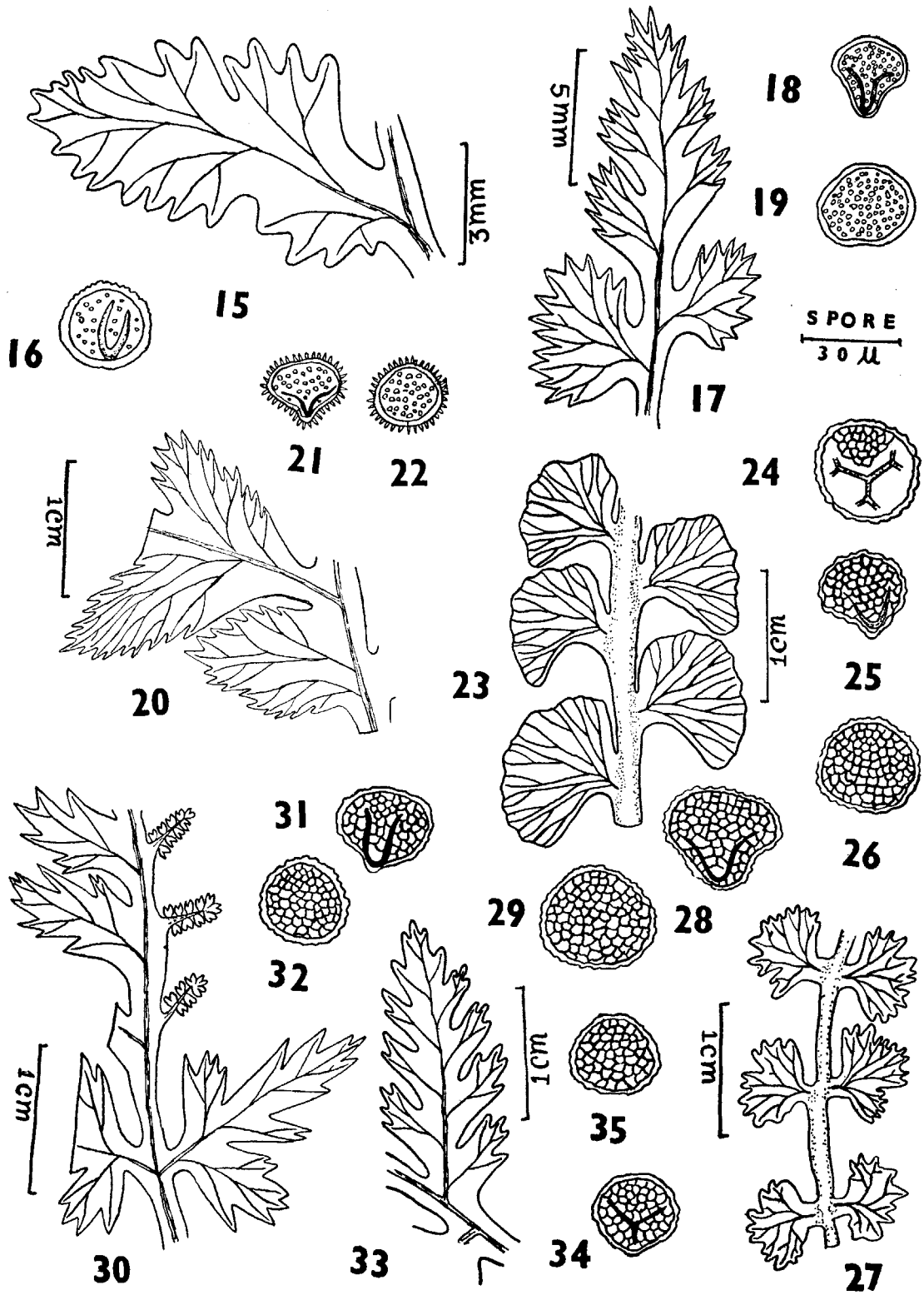
Growing among grasses in moist shady situations. Plants *ca.* 15 cm high and resemble var. *lunaria* in all respects except that the former bear membranous and shortly stalked, deeply incised pinnae, arranged remotely on the rachis (Figs. 7, 27). Spores trilete with circular *amb.*, triangular in polar view, 33–38 μ in diameter and with reticulate exine (Figs. 28, 29).

Fertile: July.

We agree with Clausen (1938, p. 68) that the spore size, on account of its great variability even in the same plant, is of no taxonomic value in the genus *Botrychium*.

Distribution in India: HIMACHAL PRADESH—Chamba district: Satrundi, *Nair* 32393 (BSD). UTTAR PRADESH—Garhwal: Rishigan Valley, *Rau* 2929 (BSD). TIBET—Chumbi: Pharee, *Dr. King's collector s.n.* (CAL).

FIGS. 15–35. 15-16, *B. multifidum*. 15, a pinnule; 16, proximal part of the spore. 17–19, *B. ternatum*. 17, a pinnule; 18, proximal part of the spore; 19, distal part of the spore. 20–22, *B. daucifolium*. 20, a pinnule; 21, proximal part of the spore; 22, distal part of the spore. 23–26, *B. lunaria* var. *lunaria*. 23, a portion of the sterile branch bearing pinnae; 24-25, proximal parts of the spores; 24, triradiate mark forked at the ends; 26, distal part of the spore. 27–29, *B. lunaria* var. *onandaganse*. 27, a sterile branch bearing pinnae; 28, proximal part of the spore; 29, distal part of the spore. 30–32, *B. lanuginosum* var. *lanuginosum*. 30, a portion of the sterile lamina bearing sporangia on certain pinnae which have assumed the form of the fertile spike; 31, proximal part of the spore; 32, distal part of the spore. 33–35, *B. virginianum* var. *virginianum*. 33, a pinnule; 34, proximal part of the spore; 35, distal part of the spore.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FIGS. 15–35.

Earlier records: India (Kashmir), Labrador, Newfoundland, Quebec, Maine, Vermont, New York, Michigan, Washington, Hungary, Germany (cf. Clausen 1938).

C. Subgenus **Osmundopteris** (Milde) Clausen, *Mem. Torrey bot. Club*, **19** (2), 93 (1938). *Botrychium*, § II, *Osmundopteris* Milde, *Verh. Zool. bot. Ges. Wien.*, **19**, 96 (1869).

This subgenus consists of two sections, viz. *Lanuginosae* 1 sp. and *Virgininae* 4 spp., in the world flora. Of these, two species, viz. *B. lanuginosum* and *B. virginianum*, occur in India.

Key to the sections and Indian species of Osmundopteris

A. Fertile segment arising laterally as the division of the foliage blade (i.e. as a lateral branch or pinnae of the sterile blade); plants stout, fleshy, often very hairy..... (*a*) Section *Lanuginosae* *B. lanuginosum*

A. Fertile segment obviously arising from the base of the sterile blade; plants membranous to subfleshy; glabrous or sparingly pubescent..... (*b*) Section *Virginianae* *B. virginianum*

(*a*) Section **Lanuginosae** Clausen, *Mem. Torrey bot. Club*, **19** (2), 94 (1938).

B. lanuginosum Wall. ex Hk. et Grev., *Icones Fil.*, **1**, t. 79 (1831); C. Chr., Index Filicum, 162 (1906); Clausen, *Mem. Torrey bot. Club*, **19** (2), 96 (1938); Hope, *J. Bomb. nat. Hist. Soc.*, **15**, 110 (1903).

var. **lanuginosum.**

Synonyms: *Botrychium lanuginosum* Wall., List, No. 48 (1828) (*nomen nudum*).

Botrychium virginianum (Linn.) Swartz var. *lanuginosum* Bedd., Handb. Ferns Brit. India, 471, f. 295 (1883), and in suppl., 110 (1892); and in Ferns South India, 22, t. 67 (1863).

Osmundopteris lanuginosa (Wall.) Nishida, *J. Jap. Bot.*, **27**, 276 (1952).

Japanobotrychium lanuginosum (Wall.) Nishida, *J. Jap. Bot.*, **33**, 201 (1958).

Growing in open hill slopes amidst grasses or on mossy cover of rock boulders, or on humus soil in the evergreen forest floor. Plants stout, pilose to glabrescent, 30–52 cm high (Figs. 8, 9); rhizome short, bearing a cluster of numerous stout, fleshy roots which become brittle when dry and covered by leafy brown sheaths (Fig. 11) and rarely two fronds arise from the same rhizome (Fig. 10); common stalk 13–23 cm long, sterile blade deltoid 15–28 × 20–35 cm, i.e. broader than long, quadripinnatifid, with the ultimate divisions obtuse or acute; veins simple or forked (Fig. 30); fertile segment arising, above the base, laterally from the rachis of the blade, in place of one of the sterile pinnae; fertile stalk 2–8·5 cm long, ending in a panicle 5–10 cm long. Spores trilete with circular *amb.*, triangular in polar view, 25–30 μ in diameter and with reticulate exine (Figs. 31, 32).

Fertile: July to November.

Abnormalities: (1) A specimen from Mussoorie, *G. King s.n.* (CAL), shows that the two fertile stalks arise laterally from the same point; (2) a specimen from North-West Himalayas: Ganges Valley, *Mackinnon s.n.* (CAL), shows the

sterile lamina bearing sporangia on certain pinnae (Fig. 12); (3) there is one interesting specimen (Fig. 36), viz. Ceylon: *Thwaites* 3266 (CAL), in which the fertile segment gets separated from the base of the sterile stalk at least 7 cm below the point of origin of the sterile blades; it can be ascribed to the section *Virginianae*, but, about 15 cm above the base of the fertile stalk, one of

FIG. 36, *B. lanuginosum* var. *lanuginosum*, an abnormal plant showing teratological modifications. (A, fertile segment separating laterally about 7 cm below the base of the sterile stalk; B, fertile stalk bearing a normal sterile branch).

the lateral (fertile) pinnae has been modified to a normal sterile one, leaving the rest of the fertile segment to form the fruiting panicle, as is characteristic of *Lanuginosae*. We consider this abnormality as a teratological modification and prefer accepting its earlier identification to *B. lanuginosum* as correct.

The above account of *B. lanuginosum* would go to establish its extreme variability with regard to the lateral insertion of the fertile segment and origin of more than one sterile or fertile fronds/segments. Chrysler (1925) considers *B. lanuginosum* as the most primitive species in the genus *Botrychium* and that the section *Lanuginosae* represents the more primitive division of *Osmundopteris* from which the section *Virginianae* has been derived. While agreeing with Chrysler (1925), Clausen (1938) prefers to consider the subgenus *Sceptridium* as more primitive because of the wide and broken geographical distribution of its members, the great variation within the group and presence of suspensor in the embryo in at least one of the species.

Distribution in India: NEFA—Kameng district: Shergaon (ASSAM); Tirap district: Kheti to Tinchl (ASSAM). ASSAM—*Dr. King's collector s.n.* (CAL); Cherrapunji, Khasi and Jaintia hills, *Panigrahi* 3405, 4262 (ASSAM); Pynursla; Khasi hills, *Clarke* 18730 (CAL); Kohima; Shillong Peak; Shillong: Latlyngkot. WEST BENGAL—*Sinchal forest*; Darjeeling, *s.l. s.n.* (CAL). UTTAR PRADESH (North-West Himalayas)—Tehri-Garhwal, *Mackinnon s.n.* (CAL); Simla, *Anderson* 474 (CAL); Mussoorie, *G. King s.n.* (CAL). MADRAS—Coimbatore, *Fischer* 315 (CAL); Upper Plains, *Fischer* 3061 (CAL); Nilgiri hills, *Gamble s.n.* (CAL); *Meebold* 11703 (CAL); *Levinge s.n.* (CAL); Annamalai hills, *Beddome* 116 (CAL); Kodaikanal hills, *Jacob* 16146 (CAL); Pulney hills; Shevaroi hills. MYSORE—*Talbot* 3087 (CAL). Abundant.

Earlier records: India, Nepal, Ceylon, Sumatra, Java, Philippines, China (cf. Clausen 1938).

The decidedly variable texture and the amount of pubescence of the leaf of *B. lanuginosum* and slender habit of some biotypes (cf. Nakai 1926) have led Clausen (1938) to accept Nakai's (1926) recognition of the two varieties as follows:

A. Plants stout and fleshy; sterile blade and stalk more or less pilose ..... var. *lanuginosum*
A. Plants slender, rather membranous and entirely glabrous ..... var. *leptostachyum*

Although Nakai (1926) reported var. *leptostachyum* from the Himalayas, China and Formosa, neither Clausen (1938) nor we could spot any specimen from the Himalayas referable to this variety.

Nishida (1966), however, recognizes another new variety, viz. *Japanobotrychium lanuginosum* (Wall.) Nishida var. *nepalense* Nishida, from East Nepal with the following diagnostic characters:

Sterile frond tripinnate; primary pinnule lanceolate-oblong and acute, secondary pinnule ovate to oval, lobate or cleft and rounded at the apex;

ultimate segments elliptical, almost entire or shallowly crenate or obtuse or rounded at apex.

(*b*) Section **Virginianae** Clausen, *Mem. Torrey bot. Club*, **19** (2), 97 (1938).

B. virginianum (Linn.) Swartz, *Scharad. Journ. für di Botanik*, **2**, 111 (1800); Clausen, *Mem. Torrey bot. Club*, **19** (2), 98 (1938); Hope, *J. Bomb. nat. Hist. Soc.*, **15**, 109 (1903).
ssp. **virginianum** (rattle-snake fern).
Basinym: *Osmunda virginiana* Linn., *Sp. Pl.*, **2**, 1064 (1753).
Synonyms: *Osmunda virginica* Linn., *Syst. nat.*, ed. 12, **2**, 658 (1787).
Botrychium virginianum (Linn.) Willd., *Sp. Pl.*, **5**, 64 (1810).
B. gracile Pursh, *Fl. Amer.*, Sept., **2**, 655 (1814).
Japanobotrychium virginianum (Linn.) Nishida, The Japanese Pteridophyta, 30, t. 7, f. 43 (1959).

Growing amidst grasses on hilly tracts and in pine and cedar forests in the Himalayas between 1400 and 3000 m altitude. Plants glabrous or sparsely pubescent, 30–75 cm high; rhizome small, bearing many fleshy branched roots which become brittle when dry (Fig. 13); common stalk 15–30 cm long; sterile blade sessile, deltoid, quadripinnatifid with the ultimate divisions oblong-lanceolate, toothed, apex blunt or acute, veins simple or forked (Fig. 33); fertile spike long-stalked and usually much exceeding the sterile blade in length (Fig. 14); the stalk being 4·5–20 cm long; fruiting spike 4–15 long, paniculate; spores trilete with circular *amb. ca.* 28 μ in diameter and with reticulate exine (Figs. 34, 35).

Fertile: May to August.

Distribution in India: NEFA—Kameng district: Shergaon, *Panigrahi* 15900 (ASSAM). UTTAR PRADESH (North-West Himalayas)—Dhamdar Valley, *Mackinnon s.n.* (CAL); Tehri-Garhwal: Deolsari, *Bhattacharya* 33790 (BSD). Rare.

Earlier records: Northern India, China, Japan, Central Europe and North America (cf. Clausen 1938).

II. **Helminthostachys** Kaulfuss

Helminthostachys Kaulfuss, Flora, 103 (1822).
Synonyms: *Botryopteris* Presl, *Rel Haenk*, **1**, 76 (1825).
Ophiala Desvaux, *Mem. Soc. Linn. Paris*, **6**, 195 (1827).
Type-species: *Helminthostachys dulcis* Kaulf., Flora, 103 (1822).
nomen illeg., since it is a later synonym of *Osmunda zeylanica* Linn., *Sp. Pl.*, **2**, 1063 (1753).

Helminthostachys zeylanica (Linn.) Hooker, Genera Filicum, Pl. 47*b* (1842); Clausen, *Mem. Torrey bot. Club*, **19** (2), 108 (1938); Bedd., Handb. Ferns Brit. India, 467, t. 292 (1883), and in suppl., 109 (1892); and in Ferns South India, 23, t. 69 (1863).
Basinym: *Osmunda zeylanica* Linn., *Sp. Pl.*, **2**, 1063 (1753).
Synonyms: *Botrychium zeylanicum* (Linn.) Swartz, *Schrad. Journ. für di Botanik*, p. 111 (1800).
Helminthostachys dulcis Kaulf., Flora, 103 (1822).
H. crenata Presl, *Suppl. Tent. Pterid.*, 60 (1845).
H. integrifolia Presl, *Suppl. Tent. Pterid*, 60 (1845).

Growing in open grassy swamps on the edge of the Terai forests and along river banks. On moist alluvial-sandy soil or on blackish mud between 200 and

1000 m altitude. Plants green to purplish in colour, 30–43 cm high; rhizome thick, fleshy, creeping and bearing many thick fleshy roots which become brittle when dry (Fig. 37); common stalk fleshy, 20–30 cm long, sterile frond consisting of sessile, palmately tripartite lamina and a stalked fertile spike, and all these four parts separate from the apex of the common stalk, divisions of the sterile blade 10–30×2–3 cm, oblong-lanceolate in shape, usually acute, rarely obtuse at the apex, cuneate at base, margin entire or slightly and irregularly toothed, midrib grooved above and raised below; veins fine, close, arising obliquely from the midrib and once or twice forked (Fig. 73); fertile spike longer than the sterile blade and stalk being 5–12 cm long, fruiting spike green to brown in colour, 4–8 cm long and bearing crowded short lateral branches, each with a sessile group of round sporangia and small sterile lobes at the apex (Fig. 88); spores trilete with circular *amb.*, 30–35 μ in diameter and with reticulate exine (Fig. 89).

Fertile: August to February.

Distribution in India: ASSAM—*Fischer s.n.* (CAL); *Panigrahi* 14366 (ASSAM); *Animadas s.n.* (ASSAM); Lebang, *Burkill* 37734 (CAL); Sibsagar; Mikir hills; Gauhati; Motharguri; Sandal Bhell and adjoining sal forest; Singri; Sylhet; Khasi and Jaintia hills; Nongpoh. UTTAR PRADESH—Bahraich: Abdullagunj, *Panigrahi* 6454 (BSA); Nishangarha: Uraital, *Mishra* 7991 (BSA); Gorakhpur: Kusmi forest and Ramgarh forest. SOUTH INDIA—*s.l. s.n.* with Accession No. 60082 (BSMH).

Earlier records: India (South India, Western forest up to 3000 ft elevation, North India, Uttar Pradesh, Bengal plains to Assam and Cachar), Ceylon, Malay Peninsula, China, Japan, Philippines, Solomon Islands, New Caledonia, New Guinea and Australia (cf. Clausen 1938).

III. **Ophioglossum** Linn.

Ophioglossum (Tourn. ex Linn., *Gen. Pl.*, 322 (1737)) Linn., *Sp. Pl.*, **2**, 1062 (1753); *Gen. Pl.*, ed. 5, 484 (1754).

Synonym: *Ophioderma* (Blume) Endl., *Gen. Pl.*, 66 (1836).

Type-species: *Ophioglossum vulgatum* Linn., *Sp. Pl.*, **2**, 1062 (1753). (The generic name is derived from two Greek words which mean snake tongue, the fertile frond having the appearance of a snake's tongue).

Rhizome usually short, erect, bearing few fronds simultaneously; vegetative frond simple, usually entire, more or less fleshy with reticulate venation. Fertile stalk simple (rarely furcate); sporangia placed in two lateral rows, partly immersed in the axis, opening by transverse slits.

According to Christensen (1934, 1938), Pichi-Sermolli (1954) and Copeland (1947), the genus *Ophioglossum* is represented by 50–54 spp. and a few more varieties in the world flora. Clausen (1938), however, reduces this number to 26 spp. (excluding 1 sp. each of *Rhizoglossum* Pr. and *Cheiroglossa* Pr.).

Wieffering (1964) not only justifies Clausen's treatment but himself advocates recognition of a still smaller number of spp. for the genus, stating that 'in general one should be very careful in basing specific delimitation primarily on characters, which are known to be of no or only secondary importance in most of the vascular plants. In the case of *Ophioglossum*, where these characters hardly show sharp demarcation and are so little correlated with other characters, I do not think we should use them'. While advocating a crossing and breeding programme, which no doubt will be a very time consuming one, he recognizes only a few species with some varieties or forms on the basis of morphological characters alone. He justifies this treatment because of the existence of a very high range of chromosome numbers (viz. $n = ca.$ 120–630), suggesting high rates of polyploidy which may well have resulted in genotypical differences and, thus, genetic variation of more than usual importance within the same species.

Key to the Indian subgenera

1. Strobilus with a sterile apex; demarcation between tropophyll and common stalk clear-cut, tropophyll not or only at the base adnate to the fertile stalk; venation mostly with at least a few secondary veinlets, leaf trace with a single strand..... Subgenus *Ophioglossum*
1. Strobilus with a fertile apex, tropophyll gradually attenuate into a common stalk (stalk often hardly discernible); tropophyll conspicuously adnate to the fertile stalk; venation consisting of the primary veins only..... Subgenus *Ophioderma*

Subgenus **Ophioglossum.**
Ophioglossum subg. *Euophioglossum* (Prantl) Clausen, *Mem. Torrey bot. Club*, **19** (2), 120 (1938).
Section *Verae* Bl., *En. Pl. Jav.*, **2**, 259 (1828).
Ophioglossum sensu Endl., *Gen. Pl.*, **1**, 66 (1836).
Section *Euophioglossum* Prantl, *Ber. Deut. bot. Ges.*, **1**, 350 (1883).

According to Clausen (1938), although the subgenus is characterized by the terrestrial habit, the short erect rhizome, the division of the leaf into a fertile and sterile segment, the small size of the plants, and the simple undivided sterile segment, it comprises of populations of plants in which an almost continuous series of forms without any clear-cut specific lines or breaks in the continuity, exist. Prantl (1884), while recognizing 26 spp., placed much emphasis on the characters afforded by the venation and size and markings of the spores. But Clausen (1938), from his studies, found both the venation and spore characters used by Prantl (1884) as completely unreliable for species differentiation in the subgenus. He also found the absolute shape of sterile blade, height of insertion of that structure and the size of the plant used for the species delimitation equally untrustworthy and concluded that 'almost every character previously employed in the classification of the small species of *Ophioglossum* is unsatisfactory for systematic purposes' and, therefore, rejected a large number of previously accepted species, 'since most of them were

based on single collections or their descriptions have been scant and without diagnostic characters'. He remarked that the literature of *Ophioglossum* abounds in isolated unrelated descriptions of new species which would never have been published at all and that the same species have been described again and again, thus increasing the synonymy.

Nishida (1959), while complimenting Clausen (1938) for summarizing our modern knowledge of Ophioglossales, considered his treatment of species of the order, particularly of Botrychiaceae, to be adequate as a whole. In line with Clausen's findings, he also treated the texture, venation, size and shape of sterile frond as most inconstant characters, being easily affected by ecological conditions but, unlike Clausen, he laid emphasis on the structure of the spore coat (exospore), used earlier by Prantl (1884), for delimiting species of *Ophioglossum*. The importance of the spore structure advocated by Nishida (1959) is, however, not shared by Wieffering (1964).

Key to the Indian species of Ophioglossum

1.	Rhizome globose, bearing many fibrous roots; tropophyll with a conspicuous pale median band, venation double, i.e. principal veins characteristically forming large primary areoles in which are included numerous veinlets forming secondary areoles (Fig. 74)	*O. costatum*
1.	Rhizome cylindrical or subglobose, bearing few to rather many roots; tropophyll without a pale median band, venation not double, i.e. principal veins forming areoles but free-ending veinlets and some areoles may be present occasionally.	
2.	Tropophyll linear or linear lanceolate, elliptic-lanceolate, rarely oblanceolate.	
3.	Tropophyll linear, more than six times as long as broad, apex nearly always acute, sometimes acuminate with 2 or 3 parallel veins at the base and in the lower part, mostly with long stretched areoles (Figs. 75, 76)	*O. gramineum*
3.	Tropophyll linear-lanceolate or lanceolate with several parallel veins.	
4.	Tropophyll somewhat fleshy in texture; common stalk 0·5–3·5 cm long; veins usually few	*O. lusitanicum*
4.	Tropophyll membranous in texture; common stalk 2·5–6 (—13·5) cm long; veins numerous	*O. thermale* var. *nipponicum*
2.	Tropophyll never linear.	
5.	Rhizome subglobose, tropophyll ovate, suborbicular or elliptical; apex acute, if blunt, then minutely apiculate, venation never with long stretched areoles at lower part of the sterile blade (Figs. 79, 80)	*O. nudicaule*
5.	Rhizome cylindrical.	
6.	Rhizome with persistent conspicuous brown sheaths formed by the bases of the old leaf stalk; tropophyll elliptic-lanceolate or lanceolate	*O. polyphyllum*
6.	Rhizome without persistent brown sheaths.	
7.	Tropophyll narrowly lanceolate, oblong lanceolate, elliptical or oblong.	

8. Plants very slender; usually with 4–8 parallel veins passing down through the base of the blade ..... *O. thermale* var. *nipponicum*

8. Tropophyll with 8–20 parallel veins passing down through the base of the blade ..... *O. vulgatum*

7. Tropophyll cordate, ovate, ovate-lanceolate, reniform, deltoid, sometimes obovate or trullate.

9. Tropophyll cordate or very variable at the base, usually coriaceous to sub-coriaceous but rarely thin in texture, veins usually numerous ..... *O. reticulatum*

9. Tropophyll membranous in texture, lance-ovate, venation lax, veins not numerous, forming large areoles; fertile segment long and slender ..... *O. petiolatum*

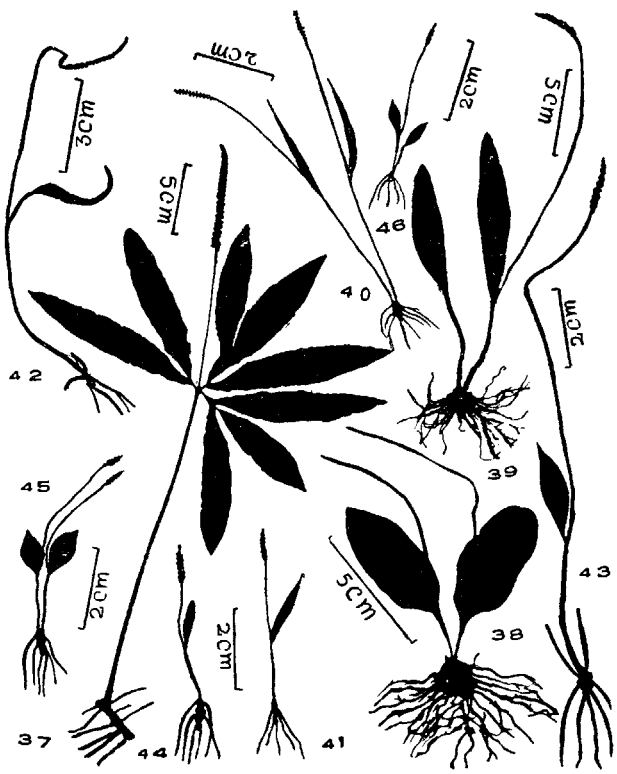


FIG. 37–46. 37, *Helminthostachys zeylanica*; 38-39, *Ophioglossum costatum*, variation in biotypes; 40-41, *O. gramineum* var. *gramincum*, variation in biotypes; 42-43, *O. gramineum* var. *majus*. 42, a normal plant; 43, a plant with one of its sterile frond (tropophyll) assumed the shape like *O. reticulatum*. 44–46, *O. lusitanicum*, variation in biotypes.

Ophioglossum costatum R. Br., *Prodr. Fl. Nov. Holl.*, 163 (1810); Pichi-Sermolli, *Webbia*, **9** (2), 626, f. 1 (1954).

Synonyms: *Ophioglossum pedunculosum* Desv., *Mag. Ges. Nat. Fr. Berlin*, **5**, 306 (1811); Clausen, *Mem. Torrey bot. Club*, **19** (2), 140 (1938).

O. pedunculatum Desv. ex Poir., *Enc. Suppl.*, **4**, 164 (1816) (error).

O. fibrosum Schum, *Beskr. Guin. Pl.*, 452 (1827); Bedd., Handb., Ferns Brit. India, 465, f. 289 (1883), and suppl., 109 (1892); Chakravarty, *Bull. bot. Soc. Bengal*, **5** (1), 6 (1951); Mahabale, *Bull. bot. Surv. India*, **4**, 71 (1962).
O. wightii Grev. et Hook., *Bot. Misc.*, **3**, part 8, 218 (1832).
O. brevipes Bedd., Ferns South India, 23, t. 72 (1863).
O. bulbosum Bedd., Handb. Ferns Brit. India, suppl., 28 (1876).
O. aphrodisiacum Welw. ex Prantl, *Ber. Deut. bot. Ges.*, **1**, 352 (1883).

Growing in open grassy forest floor or on hill slopes in sandy laterite soil, next to rock boulders. Plants 8–25 cm high; rhizome bearing one to many fronds simultaneously, of which usually one or two without sporophyll (Figs. 38, 39); common stalk 0·5–4 cm long; tropophyll 2·5–10 × 1–2·5 cm, usually elliptic, sometimes ovate, ovate-lanceolate or obovate in shape, cuneate at base, acute, apiculate or obtuse at apex, subcoriaceous in texture; fertile part (sporophyll) always much longer at maturity than sterile blade; fertile stalk 3–18 cm long; strobilus 1–6 cm long, green when young but brown at maturity, rarely branched (seen in only one specimen, *Panigrahi* 4222, from Saktua forest in Hoshangabad district of Madhya Pradesh, deposited at BSA); spores trilete (sometimes triradiate mark forked at the ends, Fig. 90) with circular *amb.*, 30–35 μ in diameter and with minutely reticulate exine (Figs. 91, 92).

Fertile: July to December.

Distribution in India: UTTAR PRADESH—Mirzapur, *Panigrahi* 4022 (BSA); Varanasi: Rajdari forest, *Panigrahi* 4150 (BSA). MADHYA PRADESH—Pachmarhi, *Panigrahi* 4490 (BSA); Hoshangabad: Kesla, *Joseph* 12828 (BSMH); Mandla: Khari Reserve Forest. BIHAR—Manbhum, *Campbell s.n.* (CAL). WEST BENGAL—*s.l. s.n.* (CAL). KERALA—Malabar, *Stocks* 359 (CAL). MAHARASHTRA—Khandala forest—*s.l. s.n.* (CAL).

Earlier records: Ascension Islands, Tropical and South Africa, Comores Arch., Madagascar, India, Ceylon, Sumatra to East Australia and New Zealand (cf. Pichi-Sermolli 1954).

O. gramineum Willd., *Nov. Act. Acad. Erf.*, **2**, 18, t. 1, f. 1 (1802); Clausen, *Mem. Torrey bot. Club*, **19** (2), 161 (1938); Bedd., Handb. Ferns Brit. India in suppl., 108 (1892); Wief., *Blumea*, **12** (2), 324 (1964).
var. **gramineum.**
Synonyms: *O. vulgatum* var. *gramineum* (Willd.) Hook. f., *Fl. Nov. Zel.*, **2**, 50 (1854).
O. dietrichiae Prantl, *Ber. Deut. bot. Ges.*, **1**, 352 (1883).
O. moluccanum Schlechtend. f. *incospicum*, *Rac. Nat. Tijd. Ned. Ind.*, **59**, 237, t. 2, f. 5 (1900).
O. costatum R. Br. *sensu* Clausen, *Mem. Torrey bot. Club*, **19** (2), 161 (1938).

Plants slender, 3–9·5 cm long; rhizome bearing 1–3 fronds simultaneously (Figs. 40, 41); common stalk 1–3·5 cm long; tropophyll 1–3 cm long, attenuate at base, subcoriaceous in texture, entire in margin; fertile stalk 1·5–3·5 cm long; strobilus 0·8–2·3 cm long; spores trilete with circular *amb. ca.* 35 μ in diameter and with broadly reticulate exine (Fig. 93).

Fertile: July to September.

Distribution in India: UTTAR PRADESH—Varanasi: Rajdari forest, *Panigrahi* 4116 (BSA). MADHYA PRADESH—Kesla, *Joseph* 12838 (BSMH); Pachmarhi, *Panigrahi* 4490B (BSA). ANDHRA PRADESH—Karim Nagar, *Subba Rao* 20238 (BSMH). MADRAS—Coimbatore: Aliyar submergible area, *Sebastine* 14697 (BSMH); Tinnevelly.

Altitude: 200–500 m.

Earlier records: The species is probably pantropical though nowhere common (cf. Wieffering 1964).

O. gramineum var. **majus** (v.A. v.R.) Wief., *Blumea*, **12** (2), 324, f. 2*b*, photo. 3 (1964).
Synonyms: *O. incospicum* (Rac.) v.A. v.R. var. *majus* v.A. v.R., *Bull. Dep. Agr. Ind. Neerl.*, **21**, 9 (1908).
O. gregarium Christ, *Nova. Guinea, Bot.*, **8**, 164 (1909).

Plants 16–24 cm high; rhizome bearing more than two fronds (Fig. 42); common stalk 6·5–12 cm long; tropophyll 6–7·5 cm long; fertile stalk 6·5–13 cm long; strobilus 3–3·5 cm long, mostly gradually passing into the stalk; spores trilete (sometimes triradiate mark forked at the ends, Fig. 94), with circular *amb.* or rarely semicircular, triangular in polar view, 38–45 μ in diameter and with broadly reticulate exine (Figs. 95–97).

Distribution in India: WEST BENGAL—Tripura, *Deb* 267 (CAL) with 7 mounted specimens, of which 6 are identified to var. *majus*, the 7th one to *O. reticulatum* Linn. But the 6th one has one of its sterile blade approaching to *O. reticulatum* in shape and size (Fig. 43).

Earlier records: Wieffering (1964) examined the specimens from the Philippines (Luzon) and New Guinea.

New record for India.

O. lusitanicum Linn., *Sp. Pl.*, **2**, 1063 (1753); Clausen, *Mem. Torrey bot. Club*, **19** (2), 159 (1938); Mahabale, *Bull. bot. Surv. India*, **4**, 71 (1962).
ssp. **lusitanicum**.
Synonyms: *O. loureirianum* Presl, *Suppl. Tent. Pterid*, p. 55 (1845).
O. alpinum Rouy, *Bull. Soc. bot. France*, **44**, 437 (1897).
O. braunii Prantl, *Ber dëutsch bot. Ges*, **1**, 351 (1883).

Plants 3–6·5 cm high; rhizome short, erect, tuberous, bearing many long fleshy roots which become brittle when dry, and usually one to two fronds simultaneously (Figs. 44–46); common stalk 0·5–2 cm long, tropophyll 1–1·7× 0·2–0·7 cm, elliptic-lanceolate, oblanceolate or sometimes spathulate in shape, blunt, acute or minutely apiculate at apex, cuneate at base, and with entire margin; venation lax with few parallel veins forming elongated large areoles without free vein-endings in the middle but few present in the marginal area (Fig. 77); fertile stalk 2–3 cm long; strobilus 0·5–1 cm long; spores trilete with circular *amb.*, 32–40 μ in diameter and with finely reticulate exine (Fig. 98). The rhizome of this species, as illustrated in Mahabale's (1962), seems to be round rather than elongated in shape.

Fertile: July to August.

Distribution in India: MADHYA PRADESH—Hoshangabad: Kesla-Banglapore, *Joseph* 12837 (BSMH).

Earlier records: Iceland, France, Portugal, Italy, Azores, Madeira, Algeria and Afghanistan, also elsewhere in Asia (India, from east coast in Chingleput district of Madras) and Africa (cf. Clausen 1938).

New record for Madhya Pradesh.

O. thermale Kumarov var. **nipponicum** (Miyabe et Kudo) Nishida in Tagwa, *J. Jap. Bot.*, **33**, 202 (1958); Nishida, *Bull. Nat. Sci.*, **4** (3), 332 (1959).

Synonyms: *O. nipponicum* Miyabe et Kudo, *Trans. Sapporo Nat. Hist. Soc.*, **6**, 122 (1916).

O. japonicum (non Thunberg) Prantl, *Ber. déut. bot. Ges.*, **1**, 353 (1883); Mahabale, *Bull. bot. Surv. India*, **4**, 71 (1962).

O. angustatum Maxon, *Proc. Biol. Soc. Wash.*, **36**, 169 (1923); Clausen, *Mem. Torrey bot. Club*, **19** (2), 129 (1938).

O. nipponicum (non Miyabe et Kudo) Nakai, *Bot. Mag. Tokyo*, **39**, 193 (1925).

We have not had access to any specimen of *O. thermale* var. *nipponicum* (Miyabe et Kudo) Nishida for our study either from India or abroad. Our report of occurrence of this variety in India is entirely on the authority of Clausen (1938) and Mahabale (1962). The following description is adapted from Clausen (*loc. cit.*), Mahabale (*loc. cit.*) and Nishida (1959):

Plants slender, 10–25 cm high (Figs. 47, 48); rhizome erect and cylindrical; common stalk 2·5–6 (—13·5) cm long; tropophyll seemingly inserted at or just below the middle of the plant, 2·5–6 (—8)×1–2 cm larger and broader than the type (0·5–4 (—6)×0·3–0·8 cm), oblong, elliptical, lanceolate or even linear-lanceolate in shape, acute, obtuse or mucronate at apex, margin entire or crenulate, venation loosely reticulate with the midvein usually disappearing towards the apex, but in its lower half emitting a few lateral veins; areoles elongated, irregular, free vein-endings divaricating, ascending or descending (Fig. 78); fertile stalk 3·5–14 cm long; spores (Fig. 99) trilete with circular *amb.*, according to Mahabale (1962), 32–40 μ in diameter (Fig. 99) and exine minutely reticulated with smooth outline (cf. Prantl 1883 in Nishida 1959). According to Clausen (1938), the species prefers sandy soils of the sea coasts.

Earlier records: It is widely distributed throughout the Japanese Islands and also is found in eastern Central China, Korea, Japan and India (cf. Clausen 1938; Nishida 1959).

O. nudicaule Linn. f., suppl., *Syst. Pl.*, 443 (1781); Clausen, *Mem. Torrey bot. Club*, **19** (2), 143, 146, 147, 150, 151, incl. var. *tenerum* (Mett.) Clausen et var. *macrorrhizum* (Kze.) Clausen, excl. var. *grandifolium* Clausen; Bedd., Handb. Ferns Brit. India, 464, t. 288 (1883), and in suppl., 109 (1892); Wief., *Blumea*, **12** (2), 324 (1964).

Synonyms: *O. luersseni* Prantl, *Ber. déut. bot. Ges.*, **1**, 352 (1883).

O. pumilum v.A. v.R., *Mal. Ferns*, 774 (1908).

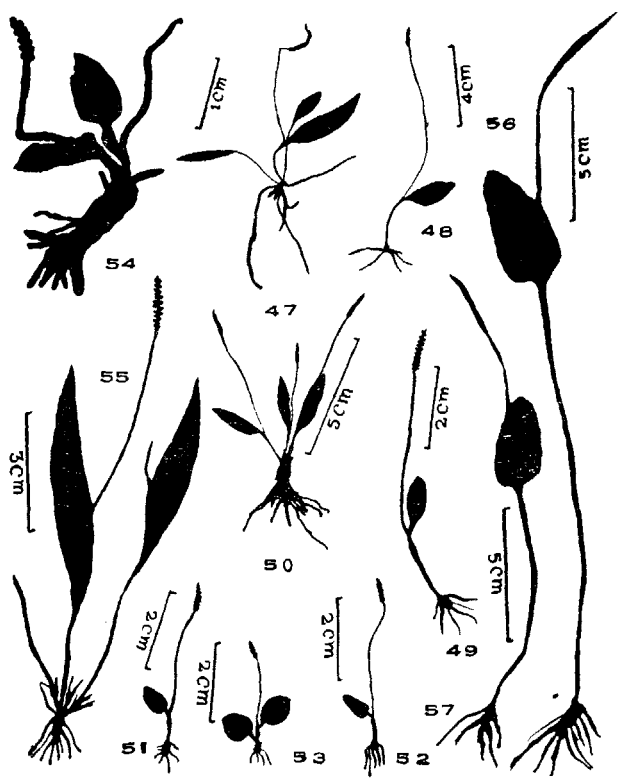
O. schlechteri Brause, *Bot. Jarb.*, **49**, 58, 59, f. 3E (1912).

O. lineare Schlechter et Brause, *Bot. Jarb.*, **49**, 59, f. 3F (1912).

O. parvifolium sensu Bedd., Ferns South India, 23, t. 71 (1863).

O. capense Sw., *Schrad. Journ.*, **1801** (2), 308 (1803).

Plants 3·5–8·5 cm high (Figs. 49, 51, 52); rhizome subglobose, rarely thickly cylindrical; common stalk 0·2–1·5 cm long; tropophyll 0·7–2·7 × 0·3–0·7 cm, attached at the lower quarter of the frond, ovate, sometimes elliptic or elliptic-lanceolate in shape, cordate, attenuate or truncate at base, mostly acute, rarely obtuse or apiculate at apex, fleshy in texture, margin entire; venation lax to dense with few to many free-ending veinlets; fertile stalk 2–5 cm long; strobilus 0·5–1·2 cm long, usually rather abruptly set off against



FIGS. 47–57. 47-48, *O. thermale* var. *nipponicum*, variation in biotypes (after Mahabale 1962 and Nishida 1959); 49–52, *O. nudicaule*, variation in biotypes; 53, *O. nudicaule* var. *macrorrhizum*; 54, holotype of *O. nudicaule* (after Pichi-Sermolli 1954); 55, *O. polyphyllum*; 56-57, *O. vulgatum*, variation in biotypes.

its stalk and the lowest sporangia, mostly reaching at maturity; spores trilete with circular *amb.*, triangular in polar view, 30–45 μ in diameter (according to Mahabale (1962)? 28–30 μ in diameter) and with coarsely reticulate exine (Figs. 100, 101).

Fertile: July-August.

Distribution in India: ASSAM—Jaintia hills, *Burkill* and *Banerjee* 262 (CAL). UTTAR PRADESH—Bundelkhand, *Vicary s.n.* (CAL); Varanasi: Rajdari

forest, *Panigrahi* 4115 (BSA). MADHYA PRADESH—Pachmarhi, *Panigrahi* 4490A (BSA).

There is a specimen (Fig. 50), *Ramamurthy* 20791, from Esani forest (Sevaganga) in Ramnad district of Madras at BSMH, approaching *O. nudicaule* var. *tenerum* (Mett.) Clausen in all respects (viz. plants large, 4–12 cm high; rhizome subglobose; tropophyll elliptical or elliptic-lanceolate, typically longer than broad) except that the fertile segment is not 4–10 times longer than the sterile blade. While Clausen (1938) separated this as a distinct variety for practical convenience, he would prefer to merge this with the type variety.

Earlier records: Pantropic (cf. Wieffering 1964).

Clausen (1938, p. 143) attributes to *O. nudicaule* var. *typicum* the characters, viz. 'Plant small, 2·5–7·5 cm high, sterile blade inserted basally or almost so, truncate or cuneate at base, ovate or orbicular in shape, usually as broad as long, fertile segments 2–4 times as long as the sterile blade.' Pichi-Sermolli (1954) and Wieffering (1964), who have seen the holotype/original photograph of *O. nudicaule* Linn. f. in the Linn. Herb. (Fig. 54), do not consider Clausen's (1938) attribution of the characters to *O. nudicaule* var. *typicum* as correct. While considering *O. nudicaule* as a polymorphic species like *O. reticulatum*, Wieffering (1964) recognizes *O. nudicaule* var. *macrorrhizum* (Kze.) Clausen as a distinct diminutive form with such characters as are attributed by Clausen (1938) for var. *typicum*.

O. nudicaule Linn. f. var. **macrorrhizum** (Kunze) Clausen, *Mem. Torrey bot. Club*, **19** (2), 150 (1938); Wief., *Blumea*, **12** (2), 326 (1964).
Basinym: *O. macrorrhizum* Kunze, *Die Farrnkräuter*, **1**, 57, t. 29, f. 1 (1840).

Plants slender, 3·5–6·5 cm high (Fig. 53); rhizome subglobose, tropophyll 5–8 × 4–6 mm, coriaceous in texture, ovate in shape, cordate at base, usually shortly apiculate, sometimes obtuse at apex; fertile stalk 2–4·5 cm long, strobilus 0·5–1·5 cm long; spores trilete with circular *amb.*, 42–45 μ in diameter, exine thin and coarsely reticulated (Figs. 102, 103).

Fertile: July.

Distribution in India: MADHYA PRADESH—Hoshangabad: Kesla Banglapore, *Joseph* 12836 (BSMH). Recently, Inamdar and Shah (1967) and Basak (1968) have this variety from Dharampur forest of Gujarat and from Kachujore forest near Suri in Birbhum district of West Bengal, respectively. Basak (1968) also attributes the occurrence of this variety in Bundelkhand area of the Upper Gangetic Plain (cf. *Vicary s.n.* (CAL)). Rare.

Earlier records: South America, China, India (Madras and Gujarat), Thailand, Malay Peninsula, Sumatra, Java, Lesser Sunda Island, Philippines, New Guinea, New Caledonia.

We have followed Wieffering's treatment and the few specimens, referred to above, are identified here to *O. nudicaule* var. *macrorrhizum* (Kunze) Clausen;

excluding them, all the other Indian specimens identified to this taxon are referred to *O. nudicaule*, which is, then, a greatly variable species.

New record for Madhya Pradesh.

O. polyphyllum A. Braun apud Seubert, *Fl. Azor.*, 17 (1844); Pichi-Sermolli, *Webbia*, **9** (2), 632 (1954).

Synonyms: *O. cuspidatum* Milde, *Bot. Zeit*, **22**, 107 (1864).

O. aitchisoni (Clarke) d'Almeida, *J. Indian bot. Soc.*, **3**, 63, f. 12-13 (1922); Clausen, *Mem. Torrey bot. Club*, **19** (2), 138 (1938); Mahabale, *Bull. bot. Surv. India*, **4**, 71 (1962).

O. lusitanicum C. W. Hope (non Linn.) in *J. Bomb. nat. Hist. Soc.*, **15**, 106 (1903).

O. regulare (Schlecht) C. Chr., Index Fil., 472 (1906).

O. capense Sw. *sensu* Chakravarty, *Bull. bot. Soc. Bengal*, **5** (1), 5 (1951).

Plants up to 11 cm tall; rhizome long, vertical, tap-root-shaped, with many fibrous roots, bearing one to four fronds with or without midrib (Fig. 55). Common stalk up to 4 cm long; tropophyll 3·5–5·5 × 0·5–1 cm, attenuate at base, acute or usually mucronate at apex, thin but firm in texture; veins forming oblong areoles with a dense network of secondary areoles (Fig. 81); sporophyll arising from a little above the base of the sterile lamina/tropophyll; fertile stalk up to 4 cm long, strobilus 1–25 cm long; spores trilete with circular *amb. ca.* 38 μ in diameter (according to Mahabale, 47 μ) and with fine reticulated exine (Fig. 104).

Fertile: July to August.

Distribution in India: UTTAR PRADESH (North-West Himalayas)—Cherat (2700 m alt.), *H. Collett s.n.* (CAL); Mount Tilla, *Aitchison* 21 (CAL): without any specific locality *s.l. s.n.* 454 (CAL). Rare.

Earlier records: Ethiopia, Kenya, Tanganyika, Rhodesia, South-West Africa, Cape Verde Islands, North Africa (Morocco), Arabia, Northern and Western India (cf. Pichi-Sermolli 1954).

According to Pichi-Sermolli (1954, p. 640), *O. polyphyllum* shows great variability with regard to the size of the plant, shape and dimension of the tropophyll, the length and breadth of the spike and the size of the spores.

O. vulgatum Linn., *Sp. Pl.*, **2**, 1062 (1753); C. Chr., Index Fil., 472 (1906); Clausen, *Mem. Torrey bot. Club*, **19** (2), 123 (1938); Chakravarty, *Bull. bot. Soc. Bengal*, **5** (1), 3 (1951); Hope, *J. Bombay nat. Hist. Soc.*, **15** (1), 107 (1903); Mahabale, *Bull. bot. Surv. India*, **4**, 71 (1962); Nishida, *Bull. Nat. Sci. Mus.*, **4** (3), 328 (1959); Bedd., Handb. Ferns Brit. India, 464 (1883), and in suppl., 109 (1892).

Synonyms: *Ophioglossum ovatum* Salisbury, *Prodr. Stirpium in harto ad Chapel Allerton vigentium*, p. 401 (1796) (*nomen nudum*).

O. polyphyllum (non A. Br. apud Seubert), *sensu* Clausen, *Mem. Torrey bot. Club*, **19** (2), 123 (1938); *sensu* Chakravarty, *Bull. bot. Soc. Bengal*, **5** (1), 3 (1951).

O. azoricum (non Presl), *sensu* Clausen, *Mem. Torrey bot. Club*, **19** (2), 123 (1938); *sensu* Chakravarty, *Bull. bot. Soc. Bengal*, **5** (1), 3 (1951).

O. thermale (non Kumarov), *sensu* Clausen, *Mem. Torrey bot. Club*, **19** (2), 124 (1938).

O. nipponicum (non Miyabe et Kudo), *sensu* Clausen, *Mem. Torrey bot. Club*, **19** (2), 124 (1938).

O. unifolium Gilibert, *Exercitia phytologica*, **2**, 544 (1790).

O. ovatum Prod., 401 (1796) (*nomen*).
O. microstichum Acharius in *Vet. Acad. Nya Handl.*, 30, 64, t. 3A (1899).
O. reticulatum non Linn., *sensu* Nakai, Nishida, *Bull. Nat. Sci. Mus.*, 4 (3), 328 (1959).

Plants 8–27 cm high; rhizome erect, cylindrical, bearing many fleshy roots which become brittle when dry and from which only one frond arises in one growing season (Figs. 56, 57); common stalk 3–15 cm long; tropophyll 2·5–5·5 × 1·5–3 cm, ovate or ovate-oblong in shape, cordate at base, obtuse or acutish at apex, fleshy in texture, margin entire; venation with elongated primary areoles in the midvein area and with irregularly shaped closely-woven small meshes with free vein-endings in the marginal area (Fig. 82). Fertile stalk 1·5–9 cm long, usually attached almost near the middle, strobilus 2–3·5 cm long; spores trilete with circular *amb.* 35–40 μ in diameter (according to Mahabale 1962, 40–50 μ whereas according to Nishida 1959, 35 μ in diameter) and with coarsely reticulate exine (Figs. 105, 106).

Fertile: May to October.

Distribution in India: UTTAR PRADESH (North-West Himalayas)—Janusar: Kothian, *Gamble* 25510 (CAL); Mussoorie, *Mackinnon s.n.* (CAL); Park Jauk, *Mackinnon s.n.* (CAL). Rare.

Earlier records: Widely distributed in temperate zones on the whole northern hemisphere (cf. Nishida 1959).

Certain similarities in features between *O. vulgatum* and *O. reticulatum* have led many botanists to confuse one with the other. While Beddome (1892 in suppl. Ferns Brit. India, p. 109) stated, 'I believe all the Himalayan specimens are referrable to *reticulatum*; I can see no difference in venation', Blatter and d'Almeida (1922, p. 199) reduced *O. reticulatum* into *O. vulgatum*, 'as they are merely forms of the same species being connected by a number of transitional stages'. Distinct identity of *vulgatum* and *reticulatum* from India is, however, advocated by Chakravarty (1951) and Mahabale (1962), the former species characterized by ovate, fleshy sterile blade with a midvein, running right up to the apex and the latter species with cordate, membranous blade with midveins running half-way to apex. Mahabale (1962) also provides an additional character to distinguish the two, viz. the epidermal cells are broad and have corrugated walls in *O. reticulatum* but an elongated with slightly wavy walls in *O. vulgatum*. Nishida (1959, p. 329), however, criticizes these criteria as of no diagnostic value and distinguishes *O. vulgatum* from *O. reticulatum* on the basis of their spore coats. Our observations in Indian biotypes confirm these observations of Nishida (1959): spores of *O. vulgatum* have coarsely reticulated exine with papillate outline in contrast to finely reticulate exine with seemingly almost smooth or minutely papillate outline in *O. reticulatum*.

The spores collected from a few specimens cited by Chakravarty (1951, pp. 3-4) under *O. vulgatum*, viz. ASSAM—Rengging, *Burkill* (CAL). SIKKIM—

Goak, *Anderson* 1409 (CAL). MADRAS—Annamalai hills, *Beddome* 1858 (CAL). MALAY PENINSULA—Perak, *Scortechnini s.n.* (CAL), possess the fine reticulated exine and, therefore, represent *O. reticulatum.*

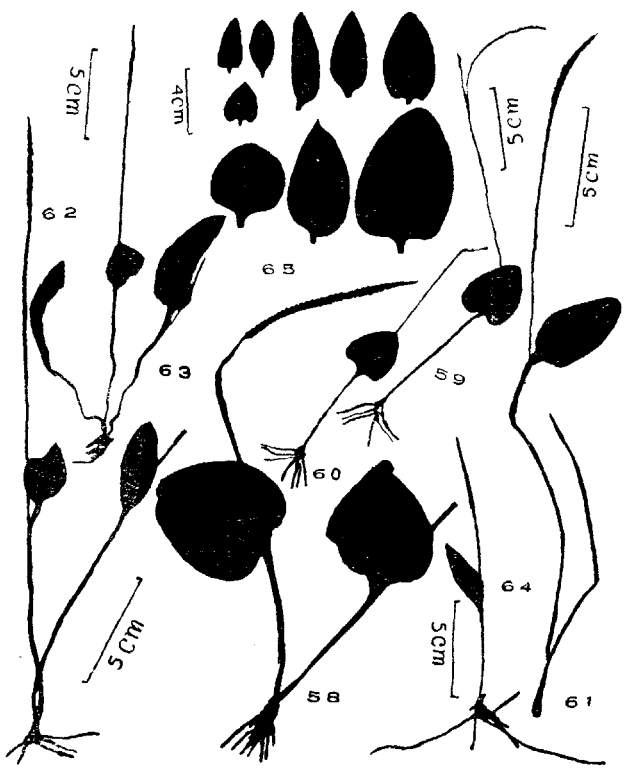
O. reticulatum Linn., *Sp. Pl.*, **2**, 1063 (1753); Clausen, *Mem. Torrey bot. Club*, **19** (2), 130 (1938); Bedd., Handb. Ferns Brit. India, 465, t. 291 (1883), and in suppl., 109 (1892); and Ferns South India, 23, t. 70 (1863); Chakravarty, *Bull. bot. Soc. Bengal*, **5** (1), 4 (1951); Mahabale, *Bull. bot. Surv. India*, **4**, 71 (1962); Wieffering, *Blumea*, **12**, 327 (1964).

forma: **reticulatum.**

Synonyms: *Ophioglossum peruvianum* Presl, *Suppl. Tent. Pterid*, p. 52 (1845).

O. petiolatum sensu Wieffering, *Blumea*, **12**, 327 (1964).

O. cordifolium Roxb. (*Hort. Bengal*, 75 (1814) *nomen*, *Wall. Cat.*, 47 (1828) *nomen*) ex Griff., *Calc. J. Nat. Hist.*, **4**, 475 (1844).



FIGS. 58–65. 58–60, *O. reticulatum* f. *reticulatum*, variation in biotypes; 61–64, *O. reticulatum*, intermediate forms; 65, *O. reticulatum*, variable shapes of the tropophyll.

Growing in forest floor amidst grasses, mosses, etc., or on moist alluvial sandy soil, with or without humus cover between 100 and 1600 m altitude. Plants 7–32 cm high; rhizome cylindrical to subglobose, sometimes stoloniferous, bearing one to several fronds simultaneously (Figs. 58–60); common

stalk 2–15 cm long; tropophyll 1–7·5×0·5–2·15 cm, ovate, ovate-lanceolate, reniform, deltoid, orbicular, rarely obovate or trullate in shape (Fig. 65), acute, acuminate or obtuse but often apiculate at apex, attenuate, cuneate, obtuse, truncate but usually cordate at base, subcoriaceous to sometimes thin in texture; venation lax with hardly any free vein-endings to rather dense and with many free-ending veinlets, without or with a few areoles (Fig. 83); fertile stalk 2–17 cm long; strobilus 1–6 cm long; spores trilete (sometimes triradiate mark forked at the ends), with circular *amb*, triangular in polar view, 35–50 μ in diameter (according to Mahabale 1962, 40–42 μ and according to Clausen 1938, 30–40 μ) and with finely reticulate exine (Figs. 110, 111).

Fertile throughout the year.

O. reticulatum seems to be a highly polymorphic species, so that a number of intermediate forms (*see* Figs. 61–63, 107–109) have been recognized from time to time as distinct species/varieties/forma. Following Wieffering (1964), we have recognized the occurrence of three forms in Indian flora and agree with his remark: 'I am aware that the forms recognized in this paper could be further subdivided, I have for practical reasons refrained from doing so, as even they themselves are connected by many intermediates.'

Distribution in India: Only a few of the specimens which integrate to *O. vulgatum* or *O. petiolatum* in possessing polymorphic features with regard to rhizomes, shape, texture and venation of the sterile blade, but which on spore morphology have been identified to *O. reticulatum* are cited below:

NEFA—Lohit district: Badasu to Sonego Dam (ASSAM). ASSAM—Haflong; Gauhati; Khasi and Jaintia hills; Cherrapunji. SIKKIM—Goak, *Anderson* 1409 (CAL). EAST HIMALAYAS—Takoor, *s.l. s.n.* (CAL). BIHAR—Parasnath hill, *s.l. s.n.* (CAL); Hazaribagh, *Clarke* 33823 (CAL); *Anderson s.n.* (CAL). BENGAL—Tipperah hill; Agartala, *Debbarmann's collector* 768; Lower Bengal, *Davies s.n.* (CAL). MADRAS—Annamalai, *Beddome* 404 (CAL). Abundant.

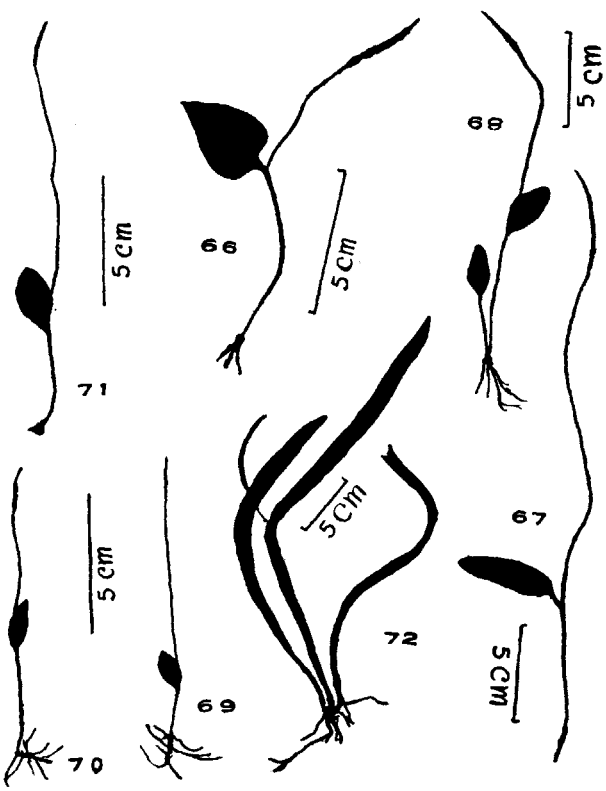
The few sheets cited below have the plants with tropophyll clearly cordate at base: ASSAM—Takureswari or Monkey hill; Dhubri-Gauhati Grand Trunk Road, *Marten s.n.* (CAL); without specific locality *Jenkins s.n.* (CAL). UTTAR PRADESH—Bahraich: Abdullagunj, *Panigrahi* 6365 (BSA); Saharapur division, *Pandey* 3488 (BSA). MADHYA PRADESH—Hoshangabad: Barethaghat, *Panigrahi* 4280 (BSA). MADRAS—Coimbatore: Doddasampagai, *Fischer* 191 (CAL); Annamalai hills: Mount Stuart, *Fischer* 3762 (CAL). KERALA—Travancore: Taragachery, *Lauson* 138 (CAL); North Canara, *Talbot* 1660 (CAL).

Earlier records: Pantropic (cf. Wieffering 1964)

**Key to the forms according to Wieffering (1964)*

A. Tropophyll in dried material thin, venation rather lax.
B. Tropophyll ovate, reniform or orbicular, apex acute, obtuse, often apiculate, base cordate, truncate, obtuse or rarely attenuate, mostly rather many free-ending veinlets ..... f. *reticulatum*
B. Tropophyll ovate, lanceolate or trullate, apex never obtuse, acute, often acuminate, never apiculate, base almost slightly cordate, at most a few free-ending veinlets ..... f. *dilatatum*
A. Tropophyll in dried material rather coriaceous, venation rather dense ..... f. *complicatum*

f. dilatatum (Miq.) Wieff., *Blumea*, **12**, 329, f. IC (1964).
Basinym: *O. moluccanum* f. *dilatatum* Miq., *Ann. Mus. Bot. Lugd. Bat.*, **4**, 92 (1868).



FIGS. 66–72. 66, *O. reticulatum* f. *dilatatum*; 67-68, *O. reticulatum* f. *complicatum*, variation in biotypes; 69–71, *O. petiolatum*, variation in biotypes; 72, *O. pendulum* f. *pendulum*.

* As in the case of *Botrychium lunaria* (Linn.) Sw. var. *onondaganse* (Underwood) House, the question of recognition of three forma in *Ophioglossum reticulatum* Linn., based largely on the variation in the ontogeny of the leaf, may be treated by some as a mere matter of opinion. We have followed Wieffering (1964), as we have had no difficulty in distinguishing our Indian specimens into three distinct groups.

Synonyms: *O. moluccanum* Schlechtend, *Adumbr Fil. Prom. Bonae Spei.*, 9 (1825), *pro specimina, excl. type.*
O. vulgatum var. *moluccanum* Luerssen, *J. Mus. Godeffr.*, **3**, t. 13, f. 78 (1875), *excl. type.*

Plant *ca.* 13 cm high (Fig. 66); rhizome subglobose; common stalk *ca.* 6 cm long; tropophyll 3·5×2·1 cm, trullate in shape, slightly cordate at base, acute at apex, thin in texture; venation lax with a few big areoles and rather a few free-ending veinlets (Fig. 84); fertile stalk *ca.* 4 cm long; strobilus *ca.* 2 cm long; spores not observed.

Distribution in India: UTTAR PRADESH—Mussoorie (the part above 1800 m), *Mackinnon s.n.* collected in 1885 (CAL).

Earlier records: Wieffering (1964) examined the specimens from Sumatra, Malay Peninsula, Java, Lesser Sunda Island, Borneo, Philippines and Fiji Islands.

New record for India.

f. **complicatum** (Miq.) Wieff., *Blumea*, **12**, 330, f. 1*a* (1964).
Basinym: *O. moluccanum* f. *complicatum* Miq., *Ann. Mus. Bot. Lugd. Bat.*, **4**, 290 (1868).
Synonym: *O. vulgatum* var. *australasiaticum* Luerssen, *J. Mus. Godeffr*, **3**, 246, t. 13, f. 66–72, t. 15, f. 107-108, t. 16, f. 125–127 (1875).

Plants 9–30 cm high (Figs. 67, 68); rhizome cylindrical or subglobose, common stalk 3·5–7·5 cm long; tropophyll attached at the lower half of the frond 2·5–5·5×0·8–1·5 cm, ovate or ovate-lanceolate or lanceolate in shape, acute, obtuse or apiculate at apex; venation with many small areoles and specially in marginal parts with many free-ending veinlets (Fig. 85); fertile stalk 3·3–16·5 cm long; strobilus 1·5–5·5 cm long, basal sporangia often not reaching maturity; spores trilete, sometimes triradiate mark forked at the ends with circular *amb.*, 35–38 μ in diameter and with reticulate exine (Figs. 112, 113).

Distribution in India: ASSAM—Janakmukh, *Burkill* 37135 (CAL); Junction of Sireng with Dihong, *Burkill* 37399 (CAL); Haflong, *Craib* 513 (CAL); Rungging, *Burkill* 36611 (CAL). SIKKIM—Sureil, *Prain s.n.* (CAL).

Earlier records: Wieffering (1964) examined the specimens from Ceylon, India (Assam), Thailand, Japan, Bonin Island, Sumatra, Malay Peninsula, Java, Lesser Sunda Island, Borneo, Philippines, Malaccas, New Guinea and New Caledonia.

O. petiolatum Hooker, *Exotic Flora*, **1**, t. 56 (1823); Clausen, *Mem. Torrey bot. Club*, **19** (2), 134 (1938); Nishida, *Bull. Nat. Sci. Mus.*, **4** (3), 330 (1959).
Synonyms: *O. cordifolium* Roxb. [*Hort. Bengal*, 75 (1814) *nomen* Wall., List, No. 47 (1828) *nomen*] ex Griff., *Calc. J. Nat. Hist.*, **4**, 475 (1844).
O. pedunculosum sensu Prantl (non Desv.) in *Jahrb. K. bot. Gart Berlin*, **3**, 328 (1884); Mahabale, *Bull. bot. Surv. India*, **4**, 71 (1962).
O. pedunculatum Nakai in *Bot. Mag. Tokyo*, **39**, 193 (1925). This name is an error for *O. pedunculosum.*

O. reticulatum (non Linn.) *sensu* Hosokawa, *J. Jap. Bot.*, **13**, 608 (1937); *sensu* H. Ito, *J. Jap. Bot.*, **18**, 200 (1942); *sensu* Wief., *Blumea*, **12**, 327 (1964) (in part).
O. vulgatum (non Linn.) *sensu* Hosokawa, occasional paper Bishop Museum, **13**, 608 (1937).
O. nipponicum (non Miyabe et Kudo) *sensu* Makino, *Illust. flora Jap.*, 967, f. 2900 (1940).

Growing on moist sandy alluvial soil amidst mosses, etc., in sal forest, up to 567 m altitude. Plants 10–13 cm high; rhizome short, slender, erect (according to Mahabale 1962, tuberous at top), bearing many long fleshy roots which become brittle when dry, and usually one or sometimes more fronds in a single growing season (Figs. 69–71); common stalk 1·5–3·5 cm long; tropophyll 1·5–2 × 0·6–1 cm; lanceolate or ovate, sometimes even elliptical in shape, acute or shortly mucronate at apex, truncate or broadly cuneate at base, venation lax, veins visible in dry specimens and few, areoles large with free-ending veinlets (Fig. 86); fertile stalk 5–7·5 cm long, strobilus 1·5–1·8 cm long; spores trilete with circular *amb.*, 30–40 μ in diameter (30–36 μ according to Mahabale 1962, whereas 35–40 μ in diameter according to Nishida 1959) and with minutely reticulate exine (Fig. 114).

Fertile: July.

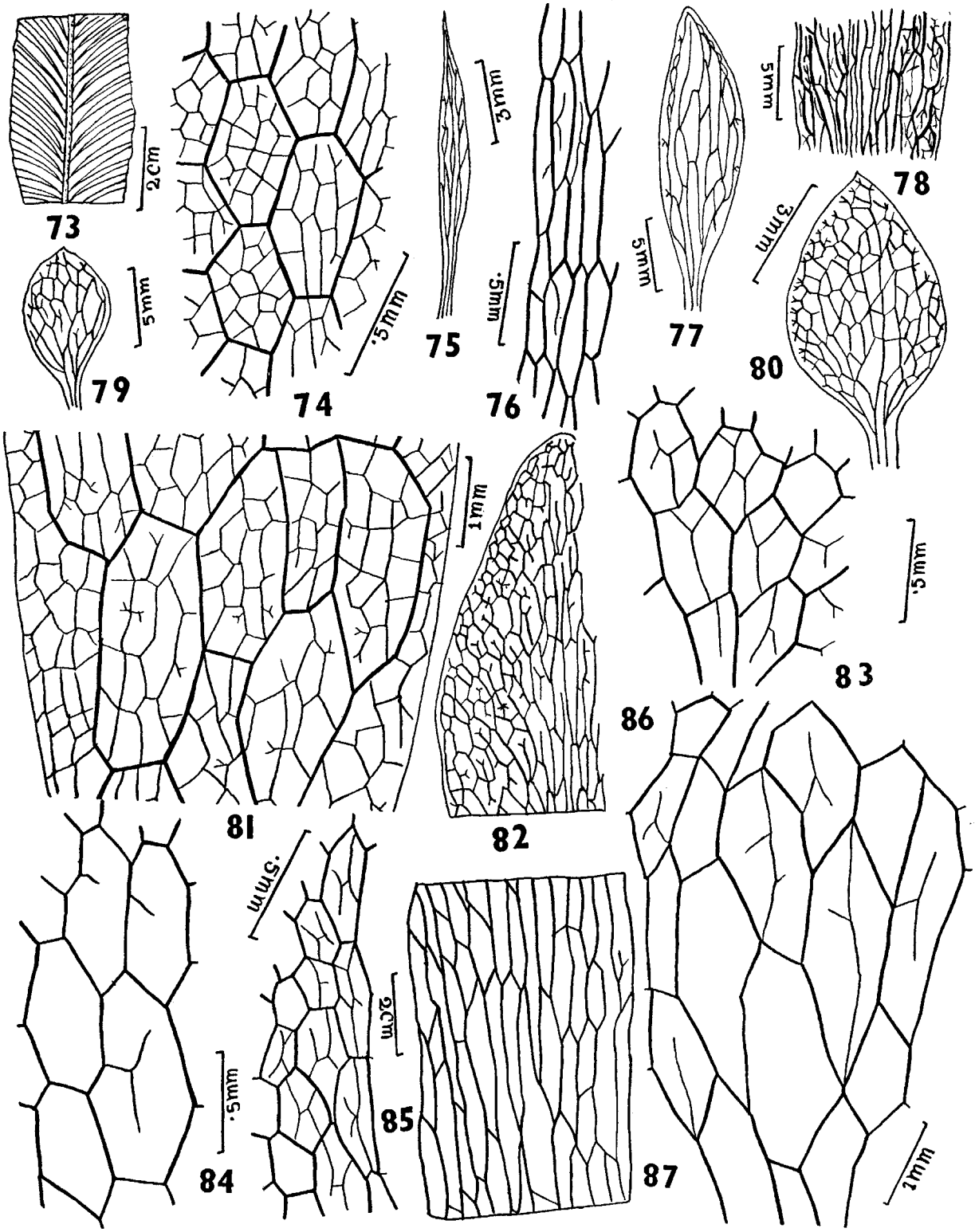
Distribution in India: UTTAR PRADESH—Bahraich: Abdullagunj, *Panigrahi* 6365B (BSA). MADHYA PRADESH—Tamiya, *Panigrahi* 4426 (BSA); Bastar: Keskal-Parewanala stream, *Subramanyam* 8959 (BSMH). This last specimen was described under *O. polyphyllum* A. Br. apud Seubert by Balkrishnan *et al.* (1960), but it possesses neither the persistent conspicuous brown sheath nor the fertile spike arises from near the middle of the sterile blade, as is characteristic of *O. polyphyllum* A. Br. apud Seubert.

Earlier records: Central Florida, Trinidad and elsewhere in the West Indies, Mexico, northern South America, tropical Africa and Madagascar, India, Ceylon, Siam, China, Japan, Philippines, Borneo, Sumatra, Java, New Guinea, New Caledonia, New Zealand, Fiji and Samoa (cf. Clausen 1938).

Subgenus **Ophioderma** (Blume) Clausen, *Mem. Torrey bot. Club*, **19** (2), 114 (1938); Nishida, *J. Jap. Bot.*, **27**, 167 (1952); Wief., *Blumea*, **12**, 321 (1964).
Ophioglossum sect. *Ophioderma* Blume, *Enum. Pl. Jav. fasc.*, **2**, 259 (1928).
Ophioderma (Blume) Endlicher, *Genera Plantarum secundum ordines naturalis disposita*, p. 66 (1836); Nishida, *Bull. Nat. Sc. Mus. Tokyo*, **4**, 334 (1959).

Three species are included under *Ophioderma* in the world flora, viz. *Ophioglossum pendulum*, *O. intermedium* and *O. simplex*. They are characterized by (i) the median origin of the single fertile segment from considerably above the base of the sterile blade, (ii) horizontal tuberous rhizome and (iii) usually a long and narrow blade, which is absent in *O. simplex*. Of these three species, *O. pendulum* only is reported from India and is an epiphyte.

Ophioglossum pendulum Linn., *Sp. Pl.*, 2nd ed., **2**, 1518 (1763); Clausen, *Mem. Torrey bot. Club*, **19** (2), 116 (1938); Bedd., Handb. Ferns Brit. India, 465, f. 291 (1883), and in suppl.,


2Cm
73
5mm
79
74
.5mm
3mm
75
.5mm
76
5mm
77
5mm
78
3mm
80
1mm
81
1mm
82
.5mm
83
86
.5mm
84
.5mm
2Cm
85
87
1mm

FIGS. 73–87.

109 (1892); and Ferns South India, 88, t. 269 (1863); Holttum, *Rev. Fl. Malaya*, **2**, 40 (1954).

f. pendulum.

Synonym: *Ophioglossum pendulum* Linn. f. *angustatum* v.A. v.R., *Mal. Ferns Suppl.*, **1**, 454 (1917).

Ophioderma pendulum (Linn.) Presl, *Suppl. Tent. Pterid*, p. 56 (1845).

O. pendulum (Linn.) Presl f. *ramosum* Nakai, *Bot. Mag. Tokyo*, **40**, 372 (1926).

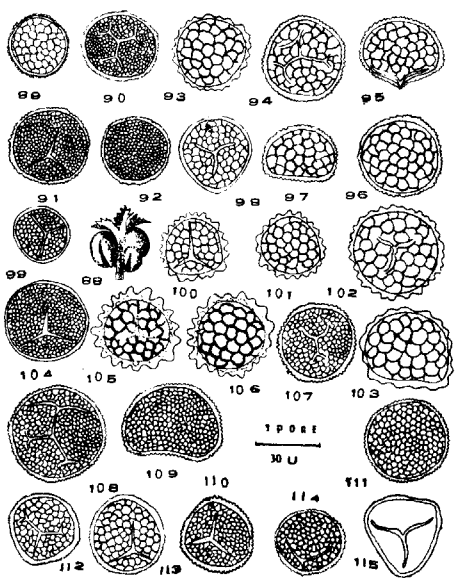
Plants epiphytic or terrestrial; rhizome small, bearing many fleshy roots (which become brittle when dry), and 1–6 fronds simultaneously (Fig. 72); tropophyll 30–200 (—400)×0·5–7 cm (—9 cm), ribbon-shaped (non-falcate), pendulous, flaccid, narrowed gradually towards the base, and comparatively abruptly to an acutish or obtuse apex, which is sometimes furcate, margin entire, texture thin in dried specimens. Veins, forming a series of long narrow areoles, are clearly visible in dried specimens (Fig. 87); fertile segment single (rarely two, collaterally), stalk 2–7 cm long, always shorter than the fruiting spike which is 6–25 (2–45) cm×5–8 mm; spores trilete, with triangular, rarely circular *amb.*, 38–50 μ in diameter and with smooth exine (Fig. 115).

Distribution in India: Although Beddome (1883, p. 467) doubted the occurrence of *O. pendulum* in Assam, he referred to a specimen (*Mann s.n.*) collected from Makum forest of Lakhimpur, Assam, in his supplement (1892, p. 109). But the specimen of Mann referred to by Beddome (1883) is not available in the herbarium (CAL). Mahabale (1962, p. 76) also refers to the Indian distribution of this species when he says that 'the specimen belonging to the subgenus *Ophioderma* are also epiphytes, growing in the forests of Lakhimpur in Assam'. But Chakravarty (1951) considers the Indian distribution of the species as a matter of dispute when he says that 'the collections from Ceylon and Burma have been made but the one gathered from Assam is doubtful, because a note on the Assam sheet indicates that it might be mixed up with the Malaccan plants. It shows a Malayan type of distribution'. We have also examined the sheet from Assam (?) referred to by Chakravarty (1951) and are in agreement with him. Clausen (1938) while discussing the distribution of the species refers to d'Almeida's report of its occurrence in different provinces of India, but states that he (Clausen) has not seen any specimen from India. The senior author (G. P.) during his collection tour over six years (1956–1962) in NEFA and Assam could not spot the species even once, although he had collected about 2,500 field nos. of ferns from the area, during the period. Thus, it may be seen that the report of the occurrence of *O. pendulum* in India is extremely doubtful.

FIGS. 73–87. Venation pattern. 73, *Helminthostachys zeylanica*; 74, *Ophioglossum costatum*; 75, *O. gramineum* var. *gramineum*; 76, *O. gramineum* var. *majus*; 77, *O. lusitanicum*; 78, *O. thermale* var. *nipponicum* (after Mahabale 1962); 79, *O. nudicaule*; 80, *O. nudicaule* var. *macrorrhizum*; 81, *O. polyphyllum*; 82, *O. vulgatum* (after Bower 1926); 83, *O. reticulatum* f. *reticulatum*; 84, *O. reticulatum* f. *dilatatum*; 85, *O. reticulatum* f. *complicatum*; 86, *O. petiolatum*; 87, *O. pendulum* f. *pendulum*.

The specimens examined and deposited in the Central National Herbarium (CAL) are from MALAY PENINSULA—Perak, *Wray* 1133; Jafa, *Wray* 171; *Kunstler s.n.* (collected in 1880). BURMA—Moulmein, *Falconer* 162. CEYLON—*Collector's name illegible*, 1409.

Earlier records: Old world tropics in Madagascar, the Mascarenes, Ceylon, Malay Peninsula, Formosa, Philippines, Sumatra, Java, Borneo, the



FIGS. 88–115. 88, *Helminthostachys zeylanica*, a portion of the fruiting spike showing a group of sporangia with irregular terminals of the sporangiophore at the apex (after Bower 1926); 89–115, spores. 89, *Helminthostachys zeylanica*, distal part; 90–92, *O. costatum*; 90–91; proximal part; 92, distal part; 93, *O. gramineum* var. *gramineum*, distal part; 94–97, *O. gramineum* var. *majus*; 94-95, proximal part; 96-97, distal part; 98, *O. lusitanicum*, proximal part; 99, *O. thermale* var. *nipponicum* (after Nishida 1959); 100-101; *O. nudicaule*; 100, proximal part; 101, distal part; 102-103, *O. nudicaule* var. *macrorrhizum*; 102, proximal part; 103, distal part; 104, *O. polyphyllum*, proximal part; 105-106, *O. vulgatum*; 105, proximal part; 106, distal part; 107–109, *O. reticulatum*, spores from the intermediate forms; 110-111, *O. reticulatum* f. *reticulatum*; 110, proximal part; 111, distal part; 112-113, *O. reticulatum* f. *complicatum*, proximal part; 114, *O. petiolatum*, proximal part; 115, *O. pendulum* f. *pendulum* proximal part.

Malaccas, New Guinea, Guam, Caroline Islands, Australia, New Hebrides, Fiji, Samoa, Tahiti and Hawaiian Islands (cf. Clausen 1938).

Ecology: The relation between *Ophioglossum* and *Platycerium* and *Asplenium* plants is interesting because forma *pendulum* often grows on the humus nests collected by large *Platycerium* and *Asplenium*. When carrying large Ophioglossums, these plants often seem to be slowly dying, not as a result of parasitism, but because *Ophioglossum* competes too drastically for food and moisture, etc. (cf. Holttum 1954; Wieffering 1964).

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