TAXONOMIC REVISION OF THE POLYPODIACEOUS GENERA OF INDIA—1: MICROSORIUM LINK

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ABSTRACT

Microsorium Link is generically distinct from Phymatodes Presl. Both the genera have hardly anything in common except for the fact that they have a common place under family Polypodiaceae. Microsorium species not only differ from Phymatodes in the position and distribution of sori (numerous small, never more than 2 mm wide, scattered in irregular rows) but also in possessing generally thin and membranaceous texture which is seldom the case in the other genus. The genus is represented in India by nine species. All of these occur in the Eastern Himalayas and in the Western Himalayas only one species, M. membranaceum is met with, while from South India only three species, M. membranaceum, M. punctatum and M. pteropus (simple-leaved form) are known. Except for M. punctatum, all the other are rather thinner in texture. Most of the taxonomic characters used for differentiating Kaulinia Nayar (typified by K. pteropus (Bl.) Nayar) from Microsorium are not constant. These are frequently shared by well recognised species of Microsorium such as M. superfluale, M. phymatodes and several others. The only dependable character in which Kaulinia differs from Microsorium is that of gametophyte and it will be attaching too much importance to a single character if Kaulinia is recognised as a genus.

INTRODUCTION

Microsorium was proposed by Link in 1833 and was typified by M. irregularare Link which is now considered identical with M. punctatum (Linn.) Copel. This genus remained unrecognised by most of the early pteridologists and its members were largely placed either in Polypodium or Pleopeltis. It was only in 1929 that Copeland first revived it but he used it in a very wide sense and included Phymatodes, Lepisorus, Colysis, Arthomeris, Cryptsinos etc. within it. A few years later Ching (1933) restricted the genus Microsorium to include only species with scattered small sori and was followed by Christensen (1938) who attributed about 40 species to the genus, all known from Asia only. Holttum's (1946, 1949, 1954) concept of the genus was the same as that of Ching and Christensen. In Genera Filicum, Copeland (1947) excluded Lepisorus and Colysis but included in Microsorium all the species generally placed under Phymatodes. Recently Sledge (1960) and Nayar (1961) adopted Copeland's concept of merging Phymatodes with Microsorium. Therefore, at present considerable confusion exists about the generic limits of Microsorium. The Indian species of this genus have largely been described under Pleopeltis and Polypodium by early workers as Clarke (1880) and Beddome (1863, 1883, 1892). Nayar's (1961) account of Microsorium is quite exhaustive but it excludes some of the Indian species such as M. normale (Don) Ching and M. phyllomanes (Christ) Koidz. and also it lacks complete synonymy. Several species of Phymatodes Presl are also included under this genus. Therefore, the taxonomic revision of the Indian species of Microsorium was taken up. In the present account the genus Microsorium is dealt with in a restricted sense and has generally been taken to include only those species which have numerous, small (never more than 2 mm wide) scattered sori in irregular rows on both sides of midrib and simple 2-7 celled uniseriate hair-like paraphyses present intermixed with sporangia. It excludes all species of Phymatodes, Lepisorus, Cryptsinos and Colysis.

In case of Polypodium phymatodes Linn. (=Polypodium scolopendria Burm.) often referred to genus Microsorium as M. scolopendria (Burm.) Copel., the sori are present in two rarely 3 irregular rows on either side of the midrib but are quite unlike true Microsorium. Not very unoften one can find the sori in one irregular row, quite typical of genus Phymatodes. Also, it shows the typical character of sori sunken in distinct cavities raised on upper surface and rhizome with thickened frondiferous leaf-bases. These two characters are not found in Microsorium. This fern shows somewhat intermediate position between Phymatodes and Microsorium, the only character of latter genus is the presence of scattered sori. In the opinion of the writers, therefore, Polypodium scolopendria really belongs to
*Phymatodes* and the superficial resemblance of scattered sori cannot be over emphasised so as to include it in *Microsorium*.

**MICROSORIUM**


Rhizome usually creeping or rarely climbing with closely or distantly placed fronds, covered with peltate*, usually small, dull-brown scales which are distinctly clathrate at least in the middle part; stipes closely situated or distant and in two rows; fronds simple and entire or in a few species pinna-tid or rarely lobed; usually of thin texture and herbaceous; both surfaces glabrous or scaly (scales may be deciduous); main lateral vein may or may not be well defined, veins forming many areolae with included free veinlets running in all directions, and sometime ending in hydatodes, generally visible; sori small and irregularly scattered, usually round, or spreading a little on veins, sometime in rather two regular rows in between adjacent main veins; sporangia with annulus of usually 14 cells and mixed with very inconspicuous, 2-7 celled, uniseriate paraphyses, in *M. normale* and *M. phyllo-

The genus is represented in India by nine species, all of which occur in the Eastern Himalayas and from Darjeeling and Sikkim region as many as 8 species are recorded by Mehra (1964). In the Western Himalayas only one species, *M. membranaceum* is met with, which is from South India only three species, namely, *M. membranaceum*, *M. punctatum* and *M. pteropus* (simple-leaved form) are known. Except for *M. punctatum*, the others are rather thinner in texture and are met with in moist shady places, often on rocks or trees near the streams, well inside the forest. *M. punctatum* is the only species which grows in open places and possesses leathery fronds, with veins never raised on the surface. The presence of umbrella-shaped paraphyses in *M. normale* and in *M. phyllo-

rows are two important characters for retaining them in *Microsorium*. It may be pointed out that species of *Lepisorus* have always got only one row of sori on either side of midrib. The similarities of some species of *Microsorium* and *Lepisorus* in possessing umbrella-shaped sporangial paraphyses may indicate that *Microsorium* might have evolved from *Lepisorus* like ancestors. *Microsorium* in turn may have given rise to *Colysis* which has often pinnatifid or pinnate, sub- or completely di-morphic fronds and Gymnogrammeoid sori. The pinnatifid or lobed species of *Microsorium* may be the result of development from simple-leaved species. Detailed information about anatomy and morphology of gametophytes of some of the Indian species of the genus is available from Nayar (1961, 1963).

**KEY TO THE SPECIES**

A. Fronds simple:
  B. Sori in young condition covered with umbrella-shaped paraphyses:
    C. Rhizome scales with tuft of reddish brown bristles at the point of attachment; lamina linear-lanceolate ... *
    M. normale
    C. Rhizome scales without bristles; lamina ovate, ovate-oblong ... *
    M. phyllo-

B. Sori not covered with umbrella-

C. Rhizome scendent, dorsiventrally flattened; scales ovate-lanceolate, with uneven margin:
  D. Stipes long (7-16 cm) lamina subcoriaceous in texture ...
  D. Stipes short (3-5 cm); lamina paperaceous in texture ...
  M. superficiale
  M. hymenodes

C. Rhizome never scendent, dorsiventrally not flattened:
  D. Texture of lamina membranaceous and veins distinct:
    E. Lamina large (about 15 cm long, 2 cm wide), under surface of midrib and main vein densely scaly ...
    M. pteropus
    E. Lamina small (about 15 cm long, 2 cm wide), immersed on both surfaces ...
    M. membranaceum

D. Texture of lamina coriaceous, subcoriaceous or chartaceous:
  E. Main veins distinct, raised on under surface, midrib sparsely scaly on lower surface ...
  M. cippeli
  E. Main veins indistinct, immersed, and never raised on lower surface, (no vein distinct in living condition) both surfaces of lamina naked ...
  M. punctatum

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*Nayar (1961)* described the scales to be basally attached in several species which really is not the case.
A. Fronds deeply lobed.
B. Usually only one pair of lateral lobes (rarely two pairs) and the terminal one: spine and lower surface of midrib of the lobes densely scaly; rhizome long creeping. M. hancockii
B. Usually 3-4 or more pairs of lateral lobes in addition to panatifid apex, spire and midrib not scaly, lobes narrowly at the base, rhizome short creeping. M. hancockii

DESCRIPTION OF THE SPECIES


Rhizome somewhat thick and woody, usually 4-5 mm in diameter, widely creeping, or scendent, may be flattened, densely scaly with fronds 1-3 cm apart; scales small, fusco-brown, clathrate with a prominent tuft of stiff reddish-brown, 2-3 mm long bristles on the upper surface at the point of attachment of the peltate base, generally ovate or sometimes lancolate and hair pointed, about 1x1 mm; stipes short, 1-4 cm long; fronds linear-lancolate, 15-60 cm long, 2-4 cm wide, narrowed gradually at the both ends, apex acuminate, edges entire or somewhat wavy in some species; both sides glabrous, except for a few scattered, adpressed scales on the stipe and lower margin of the rachises; texture thin, membranaceous; colour variable (dark-green to light green and even brown on drying); veins almost indistinct, no main lateral vein, free veinlets ending on upper surface in prominent hydatodes, large vein forming irregular aracels; sori rather large, up to 2 mm wide at maturity, round, golden brown, each at the point of fusion of veinlets, arranged either in one regular or irregular row or generally in 2-4 irregular rows, often confluent, when young covered with umbrella-shaped, clathrate paraphyses, usual simple paraphyses long and 4-7 celled; annulus cells of the sporangium 12-15; spores pale yellow, bilateral, plano-convex to concavo-convex, exine very minutely granulated, 38-67 x 32-42 μ (Figs. 1, 7-12).

It is frequently met within the Eastern Himalayas (Nepal to Bhutan through Darjeeling and Sikkim and extending to Assam, Khasia-Jaintia Hills and Manipur) between 900-2,400 m altitude. The plants usually clime the lower portion of the small trees. Distribution: Eastern Himalayas, Burma, South China, Southwards to Sumatra and Malaya.

The chief characteristic features of this fern are (i) the presence of stiff reddish-brown bristles on the back of scales of the rhizome, (ii) young sori being covered with peltate clathrate scales of the type seen in Lepisorus, (iii) free veinlets ending in thickened prominent hydatodes on the upper surface of frond. Though resembling Lepisorus in having sometimes sori apparently in two rows, one on either side of the midrib and umbrella-shaped sporangial paraphyses yet generically it is different because in vast majority of the specimens the sori are irregularly scattered and what is more important is that it has a distinct scendent habit, unlike any known species of Lepisorus. Some of the Assam and Sikkim specimens present in the Central National Herbarium, Calcutta have very close resemblance with M. fortuni (Moore) Ching forma typica of China in having the same outline of frond and large, orange yellow, uniseriate, irregular or regular and far apart sori. However, on careful observation this fern can conveniently be separated because M. fortuni lacks in having large tuft of brown bristles on the back of scales. About all the sori in M. normale are covered with peltate paraphyses whereas-in M. fortuni these are naked from the very beginning.

Specimens examined: Isotypes: Polypodium longifrons Wall. ex. Hook. & Grev., IC. Fil. 65. 1892. From Nepal, Wall. 274 in 1822 (US 1729973, 1277931). Eastern Himalayas: Darjeeling: Lebong forest (1650 m), Malhotra, Aug-Sept. 1953-54 (PAN 1111, 1114, 1116); Malhotra July 1951 (PAN 1528, 3052, 3632); Bir 56, Aug. 1956 (PAN

* Following abbreviations as proposed by Lanjouw and Staffel (1961) in the Index Herbariorum are used:

CAL Central National Herbarium, Botanical Survey of India, Sibpur, Howrah.
US United States National Herbarium, Smithsonian Institution, Washington D.C.
BLAT Blatter Herbarium, St. Xavier's College, Bombay.
MH Botanical Survey of India, Southern Circle, Coimbatore.
PAN Panjab University Herbarium, Chandigarh (not included in the Index Herbariorum).
several specimens without collector and locality. Assam (incl. Khasia-Jaintia Hills and Manipur): Cherrapunji, Oct. 1888 (CAL); Summit of Bapa (1827 m), Burkull 3657, Jan. 1912 (CAL); Burkull, Jan. 1912 (CAL); (1320 m), Jan. 1886 (US 418923);

Griffith (US 9936); Hooker & Thomson, June 1850 (CAL); Prain 114, March 1892 (CAL); Gallaty (CAL); Hooker, Oct. 1867 (CAL); Gammie-

Rhzomé widely creeping, subhypogeous, thin, upto 5 mm in diameter, densely scaly; scales dark-brown, clathrate, ovate, long-acuminate, 5-7 mm long and 4-1 mm wide at base, with small marginal teeth; fronds far apart, erect; stipes upto 20 cm long, brown-blackish, rather densely fribillose scaly, particularly at the lower part; lamina ovate-oblong or ovate acuminate, upto 30 cm long, 6 cm wide at base which is subtruncate or cuneate or decurrent on the stipe below for 2-3 cm, margin entire; fribillose scales present along the midrib on the undersurface which are linear-lanceolate with large protruding marginal teeth; texture firm, chartaceous; upper surface glabrous, underneath more or less scaly; main vein distinct nearly to the margin, patent, nearly 1 cm apart, oblique, prominently branched unlike other species of *Microsorium*, intervening veinslets partly distinct, copiously anastomosing with divericating included elevate veinslets, sori large, globose, round or elongated, irregularly multi-seriate on each side of lateral vein or often sub uni-seriate especially towards apex. clothed when young with fuscous, clathrate, peltate scales as in *Lepisorus*, in addition usual, 2-celled sporangial paraphyses with terminal cell thickened are met with; annulus cells 14-17; spores light yellow, bilateral with exine smooth. slightly thickened, oil globule present, 32.45×22.35 m (Figs. 2, 13, 17).

It is a very rare fern of the Eastern Himalayas and is met within Sikkim State, Assam and Khasia Hills between 600-1,500 m elevation. Only the simple fronds (*f. typica*) with entire margin are known from India whereas deeply lobed or lacinate-lobed forms are reported from China.

**Distribution**: North India, China, Japan and Formosa.

This fern has largely been known under genus *Neocheiropteris* Christ which is mainly characterised by the fact that the main lateral veins are branched almost as in *Dipteris*. Such branching of main-veins has not been seen in any other Indian species of *Microsorium*. With several species of *Microsorium*, this fern shares the general outline of the frond and sori irregularly scattered. Another feature of importance about this fern is that in addition to the 2-celled paraphyses like in other members of the genus, large peltate, umbrella-like paraphyses similar to those in *Lepisorus* are also met with and this probably led Ching (1940) to place this fern in *Neocheiropteris* but similar paraphyses are also found in *M. normale*. In the opinion of the writers *Neocheiropteris* is only distinguishable from *Microsorium* in having main lateral veins branched and on the bases of this character *Neocheiropteris* at the best, can be recognised as a subgenus under *Microsorium*.


Rhzomé not very thick, 2-5 mm in diameter, widely creeping, scandent, dorsiventrally flattened. densely palaceous at the apices but sparsely in the older region; scales ovate-lanceolate, apex acute (but not hair pointed), clathrate, margin crenate, brown, 34×1.5 mm; stipes 7 to 16 cm long, stramineous, scaly only at the base and naked upwards; fronds 2 cm or more apart, variable in size; lamina simple, lanceolate-linear, gradually narrowed at the both ends, apex acuminate, margin entire, 10-30 cm long and 2.5 cm broad, light to dark-green
Figs. 7-12: *Microsorum nornale* (Don) Ching


(Figs. 7, 13 x Half natural size; Figs. 8, 14a x 30; Fig. 9 x 6; Figs. 10, 15 x 200; Fig. 11 x 90; Fig. 12 x 380; Figs. 14b,c,d x 45)
in colour; texture subcoriaceous, opaque, upper surface glossy while lower minutely hairy; venation indistinct, no main lateral veins (but in some main veins are present and partly distinct), areolae numerous with free included veins, tips of free veins ending in hydathodes; sori large, round compital, at the junction of secondary and tertiary veins, brown to black, scattered over the entire surface of the lamina forming 5-8 irregular rows; sporangial paraphyses 4-7 celled, uniseriate, terminal cell often thickened; sporangia small with annulus of about 14 cells; spores light yellow, bilateral, plano-convex to concavo-convex, exine prominently granulated, granulation arranged in irregular reticulate fashion, 38.55 × 23.53 μ (Figs. 18-25).

It is a common climbing fern of Khasia, Jainria, Naga, Garo, Manipur and Mishmee Hills (throughout Assam) of Eastern Himalayas between 1,200-2,400 m altitude. It is also met within Sikkim State but very rare. The plants ascend the trunks of small trees and shrubs for several meters.

**Distribution:** North India (Eastern Himalayas), South China, Malaya, Siam, Java, Japan and Korea.

The most distinguishing features of this fern are the scandent habit, elongated stipes (never so much in any other species), sub-coriaceous texture and prominent large sori present in several irregular rows. This species is not conspecific with *M. hymenodes* as was earlier considered by Mehra & Bir (1954).

**Specimens examined:** Eastern Himalayas: Sikkim: Lachung valley (2,400 m), Gammie 1184, Sept. 1892 (CAL); Assam (incl. Khasia, Jaintia, Naga Hills and Manipur): (1,200-1,800 m); J. D. Hooker & T. Thompson (US 9941-42, 6941-42, 6940-44); Jowai (1200 m); Mann, April 1889 (US 329700); (1,500-1,800 m), Prain, Dec. 1886 (CAL); Shillong, Collett., April 1890 (CAL); Shillong-Jowai Road, Prain, March 1892 (CAL); Shillong, July 1892 (CAL); Shillong-Jowai Road, Prain, March 1892 (CAL); Shillong, July 1892 (CAL); Shillong-Jowai Road, Prain, March 1892 (CAL); Manipur (1,200 m), Watt, Jan. 1882 (CAL); Shillong, April 1890 (CAL); Shillong Hills (1935 m), Clarke, 37367, 38728, Feb. 1885 (CAL); Manipur (1,500 m), Watt 533, 6137, 6418, Jan.-April 1882 (CAL); Prain, Dec. 1886 (CAL); and several of the specimens without collector and locality (CAL).


Rhizome thin, about 2 mm in diameter, widely creeping, scandent, more or less compressed, sparsely scaly but more so near the apex; scales fusiform, brown, patent, ovate, lanceolate, apex acute or acuminate, clathrate, margin dentate, base lacerated 3.5 × 1.3 mm; fronds 1.5 cm for apart (very much variable in size) stipe short, 2.5 cm, sparsely scaly, stramineous; lamina 15-25 cm long, 14-15 cm wide, linear lanceolate, gradually attenuated to both ends (base somewhat decurrent on the stipe), apex acuminate, margin entire, more or less wavy, both surfaces glabrous, colour light brownish-green; texture papyraceous or thin herbaceous: veins distinct, no lateral main vein, primary and secondary veins anastomosing to form 2-3 areolae between midrib and margin, free included veins diverging and ending in hydathodes; sori large, round or rarely oblong, scattered all over the surface in many rows; sporangial paraphyses inconspicuous, small, 2-4 celled with terminal cell thickened; spores light yellow, bilaterally, exine thickened and with minute granulations, ca. 64 × 54 μ (Figs. 23-26).

It is very rare scandent fern collected from Bhutan by Griffith and Nepal by Wallich (cf. Clarke, 1880). Ching (1934) also records it from North India. The writers have not seen any North Indian specimen but have included it here on the authority of above noted works.

**Distribution:** North India, Burma, West China and Toukin.

This fern has the habit and habitat exactly of *M. superficiale* but differs in having thinner rhizomes with patent and more acute scales, shorter stipes (not more than 5 cm) and finally papyraceous texture.

**Specimen examined:** Yetagone, Falam, China Hills (Burma), (1800 m), Dickson 7754, May 1938 (US 1755764).

Figs. 16-17: Microsorium phyllanites (Christ) Koelz.

Figs. 18-22: Microsorium superficiale (Bl.) Ching

Figs. 23-26: Microsorium hymenodes (Kunze) Ching

(Figs. 18, 23 × Half natural size; Fig. 16 × 90; Fig. 20 × 6; Figs. 19, 24 × 30; Figs. 21, 25 × 200; Figs. 17, 22, 26 × 380)

Rhizome thick, stout, 7-10 mm across, subhypancaeous, densely scaly, widely creeping, branched, with tufts of wiry roots; scales broadly lanceolate, acuminate, sub-entire, fusco-brown, clathrate, 3-7 mm long and ½-1½ mm wide at base; stipe sub-camptose or papillose, 1-4 cm long, yellowish green, with the adaxial surface flat or rarely having a broad shallow median groove; fronds simple, broadly lanceolate to oblanceolate, 20-30 cm long, 3-10 (rarely 20) cm broad, apex acuminate, gradually attenuate at the base or rarely carinate, margin entire or somewhat wavy, texture thin, membranaceous-herbaceous, green on both sides; rachis sharply ridged on lower side, naked; venation very distinct on both sides, lateral main veins wide apart, in sub-opposite pairs, nearly horizontal or ascending, distinct near to the margin, connected by transverse secondary veins which form a series of primary areoles, further divided by irregular net work of tertiary veins into small areoles with copious free, forked, divaricated, included veins. Most of the free included veins end in hydathodes on upper surface; sori small to medium sized. Irregularly disposed or in two rows between lateral main veins, mostly complit, naked; sporangial paraphyses 2-4 celled, small, inconspicuous; spores yellowish brown, bilateral, planoconvex, slightly concavo-convex, thickened, ornamented with minute granulation, arranged irregularly, 47-67 x 29-48 μ (Figs. 3, 4, 27-31).

Extremely common throughout the Himalayas between 600-2,400 m from eastern Kashmir eastwards to Assam (N.E.F.A. and Khasia-Jaintia hills), Parasnath hills (900 m) and South India on Western Ghat from 600-1,500 m (Nilgiris and Palni hills). The plant grows well inside forest on moist rocks or epiphythically, generally at the bases of tree trunks. The South Indian specimens are much smaller and narrower than the North Indian plants.

**Distribution:** Ceylon, whole of India, Burma, Indochina, South Western China, Formosa to Philippines and Celebes.


Rhizome thin, 2-4 mm, fairly long, creeping, hypogeous, atrovius, bearing fronds 1 cm or more apart, densely scaly; scales fusco-brown, rather firm, ovate, acute, up to 4 mm long, 1 mm wide, narrowed, from peltate base to slender apex, appressed, with shortly toothed margin; stipes distinct, short, 1.5-7.5 cm long.
Figs. 27-31: *Microsorium membranaceum* (Don) Ching


Figs. 32-34: *Microsorium zippelii* (Bl.) Ching

32. Habit sketch. 33a. Rhizome scale. 33b. Frond scale. 34. Venation.

(Figs. 27, 32 × 1/2 natural size; Figs. 29, 34 × 6; Figs. 28, 33a × 30; Fig. 33b × 45; Fig. 30 × 200; Fig. 31 × 380)
winged almost to the base, the wing widening upwards into the frond; fronds broadly lanceolate, 20–30 cm long (including the stipe). 4–7 cm wide, gradually attenuate towards the base, apex acuminate or rather subacute, margin entire but somewhat wavy, midrib covered on the under surface with ovate-acuminate, clathrate, caducous scales with dentate margin; colour light to dark-green; texture subcoriaceous or chartaceous, firm; main lateral veins 1.1-1.5 cm apart, conspicuous almost to the margin, rather slightly raised on lower surface, nearly straight or oblique, intervening veinlets nearly obscure; sori small to medium sized, about 2 mm at maturity, rounded, regular, in between the adjacent main veins, about 5-6 between the costa and the margin; sporangial annulus cells 1-2.5, sporangial paraphyses small, 2-7 celled with occasionally terminal cell thickened; spores dark-brown, bilaterally and irregularly granulated are present on the exine, 32-64 x 34-44 μ (Figs. 52-60).

It is occasionally met within the North Eastern Himalayas (Darjeeling, Sikkim State, Assam, Khasia, Jaintia Hills, and Manipur) between 600-1500 m altitude. The plants generally grow on moist shaded rocks well inside the forests, or near the streams. As compared to _M. membranaceum_ this fern is very rare. Both of these though sharing similar habitats, yet can conveniently be separated by _subcoriaceous_ frond with indistinct secondary veins, large biseriate sori between lateral main veins in _M. zippelii_ and thin membranaceous fronds, with distinct main veins in _M. membranaceum_ and hence the name.

**Distribution:** North Eastern Himalayas, Burma. Malaysia, South China and Sumatra to Philippines.

**Specimens examined:**

**Eastern Himalayas: Darjeeling:** Lebong, (1500 m), *Malhotra 741._ July 1957 (PAN 1539-31, 1883); Bir (PAN 4193).

**Assam:** Sibsagar, *Mann*, Feb. 1891 (US 329706).

**Sikkim:** Levinge, Oct. 1890 (US 816738); Dickchu (600 m), _Bir_ 1019. July 1958 (PAN 2479-82).


Rhizome shortly creeping, 5-7 mm thick, subglabrous, bearing numerous densely hairy brown roots forming a spongy-mass; scales dark, dull-brown, clathrate in the middle edges of thin cells, more or less toothed or lacerated, broadly ovate, apex acuminate; about 3 mm long, dorsally affixed; stipes thick, short, usually under 1 cm or almost none, rarely long, sparsely scaly at base; fronds subcaespitose or close together, erect, 30-75 cm long (rarely much longer), 1-3 cm wide, broadly linear lanceolate, or ob lanceolate-elongated, apex acuminate, narrowed gradually downwards to a long attenuate or often rotundulo-cunate or subcauliculurate base, towards apex narrowed less gradually to narrowly rounded or pointed apex, margin entire or somewhat irregularly undulate, pale green on both sides; texture distinctly leathery, the main vein hardly visible in living condition, chartaceous when dried, perfectly naked; lateral veins about 1.5-2 cm apart in the middle of frond, copiously anastomosing with divercating included veinlets; sori usually on the upper half of the frond, irregularly scattered, covering the whole of the underside of the lamina, generally terminal on the included veinlets, irregularly fusing, when young distinctly punctate (but never like those in _Phymatodes_); sporangial paraphyses 2-3 celled, small, inconspicuous; spores pale yellow, bilateral, minutely granulated, 32-67 x 23-48 μ (Figs. 37-41).

This is a very common low land fern of the Eastern Himalayas (also in Sunderbans forests in Bengal) but is rare on the mountains of South India, often reaching an altitude of 600 m. It is found abundantly on trees or rocks, with growth habit similar to _Asplenium nidus_ Linn. but never forming symmetrical nests. The indistinct veins, leathery and fleshy texture, numerous irregularly scattered confluent sori and open habitat are very characteristic. This is a quite variable fern as to the size and shape of the base of the frond which may be anything from long attenuate to broadly rotundulo-cunaceae.

**Distribution:** South India, Ceylon, Eastern Hima-
Figs. 35-36: Microsorium zippelii (Bl.) Ching
35. Hair-like paraphyses. 36. Spore.
Figs. 37-41: Microsorium punctatum (Linn.) Copel.
Figs. 42-46: Microsoriumpteropus (Bl.) Copel.
42. Habit sketch. 43. Rhizome scale. 44. Venation. 45. Hair-like paraphyses. 46. Spore.
(Figs. 35, 40, 15 x 200; Figs. 37, 42 x half natural size; Figs. 39, 41 x 6; Figs. 38, 43 x 30; Figs. 36, 41, 46 x 380)
layas, Burma, Malaya, China, North Australia, Polynesia and West Tropical Africa with adjoining islands.

Species examined: Eastern Himalayas: Darjeeling: Teesta (150 m), Malhotra, Sept. 1934 (PAN 9361, 37), near Teesta (310 m). Malhotra, Aug. 1937 (PAN 1568, 4116-17); Gangtok Road (150 m), Bir, Aug. 1926 (PAN 037-25). Assam: Sylhet (60 m), Clarke, Jan. 1886 (US 418295); Darrang Dist. (Bali- para forest), Mann, Feb. 1889 (US 39707); Hooker & Thomson (US 95-10). South India: Palni Hills: enroute Kodaikanal (600 m). Bir, June 1962 (PAN 4827).


Rhizome widely creeping, branched, fleshy, green when young, inconspicuously dorsiventrally flattened, densely clothed with scales; scales dull brown, small, 2.4 x 5.1 mm, narrow, linear-subulate, distinctly clathrate; sori more or less scaly throughout, 1-1.4 cm apart, 4.25 cm long (upto 5 cm in simple frond), narrowly winged in the upper part; fronds mostly deeply tri-celled, rarely simple or 5-celled; simple lamina to about 15 cm long, 2 cm wide, lanceolate acuminate with entire margin, narrowed abruptly at base; tri-celled lamina to about 30 cm long, sub-deltoid, the base decurrent on the stipe for quite a distance, terminal lobe the largest and very much like the simple frond, upto 25 cm x 3 cm, acuminate, lateral lobes free almost to the base, in shape like the terminal lobe but smaller and narrower, all lobes densely scaly on midrib and frequently on main lateral veins also, scales deci- duous in age, glabrous on upper surface, margin entire of all the lobes; texture thin, herbaceous; colour deep green; midrib and main lateral veins are raised on upper surface, main veins wide apart, at a broad angle to the midrib extending to about 1/2 of the way to the margin, prominently raised on the lower surface also, forming a series of large, oblique oblong areolae and beyond there are 1-2 series of smaller areolae, larger areolae are filled with a net work of smaller irregular areolae formed by fusion of veinlets, the free simple or forked included veinlets have clavate spines; sori (in regular form) small, not very numerous, 1-3 in each main areolae, con- cipri, scattered irregularly, often confluent into transverse oblong or linear lines, sporangial paraphyses long, uniseriate, 3-5 celled; annulus cells 13-16; spore pale yellow, bilateral and smooth. 22-32 x 35-54 μ (Figs. 5, 42-46).

It is frequently met with on rocks in the beds and sides of streams and quite often the plants are more or less completely submerged in rainy season. In Sikkim State it is quite rare but in Bhutan and Assam quite common upto 600-1200 m. Also abundant in South India (500-1000 m) on Western Ghats.

Distribution: Tropical Asia, Eastern Himalayas, Burma, South China, Malaya, South India and Ceylon.

Simple, lanceolate fronds are also occasionally met with and quite frequently these are borne on the same rhizome which bears tri-celled ones. This simple leaved form has been described as Micro- sorium pteropus forma minor (Bedd.) Ching (in Bull. Fau. Mém. Biol. 4: 312, 1933). Beddome (1864. t. 179; 1883, t. 204) figured this form as Pleo- pelis pteropus var. minor. The chief characteristics of this form are the thin herbaceous texture, surface often raised between the veins and sori in main areola. Similarly, very infrequently 5-celled fronds may be present along with and in this case the two pairs of lateral lobes are 2-3 cm apart with prominently winged rachis, the upper pair of lobes always smaller than the lower ones. As far as the Himalayan material is concerned, the frond-form is very variable though the tri-celled condition is the com- monest. It may be mentioned that in South India and Ceylon only small-sized, simple-leaved form is met with and tri-celled examples are never collected (cf. Beddome, 1883; Sledge, 1960).


Rhizome short creeping, woody, thick, 5-8 mm in
diameter, sparsely scaly; scales ovate-lanceolate, lax, clathrate, brown or greyish, apex acute, margin slightly dentate, small, 1.5-2 mm long and less than 1 mm wide; stipes up to 25 cm long, closely placed, less than 1 cm apart, thick, narrowly winged near the base and wing widening upwards, sparsely scaly below; lamina large, 30-80 cm long and 13-25 cm wide, oblong ovate with acuminate apex, deeply pinnatifid to lobed to within short distance (1 cm or so) of the midrib; rachis naked; lobes 5-11 on each side excluding the pinnatifid apex, basal ones the largest, 10-20 cm long, 2-3 times as wide, oblique, separated by about 1-2 cm. Oblong lanceolate, apex acuminate, edges entire or suddenly decurrent; texture thin herbaceous; colour light green; venation distinct, main lateral vein strongly raised on lower surfaces, wavy, prominent about 2/3 the way of the margin, other veins not raised and forming irregular areolae with free included veinlets; sorus numerous, very small, round or ovoid, often elongated, complanate, irregularly scattered in 2-3 rows, in between main lateral veins; annulus cells 13-15 and sporangial paraphyses small, 2-3 celled, club shaped; spores light yellow, bilateral, plano-convex, exine smooth, 38.48 x 25.28 μ (Figs. 6, 47.5).

It is quite a common fern of the Eastern Himalayas from 600-1,800 m altitude and it is met with in Darjeeling, Sikkim State, extending upto Assam (Khasia Hills). It generally grows on rocks, by stream sides or on forest floor and rarely on the basal portion of the tree trunks.

Distribution: Eastern Himalayas, South China, Burma, Malaya, Ceylon, Malacca and Somosa Islands.

This fern is conspicuous of all the Microsorium species in having deeply lobed (to about 1 cm on each side of the midrib) large-sized fronds with numerous 10-20 x 2.4 cm lobes and minute sori.

Specimens examined: Isotype: Polypodium dilatatum Wall. ex Hook., Spec. Fil. 5. 85. 1863 from Nepal, Wallich 395 in 1820 (US 1277842). Eastern Himalayas: Darjeeling: Lebong forest (1650 m), Bir 742 A, July 1957 (PAN 3741); Bir 59. Aug. 1956 (PAN 1088-91); Malhotra, Aug. 1954 (PAN 1087, 1092); Sikkim: Thomson (US 816685). Assam: Khasia Hills (1,500-1,800 m), Hooker & Thomson (US 9934); Shillong (1,800 m), Mann, June 1888 (US 339713); Cherapunji (1,200 m), Blanford, Jan. 1884 (US 418898).

Out of nine species dealt with in the present account, two species namely, Microsorium pteropus and Microsorium hancockii have been segregated into a new genus Kaulinia by Nayar (1964) which is typified by Kaulinia pteropus and the following are the characters for this genus: (i) strictly ripiculous plants growing on wet rocks in well shaded areas, (ii) more or less dorsi-ventrally flattened rhizome which is tenaciously attached to the substratum, (iii) elongated sori which often form elongated coenosori or may form reticulated pattern running over the vein near vein plexus, (iv) lack of definite meristem, during prothallial development, (v) mature narrow, ribbon-like, branchied and perennial prothallii without midrib, the multiplication of which is effected by marginal unicellular gemmae. In contrast Microsorium, according to Nayar (loc. cit.) exhibits: (i) characteristically epiphytic or semi-epiphytic plants with a cylindrical, loosely attached thallus, (ii) compital sori, (iii) short lived cordate, massive prothallii with heavy midrib and multicellular mesostem. The other character used to distinguish Kaulinia and Microsorium is that of the scales which in case of the former genus bear glandular hairs profusely over the margin but in case of the latter genus the marginal hairs are absent.

As for as the observations of the writers are concerned the presence of marginal glandular hairs on scales of Kaulinia species (in the sense separated by Nayar) is not a constant character, except for one or two specimens these glandular hairs are generally absent. Dorsi-ventrally flattened rhizome which characterises Kaulinia can also be seen in some Microsorium (seneu stricto) species such as M. superficiale and M. hymenodes. Similarly, elongated sori which are the result of merging together of round sori at maturity, are seen in several species. Thus, most of the taxonomic characters used by Nayar for differentiating Kaulinia from Microsorium are not constant. Therefore, in the opinion of the writers the only dependable character in which Kaulinia differs from Microsorium is that of gametophyte and it will be attaching too-much importance to a single character if Kaulinia is recognised as genus.

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