

COMMON PTERIDOPHYTES OF SHIMLA (HIMACHAL PRADESH)  
PART II : ATHYRIACEAE

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ABSTRACT

The general characters of the family, genus and species alongwith their keys for identification have been presented. Six species of *ATHYRIUM*, namely *Athyrium flabellulatum*, *A. foliolosum*, *A. pectinatum*, *A. rupicola*, *A. schimperi*, *A. setiferum* and *A. strigillosum*; two species of *DEPARIA*, namely *Deparia boryana* and *D. japonica* and two species of *DIPLAZIUM*, namely *Diplazium esculentum* and *D. maximum* of family *Athyriaceae* have been dealt with.

INTRODUCTION

Ferns are of small economic value (May, 1978) inspite of the fact that they are the second largest component of Himalayan Vegetation (Khullar, 1994 and Verma et al., 1987). Shimla, being the largest town and capital of Himachal Pradesh has been explored by pteridologists (Seth *et al.* 2001). Till date no work is presented by any pictorial guide. It is with this aim that the present work had been initiated. The general information on Shimla town and its vegetation alongwith 11 species of ferns belonging to four families namely, *Adiantaceae*, *Hemionitidaceae*, *Davalliaceae* and *Aspleniaceae* have been described in Part I of this series (Seth *et al.* 2001). In the present paper 11 species of ferns belonging to 3 genera of family *Athyriaceae* have been described.

Date of receipt 19.06.2001 Date of acceptance 1.8.2001.

MATERIALS AND METHODS

Year round collections of several pteridophytes were made from various localities of Shimla as mentioned under various species. July to September are the best months for the collection of ferns and fern allies as during this period monsoon rains occur and these plants reach maturity or become fertile. After September there are sporadic rains followed by snowfall in the winter. During this period either only wintergreen species survive or they remain dormant to resume active growth in the next monsoon season.

The plants were photographed and their characteristic features were noted in the field. The collected plants were then identified in the laboratory by the usual methods of

identifying the ferns and fern allies. The terminologies followed in describing and identifying the pteridophytes are in conformity with Beddome (1863-1873, 1865-1870, 1876, 1883), Bower (1923-1928), Grounds (1974), Jain and Rao (1977), Kramer and Green (1990), Khullar (1994, 2000) and Smith (1875).

Alphabetical arrangement of the genera within each family and the species within each genus have been followed. The morphological details of the plants are followed by the general distribution of the plants in the world, habitat, distribution in India and the present places of collection. The colour photographs of whole plant in the field, its ventral side bearing sori, a detailed magnified view of the lamina bearing sori and some other features are presented in Figs. 1-11. The break-up of the families and genera is based on the classification given by Pichi Sermolli (1977) and followed by Khullar (1994, 2000). The advantages of this system are:

1. It is almost universally accepted by pteridologists.
2. It is easily workable in Herbaria.
3. It has been adopted by Love *et al.* (1977) in "Cytotaxonomical Atlas of Pteridophyta

#### ENUMERATION OF TAXA

CLASS FILICOPSIDA: Plants leptosporangiate.

SUB CLASS HYMENOPHYLLIDAE : Sporangia in well defined groups forming sori or becoming acrostichoid and without indusium.

ORDER ASPIDIALES : Sori typically dorsal or submarginal along veins or even over them; discrete, round or rarely elongate; indusia fixed below the sorus and opening around the margin; spores often with a perispore.

SUBORDER ASPIDINEAE: Plants generally terrestrial; rhizome thick, woody, stout, erect or creeping, scales basifixed.

FAMILY ATHYRIACEAE : Sori are elongate, indusia not globose, but elongate along veins, ovate, or narrower, fixed at side of sorus.

#### KEY TO THE GENERA

- |   |              |
|---|--------------|
| 1a. Articulate hairs <del>present on</del> stipe, rachis and pinnae costae  | ...DEPARIA   |
| 1b. Articulate hairs absent :   | ...2         |
| 2a. Sori generally on the acroscopic side of the vein, never double, 'Athyrroid' 'J' or 'U'- shaped or linear; marginal cells of rhizome scales never thick-walled and black, chromosome base number $X = 40$ | ...ATHYRIUM  |
| 2b. Sori diplazoid (i.e. double on both sides of the veins), generally linear; marginal cells of rhizome and stipe scales with thick walls and generally black; chromosome base number $X = 41$               | ...DIPLAZIUM |

#### KEY TO THE *ATHYRIUM* SPECIES

- |   |      |
|---|------|
| 1a. Costules (pinnule-midribs) or apices of pinnae or pinnules without setae on upper surface : | ...2 |
|---|------|

- 1b. Costules (pinnule-midribs) or apices of pinnae or pinnules with prominent setae on upper surface : ...3
- 2a. Lower pinnae almost as long as the pairs above, or very slightly smaller than the pair above ...*A. foliolosum*
- 2b. Lowest 3-4 pairs of pinnae reduced markedly, sometimes to mere auricles ...*A. rupicola*
- 3a. Rhizome creeping : ...4
- 3b. Rhizome suberect or erect : ...6
- 4a. Pinnules shallowly to deeply lobed : ...5
- 4b. Margin of pinnules deeply lobed to the costule or becoming pinnate, cut down into narrow oblong ultimate lobes ...*A. pectinatum*
- 5a. Fronds arise separately along the rhizome ...*A. schimperi*
- 5b. Fronds arising together at the apices of the rhizome ...*A. flabellulatum*
- 6a. Weak setae are present on upper surface of costae and costules ...*A. setiferum*
- 6b. Prominent setae are present on upper surface of costae and costules ...*A. strigillosum*

1. ***Athyrium flabellulatum* (Clarke)** Tardieu-Blot, Asplen. Tonkin: 85. t. 13 (1932); C. Chr., Index Fil. 3: 41. 1934.; *A. flabellulatum* (Clarke) Tardieu-Blot, Khullar, An Illus. Fern Flora of the West Himalaya. Vol. II: 47. 2000. (Fig. 1).

Rhizome thin, creeping below the ground, but terminating in an upright thick crown, scaly; scales thin. Stipes approximately 12 cm long, stramineous, glabrous above, but scaly at base; scales dark- brown, lanceolate. Rachis firm, round when dry, usually glabrous, sparsely scaly, scales deciduous. Lamina 2-pinnate, lanceolate, narrowed at both ends, 30-90 cm long, 10-15 cm broad, texture

herbaceous, upper surface glabrous. Pinnae approximately 15 or more pairs, alternate, short petiolate, lanceolate, widest about the middle, 8 -10 cm long, 1.5-2.0 cm broad, lower 2-3 pairs gradually shortened and sometimes deflexed downwards. Pinnules 8-12 pairs, close together, alternate, sessile. symmetrical, narrow, linear - lanceolate. 1.0-1.5 cm long, 0.4 cm broad, base cuncate or broadly adnate, apex rounded with short teeth. margin lobed less than half to the costa into deeply incised lobes; segments laciniate. Veins depending upon the length of the pinnule, 5-7 pairs, in groups of 2-3 pairs per lobe, free, simple, few forked, costae scaly, scales brown, concolorous, sparse. Fertile August-September. Sori scattered, round.

submedial, close to the costule; indusiate, indusia brown, small, linear, J-shaped or hippocrepiform, fugaceous, caducous, curls back at maturity, margin fimbriate. Spores  $24.5-35.0 \times 38.5-49.0 \mu\text{m}$ , yellowish-brown, non perinate, exine smooth.

*Athyrium flabellulatum* is a very rare fern between 2700 and 4000 m altitude in the west Himalaya and has been reported from Arunachal Pradesh, Darjeeling Hills, Mt. Huttu, Pithoragarh, Shimla hills and Sikkim. It is also distributed in Bhutan, China, Nepal and Tibet. This fern resembles *A. schimperi* in general aspects, but the two can be distinguished by the fact that in *A. schimperi* the rhizome is long-creeping and the fronds are not only distinct, but they usually arise singly. In *A. flabellulatum* though the rhizome is creeping below the ground, the stipes (fronds) are clustered towards the rhizome apex.

2. *Athyrium foliolosum* Wall. apud T. Moore ex R. Sim, Priced. Cat. Ferns 6: 22 (1859).; *Athyrium foliolosum* (Clarke) Tardieu-Blot, Khullar, An Illus. Fern Flora of the West Himalaya. Vol. II: 50, 2000.

Rhizome short, thick, erect, apex scaly. Stipes thin, less than 0.2 cm in diameter, 5.0-23.0 cm long, yellowish in the living state, darker towards base, scaly; but base densely scaly. Scales pale-brown or pinkish, concolorous, lanceolate, 0.8 cm long, 0.3 cm broad, apex long acuminate, margin with a few projections towards the base, rest entire, deciduous, higher up on stipe scales sparse, narrower and smaller or stipe glabrous.

Rachis brown or stramineous, grooved on upper side, sparsely fibrillose and scaly. fibrils brown, scales as on stipe. Lamina 1-2 pinnate, lanceolate, but becoming deltate in larger ones, 20.0-30.0 cm long, 4.0-10.0 cm broad, texture membranaceous. herbaceous. glabrous. Pinnac 10-15 pairs, alternate, petiolate, petiole 0.2-0.3 cm long. lanceolate, 2.0-5.0 cm long, 1.0-2.0 cm broad. margin deeply lobed to the costa (or becoming pinnate), lower pinnac almost as long as the pair above or very slightly smaller than the pair above. Pinnules about 14 pairs, alternate. attenuate, basal ones petiolate, rest sessile. 0.1-1.5 cm long, 0.3-0.5 cm broad, ovate or trapezoid symmetrical, about their axes, sloping, decurrent at their basiscopic base and often slightly auricled, acroscopically rhombic, margin  $\pm$  unlobed or lobed into wide, rounded, smooth lobes, apices narrowly obtuse or somewhat acute, basal acroscopic pinnule the largest. Veins 5-7 pairs depending upon the length of the pinnule; costae lower surface scaly. Sori rather large. medial 3-5 pairs in a single row on either side of the costule; indusiate, indusia pale-brown or greyish in living plants, rather large (but not as wide as in *A. anisopterum*). generally hippocrepiform, straight or J shaped. large. persistent, margin irregularly lobed. Spores  $31.5-35.0 \times 45.5-49.0 \mu\text{m}$ , dark brown. perinate, perine folded to form continuous thickened ridges or crests.

*A. foliolosum* is distributed in Bhutan. Myanmar. China. India and Nepal. In India it is an uncommon fern that grows on slopes and in the crevices of moist rocks between

1500-2500m altitude in Arunachal Pradesh, Darjeeling Hills, Himachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim and Uttaranchal. For the present study it has been collected from Shimla, Chadwick fall and Commermere-bridge.

In the Indian fern literature this fern has been referred either as *A. macrocarpum* (Bir 1960, 1964; and Mehra and Bir, 1960) or as *A. puncticaule* (Beddome, 1883), but according to Fraser-Jenkins (1996, 1997) and Khullar (2000) the correct name of this fern is *A. foliolosum*.

3. *Athyrium pectinatum* (Wall. ex Mett.)  
T. Moore, Index Fil.: 152 (Nov. 1859),  
186 (June 1860), non Fee. 1866.;  
*Athyrium pectinatum* (Clarke)  
Tardieu-Blot, Khullar, An Illus. Fern  
Flora of the West Himalaya. Vol. II:  
63. 2000. (Fig. 2).

Rhizome short-creeping, thin, 0.2-0.3 cm in diameter, scaly. Stipes approximately 1.0 cm apart on rhizome, as long as the lamina, usually 6.0-40.0 cm long, stramineous, thin, 0.1 cm in diameter, scaly; scales brown, concolorous, linear-lanceolate, 0.7 cm long, 0.15 cm broad, margin entire, apex acute, deciduous, higher up stipe sparsely scaly to glabrous. Rachis stramineous, slender, grooved when dry, glabrous, sometimes scaly, scales few, deciduous. Lamina bright green, finely dissected, 2-3 pinnate, lanceolate or subdeltate, 30.0 - 70.0 cm long, 10.0 - 35.0 cm broad, delicate, succulent, brittle (when alive), texture thin, herbaceous, membranaceous when dry. Pinnae 10-12 pairs, alternate, however, the lowest pair may

be opposite, petiolate, but upper pinnae more or less sessile, lanceolate, largest pinnae 3.5-13.5 cm long, 2.0 - 3.0 cm broad, lower pinnae generally as large as the pairs above or slightly reduced, distant. Pinnules approximately 10 pairs, alternate, sessile, subdeltate, 1.0-1.5 cm long, 0.4 - 0.6 cm broad, symmetrical, margin deeply lobed to the costule or becoming pinnate, cut down into narrow oblong ultimate lobes. Ultimate lobes 0.6 cm long, 0.3 cm broad, margin dentate or shallowly to deeply lobed, basal lobes the largest. Veins 3-5 depending upon the length of the lobe with a single vein to the ultimate lobe, costae and costules glabrous. Fertile August-September. Sori small (since ultimate lobes are so small there is no room for larger sori), one to each ultimate lobe; indusiate, indusia light-brown, straight, J-shaped, hippocrepiform, horseshoe-shaped or short-oblong, thin, membranaceous, subpersistent, margin irregularly lobed. Spores 28.0-35.0 × 35.0-38.5 µm, brown, perinate, perine convoluted into irregularly blunt ridge-like folds giving the appearance of reticulations.

*A. pectinatum* is the most finely dissected Himalayan species of *ATHYRIUM*, which is fairly common in west Himalaya except in Kashmir, at lower elevations up to 1800 m. In India it is distributed in the hills of Arunachal Pradesh, Bihar, Central India, Darjeeling, Himachal Pradesh, Kathua (Jammu), Madhya Pradesh, Manipur, Mount Abu, Parasnath, Rajasthan, Sikkim and Uttaranchal. In the World it has been reported from Bhutan, China, Nepal and Tibet. For the present study it has been collected from Shimla, Glen, Taradevi, Mt. Shali, Tottu.

Mount Jakhoo, Chotta Shimla, Tuti Kandi, Advanced study, Annadale, Chadwick fall, Summer Hill and Boileauganj.

4. *Athyrium rupicola* (Edgeworth ex Hope) C. Chr., Index Fil. 1: 145. 1905; *Athyrium rupicola* (Clarke) Tardieu-Blot, Khullar, An Illus. Fern Flora of the West Himalaya. Vol. II: 69. 2000. (Fig. 3).

Rhizome short, thick, suberect to erect, apex scaly. Stipes thin, 0.1 cm in diameter, 3.0 - 18.0 cm long, generally shorter than lamina, stramineous, scaly; base densely scaly, scales few, brown, bicolorous, 0.8 - 1.0 cm long, apex acuminate, margin entire, higher up stipe almost glabrous. Rachis stramineous, not grooved when dry, sparsely scaly and fibrillose, scales as on stipe, fibrils light-brown. Lamina pinnate,  $\pm$  narrow or linear lanceolate, 11.0 - 45.0 cm long, 2.5 - 6.0 cm broad, texture herbaceous, glabrous. Pinnae approximately 25 pairs, lower 3-4 pairs of pinnae gradually much reduced, sometimes to mere auricles, deflexed downwards, upper pinnae pairs alternate, sessile, decurrent on rachis, horizontal or slightly ascending (in the distal part of lamina), lanceolate, 1.5-5.0 cm long, 0.8-1.5 cm broad (largest pinnae), pinnae apex acuminate, slightly curved upwards, margins deeply lobed to the costa. Lobes 7-10 pairs, small, 0.3 - 0.5 cm long, 0.2 cm broad, apex acute, faintly serrate, lowest acroscopic lobe usually the largest. Veins 7-10 pairs depending upon the length of pinna, in groups of 3-5 per pinna lobe. Sori large, occupying almost the entire lower portion of the lobe, 3-4 pairs on either

side of the costule; indusiate, indusia light brown, straight or J-shaped, rarely hippocrepiform, persistent, curls back at maturity, margin fimbriate. Spores 31.5 - 42.0  $\times$  31.5 - 52.5  $\mu$ m, dark brown, perinate, perine convoluted into folds to form few reticulations.

*A. rupicola* is distributed in Bhutan, China, India, Nepal, Pakistan and Tibet. In India it is a fairly common fern that grows along road sides and in rock crevices at an altitude of 2100-3000 m in Arunachal Pradesh, Darjeeling, Himachal Pradesh, Jammu and Kashmir, Sikkim, Tawang and Uttarakhand. For the present study it has been collected from Khadrula, Baghi, Mt. Huttu, Narkanda, Matiana, Mahasu, Fagu, Kufri, Theog, Mt. Shali, Charabra and Chachpur.

This fern can be distinguished from *Athyrium schimperi* with which it resembles by its gradually reduced lower pinnae and in having an upright rhizome.

5. *A. schimperi* Mougeaut ex Fee, Mem. Fam. Foug. 5 Gen. Fil.: 186-187. 1852. *Athyrium schimperi* (Clarke) Tardieu-Blot, Khullar, An Illus. Fern Flora of the West Himalaya. Vol. II: 73. 2000. (Fig. 4).

Rhizome thick, 0.4-0.5 cm in diameter, long-creeping, scaly; scales bright brown, narrowly lanceolate, apex acuminate. Fronds 30-90 cm. Stipes thick, 0.1-0.2 cm in diameter, 10.0 - 46.0 cm long, 1.0-1.5 cm apart on rhizome, pale or stramineous, invariably with a dark- purplish to brown base, scaly at the base, scales brown,





Fig. 1. *Athyrium flabellulatum* (Clarke) Tardieu – Blot; A: Plant growing on forest floor, B. Part of the fertile frond





Fig. 2. *Athyrium pectinatum* (Wall. ex Mett.) T. Moore, A: A Plant growing on forest floor.  
B: Ventral side of the frond; C: Part of the fertile frond.





Fig. 3. *Athyrium rupicola* (Edgeworth ex Hope); A: A Plant growing on forest floor, B: Ventral side of the frond; C: Part of the fertile frond.





Fig. 4. *Athyrium schimperi* Mougeaut ex Fee.; A: A Plant growing on forest floor;  
B: Ventral side of the frond; C: Part of the fertile frond.



Fig. 5. *Athyrium setiferum* C. Chr., A: A Plant growing near water channels; B: Ventral side of the frond





Fig. 6. *Athyrium strigillosum* (T. Moore ex E. J. Lowe).; A: Plant growing on rock; B: Part of the fertile frond.



concolorous, lanceolate or linear-lanceolate, 0.4-1.0 cm long, 0.1-0.2 cm broad, apex acuminate, margin entire; higher up stipe sparsely scaly, becoming glabrous, glossy. Rachis firm, stramineous, round when dry, sparsely fibrillose, higher up rachis almost glabrous. The rachises of pinnae are winged, with an actual interruption of the wing only in well developed fronds. Lamina 2-pinnate,  $\pm$  lanceolate or deltate lanceolate, 30.0 - 60.0 cm long, 6.0-27.0 cm broad, texture firm, herbaceous, upper surface glabrous. Pinnae approximately 20 pairs, alternate, shortly petiolate, lanceolate, 9.0 - 15.0 cm long, 2.0 - 4.0 cm broad (largest middle pinna), lower 1-2 pairs generally slightly reduced, distant and apt to be sterile or partly so at their bases. Pinnules 10-15 pairs, alternate, sessile, linear-lanceolate or lanceolate, 1.0 - 3.0 cm long, 0.5 - 0.8 cm broad, symmetrical, margin variable, shallowly to deeply lobed. Lobes sharply crenate or inciso-dentate, basal pair of pinnules generally the largest. Veins simple, in groups of 5-10 (depending upon the length of the pinnule), costae sparsely fibrillose, costules glabrous. Sori large, 2-6 pairs to each lobe of the pinnule, often ultimately thickly covering the whole of the pinnules; indusiate, indusia light-yellow, large, straight, J-shaped, few hippocrepiform, often nephrodioid, persistent, margin fimbriate. Spores  $24.5 - 31.5 \times 38.5 - 42.0 \mu\text{m}$ , dark brown, perinate, perine broad, translucent, convoluted into folds forming ridges.

*A. schimperi*, a polymorphic fern is widely distributed in Africa, Myanmar, China, India, Nepal and Pakistan. In India it is prevalent

at 1200-3200 m altitude in Arunachal Pradesh, Central India, Darjeeling Hills. Himachal Pradesh, Jammu and Kashmir (rare), Sikkim and Uttaranchal. For the present study it has been collected from Khadralla, Baghi, Narkanda, Mt. Huttu, Mashobra, Chabba, Craignano, Baldain, Naldehra, All over Shimla town, Mt. Jakhoo. Advanced Study, Glen, Summer Hill, Jubbal, Chachpur, Chadwick Fall and Boileauganj.

This fern is often confused with *A. flabellulatum* and *A. rupicola*, but in both these ferns the fronds arise together, whereas in *A. schimperi* they arise singly along the creeping rhizome.

6. *Athyrium setiferum* C.Chr., Index Filicum 1: 146. 1905. basionym, nom. nov. for *Asplenium tenellum*.; *A. setiferum* (Clarke) Tardieu-Blot, Khullar. An Illus. Fern Flora of the West Himalaya. Vol. II: 76. 2000. (Fig. 5).

Rhizome short, thick, erect, scaly. Stipes 15.0 - 25.0 cm long or longer, stramineous, base blackish, thin, fragile, less than 0.1 cm in diameter, sparsely scaly; scales light mid-brown, concolorous, linear-lanceolate or ovate, apex acuminate, margin entire, higher up stipe almost glabrous. Rachis stramineous, grooved when dry, very scanty fibrillose, fibrils brown, small, very few, almost glabrous. Lamina 2-pinnate, narrow lanceolate, widest just below the middle, 10.0 - 30.0 cm long, 4.0 - 7.0 cm broad, texture thinly membranaceous; lower surface glabrous; pinnae approximately 10 pairs, alternate, petiolate, narrowly triangular-

lanceolate, short 2.5.- 4.0 cm long, 1.0 - 1.5 cm broad, auriculate, lowest 1 or 2 pairs of pinnae shorter than next. Pinnules 5-10 pairs, alternate, basal pinnules petiolate, rest sessile, elliptic or oblong rhombic, small, up to 0.5 1.0 cm long, 0.3-0.4 cm broad, symmetrical, asymmetrical about their axes, base cuneate, apex rounded with a few short teeth, margin shallowly lobed half way to costa, posterior margin decurrent on rachis; basal acroscopic pinnule often the largest and more lobed. Veins 3-5 pairs depending upon length of the pinnule; costae and costules with scattered, long, weak setae on upper surface. Sori small, in a single row on either side of the costule, very close to the costa; indusiate, indusia brown, mostly straight or J-shaped, thin, persistent, margin entire or slightly eroded. Spores  $31.5-35.0 \times 42.0-52.5 \mu\text{m}$ , pale-brown, non-perinate, exine smooth.

*A. setiferum*, a rare species of the genus between 2700 and 3000m altitude, is distributed in China, India, Nepal, Sri Lanka, Taiwan and Thailand. In India it has been reported from Arunachal Pradesh, Darjeeling hills, Meghalaya, Nilgiri, Palni hills, Sikkim, South India and Uttaranchal. For the present study it has been collected from Mt. Huttu, Summer Hill, Shimla, Glen and Chadwick Fall.

According to Khullar (2000) this fern has wrongly been described as *A. nigripes* by many Indian workers.

7. *Athyrium strigillosum* (T. Moore ex E.J. Lowe) T. Moore ex Salom., Nomenc. Gefasskrypt: 112. 1883; *Athyrium spigillosum* (Clarke) Tardieu-Blot,

Khullar, An Illus. Fern Flora of the West Himalaya. Vol. II: 77. 2000. (Fig.6).

Rhizome short, thick, suberect or erect: scaly, including the apex, which sometimes project out of the ground. Stipes thick. 0.15-0.2 cm in diameter and 20.0 cm long. stramineous, pink or purplish: sparsely scaly. scales brown, concolorous or bicolorous, deciduous. Rachis stramineous, pink or purplish like stipe, prominently grooved on the upper side, almost glabrous. Lamina 2-pinnate narrowly triangular-lanceolate to lanceolate. 10.0-15.0 cm broad, texture thin, herbaceous. bright green, lower surface glabrous. Pinnae 20 pairs or more, triangular-lanceolate. 5.0 - 7.0 cm long, 2.0 - 3.0 cm broad, subopposite. becoming alternate higher up, petiolate. petioles short, 0.2-0.4 cm long. lower pinnae hardly reduced and distant, upper pinnae bears small proliferous vegetative buds in their axils. Pinnules approximately 10 pairs. lanceolate, 1.0 - 2.0 cm long, 0.5 - 0.7 cm broad, alternate, sessile, obliquely inserted. symmetrical, apex acute or round. base cuneate, margin generally lobed about half way to the costa into narrow lobes. sharply serrate-dentate, the acroscopic basal pinnule generally the largest. Veins 5-7 pairs in groups of 2-3 per pinnule lobe, costae and costules coloured like the stipe. grooved. bearing prominent setae on the upper surface. up to 0.2 mm long. Fertile August - October. Sori short, submedial, nearer the costa, 3-5 pairs in a single row on either side of the costule; indusiate, indusia brown. straight or J-shaped, rarely hippocrepiform. caducous. margin eroded. Spores  $28.0-38.5 \times 35.0-$

42.0  $\mu$ m, light -brown, non perinate, exine with small scattered spinules.

*A. strigillosum*, a fern also reported from Nepal and Pakistan, is distributed in India in the hills of Arunachal Pradesh, Himachal Pradesh, Jammu and Kashmir, Meghalaya and Uttaranchal. It usually grows in well shaded ravines, wet places and banks at about 1000 m altitude. For the present study it has

been collected from Shimla, Glen, Chadwick fall, Jubbal, Chachpur, Summer Hill and Boileauganj.

The fronds of this fern give a magnificent basket-like or shuttle-cock like appearance, since they arise in groups of 4-7. It can therefore be prized as an ornamental plant, because the bright green colour of the fronds contrasts beautifully with the pale pink to purple colour of the stipe, rachis and costae.

#### KEY TO THE *DEPARIA* SPECIES

- 1a. Apex of pinnule round or acute, margin subentire to serrate, sori round, indusia round ...*Deparia boryana*
- 1b. Apex of pinnules rounded with few short blunt teeth, margin subentire or finely serrate, sori linear, indusia J-shaped or hippocrepiform ...*Deparia japonica*

8. *Deparia boryana* (Willd.) Kato, Bot. Mag. Tokyo. 90: 36. 1977.; *Deparia boryana* (Clarke) Tardieu-Blot, Khullar, An Illus. Fern Flora of the West Himalaya. Vol. II: 110. 2000. (Fig. 7).

Rhizome short, thick, ascending, apex scaly. Fronds very large up to 2 m long (1 m stipe plus 1 m lamina) and 60 cm broad. Stipes stramineous or brown, thick, 0.3 - 0.8 cm in diameter, 60 cm to 1 m long, sparsely scaly and fibrillose, scales brown, bicolorous, with the upper central region dark-brown, lanceolate, 1.5 cm long, 2.0 cm broad, margin entire, apex long acuminate, higher up on the stipe scales fewer, smaller and narrower. Rachis brown, grooved on the upper surface, but groove not continuous with those of the secondary rachises. sparsely fibrillose and

hairy (pubescent), hairs multicellular. Lamina 2-3 pinnate, very large,  $\pm$  triangular lanceolate, 50.0 cm -1.0 m long, 30.0-60.0 cm or more broad, texture herbaceous. sparsely hairy. Pinnae many pairs, alternate, lanceolate, approximately up to 45 cm long, 17 cm broad, lowest pinnae not much reduced. Pinnules 10-20 pairs, alternate, petiolate in larger fronds and sessile in smaller ones, connected by a narrow wing on either side of the rachis, lanceolate, 4.0 - 8.0 cm long, 1.0 - 3.0 cm broad, margin deeply lobed to the costa or becoming pinnate (in large fronds). Ultimate lobes 5-10 pairs, sessile, symmetrical, broadly oblong, 0.5-1.0 cm long, 0.2-0.4 cm broad, adnate, apex round or acute, margin subentire to serrate. Veins approximately 10 pairs depending upon the length of the lobes, mostly forked, costae and costules stramineous, fibrillose and hairy, hairs

brown, approximately 10 celled long, articulate. Fertile August - September. Sori: small, round, close to the main vein of the lobes or pinnules; indusiate, indusia brown, round, caducous at an early stage, margin fimbriate. Spores  $28.0 - 35.0 \times 35.0 - 45.5 \mu\text{m}$ , dark-brown, perinate, perine with thick blunt papillae.

*Deparia boryana* is distributed in Bhutan, Borneo, Myanmar, China, India, Java, Malayasia, Nepal, Philippines, Sri Lanka and Sumatra. In India it grows along streams or in moist places around 1800-2400 m altitude in forests of Arunachal Pradesh, Darjeeling Hills, Himachal Pradesh, Jammu Division, Khasi Hills, Manipur, Sikkim, South India and Uttaranchal. For the present study it has been collected from Shimla, Glen, Kotgarh and Tutikandi.

*D. boryana*, a Himalayan fern has an erect rhizome, but in *D. glabrata*, a closely related African species, horizontal, short-creeping rhizome is present (Khullar, 2000).

9. ***Deparia japonica*** (Thunb. ex Murray) Kato, Bot. Mag. Tokyo. 90: 37. 1977.; *Deparia japonica* (Clarke) Tardieu-Blot, Khullar, An Illus. Fern Flora of the West Himalaya. Vol. II: 115. 2000. (Fig. 8).

Rhizome thin, 0.1 - 0.2 cm in diameter, long-creeping or suberect, scaly. Stipes thick, 0.2 cm in diameter, about 30.0 cm long, often shorter than the lamina, stramineous with a dark-brown base, scaly; fibrillose and hairy or pubescent, scales brown, concolourous,

small, lanceolate, 0.4 - 0.6 cm long, 0.1 - 0.2 cm broad, margin entire, apex acuminate, higher up scales sparse and narrower. Rachis sparsely scaly, fibrillose and hairy. Lamina pinnate, triangular-lanceolate or sub-deltate. 20.0 - 25.0 cm long, 10.0 - 12.0 cm broad, texture herbaceous, sparsely hairy. Pinnae 10-12 pairs, distant, alternate, lower 4 - 5 petiolate, upper sessile, lanceolate, 5.0 - 6.0 cm long, 1.0 - 1.5 cm broad (largest pinnae), margin deeply lobed to the costa. Lobes about 10 pairs, small, 0.5 - 0.7 cm long, 0.3 - 0.4 cm broad, regular, symmetrical, apex rounded with few short blunt teeth, margin subentire or finely serrate, lower pinnae generally the largest or slightly smaller than the pair above. Veins 5-6 pairs per pinna lobe, simple; costae and costules sparsely scaly, hairy and fibrillose. Sori 0.2- 0.3 cm long, extending from the costule up to the margin, but not quite reaching it, a few sori towards base of the pinna lobe may be double; indusiate, indusia convex, brown, linear, rarely J-shaped or hippocrepiform, thin, membranaceous, persistent, curls back at maturity, margin fimbriate with few projections. Spores  $28.0 - 32.0 \times 35.0 - 42.0 \mu\text{m}$ , dark brown, perinate, perine convoluted into densely irregular, short, blunt folds appearing like flat protruding papillae from the exine surface.

*D. japonica* is distributed in China, Japan, India, Korea, Nepal and Pakistan. It is a rather rare fern that occurs at an altitude of 2000 m and above in wet, almost marshy places. In India it has been reported from Arunachal Pradesh, Darjeeling Hills, Himachal Pradesh, Jammu and Kashmir, Manipur, Meghalaya.





Fig. 7. *Deparia boryana* (Willd.) Kato; A: Plants growing on rocks near water channels; B: Part of the fertile frond



Fig. 8. *Deparia japonica* (Thunb. ex Murry); A: Ventral side of the plant; B & C: Part of the fertile frond.

Nagaland, Sikkim, South India and Uttaranchal. For the present study it has been collected from Summer Hill and Shimla.

*Deparia japonica* has close relationships with *D. petersenii*, but can be distinguished from it by the following features (Kato, 1984, Table 1):

TABLE 1: DIFFERENCES BETWEEN *DEPARIA JAPONICA* AND *D. PETERSENI*

	<i>D. japonica</i>	<i>D. petersenii</i>
Dimensions:	Small	Large
Stipe	30 cm long (often shorter than lamina)	30 - 50 cm long (often as long as the lamina)
Lamina	20 -25 cm × 10 - 12 cm	25 - 40 cm × 10 - 15 cm
Pinnae	5 - 6 cm × 1.0 -1.5 cm	7-10 cm × 1.5-2.0 cm
Lobes	0.5 - 0.7 × 0.3 - 0.4 cm	1 - 1.5 cm × 0.4 - 0.5 cm
Pinnule shape	Symmetrical, apex rounded with few short blunt teeth	More rectangular with broad apices and are less sloping
Indusium	Convex	Flat and fimbriate
Chromosome number	2 X	4 X

In the field *Deparia japonica* is many a time confused with *Diplazium frondosum* from which it can be

distinguished by the presence of lobed hairs on stipe, rachis and lamina. In the latter hairs are absent.

#### KEY TO THE *DIPLAZIUM* SPECIES

- 1a. Lamina texture herbaceous to subcoriaceous, pinnules auricled on one or both sides, margin of pinnules serrate or shallowly lobed, sori on almost all veinlets of a lobe

...*Diplazium esculentum*

- 1b. Lamina texture herbaceous, pinnule auricles are absent, margin minutely serrulate, sori usually on the lowermost veinlet

*Diplazium maximum*



10. **Diplazium esculentum** (Retz.) Sw. in Schrad. J. Bot. 1800(2): 312. 1803.; *Diplazium esculentum* (Clarke) Tardieu-Blot, Khullar, An Illus. Fern Flora of the West Himalaya. Vol. II: 130. 2000. (Fig. 9).

Roots black, wiry and deep rooted, occasionally budding to form new plants in a colony. Rhizome erect or ascendent, covered with persistent stipe bases, size and type of lamina varies with the age of the rhizome, young rhizomes bear pinnate, small (5.0 - 15.0 cm long, 5.0 cm broad) fronds, intermediate types (not so young rhizomes) have pinnate to partially bipinnate (50.0 cm or longer, 25.0 cm broad) fronds, old well developed rhizomes have 2 pinnate, large (up to 1 m or more) fronds. Stipes thick, erect, grooved, rather long up to 40.0 - 60.0 cm long, stramineous, base blackish and scaly; scales brown, sparse,  $1.0 - 1.5 \times 0.1$  cm, margin finely toothed, higher up stipe glabrous. Rachis often sparsely minutely hairy (hairs pale-brown) or almost glabrous. Lamina 1-2 pinnate, size variable, ovate-lanceolate, texture herbaceous to subcoriaceous, glabrous. In pinnate types pinnae 9-12 pairs, alternate, petiolate, lanceolate, 4 cm long and 1 cm broad, margin serrate, the second and third pair of pinnae from lamina base the largest, lowest pinnae usually distant. In intermediate types simple pinnae 10.0 - 15.0 cm long, 2.5- 3.5 cm broad, serrate or lobed up to half or more to the costae; pinnate pinnae with basiscopic pinnules well developed, free ovate lanceolate, lowest pinnae simple, the next two pairs or so the largest. In bi-pinnate types lamina huge, 1 m or more long, 50 cm or more broad. Pinnae 10-15 pairs, 18-50 cm long, 6-15 cm broad, ovate-

lanceolate, pinnule number variable, lanceolate, 4.5 -10.0 cm long, 1.0-2.0 cm broad, distant, alternate, sessile, but lowest shortly petiolate. pinnule base truncate or broadly cuneate, auricled on one or both sides, serrate or shallowly lobed. Veins basal 2 or more pairs of veinlets of adjacent lobes fuse to form an irregular excurrent veinlet, which runs to the sinus forking just below it with one half going to each lobe almost to the margin remaining 6-10 pairs arising from a central main veinlet in a segment free; costae usually scanty scaly, scales sparse. ovate margin toothed. Sori on almost all veinlets of a lobe including the anastomosing ones, diplazoid, many basal acroscopic, indusiate, indusia linear, membranaceous, margin wavy or fimbriate or almost entire. Spores  $24.5-31.5 \times 42.0 - 59.5 \mu\text{m}$ , light-brown non-perinate, exine reticulate.

*D. esculentum* is widely distributed in China, India, Indonesia, Malaysia, New Guinea, Pakistan, Samoa, Sri Lanka and Taiwan. It is a low level edible fern that grows near damp places up to an altitude of 2150 m throughout India including Arunachal Pradesh, Himachal Pradesh, Jammu and Kashmir, Meghalaya, Manipur, Sikkim, South India and Uttaranchal. It is also cultivated around villages in India. For the present study it has been collected from Shimla, Rampur-Bushair, Sanjauli, Glen. Tutikandi, Matiana, Narkanda, Khadrula, Chachpur, Summer Hill, Chadwick fall, Shangti and Kharapathar.

11. **Deparia maximum** (D.Don) C.Chr. Index Fil. 1: 235. 1905.; *D. maximum* (Clarke) Tardieu-Blot, Khullar, An Illus. Fern Flora of the West Himalaya. Vol. II: 135. 2000. (Fig. 10).





Fig. 9. *Diplazium esculentum* (Retz.). A A plant growing near water channel, B Single frond, C: Rhizome and stipe bases, D: Crozier formation of young frond, E & F: Part of the fertile frond





Fig. 10. *Diplazium maximum* (D. Don) C. Chr.; A: plant growing on forest floor; B: Rhizome, stipe bases and crozier formation of young frond; C: Part of the fertile frond.

Rhizome thick, short, shortly-creeping to erect or ascending; apex scaly, scales dark-brown, linear, lanceolate,  $0.4-1.7 \times 0.1-0.2$  cm, margin toothed, marginal cells thickened. Roots blackish, hard, wiry, wide-spreading. Stipes thick,  $1.0-1.5$  cm in diameter,  $\pm 75$  cm long, usually larger than the lamina, stramineous, light-brown, base dark-brown or blackish, non-mucronate; scaly at base, scales as on rhizome, but longer, narrowly lanceolate gradually getting smaller in size higher up on stipe or stipes glabrous, never muricated. Rachis stramineous, glabrous, not muricated. Lamina 2-pinnate, huge, size variable, broadly ovate-lanceolate,  $75$  cm -  $1$  m long and  $45$  cm broad, texture herbaceous, glabrous. Pinnae 10-15 pairs, alternate, petiolate, delto-lanceolate,  $35-40$  cm long,  $15$  cm broad, second basal pair the largest. Pinnules  $4.0-12.0$  cm long,  $1.8-2.5$  cm broad, apices rounded or acute, deeply lobed to the costa. Lobes  $0.6-0.7$  cm long,  $0.4-0.5$  cm broad, apex obtuse or acute, margin minutely serrulate. Veins free, simple or forked in the well developed basal lobes of a pinnule, upper lobes have simple veins with occasionally forked ones intermixed. Fertile, August - November. Sori in two oblique rows, length variable, linear, up to  $1$  cm long, stretching from costa and almost reaching the margin usually on the lowermost veinlet, diplazoid at the base of lobes; indusiate, indusia linear, thin, early caducous, margin irregularly and variously fimbriate. Spores  $21.0-28.0 \times 42.0-52.5$   $\mu$ m, light-brown, perinate, perine narrow, transparent, smooth, slightly convoluted into folds.

*D. maximum*, which has earlier been referred to as *D. frondosum* by some workers on Indian ferns, is one of the largest ferns of

West Himalayas, which may attain a size of  $2$  m or so. It is also one of the most common and abundant species of *DIPLAZIUM*, that grows besides streamlets and in ravines, around  $1200-2400$  m altitude throughout the West Himalaya in Arunachal Pradesh, Darjeeling, Himachal Pradesh, Kashmir, Meghalaya, Sikkim and Uttaranchal. It has also been reported from other parts of the World, such as China, Nepal and Pakistan. For the present study it has been collected from Shimla, Glen, Rampur-Bushair, Sanjauli, Tutikandi, Matiana, Narkanda, Khadrula, Chachpur, Summer Hill, Chadwick fall, Shangti, Kharapathar and Talgiri.

In the field this fern is often confused with *D. japonica* from which it can be distinguished by the absence of hairs. In the latter fern, hairs are present.

#### ACKNOWLEDGEMENTS

We are thankful to the Chairman, Department of Bio-Sciences, Himachal Pradesh University, Shimla for providing us the laboratory facilities and to Mr. Ramesh Thakur for helping us in photography. One of us (AK) is thankful to the Himachal Pradesh University for providing J R.F.

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