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A CONTRIBUTION TO THE TAXONOMIC STUDY OF FERN FLORA OF PUNJAB, PAKISTAN

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Abstract

During the field survey of the Punjab, a total of 36 fern species belonging to 18 genera and 13 families were ethnobotanically and taxonomically described. Dryopteridaceae was found to be the largest family with 7 species and 3 genera, whereas Adiantaceae was the second largest family with 4 species. A dichotomous key was prepared for characterization and identification of the families, genera and species on the basis of morphological characteristics of the plant body with special reference of sporangium and spores. The ferns thus reported were found ethnobotanically important, being used by the local people as ornamental, food or medicine to treat various ailments.

Introduction

Taxonomy is a synthetic science, drawing upon data from such diverse fields as morphology, anatomy, cytology, genetics, chemistry and molecular biology (Stuessy, 2008). It is both the 'queen' and 'servant' of biology; the queen in the sense that it is the ultimate, all other fields of biological research leading to the establishment or improving the classification system. It is the servant because one of the primary functions of taxonomy is to prove a basic service of information on identity, probable close relatives and characteristic of organisms to those who require it, especially to those doing research in other areas of biology (Sivarajan, 1991).

A flora is an inventory of the plants of a definite area or the sum total of plants in a definite geographical area is called flora of the region. A flora may be that of the whole world, of a continent, of a country or even of a smaller geographical region (Polumin & Stainton, 1984). Ferns have graced our planet for hundreds of millions of years. With about 12,000 named species of ferns worldwide, the variety to be found among them is staggering in its array of forms, textures, and even colors (Hoshizaki & Moran, 2001). Ferns are perennial and may take the form of twining vines, floating plants, trees, epiphytes or more commonly, terrestrial herbs and they may hug the ground or grow as tall as 50 ft (Hogan, 2004).

Stewart (1972) reported 133 species of ferns, belonging to 41 genera and 9 families from West Pakistan and Kashmir, the vast majority growing in mixed coniferous forests in mountainous regions forming a substantial component of terrestrial plant communities. Nakaike & Malik (1993) prepared a list of pteridophytes including 82 species of ferns belonging to 30 genera and 18 families along with their distribution in Pakistan.

Material and Methods

For the collection of ferns, field trips were arranged to the different areas of Punjab. Each specimen was numbered as it was collected and the detailed notes were entered in the notebook. After the identification of the family, generic name was determined and similarly the specific identity of the fern was found out. The description and identification of the collected ferns was carried out according to Hooker & Baker (1874), Beddome (1866, 1873 & 1883), Lowe (1872), Moore (1859 & 1860), Copeland (1947), Rodin (1960), Tryon & Tryon (1982) & Hoshizaki & Moran (2001), Moran (2004), Flora of Taiwan by Devol & Shieh (1994), Flora of North America (Vol. 2) by Smith (1993). The microscopic study was also carried out for making the slides of sporangium and spores along with observing the detailed structure of ferns. The properly pressed and mounted herbarium sheets of collected fern specimens were deposited in Dr. Sultan Ahmad Herbarium, GC University, Lahore, as voucher specimens after pasting their voucher numbers.

Results and Discussion

A total of 36 fern species belonging to 18 genera and 13 families were reported during the field survey of Punjab. Dryopteridaceae was the dominant family with the largest number of species, i.e., 7 belonging to 3 genera (*Cyrtomium caryotideum, C. falcatum, C. macrophyllum, Dryopteris ramosa, D. stewartii, Polystichum aculeatum* and *P. lonchitis).* Adiantaceae was the second largest family with 4 species (*Adiantum capillus-veneris, A. caudatum, A. trapeziforme* and *A. venustum*), whereas Aspleniaceae, Athyriaceae, Oleandraceae, Sinopteridaceae and Thelypteridaceae, were represented by 3 species each belonging to 1 (*Asplenium adiantum-nigrum, A. ceterach* and *A. trichomanes*), 3 (*Athyrium mackinnoni, Cystopteris fragilis* and *Diplazium esculentum),* 1 (*Nephrolepis biserrata, N. cordifolia* and *N. exaltata),* 1 (*Cheilanthes pteridioides, C. farinosa* and *C. albomarginata*) and 2 (*Ampelopteris prolifera, Thelypteris dentata* and *T. erubescence*) genera, respectively. Pteridaceae, Salviniacae, Marsileaceae and Cryptogrammaceae were the families represented by 2 species and 1 genus each (*Pteris cretica, P. vittata*; *Salvinia auriculata, S. molesta*; *Marsilea minuta, M. quadrifolia; Onychium contiguum* and *O. japonicum*). Dennstaedtiaceae and Azollaceae were represented by one genus and one species each, i.e., *Microlepia strigosa* and *Azolla pinnata*.

Terrestrial ferns naturally grow in hilly areas. Some of the examples are *Dryopteris, Athyrium, Polystichum,* etc. Aquatic ferns belong to the families, Marsileaceae, Salviniaceae and Azollaceae. Xerophytic ferns such as *Cheilanthes,* also grow only in the hilly areas. Mostly all the terrestrial and xerophytic ferns are homosporous while the aquatic ferns are heterosporous producing microspores and megaspores in a specialized structure called sporocarp. During the present study *Adiantum capillus-veneris* and *Pteris vittata,* were found much common as wild in the

study areas. *Ampelopteris prolifera* is a fern of plain areas and *Azolla pinnata* of marshy areas, richly distributed in Punjab region. Most of the above mentioned fern species were present as wild in the hilly areas of the Punjab, some in the botanic gardens, or for sale in various commercial nurseries. A few were found as aquatic ferns in wild, such as *Azolla* sp., *Marsilea* spp., and *Salvinia* spp.

The ferns thus reported were found ethnobotanically important, being used by the local people as ornamental plants and food or medicine to treat various ailments such as diarrhea, dysentery, skin diseases, chicken poxand, stomach ulcer and acidity, etc.

The description of these ferns is as follows:

Family: Dennstaedtiaceae

1. *Microlepia strigosa* (Thunb.) Presl Plate 1

Rhizome creeping, covered by brown hairs, stipe densely hairy towards the base, 25-55 cm long; lamina 40-80 cm long, bipinnate to tripinnatifid, ovate, the lower 1-2 pairs of pinnae somewhat reduced, pinnules upto 3 cm long, herbaceous, rachis densely short to hairy; pinnules touching each other or slightly overlapping at their lobes, oblong, sessile, usually dentate; veins free, slightly raised below, bearing stiff curved hairs, less raised above bearing scattered hairs, indusia broadly half-cup shaped, marginal, tomentose.

Family: Sinopteridaceae

***Cheilanthes pteridioides* (Reich.) C. Chr.**

Rhizome short, decumbent to erect, stipes tufted, covered with reddish brown linear scales; fronds 5 to 7 cm long, upto 2 cm broad, bi to tripinnatifid, pinnae small, cut down to rachis; rachis scaly, both surfaces of lamina green and glabrous; sori linear, submarginal; indusium membranous with dentate margins.

2. *C. farinosa* Kaulf.

Rhizome short, erect, tufted; frond upto 20 cm long, 7cm wide, monomorphic, subcoriaceous, deltoidly lanceolate, glabrous; stipe more or less elongated, tufted, polished, deciduous scaly; lamina unipinnate to pinnatifid at apex, lanceolate; basiscopic pinnae of the basal pinnae larger than the upper ones, papery, greenish above, white to yellowish powdery beneath; pinnae 3 to 12 pairs; veins free, forking; sori along the margins or sub-marginal, linear, covered by enrolled margins of the segments, brown, scariose, entire or toothed margins; false indusium, continuous along the margins; spores trilete, echinate.

3. *C. albomarginata* Clarke

Rhizome with tufts of hair pointed scales; stipes upto 25 cm long, shorter or longer than frond, glabrous, reddish brown, shiny, furnished particularly below and when young with lanceolate white margined scales; Frond bipinnatisect to bipinnate, deltoid to deltoid lanceolate, rachis and costae black shiny, costae somewhat covered with white powder, lower surface of lamina covered with white waxy powder, pinnae sessile, opposite, lower pair of pinnae half deltoid and with their lower pinnules much more developed than the others; sori continuous along the margins; indusia minute to absent or lacerate; sporangia dark brown at maturity, lower surface of costae and veins scaly.

Family: Cryptogrammaceae

1. *Onychium japonicum* (Thunb.) Kunze

Rhizome creeping, scaly; stipe tufted, 8-26 cm long, stramineous, straw coloured or pale brown, glabrous; lamina 12-18 inches long, ovate, tri to quadripinnate; lower pinnae lanceolate-deltoid; pinnules and segments numerous, usually deltoid, much coriaceous; rachis and both surfaces naked; indusium pale; membranaceous, ripe mass of sporaniga deep brown.

2. *O. contiguum* C. Hope

All the characters are like *O. japonicum* but the differ lies in the stipe which is rather longer and black at the base; lamina rather small, finally dissected and broadly ovate, less coriaceous; sori short upto 3 mm long.

Family: Pteridaceae

1. *Pellaea nitidula* Wall. ex Baker

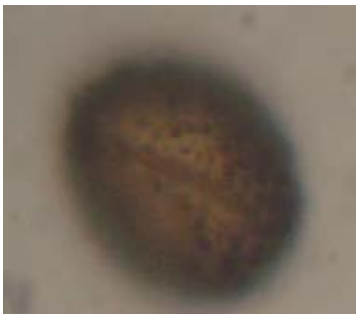
Rhizome short creeping, stout; stipe upto 8 cm long, very numerous and crowded on rhizome, deciduous dark brown scales on rhizome and rachis; frond upto 10 cm long, subdeltoid to oblong, coriaceous, shining beneath, glabrous, pinnae opposite, pinnatifid-bipinnately compound, broad-lanceolate, dimidiate, deeply pinnatifid near to rachis, lobes all oblong, entire, apex obtuse to acute, sori continuous and submarginal covered by indusium which may be continuous or interrupted, broad, flat, membranaceous, brown; spores trilete, tetrahedral.

2. *Pteris cretica* L.

Short creeping or erect rhizome, covered with small and dark scales; stipe of sterile frond upto 35 cm long, 10-20 cm broad, slender; lamina upto 25 cm long; unipinnate and basal pinnae forked; lateral pinnae 1-3 opposite sessile pairs, lower pinnae short stalked, 1.5-2 cm broad, terminal pinna upto 18cm long, subcoriaceous, glabrous, margins serrate; fertile frond somewhat narrower and much longer than sterile ones; sori submarginal covered by a continuous thin membranous flap; sporaniga brown; spores trilete.

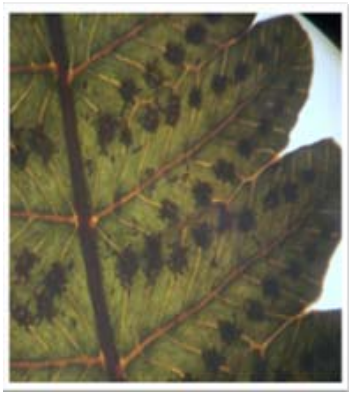
3. *P. vittata* L.

Rhizome short, stout, erect, densely scaly, pale brown scales; fronds clustered, stipe green to pale brown, upto 35 cm or more high, blade oblaneceolate, unipinnate, rachis not winged, pinnae numerous, closely spaced to overlapping distally, pinnae 2-20 cm long by 1cm broad, base not auricled, asymmetrically cordate to oblique or truncate, subopposite to alternate, hairy, sessile, margins serrulate when sterile, apex acute to acuminate; veins free, forked; sori continuous along the margins of pinnae, narrow, pinnae sterile from the base and apex.



Monolete spore

Trilete spore



Ampelopteris prolifera

Asplenium adiantum-nigrum

Diplazium esculentum

Microlepia strigosa

Salvinia auriculata

Salvinia molesta

Marsilea quadrifolia

Azolla pinnata

Asplenium trichomanes

Plate. 1. Some reported ferns from Punjab.

Family: Adiantaceae

1. *Adiantum capillus-veneris* L.

Small to medium sized fern, medium to short creeping rhizome; densely scaly; stipes 5-23 cm long, black, polished; lamina 11-23 cm long fronds in loose clusters; blade 2-4 pinnate, herbaceous, pinnules variable in size, mostly wedge shaped upto 2.5 cm broad, base cuneate, outer margins incised, glabrous, light green; sori elliptic to linear, placed in roundish sinuses on each lobe, indusia oblong and entire, spore trilete.

2. *A. caudatum* L. Plate 2

Small to medium sized fern, short and erect rhizome; distinctive pendent fronds upto 50 cm long that arch downward; stipe 4-17 cm long, dark brown densely covered with brown-reddish spreading hairs; lamina 13-34 cm long, unipinnate, upper pinnae are smaller than the lower ones, dimidiate, sessile to sub-sessile, deeply lobed, both surfaces covered with hairs; sori oblong, on the apices of lobes.

3. *A. venustum* G. Don Plate 2

Small fern, medium to short creeping rhizome; triangular blade; upto 3 pinnate, obovate segments, margins dentate to serrate; sori reniform, generally 2 per segment.

4. *A. trapeziforme* L. Plate 2

Medium sized fern, short creeping rhizome; blade triangular upto 3 pinnate with a terminal pinna similar to lateral ones; segments trapeziform and stalked, pinnule upto 5 cm long; size of petiolule upto 1.7 cm, margins lobed or incised, sori oblong.

Family: Oleandraceae

1. *Nephrolepis biserrata* (Sw.) Schott

Caudex short, erect; stipe upto 50 cm, tufted, erect, stout, glabrous except at base, shining; basal scales narrowly lanceolate; lamina unipinnate, 1-2 m long or more; pinane lanceolate, 8-18 cm long, 1.5-2 cm wide, cuneate at the base, apex acuminate, truncate or rounded at the base; basal pairs of pinnae gradually shortened; margins minutely serrulate, teeth remote; veins free, forked, ending in hydathodes near margin; rachis glabrous or nearly so; sori round; indusia round, sinus narrow; spores monolete.

2. *N. cordifolia* (L.) Presl

Tubers often found on roots; stipes tufted, 5-15 cm long, brown and greenish; fronds 30-60 cm long, taper towards tip and base, unipinntae, bases of pinna overlap, each pinna divided by its midrib into two clear unequal portions, rachis grooved, scaly above; pinnae sessile, unequal at base, auricle acute, articulate to rachis, glabrous on both surfaces; lower pinnae obtuse, gradually shortened, upper pinnae soriferous, 4 cm long, less acute to bluntly rounded apex, margins crenate; sori round, medial to submarginal; indusia lunate to reniform with open sinus; spores monolete.

3. *N. exaltata* (L.) Schott

Rhizome scales spreading, tubers absent, Stipe sparsely to moderate scaly or subglabrous, brownish, lamina glabrous 1 ft or more long, rachis and costa paleacous or often sub glabrous, fronds subcoriaceous, oblong to lanceolate, pinnate, pinnae 3-7 cm long, oblong more or less acuminated with a broad truncated or subcordate base, with a sharp auricle above and sometimes below the margin serratulate, apex acute; sori almost quite marginal present in a row on both sides of costa upto the end of base, indusia reniform with a broad sinus, spores monolete.

Family: Dryopteridaceae

1. *Cyrtomium caryotideum* (Wall. ex Hook. & Grev.) C. Presl

Rhizome short, erect; stipes 25-30 cm long, densly scaly at base, scales dark brown; lamina 30-35 cm long, imparipinnate; pinnae 2-6 pairs, short stalked, ovate to lanceolate, cuminate, acute to obtuse at base, auriculate on the upper side or both sides, margins minutely or sharply serrate, terminal pinna largest; sori scattered; indusia peltate, serrulate.

2. *C. falcatum* (L. f.) Presl Plate 2

Rhizome short, erect, densly scaly; stipes 10-30 cm long, densely scaly at base; lamina 15-40 cm long, 1-20 cm broad, oblong to lanceolate, imparipinnate; pinnae 6-14 pairs, ovate to falcate, long to attenuate towards apex, short stalked, glabrous, coriaceous, margin thickened, entire or undulate or coarsely and irregularly dentate; sori round, scattered; indusia peltate, brown at maturity, persistent, entire.

3. *C. macrophyllum* (Makino) Tagawa

Rhizome erect, scaly, frond 70 cm high, 30 cm wide, Pinnae 13-14 cm long, 3-4 cm broad, 2-8 pair, oblong to lanceolate, caudate to acuminate at the apex, broadly cuneate to rounded at the base, margins minutely serrate, glabrous, terminal pinna usually large sized; sori many, round, scattered on lower surface of pinnae; indusium peltate, falling early.

4. *Dryopteris ramosa* (Hope) C. Chr.

Rhizome creeping, covered with large acuminate brown scales; stipe upto 10 cm long, straw colouerd or plae brown with basal scales light brown; fronds upto 35 cm long, upto 30 cm broad, bipinnate, tripinnate in lower region, rachis light brown or light green somewhat scaly, grooved continuous with costae; pinnae 16 to 30 pairs, pinnules 12 to 20 pairs, long and narrow, margins of pinnae incised, apex round with serrations; sori round, commonly lacking on the basal 2 to 3 pairs of pinnae, sporangia rusty to dark brown, indusia reniform attached from the sinus; spores monolete, echinate.

Adiantum venustum ***Adiantum trapeziforme*** ***Adiantum caudatum***

Cyrtomium falcatum **in natural habitat, included veinlets and sori**

Cystopteris fragilis **in natural habitat and hood shaped sori on its frond**

Plate. 2. Some reported ferns from Punjab.

5. *D. stewartii* Fraser-Jenkins

Medium large fern, rhizome erect, stipes one fourth of the frond length, grooved, dark brown scales; blades triangular to lanceolate and bipinnate to pinnatifid with 12 to 22 pairs of pinnae, upto 15cm long, costae continuously grooved with rachis, lowest pinnae anadromic, slightly pinnatifid at base; pinnule upto 2cm, serrate or often bear spine tipped teeth, margins round to acute with dentation or serration; sori round, medial, covered with kidney shaped indusia; sporangia brown; spores monolete, echinate, ellipsoidal.

6. *Polystichum aculeatum* (L.) Roth

Medium sized fern; rhizome erect, stout, branched; fronds upto 30 cm high by 9 cm wide; stipe grooved, large and small reddish brown scales, hair like at tips of rachis; blade bipinnate, lanceolate, lamina glabrous above, but a few sparse hairs or scales below; pinnae 25

to 38 pairs, subopposite, curving upward, lower pinnae almost half the length of middle pinnae, first pinnule on the upper side of each pinnae is generally larger than the others, all pinnules have an outward pointing lobe with spiny tip, costae grooved but not continuous with rachis, margins spiny; veins free, forked; sori round on each side of the costa in one row between midrib and margin, mostly on upper half of the blade; indusium peltate, at maturity shriveled upward to look like an inverted umbrella, persistent; sporangia dark brown to black at maturity; spores monolete.

7. *P. lonchitis* (L.) Roth

Rhizome tufted, erect, scales variable in shape, ovate to lanceolate, pale brown; blade linear to lanceolate, stipe 1/8 the length of frond, slightly covered with pale straw coloured scales; unipinnate, with 25 to 38 or more pinnae, tapering from middle to upper and lower pinnae, acroscopic pinnae auricled, rarely overlapping, somewhat curved upward, margins serrulate to spiny with spreading teeth, apex acute to mucronate; veins free; only upper half of the frond fertile, sori mediate, round, covered by peltate indusium, sporangia dark brown, spores echinate, monolete.

Family: Thelypteridaceae

1. *Ampelopteris prolifera* (Retz.) Copel. Plate 1

Rhizome creeping, scaly; fronds unipinnate; buds in the axils of pinnae; stipe 30-62 cm long, lamina of two kinds, one with a stalked terminal pinna, the other growing indefinitely with small lateral pinnae, lower pinnae sessile, termilal sub-sessile; other with small lateral pinnae growing indefinitely, lower pinnae distant, upto 16 cm long and 2 cm wide, the upper most pinnae smaller and closely placed upto 10 cm long and 1.5 cm wide, base truncate to cordate, margins lobed, apex acute, firm and thin texture, glabrous, short hairs on the upper side of costae; veinlets about 8 pairs, 4 to 6 pairs unite alternately to form an intermediate excurrent vein; sori oblong to elongate present along conjugated veinlets, exindusiate with capitate orange paraphyses.

2. *Thelypteris erubescence* (Wall. ex Hook.) Ching

Rhizome erect; fronds of large size, tufted, thin scales at base, laminae ovate to lanceolate, unipinnate to pinnatifid, upto 17 cm long and upto 3 cm broad; costae containig many erect stiff hairs, entire, segments round to acute, veins free, lateral veins of the pinnule simple, the lowest one vein running to above the sinus membrane; sori round, basal or borne nearly to the costae and costules, exindusiate; spores monolete.

3. *T. dentata* (Forssk.) E. St. John

Rhizome short creeping, hairy, stiff, petiole purplish brown; blade pinnate to pinnatifid, pinnae hairy on both surfaces, hairs short, fronds thin, dull green, upto 7 to 13 cm long and 1 to 3 cm broad, unipinnate, pinnae opposite to alternate, apex of pinnae upright, acute to acuminate, pinnae lobes closely spaced, margins of the segments entire and rounded to acute at apex, veins free, basal veins of each pair of adjacent pinna lobes united into one vein which runs to the edge of pinna, making a triangle, long stipe; veins free, forking; sori round located along the margins of the pinnae at the end of veins, sometimes covered by incurved margins of segments, terminal pinna at end of rachis longer than nearly all other pinnae, sori at the end of veins, near the margins, indusia reniform, spores monolete.

Family: Athyriaceae

1. *Athyrium mackinnoni* (Hope) C. Chr.

Rhizome creeping, erect, stout with thin scales; frond upto 2 m long, rachis straw to black coloured, glabrous; lamina bipinnate to pinnatifid, oblong to elliptic; pinnae opposite to sub opposite, broad at the center and narrowing to the both ends, apex acute to acuminate, sessile to subsessile, upto 18 cm long, glabrous, margins and apex of pinnule incised to dentate, herbaceous, green; veins free, forked; sori linear along the veins, opening away from the vein; indusium j-shaped crossing or arching on the vein; spores monolete.

2. *Cystopteris fragilis* (L.) Bernh. Plate 2

Rhizome short, brown thin scales, ovate to lanceolate; fronds monomorphic closely placed on the rhizome, stipe dark at the base, green to straw coloured, slender, 4-12 cm long; lamina lanceolate to elliptic, bipinnate to bipinntifid, pinnae usually perpendicular to rachis, margins serrate to sharply dentate, glabrous; veins free; sori round, dorsal on veinlets; indusia thin, scale like, hood shaped attached by broad base; spores monolete, echinate.

3. *Diplazium esculentum* (Retz.) Sw. Plate 1

Rhizome erect, covered with brown scales; stipe stout, 30 to 60 cm long, lamina ovate, bipinnate to pinnatifid, 50 to 90 cm long and upto 50 cm broad, young fronds pinnate with broad pinnae, later fronds bipinnate with narrower pinnules, large fronds may be tripinnatifid, pinnae petiolate and pinnules subsessile, apex of lamina pinnatifid; sori linear to oblong, sometimes double, usually the basal ones paired back to back along the same vein, rachis groove U-shaped; spores monolete, echinate.

Family: Aspleniaceae

1. *Asplenium adiantum nigrum* L. Plate 1

Creeping to sub-erect rhizome, branched, scales dark brown to blackish, fronds 22 cm high by 6-7 cm wide; stipe dark reddish brown at base but often green above; blade bipinnate to pinnatifid, oblong to triangular with basal pinnae larger and most divided, glossy, dark green, hairy along the costae; pinnae upto 13 pairs, opposite to alternate, variable in shape; pinnule ovate to lanceolate,

margins finely incised; veins free, forking; sori linear along the veins, 2-4 pairs per pinna; indusium whitish; sporangia dark brown to blackish at maturity.

2. *A. ceterach* L.

Rhizome erect, branching, small scales present, bearing many roots downward; frond not articulated to rhizome, 15 cm long, 2 cm wide; stipe and rachis bearing small light brown scales, stipe short as compared to lamina; lamina unipinnate, pinnatifid, lanceolate, leathery with upper surface deep green, dense light brown small scales entirely cover the lower surface of pinnae; pinnae 6-12 pairs, alternate in a zigzag manner, entire or undulate, slightly upper and lower pinnae somewhat smaller size as compared to medial; veins netted, visible after removing the scales; sori linear along the viens covered by flap like linear indusium replaced by scales at maturity; sporangia dark brown.

3. *A. trichomanes* L. Plate 1

Small fern with short, creeping to erect rhizome, often branched with clathrate scales, lanceolate densely covered with stipe bases; stipe tufted, 1-5 cm long, glossy or shiny, brown to dark purple; fronds linear, unipinnate, 5-25 cm long, 20-36 pairs, opposite to subopposite upper and lower pinnae shortened, medial pinnae broadly ovate to circular, 0.5-1 cm long, crenate to dentate, base cuneate; sori linear upto 1.6 mm long; sporangia dark brown, hide the indusium at maturity by covering the pinna.

Family: Marsileaceae

1. *Marsilea quadrifolia* L. Plate 1

Roots arising at nodes and internodes upto 19 cm long; petiole upto 13 cm long, almost glabrous; pinnae upto 1.5 cm long and 0.6-1.5 cm broad, entire to somewhat crenate, glabrous; sporocarp present on stalk, rounded oval or elliptic.

2. *M. minuta* L.

This species is just like *M. quadrifolia*, but smaller in size, its length is about 7.5 cm and margins are crenate.

Family: Salviniaceae

1. *Salvinia auriculata* Aublet Plate 1

Floating leaves oval-oblong, 1-2 cm long, petiolate, auriculate or heart shape at base, margins entire to undulate, papillate on upper surface, with free hairs on tip of each papilla joining to form egg beater like structure; veins inconspicuous and reticulate; submerged leaf hair like upto 10 cm long; sporocarp globose, covered with brown, multicellular hairs.

2. *S. molesta* D. Mitch. Plate 1

Floating leaves bilobed on both sides, upto 3 cm long and 2.5-3 cm wide, sessile to sub-sessile, margins entire to undulate, papillate on upper surface, with free hairs on tip of each papilla joining to form egg beater like structure; veins inconspicuous and reticulate; submerged root like leaf upto 15 cm long, petiolate, bearing male and female sporocarp on branches covered with brown multicellular hairs.

Family: Azollaceae Plate 1

1. *Azolla pinnata* R. Brown

Triangular plant, about 1 cm wide; leaves trapezoidal; bilobed bearing pointed trichomes on ventral side; megasporangium warty, without collar, terminal flagellated crown.

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