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Taxonomic characterization of some moss families of Mansehra, Pakistan

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Key words: Enclyptaceae, Hedwigiaceae, Mansehra, Pleurocarpous, Timmiaceae.

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Abstract

This paper deals with the taxonomic studies of the representative species of five moss families; Enclyptaceae, Hedwigiaceae, Hypopterygiaceae, Splachnaceae and Timmiaceae reported from Mansehra District, Pakistan. Among these Enclyptaceae and Timmiaceae are acrocarpous while Hedwigiaceae, Hypopterygiaceae and Splachnaceae are Pleurocarpous. The aim of this study was the critical taxonomic characterization of the rare species of the mentioned families and to check the distribution of in the District Mansehra. Only one specimen of *Enclypta streptocarpa*, *Timmia megapolitana* and *Tayloria froelichiana,* collected by previous workers were examined in this study, no new specimen were found in the study area in recent investigation; however *Hypopterygium flavolimbatum* is collected from two more localities of the district. *Hedwigia ciliata* is new record for the district and occurred in one locality. The investigation is based on study of plants through extensive field surveys conducted from May 2013 to Jun 2015 along previously collected specimens hosted at Pakistan Museum of Natural History (PMNH). For identification examination of specimens was done both on morphological and anatomical basis. Detailed taxonomic descriptions, dates, collectors name, locality, key notes and Voucher specimen number has been given for each species along with altitude. This study reveals that the analyzed species are very rare in not only in the study area but also in Pakistan, *Timmia megapolitana*, *Tayloria froelichiana* and *Enclypta streptocarpa* were found extinct in the study area. The current study will help to upgrade the existing information's of the mosses taxonomy and distribution in the district Mansehra with special reference to Pakistan.

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Introduction

The Bryopsida comprises the largest class of mosses, consisting of 95% of all moss species. It is common throughout the world. Among the Bryopsida, the shape of the capsule (fruiting body) attachment and its pattern of development is very helpful in classification and identification of moss families, genera and species (Goffinet *et al*., 2008).

The research on Bryophytes in Pakistan has been generally neglected and few workers contributed in this field (R.R. Stewart, 1982).

Initially, some workers collected mosses from some selected localities of Northern part and plains of the country (Brotherus, 1898a, 1898b; Dixon, 1926, 1929; Blater & Fernandez, 1929; Herzog, 1938; Stoermer, 1954; Bartram, 1955; 1956; Noguchi, 1956, Asghar, 1957; Noguchi, 1959, 1964; Higuchi, 1992; Froiehlich, 1964; Nishimura *et al.,* 1993a, 1993b; Townsend, 1993;1994, Nishimura & Higuchi 200, Higuchi & Nishimura 2003, Solman, 2008, Gruber & Peer, 2012, Islam *et al*., 2015, Islam *et al*., 2016a & 2016b).

Dixon (1926) was the first, who visited the Kaghan valley (Mansehra), in his investigation he reported 25 taxa belonging to 16 genera and 8 families among these 6 were new records for the country. Noguchi (1964) reported 10 species from 6 families in his visit of Northern Pakistan from the Kaghan valley (Mansehra). Later on some Japanese workers investigated the northern Pakistan. Higuchi (1992) presented 41 species from Mansehra (Kaghan valley) in his checklist. Nishimura *et al*., (1993a,b) presented 51 taxa in their checklist of Mosses of Pakistan, belonging to 22 families.

Recently Islam *et al*., (2015) conducted a detailed taxonomic study on Batramaceae from district Mansehra and documented 6 species with detailed taxonomic description. Later on Islam *et al*., (2016)*a*, presented a checklist of lithophytic mosses from Mansehra district with life form distribution and altitude. Islam *et al*., 2016*b* presented another checklist of Mosses of Mansehra District which include all the known moss flora of the Mansehra district (105) reported from Mansehra district.

Current work is aiming to provide detailed description of the representative members of moss family as no such description was available before. Another aim was to check the status of the previously collected rare Moss species from the Pakistan in Mansehra District and to compare the new collected specimens of the species with previously collected specimens from the study area. There is need for thorough exploration of moss Flora of the region and complete taxonomic description of the species reported from the area.

Material and method

Experimental Design

Mansehra is the North Eastern District of Khyber Pakhtoonkhwa at elevation range of 975.36-4200 meters. The topography of Mansehra is dominated by the high mountains varying in elevation from 1900 m in the south to over 4900 m above sea level in the north (Anon, 1998); (Fig. 1).

The vegetation of Mansehra region mainly falls in the sub-tropical, temperate, sub-alpine and alpine zones (Husain & Ilahi, 1991). The classification of vegetation in the present case is based on the ecological zones as revised by the Champion *et al* (1965) and Beg (1975), (Fig.2).

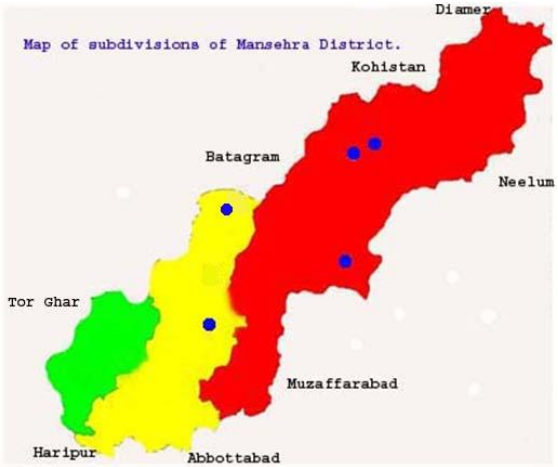

Fig. 1. Map of Mansehra District. Blue dots indicate the collection points in study area.

Fig. 2. Pictorial view of the study area (Mansehra District, Pakistan).

Initially literature was reviewed. Specimens of the families hosted at Pakistan Museum of Natural History (PMNH) were systematically studied. Besides PMNH specimens, own collections were also examined and included. Plant material was collected in plastic zip bags. Each specimen was given a separate collection number. Each specimen was examined under stereoscope and microscope at Cryptogamic Lab, Hazara University and was identified with the help of Moss Flora of China, Bryophytes Flora of North America and Moss Flora of Central Europe. Specimens were deposited in the Cryptogamic Lab, Hazara University Herbarium (HUP).

Morphological Studies

For morphological analyses, specimens were washed with water to remove soil contents. Size of different parts was noted using ruler. Qualitative morphological characters were examined using stereoscope and were described using standard terminologies.

Microscopic Studies

For anatomical feature description, leaves were separated for slide preparation and were directly put on slides and were treated with acetic acid and alcohol along lectophenol. After staining; cover slips were fixed on specimen. Apical, marginal, median laminal, basal and alar cells were analyzed under microscope. In some cases micrometer was also used for measurement of cells size.

Results and discussion

In this study, five families from Mansehra district have been described based on Morphological and anatomical characters. Among these, two families having Acrocarpous life form, while three with Pleurocarpous life form. Descriptions, keys, general distribution, and foot notes have been given provided.

Keys to the Families

1+ Plants pleurocarpous.....2
- Plants acrocarpous.....4
2+ Leaves arranged in three ranks.....Hypopterygiaceae (1)
Leaves not arranged in three ranks.....3
3+ Leaves on stem and branches monomorphic; capsule immersed.....Hedwigiaceae (2)
- Leaves on stem and branches dimorphic; capsule not so.....Splachnaceae (3)
4+ Leaves lanceolate to long-lanceolate.....Timmiaceae (4)
- Leaves elliptic to oblong-ovate.....Enclyptaceae (5)

1. HYPOPTERYGIACEAE

Hypopterygium flavolimbatum Müll. Hal, Musc. Frond. 2: 10. 1850

Syn. *Hypopterygium tibetanum* Mitt. Musc. Frond. 2: 10 1850

Plant Pinnnate-umbbelate Plants pinnate to umbellate, 50-65 mm long. Stipe tomentose above base, frond glabrous; ramification tripinnate; Leaf entirely complanate, in 3 ranks at stipe and in 3 ranks at rachis and branches, dull or light green or yellowish green, 1.3-1.8 mm long and 0.4-0.9 mm wide, ovate-triangular, apex acute-apiculate, margin dentate from mid upper portion teeth single celled, paired, margin bordered, border cells linear.

laminal cells irregularly quadrate, rhomboidal, isodiametric, alar cells somewhat rhomboidal, basal cells irregularly rectangular; costa single, furcat, subdecurent, reaching 50-70 % of the leaf length; leaves of 3rd rank are smaller in size, 0.5-0.7 mm long, 0.3-0.4 mm wide (Fig. 3). Sporophyte not seen in specimens reported from study area.

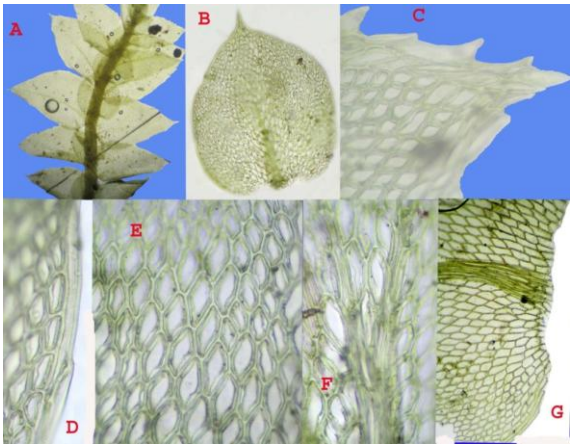

Fig. 3. A, *Hypopterygium flavolimbatum* branch. B, Leaf. C, Apex with prominent dentate margin. D, Median leaf margin. E, Median laminal cells. F, Bifurcate costa. G, Basal and marginal cells.

Specimens examined: Siran Valley, Mandagucha, 2180 m, 08.05.2015 *Mazhar-Ul-Islam, Jan Alam & Shafique Ahmad* 806 (HUP), Kaghan valley, Nadi, 2020 m, 18.09.1992. *Nishimura* 9633 (PMNH).

Habitat: On moist, cliffs, along streams.
General Distribution: Europe, Japan, North America and Pakistan. This species could not be recollected during field studies from the respective locality. However, description has been based on Nishimura's collected specimen. This species seems to a rare one for the study area.

2. HEDWIGIACEAE
Hedwigia ciliata (Hedwig) P. Beauvois, Prodr. Aethéogam. 15. 1805.
Syn: Anictangium ciliatum Hedwig, Sp. Musc. Frond., 40. 1801.

Plant 15-28 mm long, in loose tuff; light green-silvery green. Leaves 1.5-2.5 mm; margins slightly recurved to apex, slightly dentate distally, broad teeth at apex, papillose; apex hyaline, muticous and acuminate, medial and distal laminal papillose, small, simple, low papillae in hyaline part of laminal cells, simple, apical cell rhomboidal to quadrate, 43-65µm, multip-apillose-coronate basal cells rectangular, Alar cells quadrate. Perichaetial leaves plane, margins ciliated distally. Vaginula sparsely to densely pilose. Calyptra exposed, sparingly pilose proximally or densely pilose throughout (Fig. 4-5).

Fig. 4. *Hedwigia ciliata* habitat; B, Capsule immersed in leaves; C, Habit of plant

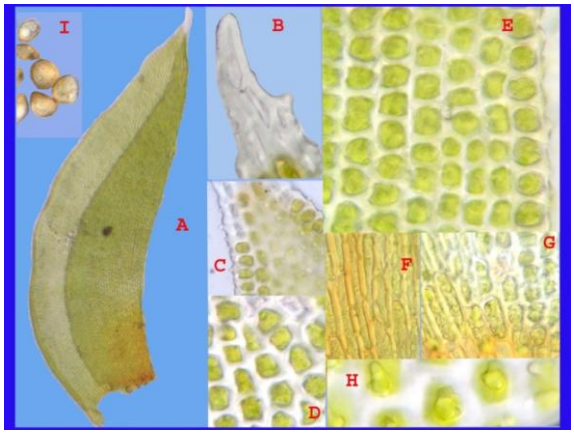

Fig. 5. A, *Hedwigia ciliata* Leaf with incurved margin. B-D, Apex and apical cells. E, Medial marginal cells. F-G, Basal and alar cells. H, Cells with prominent papillae.

Specimens examined: Shinkiari; Forest collage, 1363 m, 16.05.2015, *Mazhar-ul-Islam, Jan Alam, Suhail Karim* and *Shafique Ahmad* 997 (HUP).
Habitat: On dry boulder mixed with Grimmia spp.
General Distribution: North & Central Europe, North America, Himalaya, Pakistan. This species is found very rare and in very small patch. Easily be differentiated on field from other species due to its bright silvery and hairy appearance.

3. SPLACHNACEAE
Tayloria froelichiana (Hedwig) Mitten, J. Linn. Soc. London (Suppl.) 1: 57. 1859.
Syn. Splachnum froelichianum Hedwig, Sp. Musc. Frond., 52. 1801.

Plants small to medium size, in loose tufts, yellowish green 10-20 mm long, unbranched. Leaves distichous-complanate, lanceolate-falciform, bluntly acute, 1-1.6 mm long and 0.6-1 mm wide; apex subulat-acuminate; Margin slightly denticulate to smooth; laminal cells linear, smooth, alar cells similar to laminal cells, isodiametric proximal leaves smaller; costa fat, subpercurrent, scarcely narrowed distally, ending 6-9 cells below the apex (Fig. 6).

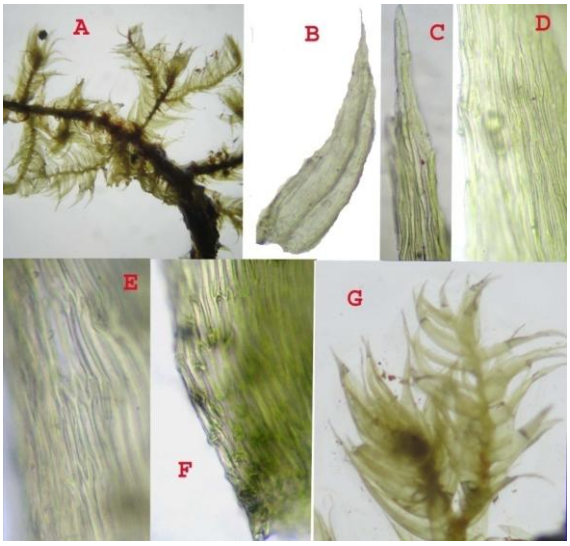

Fig. 6. A, *Tayloria froelichiana* habit. B, Individual Leaf. C, Apex of leaf. D, Margin of proximal lamina. E, Basal laminal cells. F, Alar cells. G Shoot of individual plant.

Specimens examined: Kaghan valley; Shogran, 2710 m, 16.08.1993, *Nishimura* 9506 (PMNH).
Habitat: On rotten logs at higher altitudes
General Distribution: North & Central Europe, North America, Himalaya, Pakistan. This species could not be recollected, Description has been made based on Nishimura specimens (i.e. 9506).

4. TIMMIACEAE
Timmia megapolitana Hedw. subsp. *bavarica* (Hessl.) Brassard, Lindbergia 10:34 (1984). Crypt. Fl. Pak. 2: 251. 1993. Plants dark green to brownish green. stem unbranched, 30-35 mm tall. Leaves patant, 4-7 mm long and 1.5-2 mm wide, lanceolate, ovate-lanceolate, gradually tapering towards apex, apex acuminate- apiculate; costa single, subpercurrent; margin slightly denticulate, teeth single, dentate at mid upper to apex but fever teeth below; lamina cells irregularly quadrate-pantagonal or rhomboidal, isodiametric, apical cells quadrate-pantagonal, nerve cells irregularly pentagonal at apical region apical cells irregularly quadrate.; limb laminal cells 5-14 µm long and 6-10 µm wide, with rounded to flattened mamillae on the adaxial surface; abaxial sheath laminal cells plane or with papillae on lumen (Fig. 7).

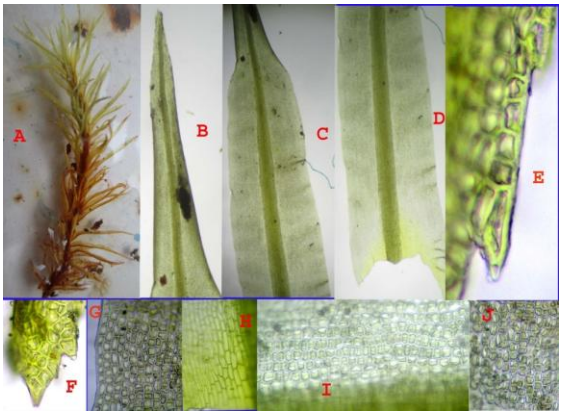

Fig. 7. A, *Timmia megapolitana* habit. B-D, Different portions of leaf. E, Proximal laminal margin. F, Apex of leaf. G, Medial laminal margin. F, Basal laminal cells. I, Medial juxtacostal cells. J, Medial laminal cells.

Specimens examined: Kaghan valley; Shogran-Sali Hut, 2740 m, 16.08.1992, *Nishimura* 9529 (PMNH).
Habitat: On ledges of cliffs.
General Distribution: All the major mountains of northern Hemisphere (Europe, North America, Pakistan). This species could not be recollected from the study area. Description has been made based on Nishimura specimens (i.e. 9529).

5. ENCALYPTACEAE
Encalypta streptocarpa Hedw., Spec. Musc. 62 (1801). Crypt. Fl. Pak. 2: 245. 1993.
Plants 5-7 mm long, brownish green to dark green, in tufts. Stems erect, branched. Leaves apressed-spreading, broad, dark green to brownish green and very shiny, 3-5 mm long and 1-1.3 mm wide, oblong-lingulate, apex obtuse-acute, margins papilose; costa single, prominent, percurrent; laminal cells irregularly quadrate-pentagonal, rhomboidal,

lower laminal cells rectangular, rhomboidal and pluri mammilose; Alar cells rectangular-quadrate, smooth, apical cells quadrate, pluri papilose, marginal cells oblong-quadrate (Fig. 8).

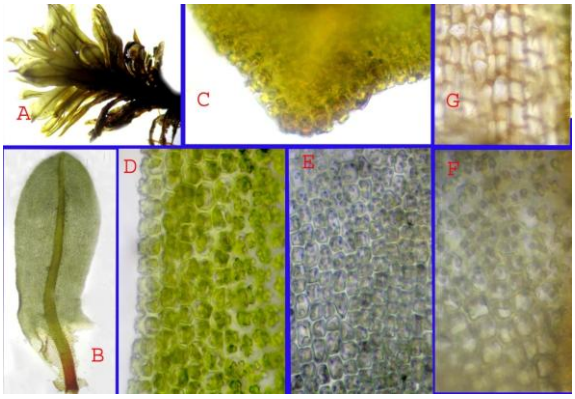

Fig. 8. A, *Encalypta streptocarpa* habit. B, Leaf. C, Apex of leaf. D, Median leaf margin. E, Medial laminal cells. F, Medial juxtacostal cells. G, Basal laminal cells.

Specimens examined: Kaghan valley, Nadi, 2020 m, 20.09.1992. *Nishimura* 9676 (PMNH).
Habitat: On moist, cliffs, along streams.
General Distribution: Europe, Japan, North America and Pakistan. This species could not be recollected during field studies from the respective locality. However, description has been made based on Nishimura's collected specimen (9676). This species seems to a rare for the study area.

Discussion

In this study 5 families having single species in the District Mansehra has been studied. The taxa of the proposed families were tried to recollect from the whole district and older specimens hosted at (PMNH) were also examined on Morphoanatomic basis. Based on specimens examined the description of the taxa elaborated with complete reference and voucher specimens number.

Among these taxa, *Encalypta streptocarpa, Hypopterygium flavolimbatum, Tayloria froelichiana* and *Timmia megapolitana* previously collected by Noguchi (1992) and Nishimura *et al*, (1993a) from three different localities of Kaghan valley (Mansehra). However in recent investigation none of previously collected taxa were found during field visits from the localities previously collected. The reason is probably construction, pollution and forest cutting.

Hypopterygium flavolimbatum only the species, which was recollected from Mansehra. This was previously collected by Nishimura *et al* (1993) from Nadi (Kaghan Valley-Mansehra) and Aybia National Park, Abbotabad. This species grows in high moist condition, all three collection sites are falls in moist and conserved forests.

Hedwigia ciliata is found new to the study area. This species was previously collected from south of Muzaffarabad (Azad Jammu & Kashmir) by Nishimura *et al*., (1993a) and from Fairy Meadows by Nakaike (1993a). In recent investigation the specimens was found in thick cheer Pine forest on soil submerged boulder along with other lithophytic mosses. This habitat is somewhat changed from previous collection sites.

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