



Taxonomic characterization of some moss families of Mansehra, Pakistan

Mazhar-ul-Islam*, Jan Alam, Muhammad Fiaz, Abdul Majid

Department of Botany, Hazara University, Mansehra Pakistan

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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.

* **Corresponding Author:** Mazhar-ul-Islam ✉ mazharawanhu@gmail.com

Introduction

The Bryopsida constitutes 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 studies in Pakistan have been generally neglected with a 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; Froiehllich, 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 till now.

Current work is aiming at the 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 is the needed.

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).

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.

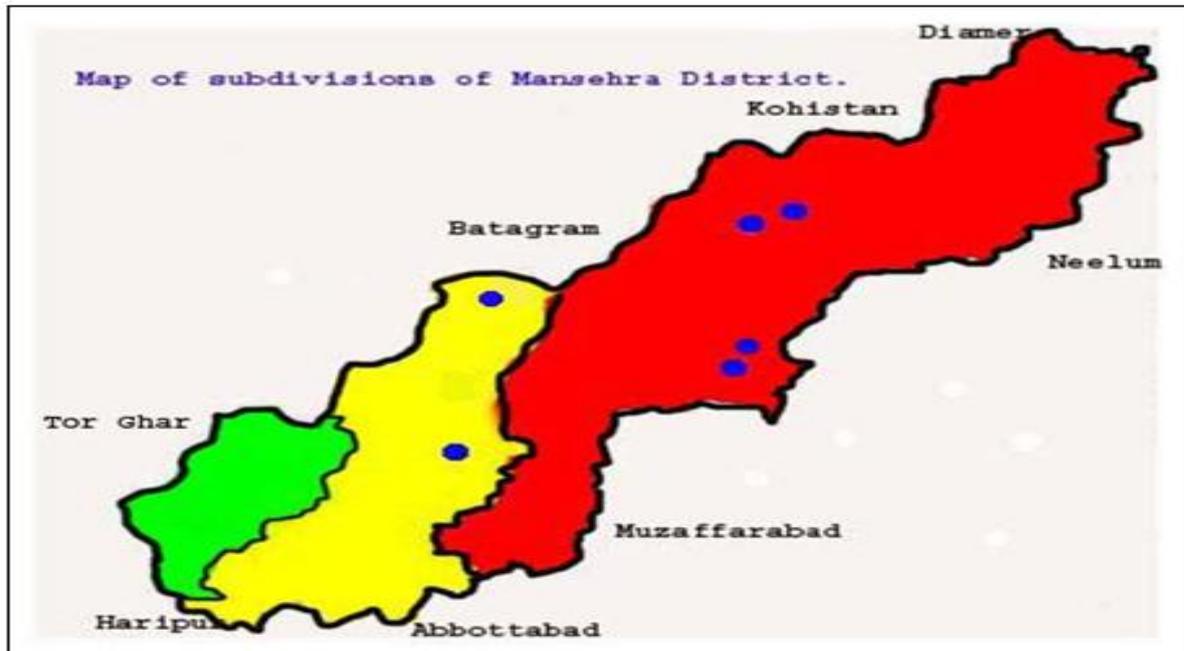


Fig. 1. Map of Mansehra District. Blue dots indicate the collection points in study area.

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, Syn. Musc. Frond. 2: 10. 1850.
- Syn. *Hypopterygium tibetanum* Mitt. Musc. Frond. 2: 10 1850.
- Plant Pinnate-umbellate 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 self collected and previously reported specimens from study area.



Fig. 2. Pictorial view of Study area (Mansehra District).

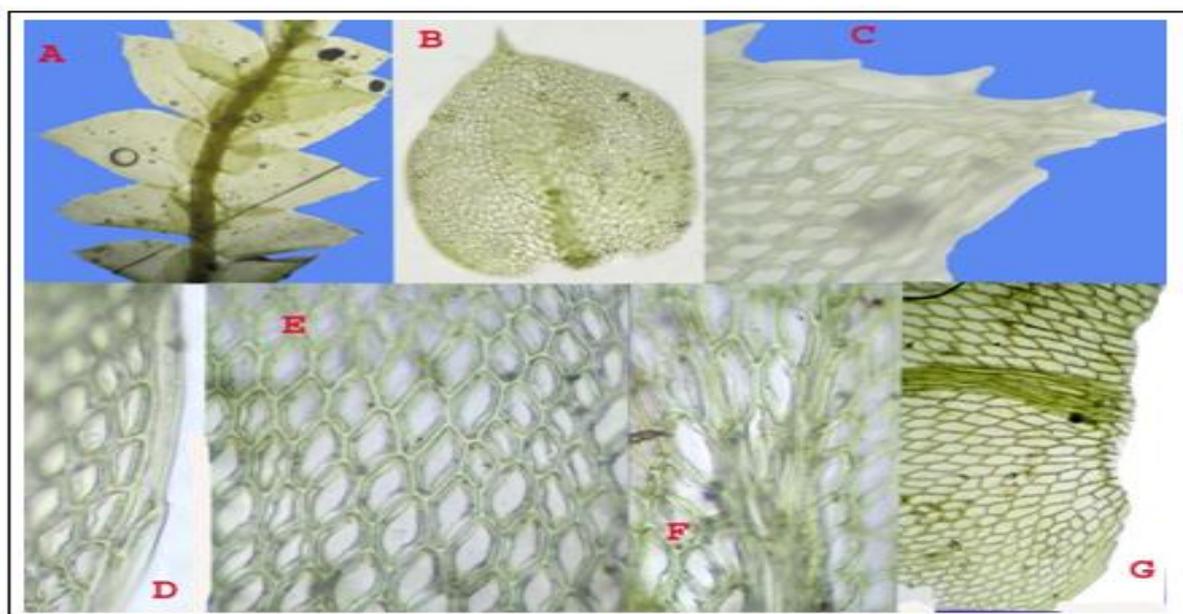


Fig. 3. A, *Hypopterygium flavolimbatum* branch; B, Leaf; C, Apex with prominent dentate margin; D, Median leaf margin; E, Median laminal cells; F, Bifurcate costa; G, Basal and marginal cells.

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 tuft; 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, mucicous 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, multipapillose-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 (Figs. 4-5).

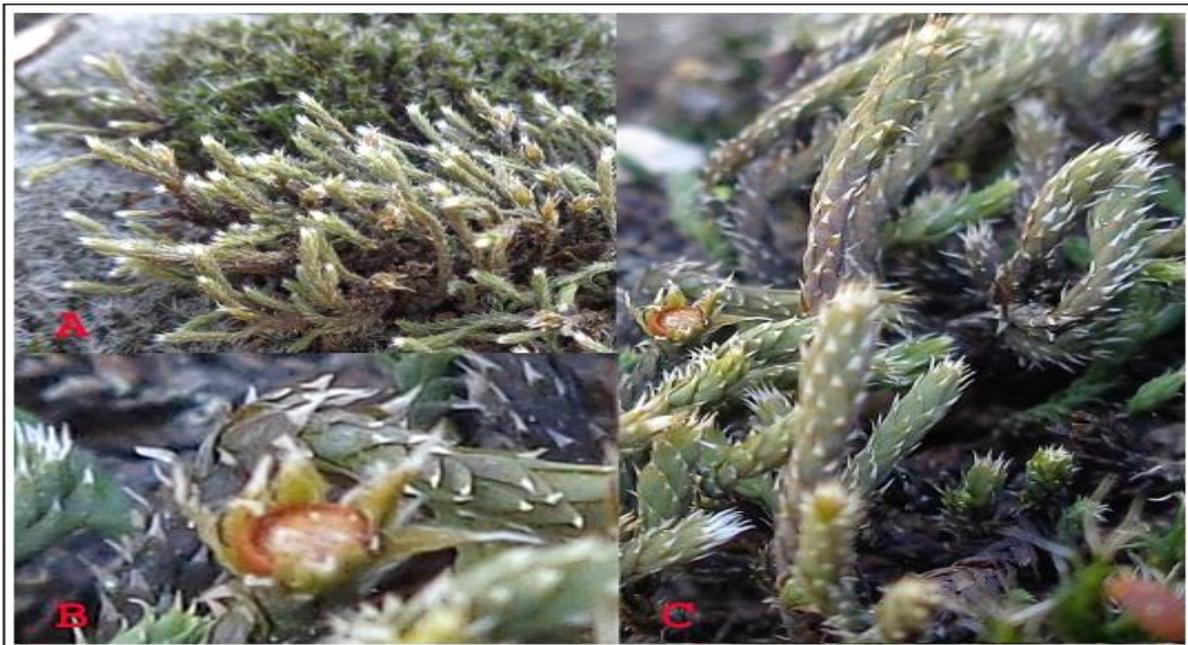


Fig. 4. A, *Hypopterygium flavolimbatum* habitat; B, Capsule immersed in leaves; C, Habit of plant.

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).

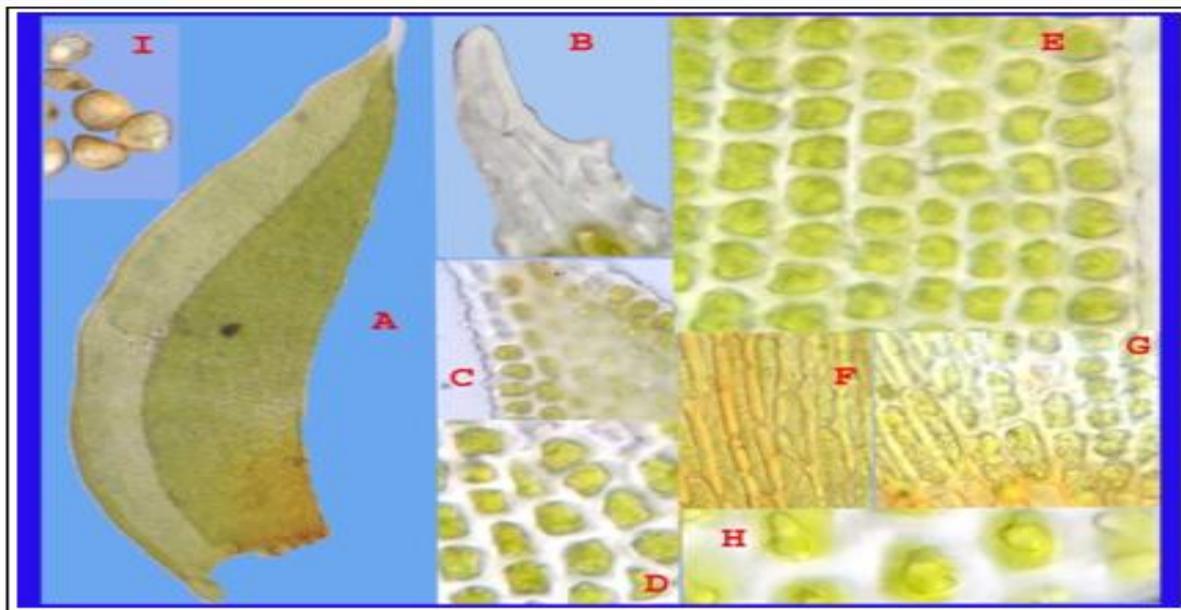


Fig. 5. A, *Hedwigia ciliata* Leaf with incurved margin; B-D, Apex and apical cells; E, Medial marginal cells; F-G, Basal and alar cells; H, Cells with prominent papillae.



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.

Sporophyte not seen in previously reported specimens from study area.

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 patent, 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 fewer teeth below; lamina cells irregularly quadrate-pentagonal or rhomboidal, isodiametric, apical cells quadrate-pentagonal, 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). Sporophyte not seen in previously reported specimens from study area.

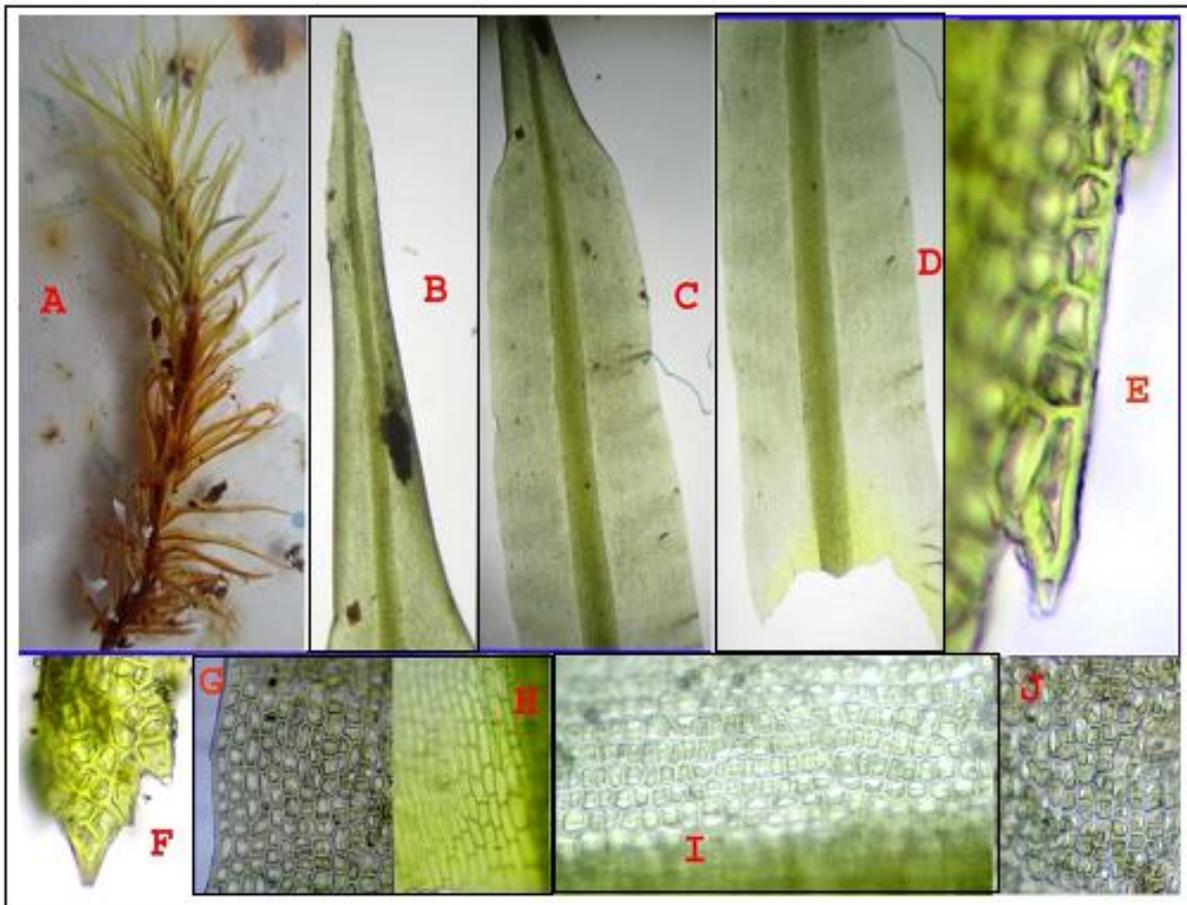


Fig. 8. A, *Encalypta streptocarpa* habit; B, Leaf; C, Apex of leaf; D, Median leaf margin; E, Medial laminal cells; F, Medial juxtacostal cells; G, Basal laminal cells.

Specimens examined

Kaghan valley; 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 appressed-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 papillose; 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 papillose, marginal cells oblong-quadrate (Fig. 8).

Sporophyte not seen in previously reported specimens from study area.

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 be 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 5, *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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