



RESEARCH COMMUNICATION

A study on some taxa of family Mniaceae (Bryophyta) in Darjeeling (West Bengal), India

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ABSTRACT

During study on the family Mniaceae in Darjeeling and its neighbouring areas, three genera and six species (*Mnium lycopodioides*, *Orthomnion bryoides*, *Plagiomnium acutum*, *P. confertidens*, *P. rhynchophorum* and *P. succulentum*) have been identified. Of these *Plagiomnium acutum* is reported here for the first time from eastern Himalaya. A detailed morpho-taxonomic account of these species with their current status and a key to all the taxa of family Mniaceae in Darjeeling is provided here.

Introduction

Darjeeling is located in West Bengal, surrounded by Sikkim in North, Bihar in South, Kalimpong in East and Nepal in West, at an elevation of 6700 ft. The humidity usually ranges between 72 to 96% and annual temperature ranges between 2 to 19°C with 309.2 cm annual precipitation. Darjeeling has a temperate climate and the vegetation comprises of Sal, oak, semi evergreen temperate and alpine forests. The members of family Mniaceae Schwägr. are distributed all over the world in temperate regions where they grow in moist and shady places on rocks and bark of trees. The family has been treated by several authors from time to time and only later, a reasonable criterion for demarcation of different genera has been developed (1). Family Mniaceae on worldwide basis contains nine genera and about 75 infra-generic taxa but in India five genera (*Mnium* Hedw., *Orthomnion* Wils., *Plagiomnium* T. J. Kop., *Pseudobryum* (Kindb.) T. J. Kop. and *Rhizomnium* T. J. Kop.) and about 27 taxa are present (2-7).

As far as diversity of family Mniaceae in Darjeeling is concerned, earlier researchers had documented 18 taxa (4-6, 8-12). Of these, 14 taxa are recognized except *Mnium laevinerve* Card. which is synonymised under *M. lycopodioides* Schwaegr., *M. undulatum* Hedw. is not found in India (6), *M. marginatum* (With.) P. Beauv. var. *riparium* and *M.*

pseudopunctatum Bruch & Schimp. earlier described now considered as *Mnium lycopodioides* and *Rhizomnium nudum* (Britt. & Williams) T. J. Kop. respectively (4, 6, 13). During the present study, out of these 14, six taxa have encountered including *Plagiomnium acutum* (Lindb.) T. J. Kop. which is recorded here for the first time from eastern Himalaya (4-7). The members of this family are remarkable for being almost confined to moist and shady places and having significant diagnostic characters like erect and prostrate habit, smooth or serrated leaf margin, teeth on leaves double or single or none, the anatomy of costa as well as border and pattern of leaf cells, pitted or not (1). At present, no up to date information is available on the diversity in family Mniaceae in India and hence a taxonomic revision is needed.

Materials and Methods

The present study is based upon the specimens collected from different areas of Darjeeling. The specimens have been deposited in the Bryophyte Herbarium, National Botanical Research Institute, Lucknow (LWG). Plants were soaked in water to regain their natural form and then identified with the help of binocular and Leica microscope. Plants were also photographed for easy identification of species.

Results

Taxonomic treatment

Key to the taxa of family Mniaceae in Darjeeling

1a. Leaves serrated, costa with stereids.....2

1b. Leaves entire, costa without stereids.....11

2a. Plants reddish, erect, without plagiotropic shoots, marginal teeth of leaf double (paired), costa with two stereid bands.....3

2b. Plants green to brown, with plagiotropic shoots, marginal teeth of leaf single, costa with one stereid band.....4

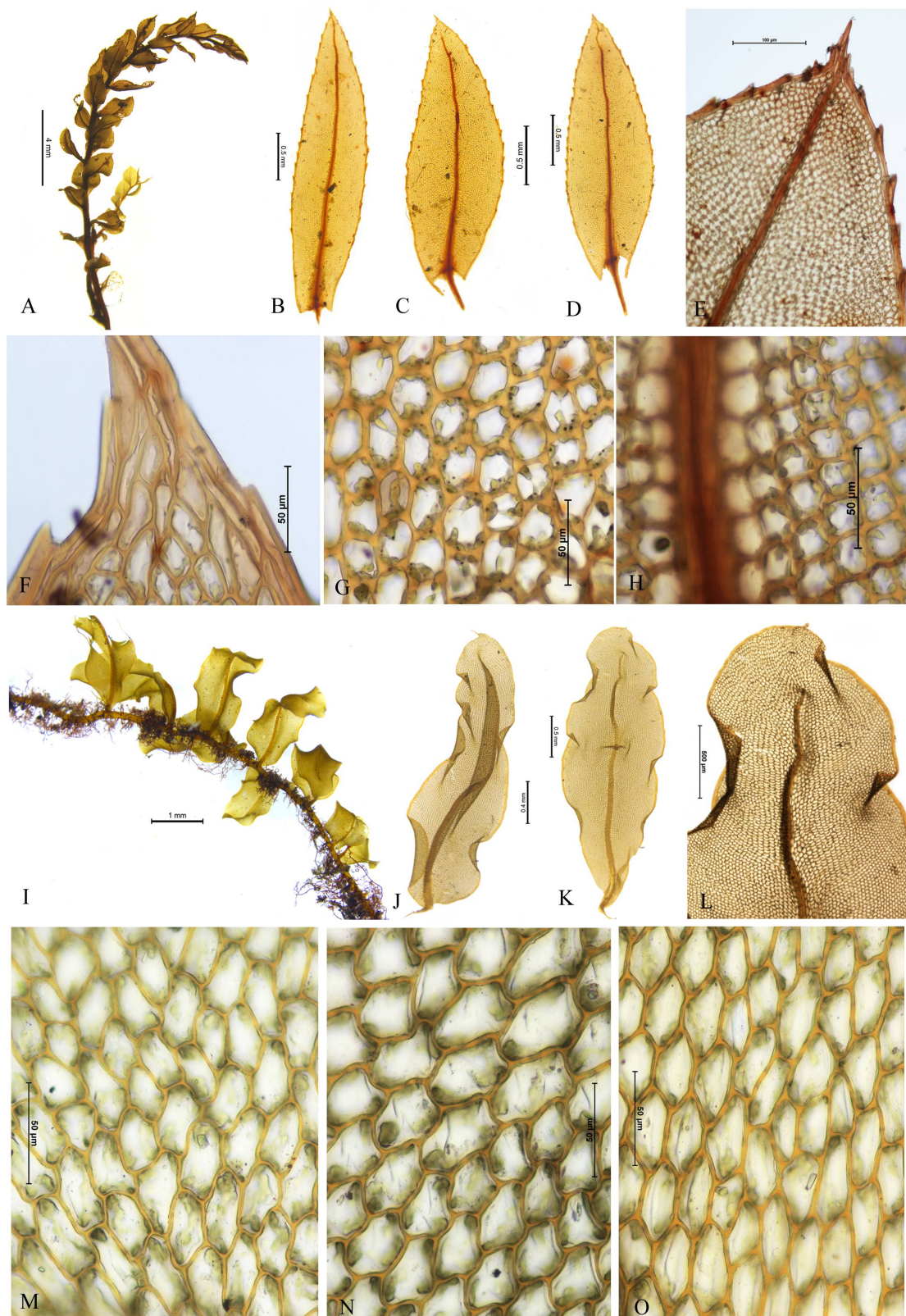


Fig.1. (A–O). *Mnium lycopodioides* Schwager. (LWG 225364C) A–H: A. Plant habit; B–D. Leaves; E. Leaf apex; F. Leaf apical cell; G. Leaf basal cells; H. Leaf median cells. ***Orthomnion bryoides* (Griffith) Nork. (LWG 225495B) I–O:** I. Plant habit; J, K. Leaves; L. Leaf apex; M. Leaf apical cells; N. Leaf median cells; O. Leaf basal cells.

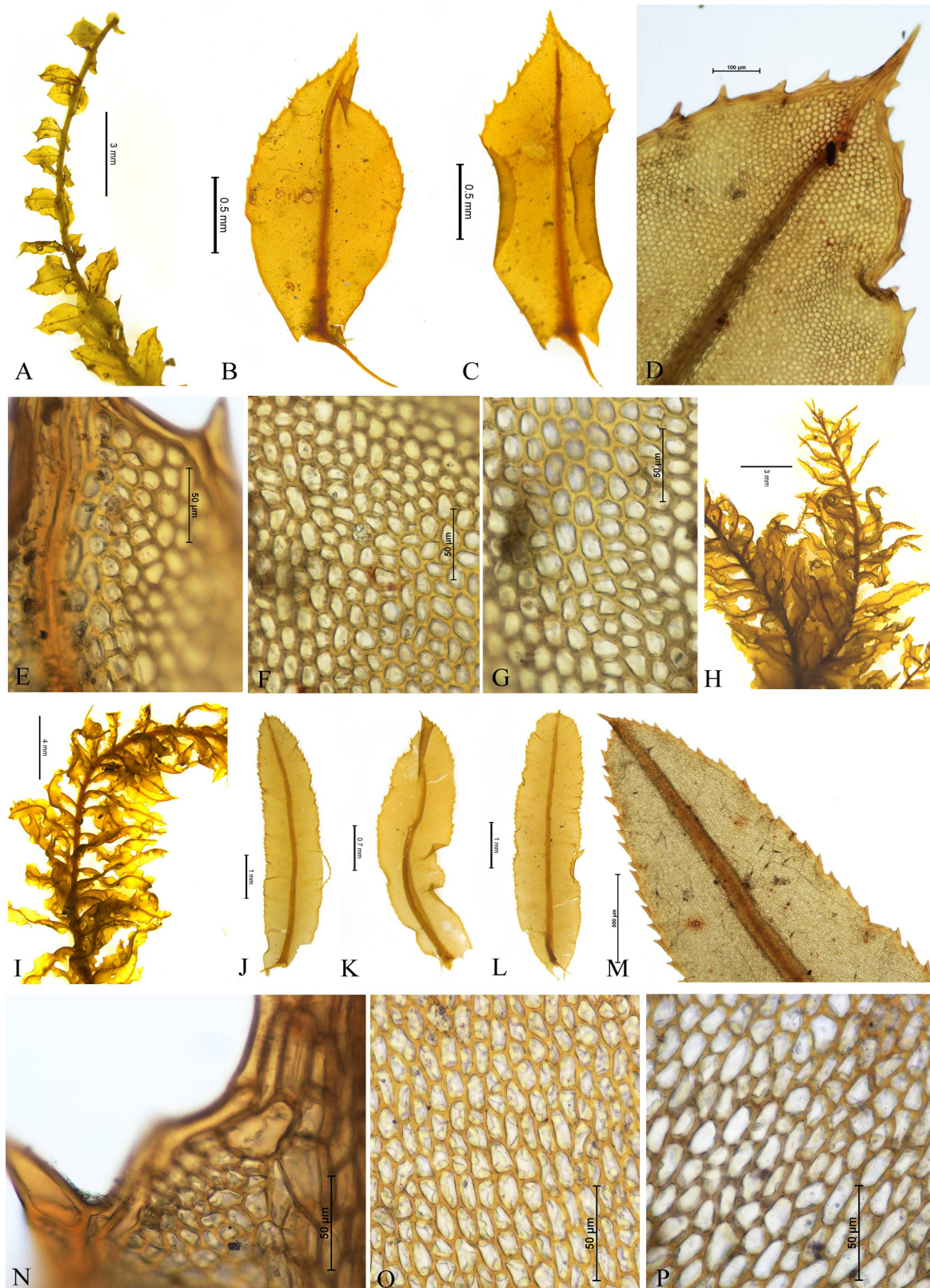


Fig. 2. (A-P). *Plagiomnium acutum* (Lindb.) T. J. Kop. (LWG 223977A) A-G: A. Plant habit; B, C. Leaves; D. Leaf apex; E. Leaf apical cells; F. Leaf median cells; G. Leaf basal cells. *Plagiomnium confertidens* (Lindb. & Arnell) T. J. Kop. (LWG 225364C); H-P: H, I. Plant habit; J-L. Leaves; M. Leaf apex; N. Leaf apical cells; O. Leaf median cells; P. Leaf basal cells.

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| <p>3a. Leaves ovate-lanceolate to broadly elliptic, laminal cells heterogenous (22.5–30 μm)
 <i>Mnium lycodioides</i>*</p> <p>3b. Leaves elliptic to narrowly elliptic, laminal cells homogenous (11.25–18.75 μm).....
 <i>Mnium thomsonii</i></p> | <p>4a. Leaf margin toothed up to middle.....<i>Plagiomnium acutum</i>*</p> <p>4b. Leaf margin toothed up to base.....5</p> <p>5a. Leaf marginal teeth long and sharp.....6</p> <p>5b. Leaf marginal teeth small and blunt.....7</p> |
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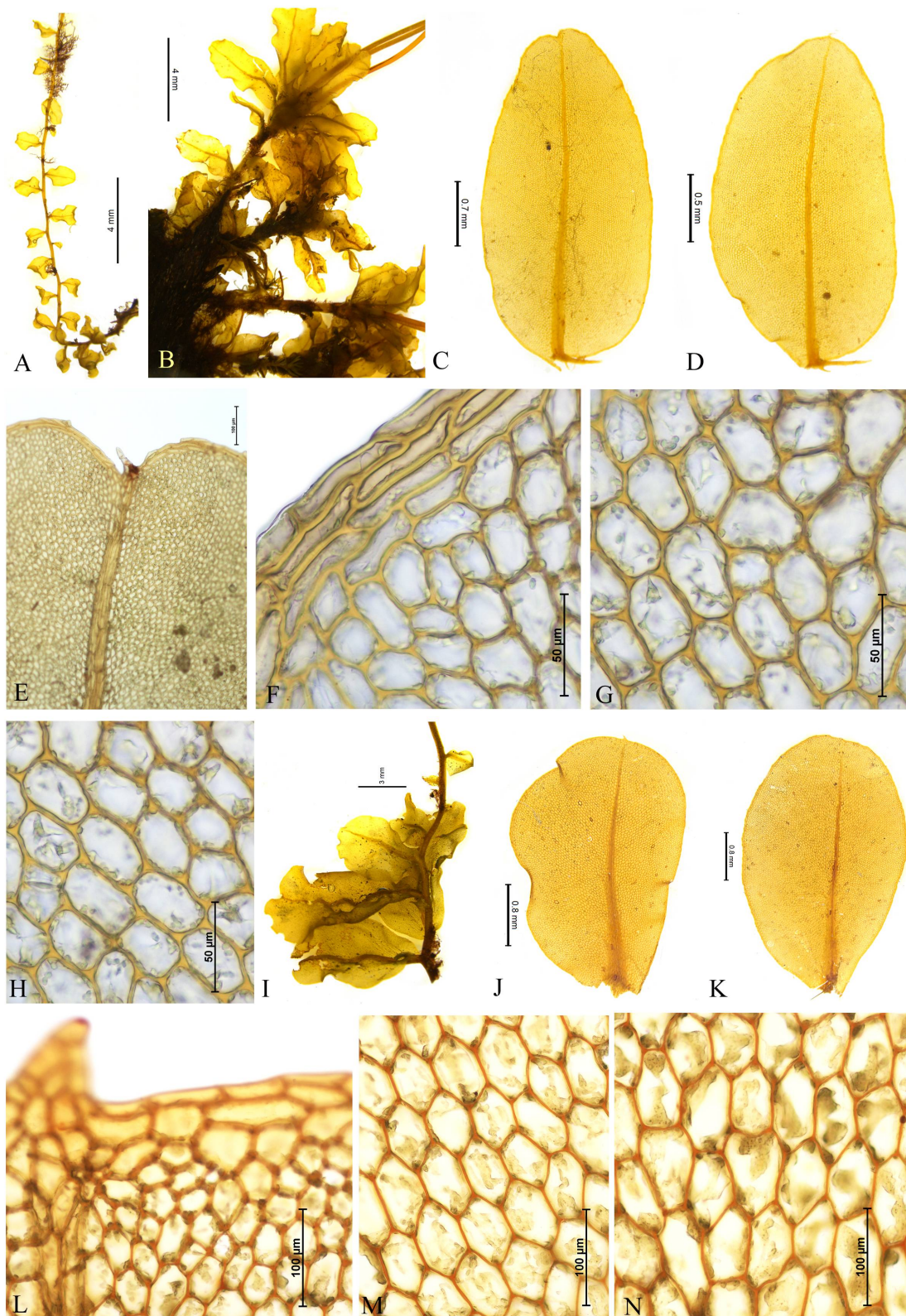


Fig. 3. (A–N). *Plagiomnium rhynchophorum* (Hook.) T. J. Kop. (LWG 223977B) A–H: A, B. Plant habit; C, D. Leaves; E. Leaf apex; F. Leaf apical cells; G. Leaf median cells; H. Leaf basal cells. *Plagiomnium succulentum* (Mitt.); T. J. Kop. (LWG 202050A) I–N: I. Plant Habit; J, K. Leaves; L. Leaf apical cells; M. Leaf median cells; N. Leaf basal cells.

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|---|---|
| <p>6a. Leaves oblong, transversely undulated.....
.....<i>Plagiomnium confertidens</i>*</p> <p>6b. Leaves elliptic to broadly elliptical, not undulated.....<i>Plagiomnium medium</i></p> <p>7a. Leaves with indistinct border, laminal cells much larger.....<i>Plagiomnium succulentum</i>*</p> | <p>7b. Leaves with distinct border, laminal cells smaller.....8</p> <p>8a. Leaf bases not decurrent.....
.....<i>Plagiomnium rostratum</i></p> <p>8b. Leaf bases decurrent9</p> <p>9a. Leaves with undifferentiated juxta costal cells
.....<i>Plagiomnium integrum</i></p> |
|---|---|

- 9b. Leaves with differentiated juxtacostal cells.....10
- 10a. Plants synoicous.....
Plagiomnium rhynchophorum subsp.
*rhynchophorum**
- 10b. Plants dioecous.....
Plagiomnium rhynchophorum subsp.
maximoviczii
- 11a. Leaf margin with undifferentiated border, costa single and branched.....
.....*Pseudobryum cinclidiodes*
- 11b. Leaf margin with differentiated border, costa single and unbranched.....12
- 12a. Plants green to brownish, with plagiotropic shoots.....13
- 12b. Plants reddish, erect, without plagiotropic shoots.....14
- 13a. Leaf border strong, throughout the leaf length.....*Orthomnion bryoides**
- 13b. Leaf border weak, restricted to base, hardly reaching till middle.....*Orthomnion noguchii*
- 14a. Leaves broadly obovate, leaf apex apiculate, laminal cells large.....*Rhizomnium horikawae*
- 14b. Leaves elliptical, leaf apex not apiculate, laminal cells small.....*Rhizomnium striatum*
- (*dealt in the present study)

Mnium Hedw., Spec. Musc. Frond. 188 (1801).

Mnium lycopodioides Schwaegr., Sp. Musc. Frond. Suppl. 2: 24 (1826).

Description

Plants green to reddish brown, erect, leaves closely arranged at apex, 2.5–3 cm long. Leaves ovate lanceolate, 2.5–3.0 × 1.8–2.0 mm, leaf base long decurrent, apex acute, border 2–3 layered, teeth double (paired), costa excurrent, 100–120 µm wide at base, leaf in cross section shows both dorsal and ventral stereid bands. Leaf apical cells short quadrate to isodiametric, 8–20 × 8–20 µm, middle cells thick walled, corner thickenings prominent, 22.5–30 × 18.75–26.25 µm basal cells rectangular, 28–36 × 12–16 µm. (Fig. 1. A–H).

Specimens examined: India, West Bengal, Darjeeling, Tonglu, ca 2500m, epiphytic, 24.04.1965, S. Chandra 202275A (LWG); Tonglu–Sandakphu, ca 3500 m, on soil, 24.04.1965, S. Chandra 202303C, 202341B, 202360A (LWG); Sandakphu–Phalut, ca 3500 m, epiphytic, 26.04.1965, S. Chandra 202396D, 202430F, 202432G, 202436C, 202458A (LWG); on soil, 26.04.1965, S. Chandra 202448D, 202462B, 202477H (LWG); on way to Teesta, ca 1696 m, on stone rock, 26.09.2002, A. K. Asthana and V. Sahu 224155C (LWG); on way to Phalut from Sandakphu, ca 3636 m, on soil covered rock, 06.11.2003, A. K. Asthana and V. Sahu 225380B, 225385A (LWG).

Distribution: India: Eastern Himalaya (Arunachal Pradesh, Sikkim, West Bengal–Darjeeling), Western Himalaya (Garhwal); Afghanistan, Bhutan, China,

Japan, Korea, Nepal, Philippines, Taiwan and Vietnam (3–7).

Other specimens studied: Musci Japonici Exsc. 67 (as *Mnium laevinerve* Card.), 231 (as *Mnium thomsonii* Schimp.) 433.

Orthomnion Wils. in Mitt., Kew J. Bot. 9: 368 (1857).

Orthomnion bryoides (Griffith) Nork., Trans. Brit. Bryol. Soc. 3: 445 (1958).

Orthotrichum bryoides Griffith, Calcutta J. Nat. Hist. 2: 486 (1842).

Description

Plants yellowish green, creeping, reddish brown rhizoids present all over the stem surface, up to 4 cm long. Leaves elliptical to narrowly elliptical, 3–4 × 1.5–2 mm, leaf base not decurrent, apex apiculate, border 3 layered, entire, recurved and wavy when moist, costa narrow percurrent, guide cells not visible, typical stereids lacking in the cross section of leaf. Leaf apical cells elongated hexagonal, 36–48 × 28–40 µm, middle cells elongated hexagonal, thin walled, pitted, incrassate, corner thickening present but not prominent, 37–49 × 19–26 µm, basal cells rectangular, 60–100 × 28–40 µm (Fig. 1. I–O).

Specimens examined: India, West Bengal, Darjeeling, Tiger Hill, ca 2500 m, epiphytic, 19.04.1965, S. Chandra 202180A (LWG); on way to Mungpoo, ca 1757 m, epiphytic, 26.09.2002, A. K. Asthana and V. Sahu 224129A (LWG); on way to Tonglu, ca 2489 m, epiphytic, 02.11.2003, A. K. Asthana and V. Sahu 224346J (LWG); ca 2697 m, epiphytic, 02.11.2003, A. K. Asthana and V. Sahu 224360D (LWG); Sirikhola, Rimbick, ca 2121 m, on rock, 08.11.2003, A. K. Asthana and V. Sahu 225495B (LWG).

Distribution: India: Eastern Himalaya (Assam, West Bengal–Darjeeling, Meghalaya–Khasi and Jaintia Hills, Sikkim), South India; China, Laos, Myanmar, Nepal, Thailand, Vietnam. (4–7, 12).

Other specimens studied: Isotype (232004 H-SOL).

Plagiomnium T. J. Kop., Ann. Bot. Fenn. 5: 146 (1968).

Plagiomnium acutum (Lindb.) T. J. Kop., Ann. Bot. Fenn. 12: 57–58 (1975).

Mnium acutum Lindb., Acta Soc. Sci. Fenn. 10: 227 (1875).

Description

Plants yellowish green, sub erect to prostrate, upper leaves more crowded, 1.5–3 cm long. Leaves contiguous to distantly arranged, ovate spatulate, 2.5–4.0 × 1.2–1.8 mm, leaf base long decurrent, apex acute, border 3–4 layered, teeth sharp, projecting, 1–2 celled, dentate up to middle, costa reddish brown, excurrent, 120–160 µm wide at base, leaf in cross section shows only dorsal stereid band (sometimes both dorsal and ventral stereid bands present). Leaf apical cells quadrate to isodiametric, 12–24 × 8–16 µm, middle cells usually isodiametric, thick walled, corner thickening absent, 15–19 × 15–23 µm, basal cells rectangular, 8–28 × 12–16 µm (Fig. 2. A–G).

Specimens examined: India, West Bengal, Darjeeling, Lloyd Botanical Garden, ca 1818 m, on soil covered rock, 22.09.2002, A. K. Asthana and V. Sahu 223962B, 223966B, 223971B, 223977A (LWG); on way to Sandakphu, ca 3091 m, on soil, 05.11.2003, A. K. Asthana and V. Sahu 225366A (LWG).

Distribution: India: Eastern Himalaya (West Bengal–Darjeeling), Western Himalaya (Kashmir); Bhutan, China, Japan, Korea, Mongolia, Nepal, Russia, Vietnam (4–7).

Other specimens studied: Musci Japonici Exsc. 68, 375 (as *Mnium trichomanes*), Holotype (232001 H-SOL).

Plagiomnium confertidens (Lindb. & Arnell) T. J. Kop., Ann. Bot. Fenn. 5: 146 (1968).

Astrophyllum confertidens Lindb. & Arnell, Kongl. Svenska Vetensk. Akad. Handl. n.s. 23 (10): 17 (1890).

Description

Plants yellowish green, robust, erect, dendroid with subterranean stolons, branched, 4–7 cm long. Leaves curled when dry, oblong, elliptical to lingulate, 5–8 × 2–3 mm, leaf base long decurrent, apex acute, border 2–4 layered, teeth blunt 1–2 celled, dentate up to base, costa excurrent, 240–260 µm wide at base, leaf in cross section shows only dorsal stereid band. Leaf apical cells short quadrate to isodiametric, 8–12 × 8 µm, middle cells rectangular, slightly pitted, thick walled, corner thickening prominent, 33–38 × 11–15 µm, basal cells rhomboidal hexagonal 20–40 × 12–16 µm (Fig. 2. H–P).

Specimens examined: India, West Bengal, Darjeeling, Forest Rest House, ca 2000 m, on soil, 16.04.1965, S. Chandra 202023A (LWG); Tonglu–Sandakphu, ca 2500 m, epiphytic, 25.04.1965, S. Chandra 202322D, 202342A (LWG); Sandakphu–Phalut, ca 3500 m, on soil, 26.04.1965, S. Chandra 202379C, 202400D (LWG); Kalipokhri, ca 2909 m, on soil covered rock, 05.11.2003, A. K. Asthana and V. Sahu 225357G (LWG); on way to Sandakphu, ca 3091 m, on soil covered rock, 05.11.2003, A. K. Asthana and V. Sahu 225364C, 225376D (LWG).

Distribution: India: Eastern Himalaya (West Bengal–Darjeeling); Bhutan, China, Japan, Manchuria, Mongolia, Nepal, North Korea, Siberia (4, 6, 7).

Other specimens studied: Musci Japonici Exsc. 435 (as *Mnium undulatum* Hedw.)

Plagiomnium rhynchophorum (Hook.) T. J. Kop., Hikobia 6: 57 (1971).

Mnium rhynchophorum Hooker, Icon. Pl. 1, tab. 20, Fig. 3 (1836).

Description

Plants yellowish green, prostrate, densely tomentose, 3–7 cm long. Leaves oblong elliptic, 3–7 × 1.8–2 mm, leaf base decurrent, apex obtuse to emarginated, border 3–4 layered, teeth blunt, 1–2 celled, not projecting, rarely absent, costa conspicuous, percurrent or mucronate at apex, 80–200 µm wide at base, dorsal epidermis thick walled, ventral slightly thick walled, guide cells visible, leaf in cross section shows only dorsal stereid band. Leaf apical cells

isodiametric to hexagonal or polygonal, 12–24 × 8–12 µm, middle cells elongated hexagonal, 34–38 × 23–27 µm, thin walled, corner thickening prominent, juxtacostal cells present, basal cells rectangular, 40–68 × 12–20 µm (Fig. 3. A–H).

Specimens examined: India, West Bengal, Darjeeling, ca 2000 m, epiphytic, 18.04.1965, S. Chandra 202075C, 202077B, 202089A (LWG); Mungpoo, ca 2000 m, epiphytic, 18.04.1965, S. Chandra 202102A, 202105D, 202115B, 202116A, 202124C (LWG); Sandakphu–Tonglu, ca 3500 m, epiphytic, 26.04.1965, S. Chandra 202430 D, 202454 (LWG); Lloyd Botanical Garden, ca 1818 m, on stony wall, 22.09.2002, A. K. Asthana and V. Sahu 223944B, 223977B, 223950B, 223959A (LWG); on soil covered rock, 31.10.2003, A. K. Asthana and V. Sahu 224288B, 224289A (LWG); Manebhanjang, ca 1879 m, on soil covered rock, 01.11.2003, A. K. Asthana and V. Sahu 224311C (LWG); Singalila National Park, ca 2515 m, epiphytic, 03.11.2003, A. K. Asthana and V. Sahu 225305A (LWG); Gurdum, ca 2394 m, on soil covered rock, 08.11.2003, A. K. Asthana and V. Sahu 225452A (LWG).

Distribution: India: Eastern Himalaya (West Bengal–Darjeeling, Meghalaya–Khasia Hills), South India (Nilgiri hills); Borneo, Bhutan, China, Indonesia, Nepal, North Vietnam, Myanmar, Philippines, Sabah, Sri Lanka, Taiwan, Thailand (4–8).

Plagiomnium succulentum (Mitt.) T. J. Kop., Ann. Bot. Fenn. 5: 147 (1968).

Mnium succulentum Mitt., J. Proc. Linn. Soc. Bot. Suppl. 1: 143 (1859).

Description

Plants yellowish green, prostrate, branched, 3–4 cm long. Leaves open when dry, oblong ovate to broadly elliptic, 8–10 × 6–7 mm, leaf base not decurrent, apex apiculate, border 1–2 layered, inconspicuous, entire or minutely dentate, teeth blunt, 1–2 celled, costa weak, ending below apex, 120–140 µm wide at base, leaf in cross section shows only dorsal stereid band. Leaf apical cells hexagonal, 48–88 × 40–48 µm, middle cells much larger elongated hexagonal, thin walled, corner thickening absent, 101–128 × 37–41 µm, basal cells rectangular, 60–88 × 32–44 µm (Fig. 3. I–N).

Specimens examined: India, West Bengal, Darjeeling, on way to Manebhanjang, ca 2000 m, epiphytic, 17.04.1965, S. Chandra 202050A (LWG).

Distribution: India: Eastern Himalaya (Assam, West Bengal–Darjeeling (Kurseong, Mungpoo), Meghalaya–Khasia Hills); Bonin Islands, Bhutan, China, Japan, Nepal, North Borneo, Indonesia, Malaysia, Myanmar, Korea, North Vietnam, Philippines, Taiwan, Thailand (4–8).

Other specimens studied: Musci Japonici Exsc. 230.

Discussion

The recent study reveals the occurrence of six taxa of family Mniaceae in Darjeeling (Fig. 4) belonging to three genera *Mnium*, *Plagiomnium* and *Orthomnion*. Genera *Mnium* and *Orthomnion* are represented by

single species each while *Plagiomnium* is represented by four species. *Mnium lycopodiodes* Schwaegr. is remarkably different from *Orthomnion* and *Plagiomnium* in having red colour on stem, paired tooth, two stereid bands in cross section of costa, whereas *Orthomnion bryoides* (Griffith) Nork. morphologically characterised by plagiotropic shoots, entire leaf margin, costa ceasing below tip or excurrent, well developed leaf border and no stereid band in cross section of costa. *Plagiomnium acutum* (Lindb.) T. J. Kop. comes under the section *Plagiomnium* T. J. Kop. of genus *Plagiomnium* and can be easily differentiated from all other species in

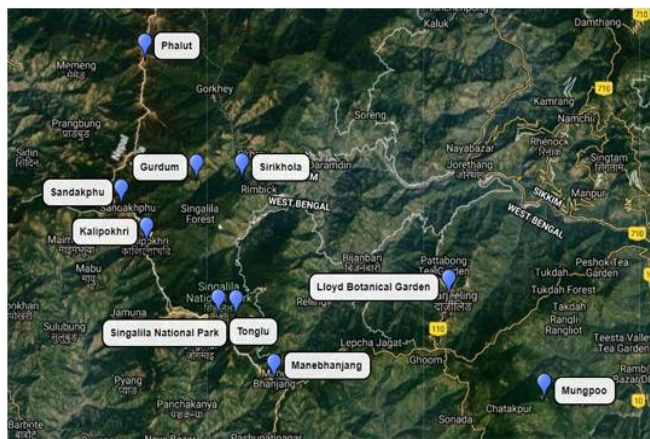
belongs to section *Undulata* (Kindb.) T. J. Kop., having oblong leaves toothed up to base. Although *Plagiomnium succulentum* (Mitt.) T. J. Kop. and *Plagiomnium rhynchophorum* (Hook.) T. J. Kop. belong to same section *Rostrata* (Kindb.) T. J. Kop., but former species comprises of not decurrent leaf bases, much larger laminal cells, costa vanishing below tip whereas the latter has decurrent leaf bases, smaller laminal cells and excurrent costa.

According to earlier published literatures (4-6), all the 18 species described and enlisted by them were treated in genus *Mnium* Hedw. which are now placed in distinct genera with 14 species (1, 3, 6, 8, 13). During the present study, it was found that some species described earlier have been synonymized or their status is changed. This work is based on the collections made from selected 10 localities of Darjeeling and specimens were deposited in CSIR-National Botanical Research Institute, Lucknow (LWG). After critical and comparative study with authentic Herbarium specimens obtained on loan from Finnish Museum of Natural History, Botanical Museum (H) and recent literature, the updated number of taxa in Darjeeling is now 15 with *Plagiomnium acutum* (Lindb.) T. J. Kop. as new report to eastern Himalaya.



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Competing interest

Authors do not have any conflict of interest to declare.

Authors' contribution

The first and second authors identified the specimens and prepared the manuscript, photo plates and map of the study area. The second and third author carried out field explorations to Darjeeling and neighbouring areas and collected the plant specimens. The third and corresponding authors finalized and investigated all the details, checked the manuscript and submitted for publication.

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Coordinates of Localities

Phalut	27° 12' 25.398" N, 88° 0' 56.7612" E
Sandakphu	27° 6' 18.4752" N, 88° 0' 5.6052" E
Manebhanjang	26° 59' 14.19" N, 88° 7' 18.3144" E
Singalila National Park	27° 2' 11.8356" N, 88° 4' 33.9312" E
Gurdum	27° 7' 25.9284" N, 88° 3' 29.0448" E
Rimbick Sirikhola	27° 7' 50.6784" N, 88° 4' 28.9884" E
Kalipokhari	27° 5' 1.7988" N, 88° 0' 55.1664" E
Tonglu	27° 1' 37.0632" N, 88° 5' 35.1456" E
Mungpoo	26° 58' 39.7668" N, 88° 20' 23.1828" E
Llyod Botanical Garden	27° 2' 43.2564" N, 88° 15' 46.0188" E

Fig. 4. Map of Darjeeling showing localities of study area with their co-ordinates.

in obovate and distally toothed leaves, while *Plagiomnium confertidens* (Lindb. & Arnell) T. J. Kop.

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