



RESEARCH ARTICLE

Diversity of mosses in some selected regions of Nagaland (North-East India), India

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Abstract

During an investigation on mosses of some underexplored regions of Nagaland, 121 taxa of mosses belonging to 74 genera and 29 families have been identified. *Atrichum crispulum* Schimp. & Besch. and *Plagiothecium neckeroideum* var. *niitakayamae* (Toyama) Z. Iwats. are new records for India. Five taxa namely *Fissidens crassinervis* var. *laxus* (Sull & Lesq.) A. Eddy., *Barbula inaequalifolia* Taylor, *Amblystegium saxatile* Schimp., *Dicranum orthophylloides* Dixon and *Fabronia madurensis* Dixon & Vard. are reported for the first time from Eastern Himalaya, while 57 taxa are new additions to Nagaland.

Keywords

Eastern Himalaya, India, Nagaland

Introduction

Nagaland state is located in the north-east region of India, between latitude 25°10'N to 27°4'N and longitude 93°15' E to 95°6'E. The state is surrounded by Assam at North-West and West, Arunachal Pradesh at North, Myanmar in the East and Manipur towards South. The state is having 12 districts with an area of about 16579 km². It has been the centre of attraction for Botanists in terms of Biodiversity. 75.31% of the state area is covered under dense forests (1). The natural vegetation of Nagaland is tropical evergreen, coniferous and temperate evergreen type varies according to altitudinal gradient. Nagaland is rich in medicinal plants and also home for large number of animals. The vegetation of this area is mainly *Alnus*, *Bambusa*, *Castanopsis*, *Quercus*, *Elaeocarpus*, *Dipterocarpus*, *Juniperus*, *Pinus*, *Prunus*, *Rhododendron*, *Taxus* and *Terminalia* species. It receives annual rainfall of the 1800–2500 mm and maximum rainfall occurs in the month of May to September. The state usually has monsoon climate being largely influenced by topography of the hilly region. The altitude of Nagaland ranges between 160 m to 3841 m with average annual temperature of 18 to 25 °C. Saramati is the highest peak (3841 m) in the state. Nagaland is one of the rich bryogeographical regions of India. The information on the bryophytes of Nagaland has so far been provided earlier by few bryologists (2-14).

With reference to studies on bryophytes of this area, there are 77 taxa of mosses from different areas of Nagaland (14). A new species, *Anthoceros pandei* Udar & Asthana had been reported from Nagaland (2). Reports are there on 3 species of *Brachymerium* Schwaegr, viz. *B. bryoides* Hook., *B. capitulatum* (Mitt.) Kindb. and *B. longicolle* Ther. from Nagaland (3). Again

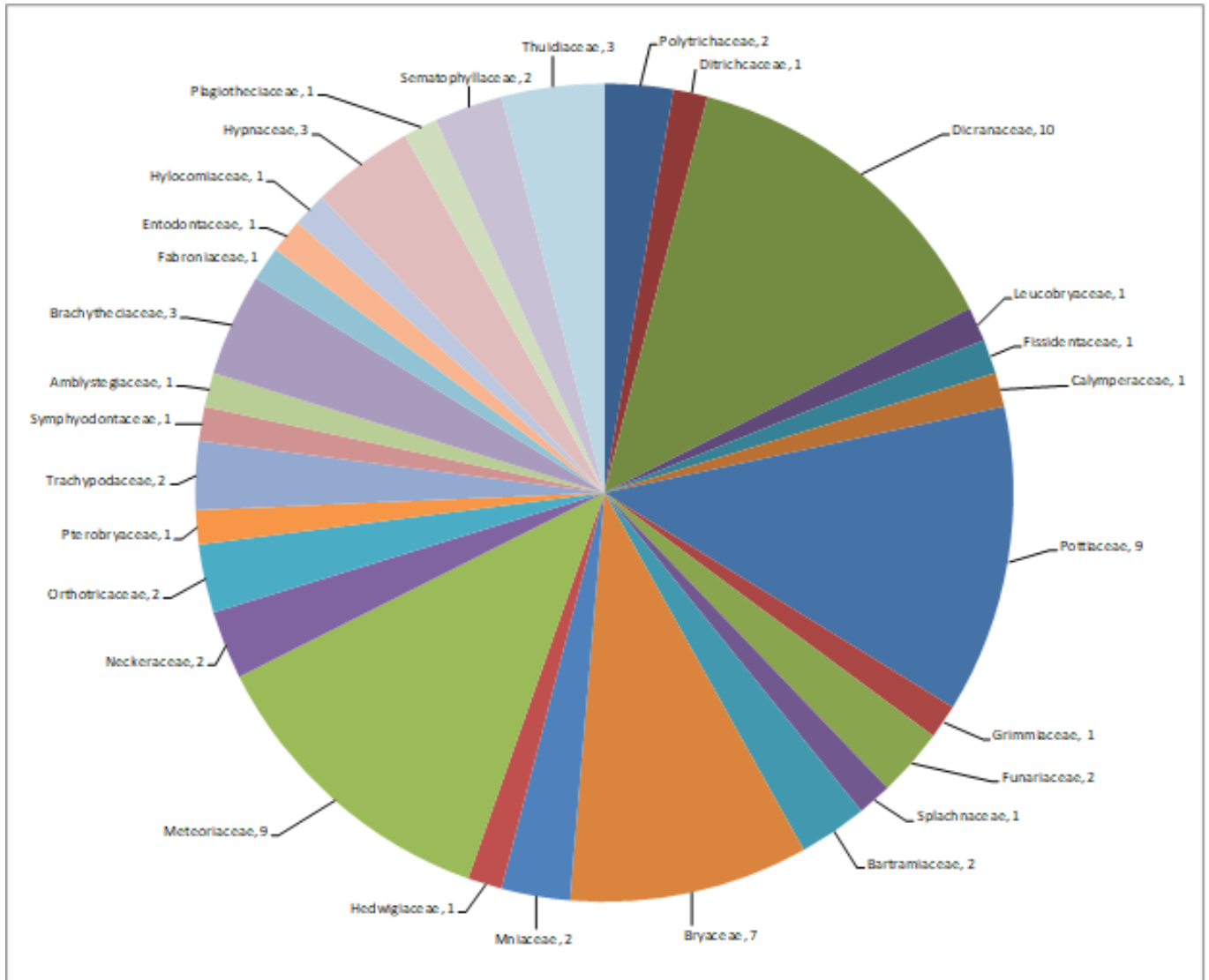


Fig. 1. Different genera of Mosses found in different families in Nagaland.

reports are on 12 taxa of mosses [*Hyophila nymaniana* (M. Fleisch.) M. Menzel, *Entodontopsis leucostega* (Brid.) W. R. Buck & Ireland, *Fabronia secunda* Mont., *F. schensiana* Mull. Hal., *Brachytenium capitulatum* (Mitt.) Paris, *B. longicolle* Ther., *Plagiothecium cavifolium* (Brid.) Z. Iwats. *P. neckeroideum* var. *sikkimense* Renaud & Cardot, *Regma-*

odon orthostegius Mont., *Floribundaria floribunda* (Dozy & Molck.) M. Fleisch., *Entodon scariosus* Renaud & Cardot, *Erythrodonium julaceum* (Schwaegr.) Paris] and 4 species of liverworts [*Frullania ericoides* Nees, *F. wallichiana* Mitt. *Lejeunea cavifolia* (Ehrh.) Lindb. and *L. curviloba* Steph.] from Nagaland growing on *Thuja orientalis* L. (4). Three

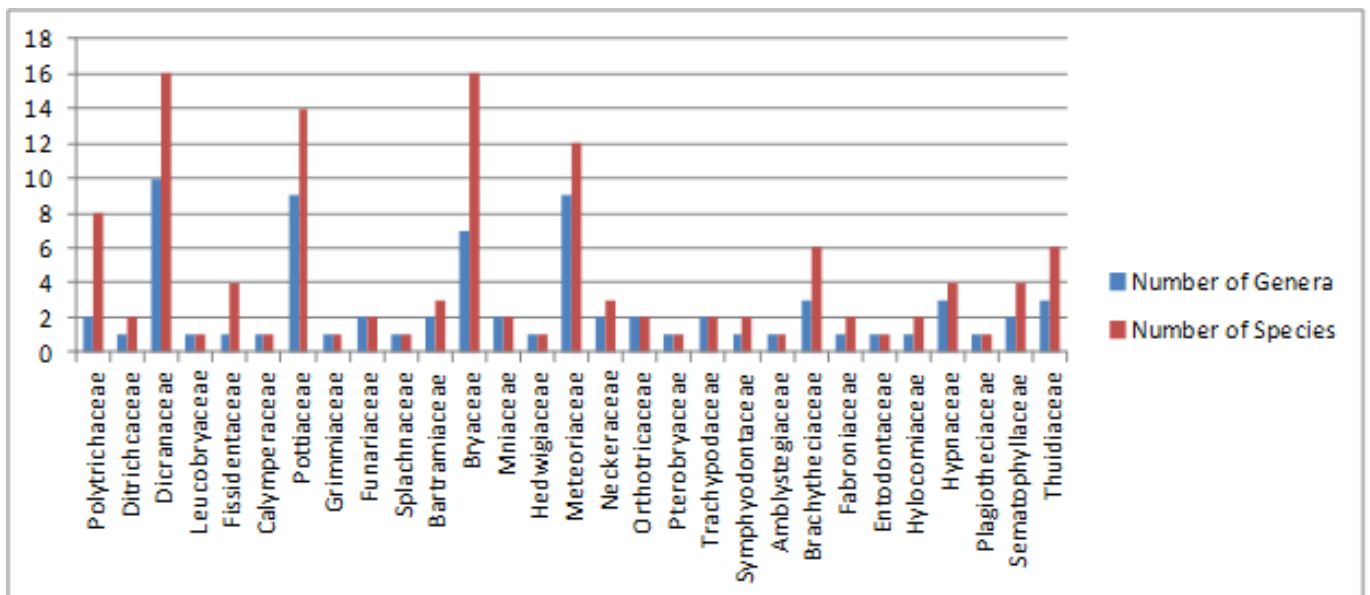


Fig. 2. Number of Genera and species recorded in moss Families.

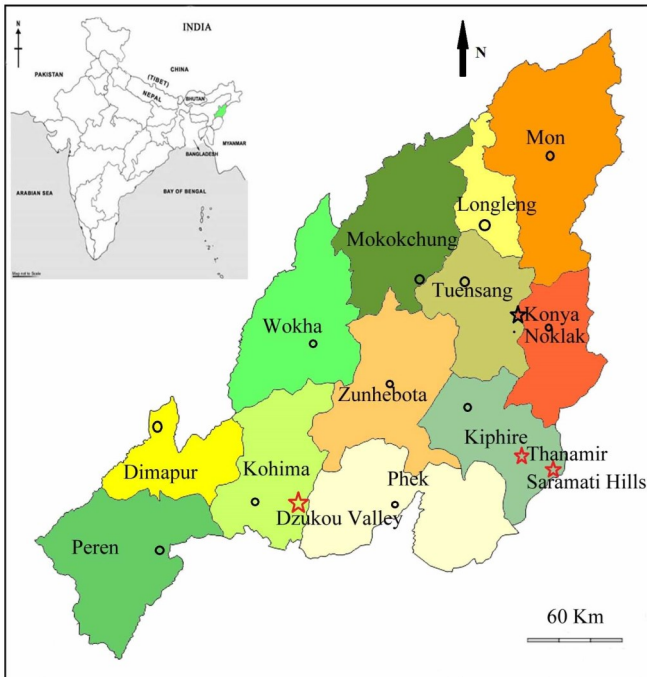


Fig. 3. Map showing study sites in Nagaland.

species of genus *Frullania* Raddi were also described from Nagaland viz. *F. ericoides* Nees, *F. muscicola* Steph. and *F. wallihiana* Mitt. (5). Reports are also available on the diversity of thalloid liverworts in Mokokchung and Zunheboto districts, Nagaland (6). There are reports on five moss taxa [*Dicranum lorifolium* Mitt., *Homaliodendron montagnanum* (Mull. Hal.) M. Fleisch., *Cyathophorella adiantum* (Griff.) M. Fleisch., *Ptychomitrium indicum* (Schrad.) A. Jaeger and *Trachypodopsis serrulata* (P. Beauv.) M. Fleisch.] as first time record from Nagaland (7). Abnormal asexual reproduction was reported in *Asterella khasiana* (Griff.) Pandey, K. P. Srivast. & Sultan Khan from Nagaland (8). Reports are there on six species of *Bazzania* Gray from Nagaland [*B. appendiculata* (Mitt.) S. Hatt., *B. himalayana* (Mitt.) Schiffn., *B. sikkimensis* (Steph.) Herzog., *B. ovistipula* (Steph.) Abeyw., *B. praerupta* (Reinw. Blume & Nees) Trevis and *B. tricrenata* (Wahlenb.) Trevis.] (9). Records are also available on the distributional range of Genus *Saccogynidium* Grolle (Hepaticae: Geocalyceaceae) in North East India (10). There were 4 species of genus *Scapania* (Dumort.) Dumort. described from Nagaland [*S. ferruginea* (Lehm. & Lindenb.) Gottsche, *S. griffithii* Schiffn., *S. ligulata* Steph. and *S. parva* Steph.] (11). There are reports on 3 species of *Radula* Dumort. (*R. javanica* Gottsche, *R. madagascarensis* Gottsche and *R. obscura* Mitt. from Nagaland (12). Three species of *Herbertus*, Gray viz. *H. dicranus* (Taylor & Gottsche et al.) Trevis, *H. aduncus* (Dicks.) Gray and *H. arminatus* (Steph.) H.A. Mill for the first time from Nagaland were described (13). A review of literature on contributions of the Mosses of Nagaland indicates that approximately 90 taxa of mosses were reported from Nagaland prior to our study. Present study revealed 57 taxa as new addition to the moss flora of Nagaland. At present, 121 taxa of mosses belonging to 74 genera and 29 families are enumerated with habitat, altitudinal gradient and specimen numbers (Supplementary Table 1, Figs. 1 & 2).

Present study revealed 2 taxa as new to India, viz.

Atrichum crispulum and *Plagiothecium neckeroideum* var. *niitakayamae* and 5 taxa, viz. *Amblystegium saxatile*, *Barbula inaequalifolia*, *Dicranum orthophylloides*, *Fabronia madurensis* and *Fissidens crassinervis* var. *laxus* (Sull & Lesq.) A. Eddy. new to Eastern Himalaya.

Materials and Methods

Plant samples were collected from different localities of Nagaland, viz. Dzukou valley, Saramati Hills, Thanamir, Tuensang, Konya, Noklak and Mokokchung (Fig. 3) and dried in blotting paper for 3-4 days and preserved in brown paper packets. The specimens were deposited in the Bryophyte Herbarium, CSIR-National Botanical Research Institute, Lucknow (LWG).

Taxonomic Description

Atrichum crispulum Schimp. ex Besch. in Ann Sci. Nat. Bot. ser. 7, 17: 351. 1893.

Plants green at apex and yellowish or brown below, growing in dense tufts, erect, 1-2.5 cm long. Leaves crisped and curled when dry and erect spreading when moist, closely imbricate, narrowly oblong, 6-7 mm long and 0.8-1 mm wide, apex acuminate, costa percurrent, 120-140 μ m wide at base, margin sharply serrate in the upper half, teeth spinose, biseriate, extending to near leaf base, margin 2-3 layered. In cross section of leaf lamellae usually 1-2 cells high rarely 3. Leaf apical cells quadrate-hexagonal, 8-20 μ m long and 8-12 μ m wide. Basal cells hyaline, rectangular, 28-60 μ m long and 16-20 μ m wide.

Notes

Atrichum crispulum is differentiated with *A. undulatum* on the basis of height of the lamellae that are generally 4-5 cells high in *A. undulatum* while 1-2 cells (rarely 3) high in *A. crispulum*.

Distribution

Canada, China, Korea, Japan, Philippines, Taiwan, USA. New to India.

Plagiothecium neckeroideum Schimp. var. *niitakayamae* (Toyama) Z. Iwats. in J. Hattori Bot. Lab. 33: 354. 1970.

Plants bright green, main stem creeping, branches erect, 3-4 cm long, densely foliate. Leaves erectopatent, ovate oblong, 1.2 mm long and 0.8-1 mm wide, costa two with forks, covering 1/3 rd of the leaf length, margin minutely dentate at apex. Filamentous gemmae present on leaf tips. Leaf apical cells 60-88 μ m long and 4-8 μ m wide, elongated rhomboidal. Basal cells 28-60 μ m long and 16-20 μ m wide. Leaves weakly asymmetrical, base narrow decurrent, wing composed of narrowly elongated cells, end cells triangular.

Notes

P. neckeroideum var. *niitakayamae* can be separated from *P. euryphyllum* (Cardot & Ther) Z. Iwats. by having propaguliferous leaf apices and widely decurrent base.

Distribution

China, Philippines, Taiwan (Formosa). New to India.

Amblystegium saxatile Schimp., Syn. Musc. Eur. 595. 1860.

Plants green, prostrate, irregularly branched. Leaves on drying irregularly spreading, ovate-lanceolate, 1.5-1.8 mm long and 0.56-0.64 mm wide, margin entire or minutely dentate, apex abruptly acuminate, costa reaching half of the leaf, 36-44 μm wide at base. Leaf apical cells incrassate, linear rhomboidal, 40-80 μm long and 8 μm wide. Median cells linear rhomboidal, 60-80 μm long and 4-8 μm wide. Basal cells at alar region short quadrate to rectangular, incrassate, 16-24 μm long and 12-16 μm wide.

Notes

Amblystegium saxatile is distinct from other species in having large leaves and incrassate leaf cells.

Distribution

Western Himalaya (Kashmir, Himachal Pradesh-Chamba); Britain, Czech Republic, Ecuador, France, Germany, North America, Norway, Poland, Sweden, Switzerland, Yugoslavia. New to Eastern Himalaya.

Barbula inaequalifolia Taylor in London J. Bot. 5: 49.1846.

Plants yellowish brown, erect, usually unbranched. Leaves closely imbricate, erectopate, appressed to stem when dry, ovate, 1.28 mm long and 0.56-0.64 mm wide, apex obtuse, margin reflexed, costa ending just below apex 80 μm wide almost same width throughout. Leaf apical cells 8-12 μm long and 8 μm wide, papillose. Leaf basal cells rectangular 28-60 μm long and 12 μm wide, smooth. Numerous gemmae present in leaf axils. Gemmae unicellular, brown, rounded, smooth, 20-24 μm wide.

Notes

Barbula inaequalifolia is differentiated from *Barbula obscura* Mitt. by having obtuse apex and ovate leaves.

Distribution

South India (Tamil Nadu), western Himalaya (Himachal Pradesh); China, Colombia, Ecuador, Nepal, North America, Southern Mexico. New to Eastern Himalaya.

Dicranum orthophylloides Dixon in Notes Roy. Bot. Gard. Edinburgh, 19: 280 (1938).

Plants robust, green, erect, up to 10 cm long, branched. Leaves closely imbricate, falcate, up to 6-9 mm long and 0.8-1 mm wide, lanceolate, gradually narrowing from sheathing base into a long canaliculated subula, costa percurrent, dentate at tip and back, 160 μm wide at base. Leaf margin dentate at upper portion. Leaf apical cells 40-60 μm long and 8-12 μm wide, rhomboidal. Basal cells near margin at alar region reddish, short rectangular 40-68 μm long and 28-40 μm wide, near costa hyaline. Leaf cells at base rectangular, incrassate with highly porose longitudinal wall, 60-80 μm long and 16-24 μm wide.

Distribution

Western Himalaya (Uttarakhand); Nepal. New to Eastern Himalaya.

Fabronia madurensis Dixon & P. de la Varde in Arch. Bot. Bull. Mens. 1 (8-9): 171. 1927.

Plants minute, prostrate, yellowish green, irregularly branched. Leaves erectopate wide spreading, ovate lanceolate, 0.64 mm long and 0.16 mm wide, gradually taper-

ing into a long piliferous flexuose acumen, costa covering half of the margin, margin irregularly serrate up to base. Leaf apical cells 40-80 μm long and 4-8 μm wide, incrassate, linear rhomboid. Basal cells quadrate, 8-12 μm long and 8-12 μm wide, extending upwards obliquely for some distance. Seta 3-4 mm long, erect. Capsule ovoid, erect, 0.8-1 mm long and 0.40-0.48 mm in diameter, operculum conical. Peristome lanceolate, 160-172 μm long and 60 μm wide at base. Spores yellowish brown, rounded, papillose, 16-20 μm wide.

Notes

Fabronia madurensis is distinct from other Indian species in having longer leaf cells and piliferous flexuose leaf apex.

Distribution

South India (Tamil Nadu), Western Himalaya (Himachal Pradesh). New to Eastern Himalaya.

Fissidens crassinervis var. *laxus* (Sull & Lesq.) A. Eddy., Handb. of Malaes. Mosses 1: 70 (1988).

Plants yellowish green, 5-8 mm long and 2-2.2 mm wide including leaves, about 6-10 pairs of leaves present. Leaves ligulate lanceolate, 1.8-2 mm long and 0.32-0.40 mm wide, sheathing lamina open, covering half of the leaf, apex mucronate, B/L = $\pm 20.24/100$, S/L = $\pm 51.21/100$. Leaf apical cells, quadrate, 4-8 μm papillose. Basal cells rectangular, 12-16 μm long and 4-12 μm wide. Leaf margin crenulate due to projection of cells. Limbium absent but several rows of elongated cells present at extreme base margin of sheathing lamina.

Distribution

South India (Andhra Pradesh); Borneo, China, Japan, Malaysia, Myanmar, Nepal, Philippines, Singapore, Sri Lanka, Thailand, Vietnam.

Results and Discussion

Species Endemic to India

Nineteen species, viz. *Bartramia leptodonta* Wils., *Brachymerium sikkimense* Renaud & Cardot, *Brothera leana* (Sull.) Müll. Hal., *Brotherella filiformis* Dixon, *Bryum billardieri* Schwäegr., *Calyptothecium dixonii* Gangulee, *Chionoloma orthodontum* (Müll. Hal.) M. Alonso, M.J. Cano & J.A. Jiménez, *Didymodon hastatus* (Mitt.) R. H. Zander, *Ditrichum apophysatum* Hamp. ex Gangulee, *Ectropothecium manii* Broth., *Fabronia madurensis* Dixon & Vard., *Fissidens laxus* Sull. & Lesq., *Ptychostomum pallescens* (Schleich. ex Schwäegr.) J.R. Spence, *Rhynchostegiella asamica* Cardot & Dixon, *R. divaricatifoila* (Renaud & Cardot) Broth., *Rhynchostegium duthiei* Müll. Hal. ex Dixon, *Symblepharis vaginata* (Hook.) Wijk. & Margad, *Symphyodon complanatus* Dixon and *Symphyodon oblongifolius* (Renaud & Cardot) Broth. are presently identified from Nagaland and are considered endemic to India.

Taxa with frequent Occurrence

Anomobryum auratum (Mitt.) A. Jaeger, *A. concinnatum* (Spruc.) Lindb., *Campylopus ericoides* (Griff.) A. Jaeger., *C. schimperii* J. Milde, *Entosthodon wichurae* M. Fleisch, *Lepto-*

dontium viticulosoides (P. Beauv.) Wijk. & Margad, *Macrothamnium macrocarpum* (Reinw. & Hornsch.) M. Fleisch., *Microcampylopus khasianus* (Griffith) Giese & J.-P. Frahm., *Plagiomnium rhynchophorum* (Hook.) T.J. Kop., *Pogonatum microstomum* (Schwäegr) Brid., *P. neesii* (Müll. Hal.) Dozy, *Pohlia gedeana* (Bosch. & Lac.) Gangulee, *Ptychostomum pallescens* (Schleich. ex Schwäegr.) J.R. Spence, *Rhynchostegiella divaricatifoila* (Renauld & Cardot) Broth., *Rosulabryum capillare* (Hedw.) J.R. Spence, *Toloxis semitorta* (Müll. Hal.) W.R. Buck., *Thuidium cymbifolium* (Dozy & Molk.) Dozy & Molk. and *Trachypodopsis serrulata* (P. Beauv.) M.Fleisch. var. *crispatula* (Hook.) Zanten showed higher frequency of occurrence in the study area (SupplementaryTable 1, Fig. 1).

Taxa with few populations

There are some taxa which were recorded only from single locality in the study area. These species include *Aerobryidium aureo-nitens* (Schwäegr.) Broth., *Amblystegium saxatile* Schimp., *Barbella bombycina* (Renauld & Cardot) M. Fleisch., *Barbula inaequalifolia* Taylor, *Bartramia leptodonta* Wils., *Brachymenium sikkimense* Renauld & Cardot, *Brachythecium buchananii* (Hook.) A. Jaeger, *Brothera leana* (Sull.) Müll. Hal., *Brotherella curvirostris* (Schwäegr.)

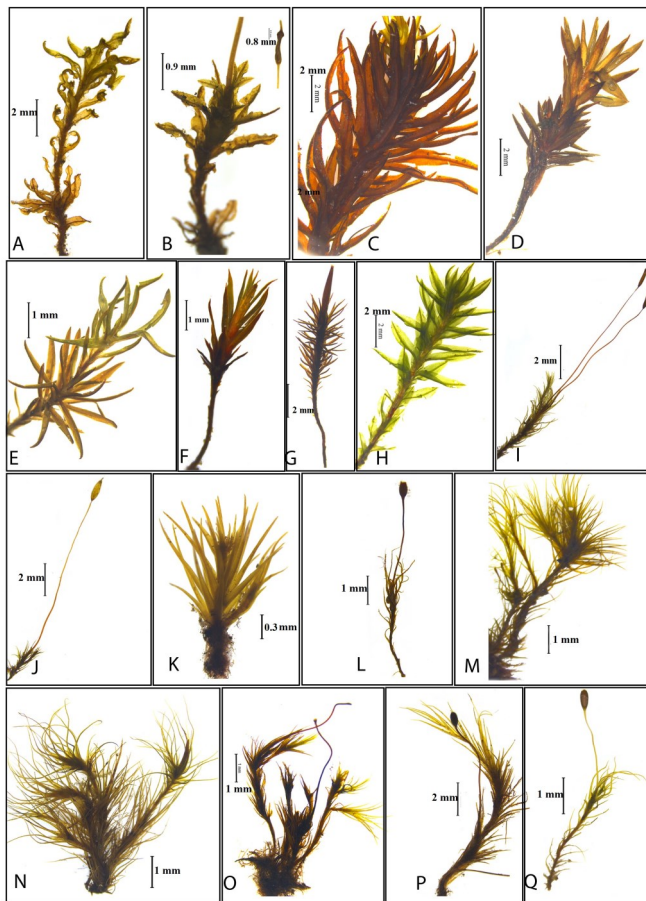


Fig. 4. Mosses of Nagaland. **A.** *Atrichum crispulum*. **B.** *A. undulatum*: Plant and Capsule. **C.** *Pogonatum cirratum* subsp *cirratum*. **D.** *P. microstomum*. **E.** *P. neesii*. **F.** *P. perichaetiale* ssp. *perichaetiale*. **G.** *P. patulum*. **H.** *P. proliferum*. **I.** *Ditrichum apophysatum*: Plant with sporophyte. **J.** *D. heteromallum*: Plant with sporophyte. **K.** *Brothera leana*. **L.** *Campylopediella himalayana*: Plant with sporophyte. **M.** *Campylopus ericoides*. **N.** *C. pyriformis*. **O.** *C. schimidii*. **P.** *C. schimperii*: Plant with sporophyte. **Q.** *Dicranella divaricata*: Plant with sporophyte.

M. Fleisch., *B. filiformis* Dixon, *Campylopediella himalayana*

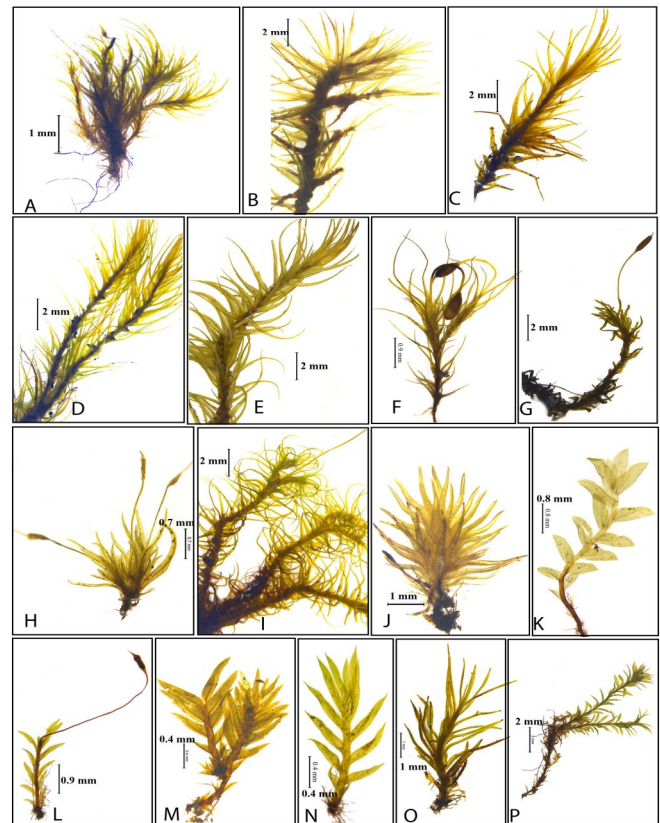


Fig. 5. Mosses of Nagaland. **A.** *Dicranodontium didymodon*. **B.** *Dicranum crispifolium*. **C.** *D. lorifolium*. **D.** *D. orthophylloides*. **E.** *D. scoparium*. **F.** *Microcampylopus khasianus*: Plant with sporophyte. **G.** *Oreoweisia laxifolia*: Plant with sporophyte. **H.** *Rhabdoweisia crenulata*: Plant with sporophyte. **I.** *Symblepharis vaginata*. **J.** *Leucobryum juniproideum*. **K.** *Fissidens bryoides*. **L.** *F. crassinervis* var. *laxus*: Plant with sporophyte. **M.** *F. pulchellus*. **N.** *F. zollingeri*. **O.** *Syrrophodon gardneri*. **P.** *Anoetangium thomsonii*.

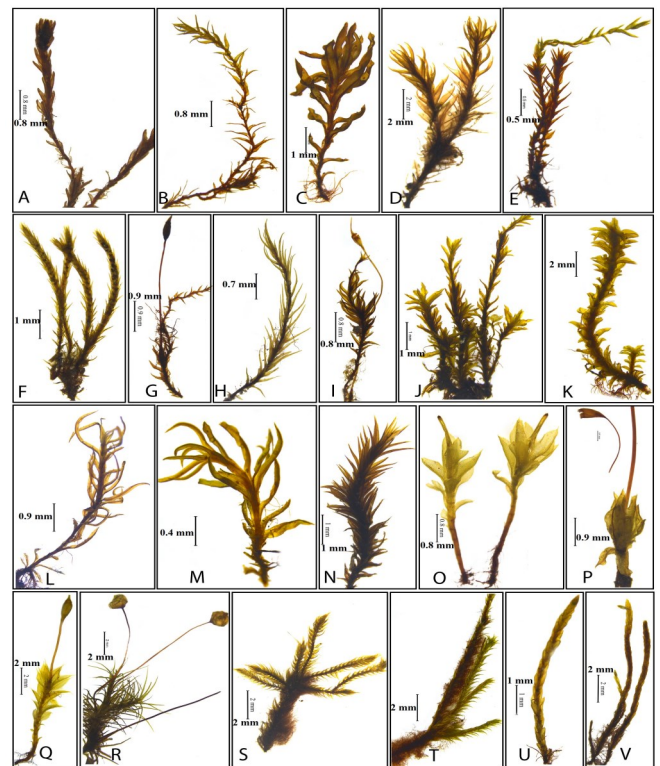


Fig. 6. Mosses of Nagaland. **A.** *Barbula inaequalifolia*. **B.** *Bellibarbula recurva*. **C.** *B. wallichii*. **D.** *Syntrichia gemmascens*. **E.** *Didymodon hastatus*. **F.** *D. michiganensis*. **G.** *Didymodon nigrescens*: Plant with sporophyte. **H.** *D. vinealis*. **I.** *Hymenostylium recurvirostrum*: Plant with sporophyte. **J.** *Leptodontium flexifolium*. **K.** *L. viticulosoides*. **L.** *Chionoloma tenuirostre*. **M.** *Chionoloma orthodontum*. **N.** *Racomitrium subsecundum*. **O.** *Entosthodon wichuriae*. **P.** *Funaria hygrometrica*. **Q.** *Tayloria subglabra* var. *spinosa*: Plant with sporophyte. **R.** *Bartramia leptodonta*: Plant with sporophyte. **S.** *Philonotis angusta*. **T.** *P. falcata*. **U.** *Anomobryum auratum*. **V.** *A. concinatum*.



Fig. 7. Mosses of Nagaland. **A.** *Brachytenium capitulatum*. **B.** *B. ptychothecium*: Plant and Capsule. **C.** *B. sikkimense*: Plant with sporophyte. **D.** *Bryum argenteum*: Plant with sporophyte. **E.** *B. billardieri*. **F.** *Gemmabryum exile*. **G.** *Pohlia campotrichela*. **H.** *P. elongata*: Plant and Capsule. **I.** *P. flexuosa*: Plant and Capsule. **J-K.** *P. gedeani*: Plant with sporophyte. **L.** *Pohlia ludwigii*. **M.** *Pohlia minor* ssp. *acuminata*. **N.** *Ptychostomum pallescens*. **O.** *Rosulabryum capillare*. **P.** *Plagiommium rhynchophorum*. **Q.** *Rhizomnium striatulum*. **R.** *Bryowijkia ambigua*

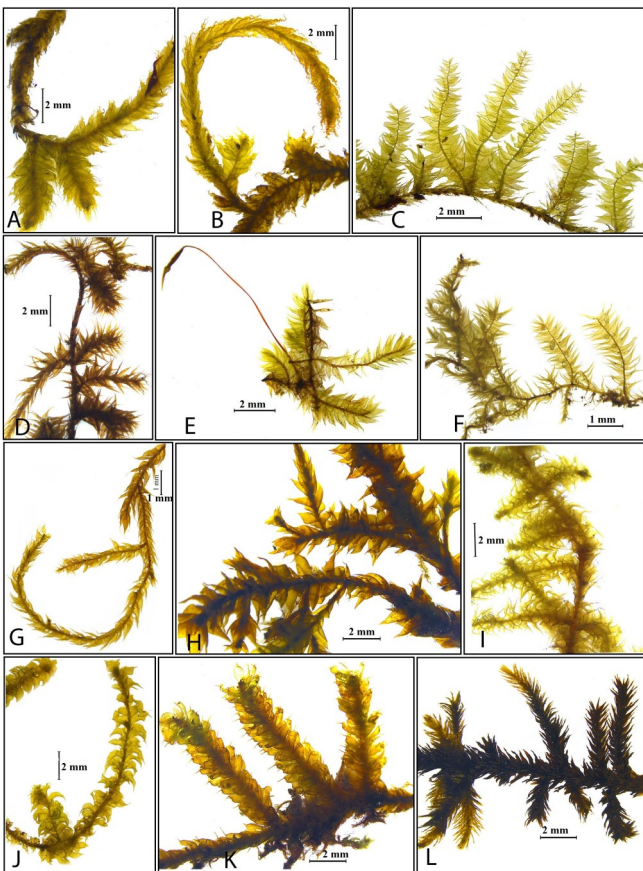


Fig. 8. Mosses of Nagaland. **A.** *Aerobryidium aureo-nitens*. **B.** *A. filamentosum*. **C.** *Barbella bombycina*. **D.** *Pseudotrachypus convolvens*. **E.** *Pseudotrachypus stevensii*: Plant with sporophyte. **F.** *Floribundaria floribunda*. **G.** *Trachycladella sparsa*. **H.** *Meteoriella soluta*. **I.** *Meteoriopsis reclinata*. **J.** *M. squarrosa*. **K.** *Meteorium buchananii*. **L.** *Toloxia semitorta*

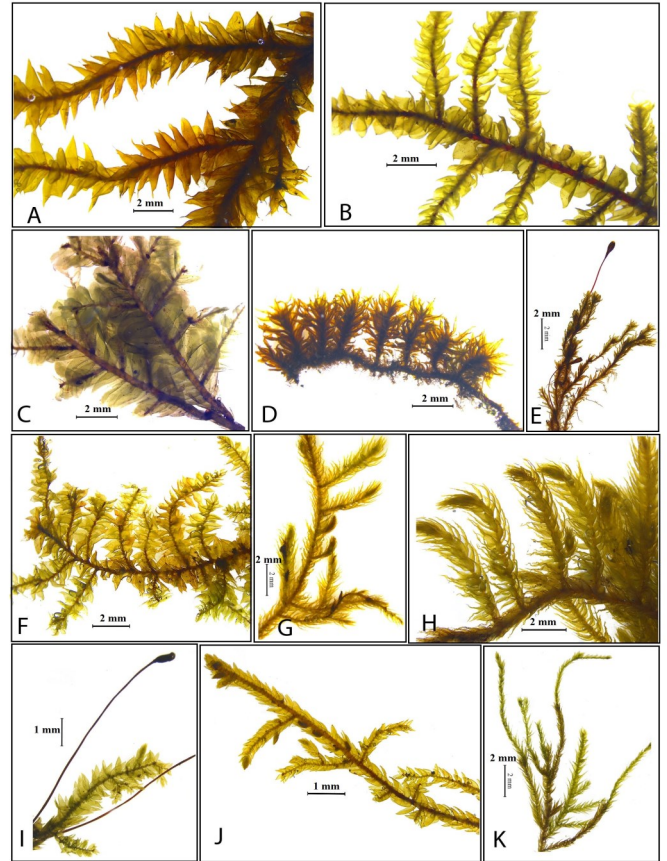


Fig. 9. Mosses of Nagaland. **A.** *Calyptothecium dixonii*. **B.** *C. hookeri*. **C.** *Homaliodendron montagneum*. **D.** *Macromitrium moorcroftii*. **E.** *Leratia obtusifolia*: Plant with sporophyte. **F.** *Penzigiella cordata*. **G.** *Duthiella declinata*. **H.** *Trachypodopsis serrulata* var. *crispatula*. **I.** *Symphiodon complanatus*: Plant with sporophyte. **J.** *S. oblongifolius*. **K.** *Amblystegium saxatile*.

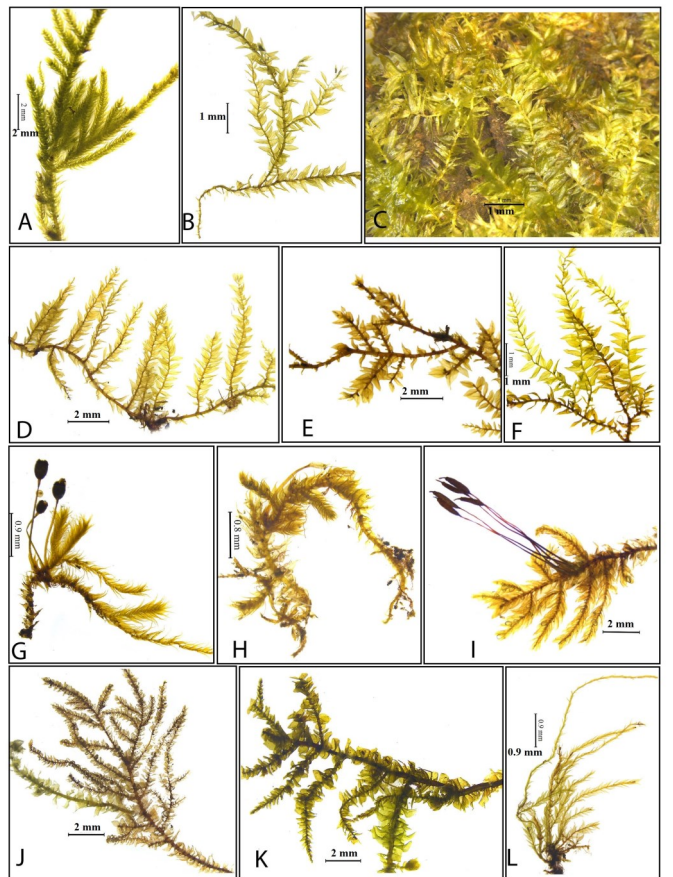


Fig. 10. Mosses of Nagaland. **A.** *Brachytenium buchananii*. **B.** *Rhynchostegiella assamica*. **C.** *R. divaricatifoila*. **D.** *Rhynchostegium duthiei*. **E.** *R. herbaceum*. **F.** *R. planiusculum*. **G.** *Fabronia madurensis*: Plant with sporophyte. **H.** *F. secunda*. **I.** *Entodon prorrepens*: Plant with sporophyte. **J.** *Macrothamnium leptohymenioides*. **K.** *M. macrocarpum*. **L.** *Ectropothecium manii*.

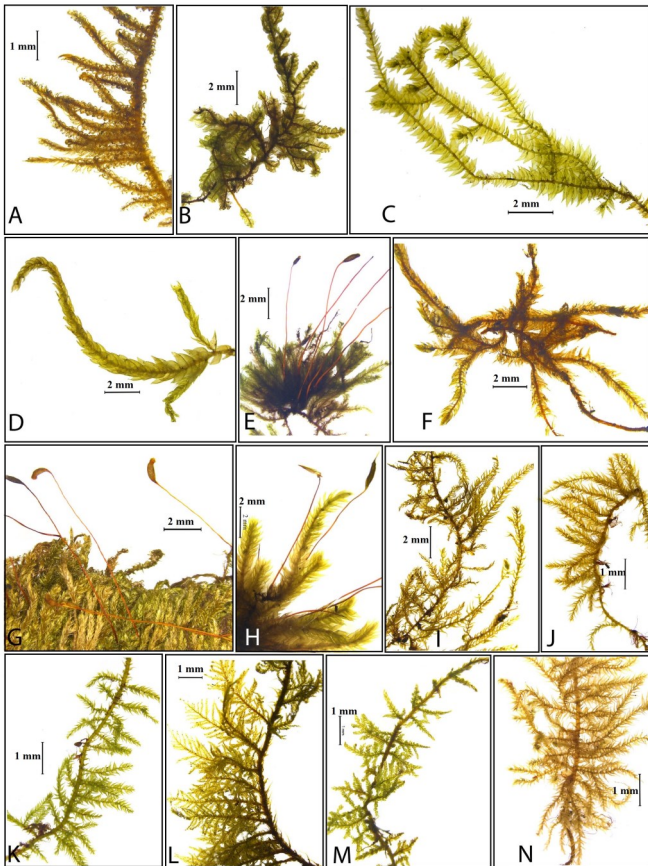


Fig. 11. Mosses of Nagaland. **A.** *Hypnum cupressiforme*. **B.** *H. sikkimense*. **C.** *Taxiphyllum taxirameum*. **D.** *Plagiothecium neckeroideum* var. *niitakayamae*. **E.** *Brotherella curvirostris*: Plant with sporophyte. **F.** *B. filiformis*. **G.** *B. nictans*: Plant with sporophyte. **H.** *Sematophyllum subpinnatum*: Plant with sporophyte. **I.** *Claopodium prionophyllum*. **J.** *Haplocladium angustifolium*. **K.** *H. schimperii*. **L.** *Thuidium cymbifolium*. **M.** *T. pristocalyx* var. *pristocalyx*. **N.** *T. delicatulum*.

(Broth.) J.P. Frahm., *Calyptothecium dixonii* Gangulee, *C. hookeri* (Mitt.) Broth., *Campylopus pyriformis* (Schultz) Brid., *Chionoloma orthodontum* (Müll. Hal.) M. Alonso, M.J. Cano & J.A. Jiménez., *Dicranella divaricata* (Mitt.) A. Jaeger, *Dicranum crispifolium* Müll. Hal., *D. orthophylloides* Dixon, *Didymodon michiganensis* (Steere) K. Saito, *D. nigrescens* (Mitt.) K. Saito, *D. vinealis* (Brid.) R. H. Zander, *Ditrichum apophysatum* Hamp. ex Gangulee, *D. heteromalum* (Hedw.) Brit., *Duthiella declinata* (Mitt.) Zanten, *Ectropothecium manii* Broth., *Entodon prorepens* (Mitt.) A. Jaeger., *Fabronia madurensis* Dixon & Vard., *F. secunda* Mont., *Fissidens pulchellus* Mitt., *F. zollingeri* Mont., *Floribundaria floribunda* (Dozy & Molck.) M. Fleisch., *Haplocladium angustifolium* (Hamp. & Müll. Hal.) Broth., *H. schimperii* Ther., *Hymenostylium recurvirostrum* (Hedw.) Dixon, *Hypnum cupressiforme* Hedw., *H. sikkimense* Ando, *Leratia obtusifolia* (Hook.) Goffinet, *Leucobryum juniproideum* (Brid.) Müll. Hal., *Macromitrium moorcroftii* (Hook. & Grev.) Schwaegr., *Meteoriella soluta* (Mitt.) S. Okamura, *Meteorium buchananii* (Brid.) Broth., *Oreoweisia laxifolia* (Hook. f.) Kindb., *Plagiothecium neckeroideum* var. *niitakayamae* (Toyama) Z. Iwats, *Philonotis falcata* (Hook.) Mitt., *Pohlia ludwigii* (Schwaegr) Broth., *Pseudotrachypus convolvens* (Mitt.) W.R. Buck, *Pseudotrachypus stevensii* (Renauld & Cardot) W.R. Buck, *Racomitrium subsecundum* (Hook. & Grev.) Mitt., *Rhabdoweisia crenulata* (Mitt.) H. Jameson, *Rhizomnium striatulum* T.J. Kop., *Rhynchostegium duthiei* Müll. Hal. & Dixon, *Sematophyllum subpinnatum* (Brid.) E. Britton, *Symphiodon*

complanatus Dixon, *S. oblongifolius* (Renauld & Cardot) Broth., *Syntrichia gemmascens* (P. C. Chen) R. H. Zander, *Syrhophodon gardneri* (Hook.) Schwäegr., *Trachycladiella sparsa* (Mitt.) M. Menzel (Supplementary Table 1, Fig. 1 & 2).

Conclusion

During the present study investigation on the bryophytes collected from Dzukou valley, Saramati Hills, Thanamir, Tuensang, Konya, Noklak and Mokukchung have been carried out. It revealed the occurrence of 121 species of mosses belonging to 74 genera of 29 families (Figs. 4-11). Among the investigated families in mosses Bryaceae, Dicranaceae and Pottiaceae are more dominant in the region, followed by Meteoriaceae and Polytrichaceae. *Pogonatum* P. Beauv. and *Pohlia* Hedw. have maximum 6 numbers of taxa followed by *Fissidens* Hedw. and *Dicranum* Hedw. both represented by 4 species each.

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Authors contributions

HS and AKS collected fresh moss samples from different localities of Nagaland; VS studied the collected specimens, carried out their identification, preserved them in Herbarium of LWG and drafted the manuscript. AKA authenticated the identity of specimens reported in the paper, improved the manuscript and supervised the whole study.

Compliance with ethical standards

Conflict of interest: The authors do not have any conflict of interests to declare.

Ethical issues: None

Supplementary data

Supplementary Table 1. Occurrence of different Moss taxa in the study area of Nagaland

References

1. Forest Survey of India, Nagaland. 2019;192-201. (fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-nagaland.pdf).
2. Udar R, Asthana AK. A new *Anthoceros* from Nagaland. J Indian Bot Soc. 1985;64:303-05. <https://doi.org/10.1007/BF03053240>

3. Bansal P, Nath V, Chaturvedi SK. Morphotaxonomic study on the genus *Brachymenium* Schwaegr. from Nagaland (North-eastern Hills), India. *Phytomorphology*. 2010;60(3&4):150-55.
4. Bansal P, Nath V, Chaturvedi SK. Epiphytic bryophytes on *Thuja orientalis* in Nagaland, North-eastern India. *Bangladesh J Plant Taxon*. 2011;18(2):163-67. <https://doi.org/10.3329/bjpt.v18i2.9303>
5. Nath V, Chaturvedi SK, Bansal P. Studies on the genus *Frullania* Raddi of Nagaland. In: Gupta, RC. Editor, Nagaland University Research Communication, Cambridge University Press India Pvt. Ltd., New Delhi. 2010; p. 171-78.
6. Chaturvedi SK, Chaturvedi S. Diversity of thalloid liverwort in Mokokchung and Zunheboto districts, Nagaland, India. In: Mohamed H, Baki BB, Nasrulhaq-Boyce A, Lee PKY. Editors. *Bryology in the new Millennium*. Kuala Lumpur: University of Malaya. 2008; p. 83-91.
7. Chaturvedi SK, Sale V. Morphotaxonomic study on some corticolous mosses of Longkhum reserve forest, Mokokchung, District, Nagaland. *Bionature*. 2011;31(1):1-12.
8. Chaturvedi SK, Eshuo K. Abnormal asexual reproduction in *Asterella khasiana* (Griff) Pande, K. P. Srivast. and Sultan Khan (Marchantiophyta: Hepaticae) from Nagaland. *Int J Pl Reprod Biol*. 2012;4(2):89-92.
9. Eshuo K, Chaturvedi SK. New distributional record for six species of *Bazzania* S. F. Gray (Lepidoziaceae) from Nagaland, India and their morpho-taxonomic studies. In: Ghosh C., Das AP. Editors. *Recent studies in Biodiversity and Traditional knowledge in India*. Published by Gour Mahavidyalaya Malda. 2011a; p. 45-57.
10. Eshuo K, Chaturvedi SK. Distributional range of Genus *Saccogynidium* Grolle (Hepaticae: Geocalyceae) in North East India. *Bionature*. 2011b;31(2):85-89.
11. Eshuo K, Chaturvedi SK, Sale V. Morpho-taxonomic studies on genus *Scapania* (Dumort.) Dumort.: Hepaticae In Nagaland, India. *Indian J. Fundamental App Life Sci*. 2012;2(2):42-50.
12. Eshuo K, Lokho A, Doulo V. Morpho-taxonomic studies on genus *Radula* Dumort. (Radulaceae: Hepaticae) from Nagaland, North East India. *Indian J Plant Sci*. 2013;2(3):66-72.
13. Eshuo K. Studies on genus *Herbertus* Gray and its new extensional distribution to North East India Sub-region. *Int J Curr Microbiol App Sc*. 2014;3(3):187-95.
14. Gangulee H.C. *Mosses of Eastern India and Adjacent Regions*, Vol. I-III. Books and Allied (P) Ltd., Kolkata, India. 1969-80.

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