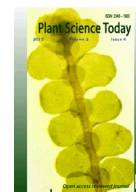




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Research Communication

## The state of *Scapania ligulata* Steph. (Scapaniaceae, Marchantiophyta) in Western Himalaya, India

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Abstract

The two subspecies of the leafy liverwort, *Scapania ligulata* Steph., namely, subsp. *ligulata* and subsp. *stephanii* (Mull Frib.) Potemkin, Piippo & T.J. Kop., collected from the Kumaun and adjacent region in Western Himalaya, India are being described and compared. The report of the presence of the subspecies *stephanii* in this region confirms the fact that the *ligulata-stephanii* species complex having both subspecies migrated to Himalaya. The paper provides some additional distinctive features between the two subspecies.

Keywords

*Scapania*; Leafy liverwort; Kumaun; Western Himalaya; *ligulata-stephanii* complex

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### Introduction

In course of survey of the liverwort flora of Kumaun region and adjoining areas, located in Uttarakhand state of Western Himalaya, we recently came across some populations of an interesting species of *Scapania* (Dumort.) Dumort. at Gwaldam (79.56°E; 30.00°N; alt. 1882 m). The population had all the shades ranging between green to reddish brown and were rhizomatous in nature. A closure examination of the specimens suggested these to be *S. ligulata* subsp. *stephanii* (Müll Frib.) Potemkin, Piippo & T. J. Kop. A perusal of literature on the occurrence of this species in Western Himalaya revealed that Srivastava & Srivastava (2007) had described a taxon, namely, *S. stephanii* K. Müll. and an 'ecotype' from Champawat (80.08°E; 29.40°N; alt. 1649 m) in Kumaun region. On the basis of closer similarities, *S. stephanii* K. Müll. had often been considered a synonym of *S. ligulata* Steph. However, recently Potemkin *et al.* (2004), based on their observations, segregated the *ligulata-stephani* complex into two subspecies. In the light of this development, the issue remained unresolved as to which of the two subspecies the Champawat

specimens belonged? Therefore, the herbarium specimens of Champawat, described by Srivastava & Srivastava (2007), were also critically examined and revalued in the present study: and, the subspecies described by them subsequently turned out to be that of *S. ligulata* Steph. subsp. *ligulata* and its 'ecotype' as *S. ligulata* subsp. *stephanii* (Müll Frib.) Potemkin, Piippo & T. J. Kop.

As the situation stands today, both the subspecies namely *S. ligulata* subsp. *ligulata* and *S. ligulata* subsp. *stephanii* are now known from the Kumaun region and adjacent areas in Western Himalaya in India (Plate 1).

The two taxa may be separated as follows:

Plants smaller, 8 to 13 mm long, green to reddish brown; stem cortex in 2 – 3 layers; leaf – lobes triangularly ovate with a distinct pointed tip, marginal teeth absent or 1 – 2 indistinctly present; gemmae largely unicellular

-----*S. ligulata* subsp. *stephanii*

Plants larger, 10 to 30 mm long, dark brown; stem cortex in 3 – 4 layers; leaf – lobes broader and obtuse to subacuminate, marginal teeth rather common; gemmae 2-(1) celled

-----*S. ligulata* subsp. *ligulata*

With the inclusion of the two sub species of *S. ligulata* Steph. the total number of *Scapania* taxa in the Western Himalaya becomes twelve (Kashyap 1932; Srivastava & Srivastava 1993; Parihar *et al.* 1994; Srivastava & Srivastava 1995; Dandotiya *et al.* 2007; Srivastava & Srivastava 2007; Singh & Singh 2009). These include: *S. aequiloba* (Schwaegr.) Dumort., *S. ferruginea* (Lehm. & Lindenb.) Gottsche *et al.*, *S. glaucocephala* (Taylor) Austin, *S. griffithii* Schiffn., *S. orientalis* Steph., *S. parva* Steph., *S. purpurea* Kash., *S. stephanii* K. Müll. (*S. ligulata* Steph. subsp. *ligulata*), *S. ligulata* Steph. subsp. *stephanii* (Müll Frib.) Potemkin, Piippo & T. J. Kop., *S. udarii* Srivastava & Srivastava, *S. undulata* (L.) Dumort, and *S. verrucosa* Heeg.

The paper describes the two taxa collected from the Kumaun and adjacent region in the Western Himalaya, submits an ecological note and discusses their probable radiation.

## Materials and Methods

The morphological studies of both fresh and herbarium specimens were made using Motic BA 210 Digital microscope. The slides of various plant parts including hand sections were mounted in glycerine jelly. The field photographs were taken by Olympus camera. All the specimens are deposited in Duthie Herbarium, Botany Department, University of Allahabad.

## Description

### *Scapania ligulata* subsp. *stephanii* (Mull Frib.) Potemkin, Piippo & T. J. Kop.

Ann.Bot. Fennici 41:423 (2004); *Scapania stephanii* C. Muell, Nova Acta Acad. Caes. Leop.-Carol, German Nat. Cur. 83:273 (1905); Amakawa & Hattori, Journ. Hattori Bot. Lab. 12: 96 (1954). (Plate 2: Figures A-L).

Plants small, 8 to 13 mm long, 1.5 to 3.0 mm wide with leaves, green to reddish brown, in tufts, arising from a dark brown to blackish creeping rhizomatous portion. Stem 0.18 – 0.3 mm wide, rigid, brown, ascending, simple or sparingly branched, branches intercalary; in cross section the cortex and medulla well differentiated, the cortical cells in 2 to 3 layers, 10-12 x 12-20 µm, dark to light brown, walls as thick as or thicker than the radial diameter of cell cavity, medullary cells larger, 20-28 x 12-20 µm, thin-walled, pale to white. Rhizoids numerous, long, colourless, confined to rhizomatous portion only. Leaves much smaller near the base but gradually becoming larger towards the apex of the stem, all leaves in a plant may be green, reddish brown or a mix of the two colours with upper leaves turning brown first, 8 to 12 pairs, distant but imbricate towards the stem apex, widely spreading and and unequally bilobed. Keel short, 0.2 to 0.5 mm long, about 1/4.5 of the leaf-lobule, dorsally somewhat concave, 2 to 3 celled thick. Leaf-lobe appressed to stem, triangularly ovate,

arching halfway or more the stem width, nearly transversely inserted, not decurrent, 0.4 – 0.6 mm long and 0.35 – 0.5 mm wide, 0.35 of the length of the leaf-lobule, acuminate with a sharply pointed tip, margin smooth or with a few undulations but never denticulate. Leaf-lobule ligulate, 1.14 – 1.75 mm long, 0.7 – 1.2 mm wide (about 1.5/1 as long as wide, the line of insertion arcuate upwards on the stem and ending below the keel, decurrent, apex subacute to obtuse, margin minutely to coarsely dentate, teeth variable, 1 – 3 cells in height to 1 – 3 cells in width. Marginal cells of the leaf 10 – 20 x 10 – 17 µm, equally thickened; median cells 13 – 24 x 13 – 20 µm; basal cells 20 – 30 x 12 – 24 µm, walls thin, trigones distinct, slightly to moderately bulging, cuticle nearly smooth; Oil-bodies, oval to spherical 2 – 4 per cell, large 9 x 5 µm. Gemmae 1 – celled, ovate with a broader base, 15 – 22 x 10 – 16 µm, produced in branching fascicles from the marginal and even submarginal cells of the youngest leaves, whitish green, each gemma with 1 – 4 oil-bodies.

## Specimens examined

India, Western Himalaya, State of Uttarakhand, Kumaun & adjacent region (i) District Chamoli, Gwaldam: WHKB 0207 L/14, WHKB 0208 L/14, March 2014, leg. S. N. Srivastava & party, det. M Rai *et al.* (ii) District Champawat, Mayavati in Lohaghat (alt.1950 meters), 460, September 1977. Deposited in the Duthie Herbarium of the Botany Department, University of Allahabad.

## Ecology & Distribution

The Gwaldum populations were growing on the exposed vertical cliffs of the roadside along with the thalli of *Targionia hypophylla* and some pleurocarpous mosses; whereas the Lohaghat populations were growing under rather not so exposed sites. At both locations it was an oak (*Quercus leucotrichophora*) dominated forest.

### *Scapania ligulata* Steph. subsp. *ligulata*

Hedwigia 44:14 (1904); Amakawa, Journ. Hattori Bot. Lab. 27:15 (1964); *S. stephanii* K. Muell., Srivastava & Srivastava, Phytomorphology 57(3):134 (2007) (Plate 3: Figures A-J)

Plants medium-sized, brownish red. Stem 10-30 mm long and 0.18-0.30 mm in diameter, with leaves 2.5-3.0 mm wide, ascending to erect, simple or sparingly branched, brown or red, sometimes green; in cross-section, the cortex and medulla well-differentiated, cortical cells in 3-4 layers, brown, 6-9 µm, walls thick as cell cavities, often bast-fiber like, medullary cells, white, 14-18 µm, thin-walled. Rhizoids numerous. Leaves rather larger near the stem tip, keel rather short, 3/10-4/10 the length of leaf-lobule, slightly concave on dorsal side, wings often distinct; the leaf-lobe nearly transversely inserted, not decurrent, appressed to the stem, rectangular to ovate, about 3/5 the length of leaf-lobule, 0.7-1.1 mm long and 0.6-0.9 mm wide, arching to the middle of the stem up to its farther edge, apex subacute with a point or obtuse, margin denticulate to dentate, teeth unicellular to multicellular; the leaf-lobule nearly transversely inserted with the line of insertion curved upwards

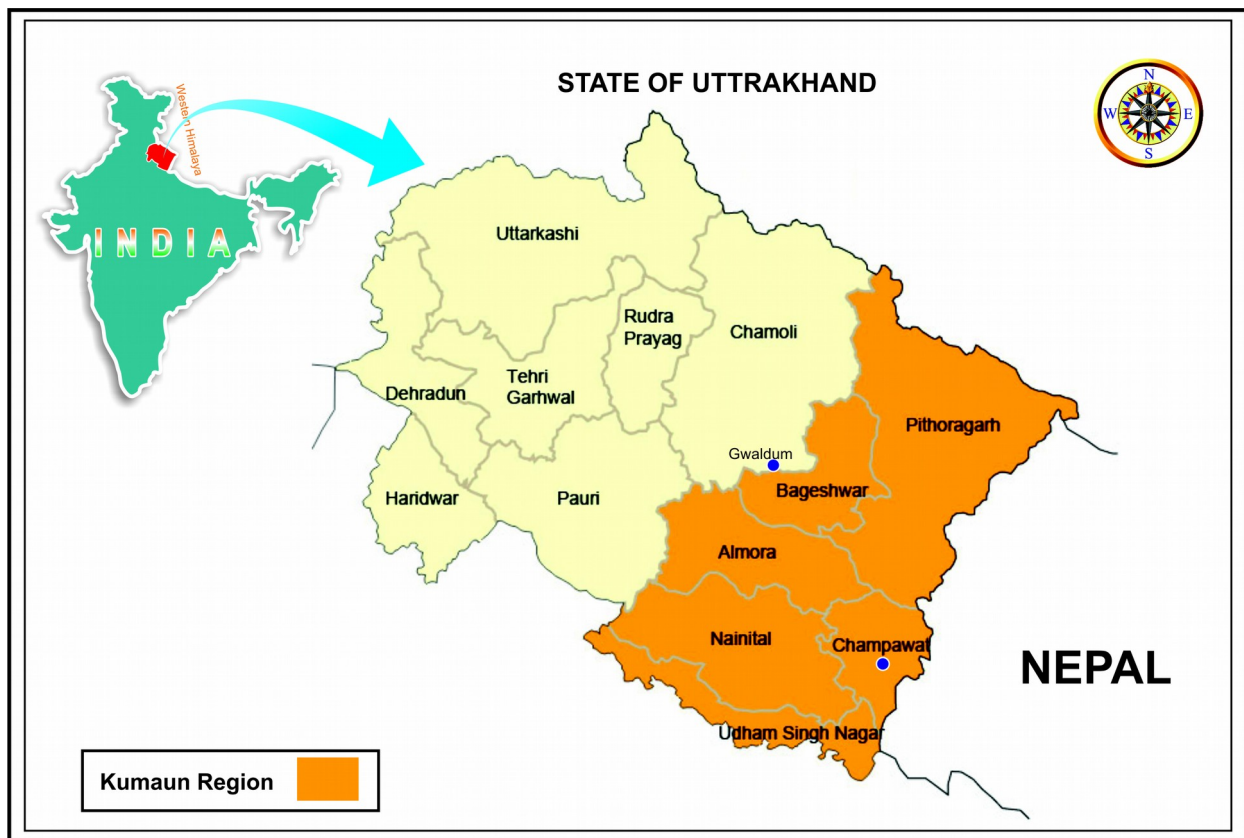


Plate 1: A Map of India showing the state of Uttarakhand in Western Himalaya and the two collection sites in Kumaun Region in State

on the stem and ending below the keel, more or less decurrent, obovate to oval, 1.0-1.8 mm long and 0.7-1.1 mm wide, apex subacute with a point or obtuse, margin often recurved, minutely to coarsely dentate, teeth 1-4 celled long and 1-3 celled wide at base. Marginal cells of the leaf 12-15×10-12 μm, cell cavities oval to round, rarely squarish, with thickened walls and trigones, median cells 15-18×20-24 μm, oval to quadrate, with rather thin walls and not so large trigones, basal cells 28-32×15 μm, cells of decurrent base up to 42×12 μm; cuticle smooth to somewhat verrucose. Gemmae green, 18-20×10-12 μm, 2- (occasionally 1-) celled, borne at the margin of very young leaves.

#### Specimens examined

India, Western Himalaya, Uttarakhand, Kumaun Region, Champawat District, Mayavati in Lohaghat (alt. 1950 m): 446 & 458, Sept. 1977, and Abbott Mount in Lohaghat (alt. 1900 meters), H-79/21 May 1979, leg. S. N. Srivastava & party, det. M. Rai *et al.* Deposited in the Duthie Herbarium of the Botany Department, University of Allahabad.

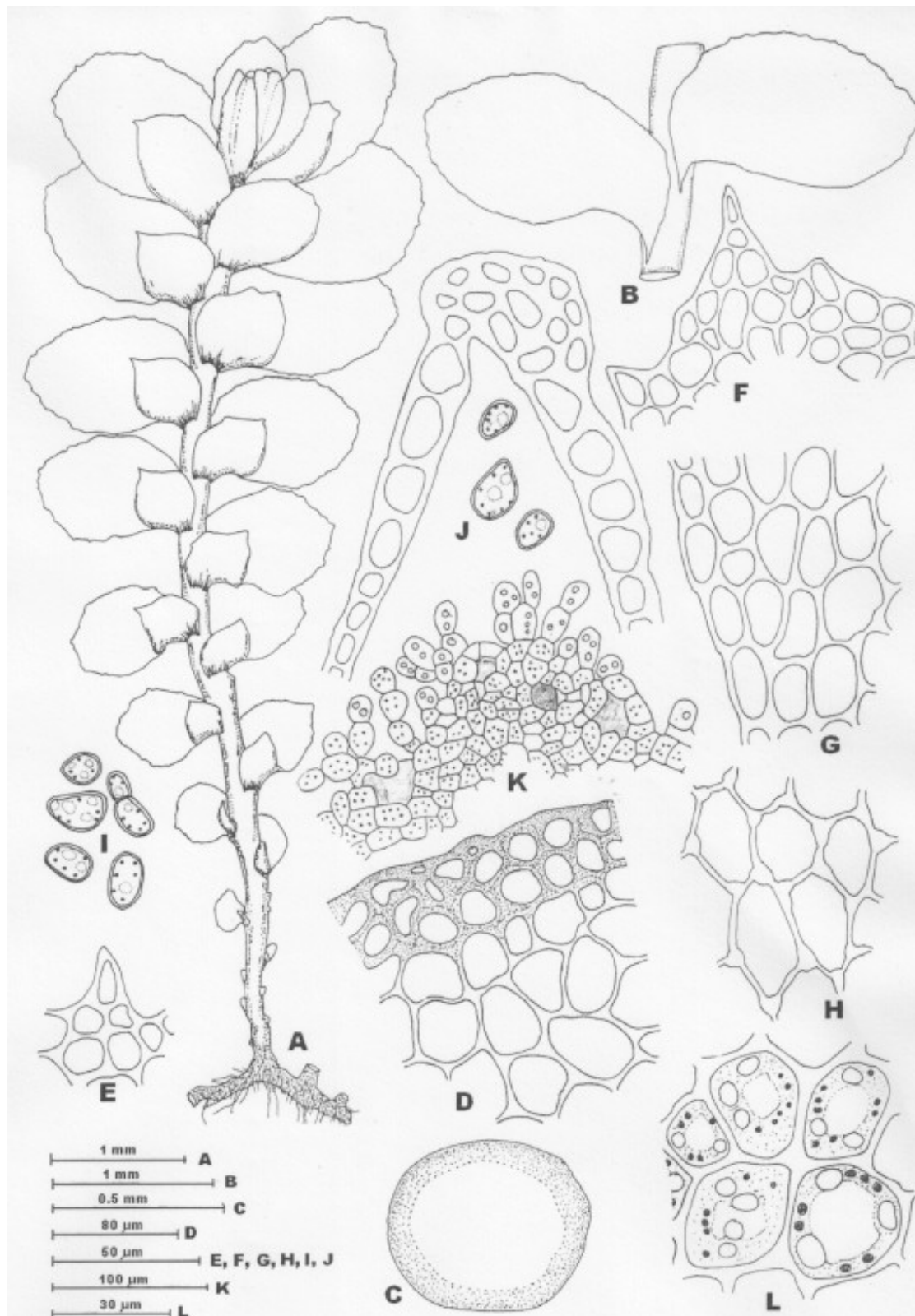
#### Ecology & Distribution

The populations of this taxon were growing along with *Plagiochila chinensis* on the rocks which were heavily shaded in the interior of the oak (*Quercus leucotrichophora*) dominated forest and not on the roadside.

The species grows in pure stands on vertical cliffs under very moist and shady conditions. Sometimes, it is associated with *Plagiochila chinensis*.

#### Discussion and Conclusion

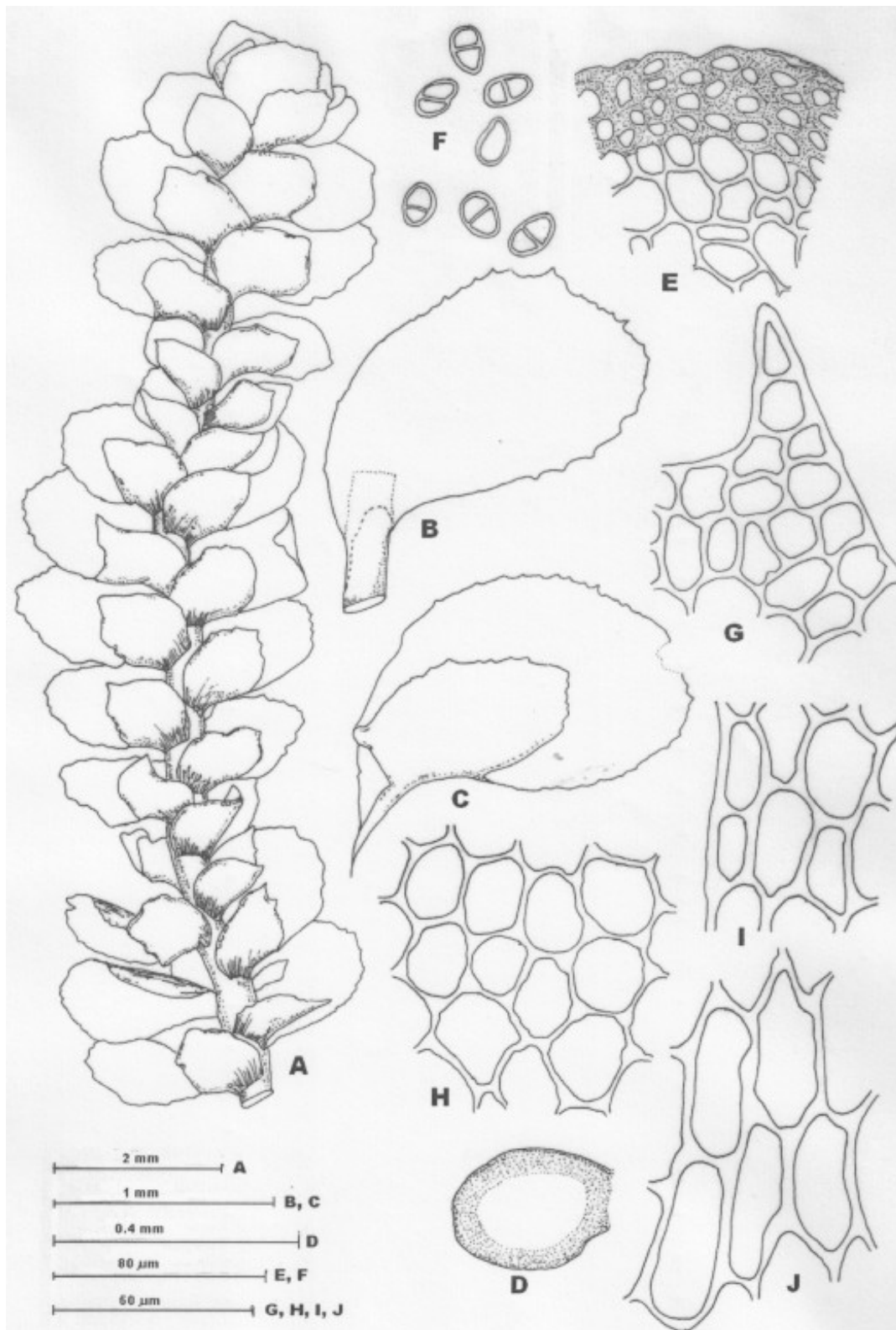
The two species of the genus, *Scapania*, namely, *S. ligulata*, instituted by Stephani in 1904 and *S. stephanii*, instituted by C. Müller (Now, referred as Müll. Frib.) in 1905 are purely the Asian taxa belonging to the primitive Section, Nemorosae (Müll. Frib.) H. Buch. Besides the 'type' locality Japan, the two forms are reported from Taiwan, India and China (See, Amakawa, 1964; Parihar *et al.*, 1994; Potemkin *et al.*, 2004; Dandotiya *et al.* 2007; Singh & Nath, 2007; Srivastava & Srivastava, 2007; and, Eshuo *et al.*, 2012). At present, *S. stephanii* C. Müll., because of its similarities and overlapping traits with *S. ligulata* Steph. is treated as synonym of the latter. Potemkin *et al.* (2004) have, however, made a detailed study of the Chinese populations of the *ligulata-stephanii* complex and observed that the two taxa can be segregated on the basis of the size of the plants, size of the leaf lobes and length of the keel, and treated these distinctions at the subspecies level. They noted that "the subsp. *stephanii* appears to represent a complex of small forms with rather narrow and largely triangularly pointed lobes, whereas subsp. *ligulata* is a complex of larger forms with broader and often obtuse leaf lobes". In the light of these observations, an examination of the herbarium specimens collected from Champawat district in Kumaun Region of Western Himalaya and referred to as *S. stephanii* along with its 'ecotype' by Srivastava & Srivastava (2007) was made. We found



**Plate 2: *Scapania ligulata* subsp. *stephanii* (Mull Frib.) Potemkin, Piippo & T. J. Kop. (Figures A-L). A. Plant, dorsal view; B. Part of the plant, ventral view; C. Stem, t.s.; D. Part of the same magnified; E. & F. Marginal cells and teeth of the leaf-lobule; G. Median cells of the leaf-lobule; H. Basal cells of the leaf-lobule; I. & J. Gemmae; K. Margin of the young leaf-lobule with developing gemmae; L. Oil-bodies in the median cells of the leaf-lobule.**

that the two forms cited by them were, in fact, *S. ligulata* subsp. *ligulata* and *S. ligulata* subsp. *Stephanii* respectively. Our recent collection of the subsp. *stephanii* from Gwaldam adjacent to Kumaun

Region and that of Singh & Nath (2007) from Meghalaya in Eastern Himalaya reaffirms the fact that the subspecies is well distributed in Indian Himalaya. This is in contravention of the observation



**Plate 3: *Scapania ligulata* Steph. subsp. *ligulata*.** (Figures A-J). A. Plant, dorsal view; B. Leaf attached on the ventral side of the stem; C. Leaf, dorsal view; D. Stem, t.s.; E. Part of the same, magnified; F. Gemmae; G. Marginal cells and tooth of the leaf-lobule; H. Median cells of the leaf-lobule; I. Basal marginal cells of the leaf-lobule; J. Basal cells of the leaf-lobule.

of Potemkin *et al.* (2004), who, while talking of radiation of the two subspecies in Chinese specimens of the *ligulata* - *stephanii* complex, stated that "...they have somewhat different distributions; subsp. *stephanii* is distributed further northwards than

subsp. *ligulata* and does not penetrate into Himalaya." Nonetheless, the authors are justified when they suggest that "these complexes seem to be genetically stabilized" since the Indian specimens strongly corroborate this observation. In addition to

the distinguishing points mentioned by them we have noted that in stem anatomy and that of gemmae the two subspecies further differ. While the subsp. *stephanii* has fewer layers of cortical cells (2 or occasionally 3) with lesser degree of thickening than subsp. *ligulata* which have more layers of cortical cells (3 or 4; occasionally 5) and the thickenings are more, almost bast-fiber like. Similarly, on the subject of cell number in gemma, the subsp. *ligulata* has predominantly 2-celled gemmae as against 1-celled gemmae in subsp. *stephanii*. Since 2-celled state of gemma is considered 'basal' (Potemkin, 2002) besides the large sized plants the subsp. *ligulata* appears to be primitive than the subsp. *stephanii*. So far as the morphology and number of the oil-bodies are concerned, both have large, spherical to ovoid and coarsely segmented oil-bodies which are 2-4 per cell (Singh *et al.* 2012).

### Competing Interests

The competing interests of the present research paper include (i) the understanding of the taxonomy of the Indian specimens of *ligulata-stephanii* complex of the genus *Scapania*; (ii) the confirmation of the existence of the two subspecies in the genus; and (iii) the contradiction of the statement of Potemkin (2004) about the radiation of the subspecies *ligulata* that it has not penetrated in the Himalayan mountain.

### Authors' Contributions

MR conceptualized the idea of the research paper besides identifying the freshly collected and herbarium specimens; BKK made microscopic studies, prepared the illustrations and suggested some valuable points on species radiation; and, SNS coordinated the work, interpreted the results and drafted the manuscript after thorough discussion with other two authors. All authors read and approved the final manuscript.

### Acknowledgement

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