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Cover: Pseudo-flying animals and wind-dependent seed & spore dispersers – made with digital painting in Krita. © Melito Prinson Pinto

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COMMUNICATION

Rediscovery of *Sewardiella tuberifera* Kash., a long-lost monotypic endemic Indian liverwort

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Abstract: An extremely rare, long-lost, monotypic endemic, Indian liverwort, *Sewardiella tuberifera* Kash. has recently been recollected after a gap of over three-and-a-half decades from an altogether new location, the Mukteshwar region (2,171 m) of Nainital district in the Kumaun Himalaya, Uttarakhand. The remarkable rediscovery of this monotypic, endemic Himalayan liverwort is a significant finding for the world's bryological treasure. Along with other rare Himalayan monotypic endemics such as *Aitchisoniella himalayensis* Kash. and *Stephensoniella brevipedunculata* Kash., the currently located sporiferous population of *Sewardiella* was discovered persisting in small, dispersed, sparse patches with 5–30 individuals. The currently spotted collection site is being considered a 'bryological hotspot'. As the area develops as a popular ecotourism destination, the original habitat of these hepatics in a lime stone-dominated, south-west facing, unstable sloppy site at Mukteshwar is under constant pressure from several developmental activities. Hence, serious conservation steps are needed to protect this hotspot supporting Himalayan bryophyte jewels. To ensure long term perpetuation and conservation of red-listed hepatic taxa, an attempt is being made to translocate part of the population to ecologically and climatically identical safer site, including a developing 'moss garden' at Lingadhar (Nainital).

Keywords: Endemic, hotspot, rare hepatic, Himalayan liverwort, Kumaun Himalaya, Nainital district, Red List

Hindi: अत्यन्त दुर्लभ, लंबे समय से अप्राप्त, एक प्रतिरूपी, स्थानिक, भारतीय लिवरवर्ट, *सिवारडिऐला टयूबरिफेरा* कश्यप हाल ही में नए स्थान, मुक्तेश्वर (2,171 मीटर) क्षेत्र से साढ़े तीन दशकों के अंतराल के बाद पाया गया है। उत्तराखण्ड के कुमाऊँ हिमालय क्षेत्र में नैनीताल जिले से इस एक प्रतिरूपी, स्थानिक हिमालयी लिवरवर्ट की उल्लेखनीय पुनर्खोज दुनिया के ब्रायोलॉजिकल कोष के लिए एक महत्वपूर्ण अन्वेषण है। *सिवारडिएला* की वर्तमान में बीजाणुजनित आबादी छोटे, बिखरे हुए, विरल पैच (5–30 संख्याओं) में अन्य दुर्लभ हिमालयी एक प्रतिरूपी, स्थानिक हिपेटिक्स जैसे *एचिसोनिएला हिमालयेन्सिस* कश्यप और *स्टीफेन्सोनिएला ब्रेविपेडुनकुलाटा* कश्यप के साथ बनी हुई पाई गई। वर्तमान में चिन्हित किये गए स्थल को एक 'ब्रायोलॉजिकल हॉटस्पाट' माना जा सकता है। मुक्तेश्वर क्षेत्र में चूने के पत्थर के वर्चस्व वाले दक्षिण पश्चिम की ओर अस्थिर ढलान वाले स्थल में इन हिपेटिक्स का मूल निवास स्थान कई विकासात्मक गतिविधियों के कारण लगातार दबाव में है, क्योंकि यह क्षेत्र एक लोकप्रिय ईकोटूरिज्म गंतव्य के रूप में विकसित हो रहा है। इसलिए हिमालयी ब्रायोफाइट रत्नों को आश्रय प्रदान करने वाले इस 'हॉटस्पाट' की सुरक्षा के लिए गंभीर संरक्षण कदम आवश्यक है। दीर्घकालिक स्थायित्व और संरक्षण को सुनिश्चित करने के लिए लाल सूचीबद्ध हेपेटिक टैक्सा की आबादी से एक हिस्से को पारिस्थितिक और जलवायु रूप से समान अन्य सुरक्षित साइट पर स्थानान्तरित करने का प्रयास किया जा रहा है, जिसमें लिंगाधार (नैनीताल) में विकसित किया जा रहा 'मॉस गार्डन' भी शामिल है।

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INTRODUCTION

Sewardiella Kash., a monotypic, endemic, and long-lost Indian liverwort genus of the phylum Marchantiophyta, class Jungermanniopsida, family Petalophyllaceae, order Fossombroniales, has been discovered after a long period of time in the Kumaun region of the western Himalaya (Bryophyte Specialist Group 2000). The genus *Sewardiella* is classified as 'Vulnerable' in the IUCN Red List due to its limited distribution in the Indian western Himalaya (Bryophyte Specialist Group 2000). Kashyap (1915) established and described this unusual genus based on a collection from Shimla (Himanchal Pradesh) and Mussoorie (Uttarakhand) in the western Himalayan region. Kashyap (1929) has described the morpho-taxonomic details of a single species as *S. tuberifera*. Occasionally, many workers collected and described *Sewardiella* from different localities of the western Himalaya, India (Pande et al. 1955; Pant 1983; Udar & Srivastava 1983a,b; Tewari & Pant 1984). The mycorrhiza and tuber formation of this liverwort was studied by Chalaud (1932). Pande & Mishra (1937) delineated the life history of this plant, and Mehra (1938) reported 18 numbers of diploid (2x) chromosomes from the archaesporial cell nucleus of this plant. A detailed embryological account of this extraordinary genus *Sewardiella* was provided by Mehra & Khanna (1950). Pande et al. (1955) reported this hepatic as of common occurrence in Nainital and environs. Udar & Srivastava (1983a,b) have also thoroughly described the documentation of rare and endangered liverworts in India, as well as their reproductive biology. Pant (1983) listed this taxon as threatened bryophyte of Kumaun Himalaya. Tewari & Pant (1984) made scanty collections of this plant in a sterile state from the Kumaun region, viz., Suyalbari (1,100 m), Chaubatia (1,820 m), and Dhakuri (2,500 m). Pant et al. (1994) have again stated that this taxon is on the 'red list hepatic'. After 1984, there is no report of the collection of this extremely rare, phylogenetically significant liverwort from any other part of the country. Recently, Singh (2008) marked this taxon as red list endemic hepatics. One of the authors (SDT) has revisited all the earlier mentioned sites, but no traces of its occurrence could be recorded. Due to drastically changing original habitat conditions, it has gradually disappeared from the site of its occurrence over the years. Fortunately, during a recent bryophyte survey and collection in the Kumaun region of the western Himalaya, a new location of this liverwort in a fully fruiting state was discovered in and around the Mukteshwar area of district Nainital (Uttarakhand). The currently encountered poor sporiferous *Sewardiella* population was observed as small, scattered, scanty patches ranging 5–30 individuals in extremely disturbed habitat conditions gripped by rapid urbanization and anthropogenic activities, as well as the enormous mounting pressure of ecotourism. Based on the earlier records as well as the present collection of many interesting Himalayan hepatics like *Aitchisoniella, Stephensoniella, Athalamia, Cryptomitrium*, *Exormotheca*, *Fossombronia, Sewardiella*, and *Haplomitrium* species from the anthropogenically disturbed site at Mukteshwar, this locality may be declared a unique 'bryological hotspot'. Hence, conservation measures are urgently needed to save this hotspot as well as the dwindling hepatic jewels of the Himalaya from unplanned urbanization and developmental activities.

MATERIAL AND METHODS

During the months of April (10 April 2021) to September (26 September 2021), a thorough survey and collection were conducted in and around the Mukteshwar area of district Nainital (29.4727^{0}N & 79.6466^{0}E) within an elevational range of 2,240–2,266 m (Figure 1). Sterile patches of *Sewardiella* were first noticed at the end of September. Fortunately, in the first week of October (2 October 2021–6 October 2021), we were able to collect both sterile and copiously sporiferous thalli of *S. tuberifera* from a south-west facing, sloppy, lime stone hill site. Field as well as microphotographs of both gametophytic and sporophytic parts of the liverwort were taken. The identification was confirmed by Dr. S.D. Tewari based on the earlier collections made from Kumaun region (Tewari & Pant 1984). Underlying substrate pH was measured by means of pH meter. The voucher specimens have been deposited in the herbarium of Botany Department, I.P.G.G.P.G. College of Commerce, Haldwani, Nainital (SP 112, SP 154, SP 187, SP 204, SP 234) and cryptogamic herbarium of National Botanical Research Institute (NBRI), Lucknow (LWG/ SP 154, SP 204/ SD-2).

RESULTS

Taxonomic description

Sewardiella tuberifera Kashyap, New Phytol. 14:5. 1915.

Dioicous, thallose, green, forming scattered patches, when young are generally confused with fern prothallus.

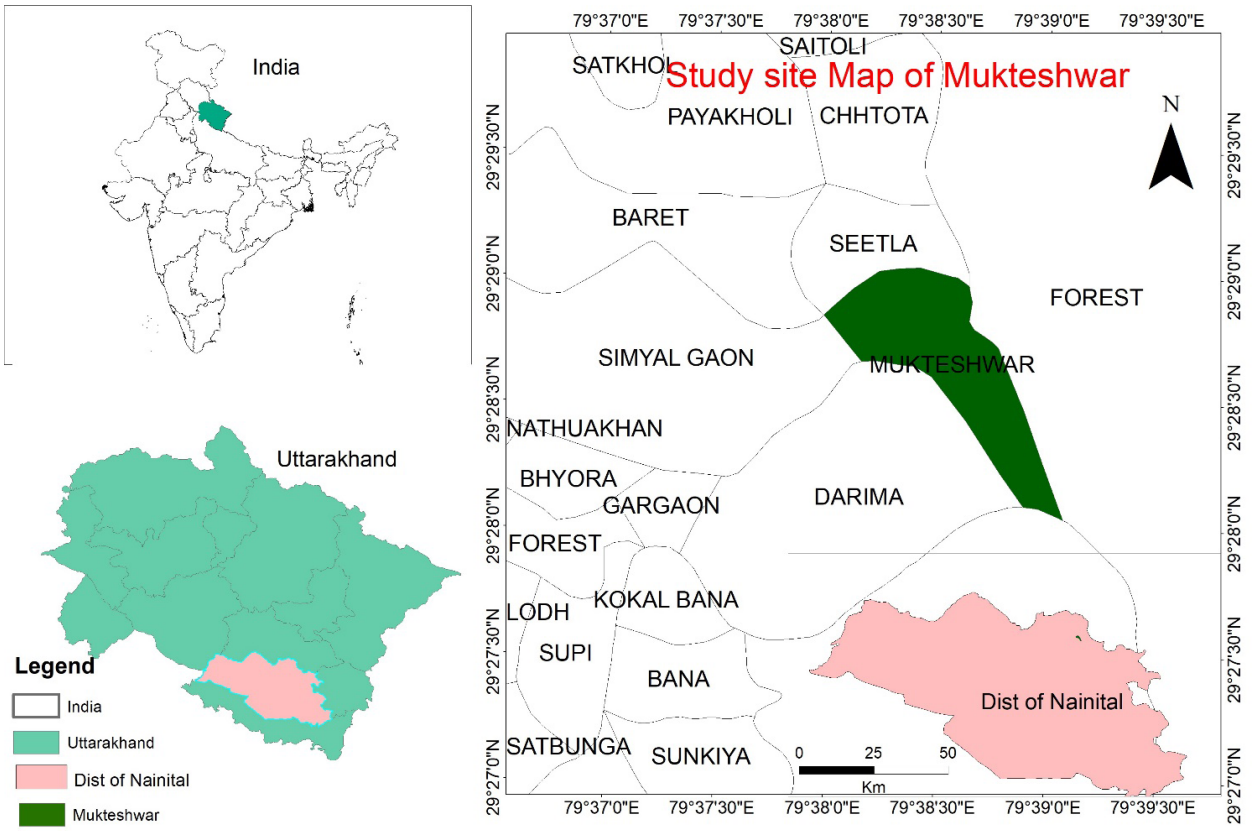

Figure 1. Study site at Mukteshwar (*Source: Bhuvan NRSC).

Thallus winged, 8–9 mm long, 12–13 mm wide, often forked with thick midrib; wings unequal, many layered at base, gradually becoming thin with wavy margin. Lobe cells hexagonal to ovoid, 46.55–53.52 x 26.6 µm towards apex, 133–159.6 x 39.9–53 µm in the middle, 66.5–93.1 x 53.2 µm towards base. Rhizoids abundant on ventral surface, long, hyaline, unicellular. Ventral scales in two rows, minute, red colored, multicellular. Perianth bell shaped, lacerated margin with numerous narrow projections; calyptra thin. Sporophyte one or more in each perianth; foot small, seta dull green, included with in the perianth or slightly exerted, 1.5–1.8 cm long. Capsule, rounded, 1.5–2.0 mm in diameter, at maturity looks like "miniature black plum"; wall 2–3 layered; inner layer with U shaped thickening bands. Spores reticulate - lamellate, 40–48 µm in diameter. Elaters brown, bi - tri spiral, 332–425 µm long, 9.6–10 µm wide at middle (Image 1 A–L).

Specimens examined: India, Western Himalaya, Uttarakhand, Nainital, Mukteshwar, 2,240–2,266 m, (29.4727^{0}N & 79.6466^{0}E) 10 April 21: SP 112, 26 September 2021: SP 154, 2 October 21: SP 187, SP 204, SP 234, leg. S.D. Tewari, Sapana Pant, Manisha Bhandari (Herbarium of Botany Department, Indira Priyadarshini Govt. Girls Post Graduate College of Commerce Haldwani, Nainital).

Distribution: India (Himachal Pradesh, Uttarakhand).

Ecology: Scattered, scanty, sporiferous population of *S. tuberifera* were found to be growing on shady, moist, lime stone (pH 7.1–7.3) dominated south-west facing, sloppy site at Mukteshwar area of District Nainital in association with other thalloid liverworts like *Asterella, Stephensoniella*, *Fossombronia;* hornwort like *Anthoceros*, and mosses like *Anomobryum, Anoectangium, Barbula, Cryptoleptodon, Dicranum, Entodon, Fissidens, Herpetineuron, Hyophila, Pogonatum, Symblepharis*, and *Timiella* species.

DISCUSSION

The 'butterfly-like' morphology of *S. tuberifera*, with a prominent apical tuber, makes this liverwort easily identifiable in the field, even with the naked eye, but it can also be confused with fern prothallus in a sterile state. Still, the fact that the species could not be found in its known locations and habitat conditions in the western Himalaya, where it was once abundant for a

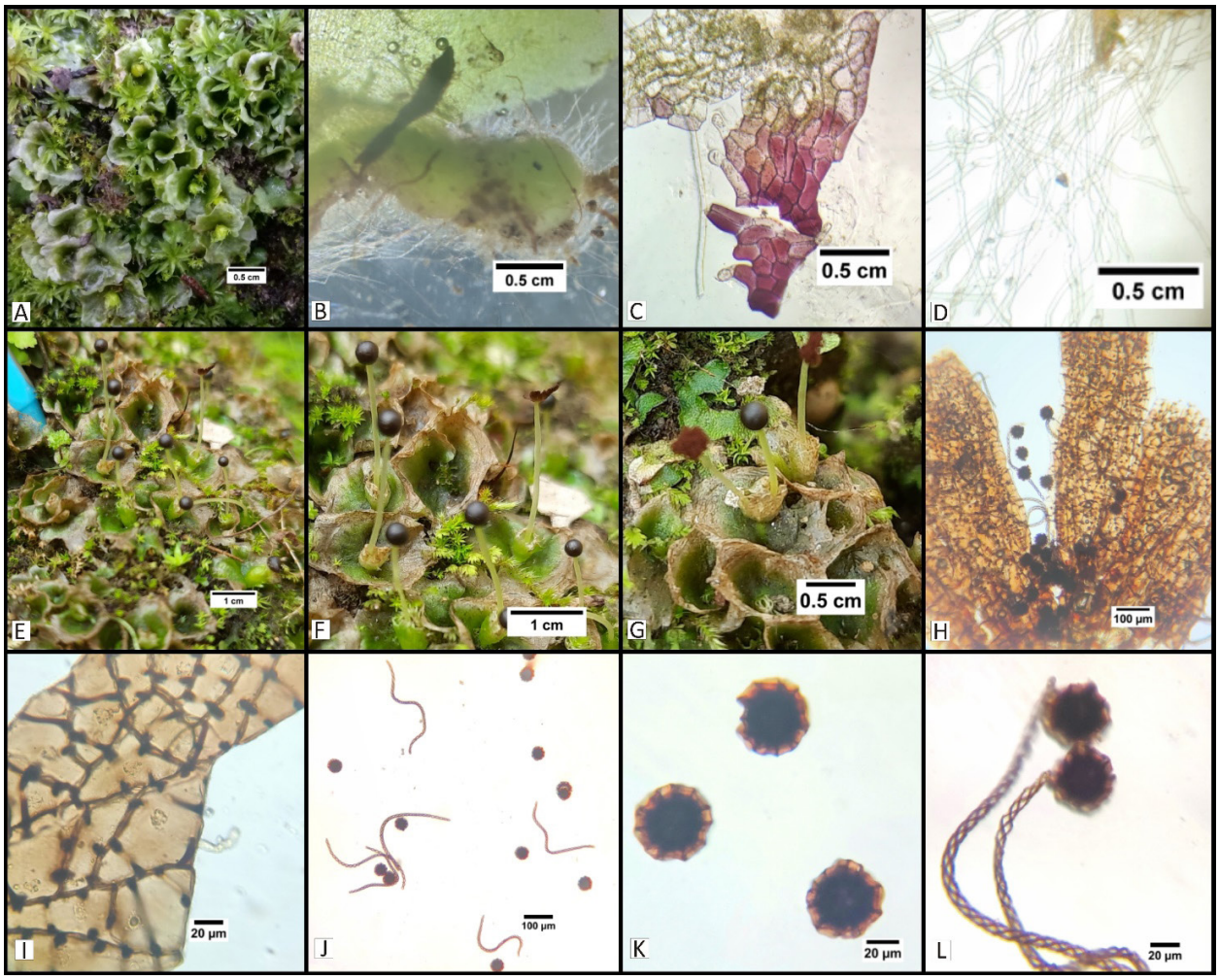

Image 1. *Sewardiella tuberifera* Kash.: A—Thalli | B—Perennating tuber | C—Multicellular scales | D—Unicellular rhizoids | E—Sporiferous patch | F—Mature sporophyte with long seta bearing "miniature black plum" like globose capsule | G—Enlarged sporophyte showing dehisced capsule | H—Inner capsule wall with annular bands | I—Outer capsule wall showing U-shaped bands | J—Spores and elaters | K—Reticulate – lamellate spores | L—bi-trispirate elaters. © Sapana Pant and S.D. Tewari.

long time, is cause for concern and indicates the species' extreme rarity.

CONSERVATION MEASURES

If the lone surviving site of *S. tuberifera* in India, Mukteshwar, is not protected and conserved in time, this fragile liverwort will become extinct. Keeping this in mind, an attempt is being made by us to transplant this liverwort from the highly disturbed site to a relatively undisturbed site with more or less the same topographical habitat conditions (sloppy site). Another attempt is being made to transplant some populations in small patches by creating similar habitat conditions in the recently developed "Moss Garden" at Lingadhar (Nainital), in order to monitor long-term perpetuation and conservation progress. Some of the sporiferous material may be preserved in vitro in the future.

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