Addition to the liverwort flora (Marchantiophyta) of Arunachal Pradesh, India

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Abstract: The present study identified 20 liverwort species from Tirap district, Arunachal Pradesh, India, marking the first ever documentation of bryophytes from the region. The specimens were collected from various locations within the study area and subsequently brought to the laboratory. Micromorphological and anatomical characteristics of the specimens were analysed and identified by consulting relevant literatures. Three species, viz. *Plagiochila himalayana* Schiffn., *P. khasiana* Mitt., and *Solenostoma lanigerum* (Mitt.) Váňa & D.G.Long, are newly reported for the first time from the state of Arunachal Pradesh. The species were found to be an integral part of ecosystem growing in association with various plant species, providing soil stability, and shelter for other organisms. The study is important for understanding bryophyte diversity and ecosystem health of the region. In addition, it will also help in planning conservation strategy and sustainable management of bryophytes, their habitat or host species and the overall biodiversity in the region.

Keywords: Bryophytes, conservation, diversity, eastern Himalaya, ecosystem, epiphytic, *Plagiochila himalayana*, *Plagiochila khasiana*, *Solenostoma lanigerum*, Tirap district.
INTRODUCTION

Marchantophyta is globally represented by about 7,486 species (Söderstrom et al. 2016) of which nearly 854 species have been recorded in India (Singh et al. 2016a; Majumdar & Dey 2021). A few studies reported the presence of liverworts in Arunachal Pradesh. Deo & Singh (2013, 2014, 2016, 2020), Singh & Singh (2016) documented bryophytes from West Siang district, Majumdar et al. (2013), Majumdar & Singh (2015, 2016, 2017) and Singh et al. (2016b) reported bryophytes from Anjaw district. Rawat & Verma (2014) and Rawat et al. (2017) collected bryophytes from Tawang District and Dey et al. (2009) from many areas of Arunachal Pradesh. In total, at present 84 species of liverworts from the state are recorded. However, the Tirap district of the state was bryologically unattended.

Tirap district is a part of the Eastern Himalayas, one of the biodiversity hotspots of the world. It is located in the southernmost part of the state and lies between the latitude 27.018 °N, 95.519 °E (District website of Tirap 2022, accessed on 22 September 2022). The elevation of the district ranges 200–4,000 m in the northwest to the Patkai hills. Tirap is bounded by Changlang district in the east, Assam state in the north, Longding district and Nagaland in the west, and Myanmar in the south (Wangpan et al. 2019). The district has an annual rainfall of 2,754 mm per year and temperature ranges 14–25 °C (World Data Atlas 2023). The vegetation of Tirap is primarily comprised of tropical and subtropical evergreen forests, with interspersed grasslands and temperate forests in the upper elevations. The temperature in Tirap is moderate to warm with frequent rainfall. The district offers a virgin area for the diverse and luxuriant growth of many plants including bryophytes. The inhabitants of Tirap, revere and offer prayers to nature for their reliance on plants for food, shelter, livelihood, and well–being. Wangpan et al. (2019) and Tangjang et al. (2011) documented flowering plants for various purposes such as food, medicine, and house construction. The district remained unattended for the lower plant groups like bryophytes and pteridophytes which provide the intricate relation with the higher plants. Therefore, the present study was undertaken to survey and document the bryoflora of the region (Figure 1).

MATERIALS AND METHODS

Liverwort samples were collected from the Tirap district, Arunachal Pradesh, India, during May 2021 and 2022. Field data, including habit, habitat, temperature, humidity, and soil types, were recorded for each species. The specimens were initially stored in zip–lock plastic bags, air-dried, and later transferred to paper bags in the laboratory. To aid in identification, the specimens were rehydrated in water until they regained their original shape. Micromorphological and anatomical characteristics were studied using a stereo zoom microscope (Zeiss Stemi 508) and a compound microscope (Zeiss Lab A.1). Identification was based on relevant literature. Voucher specimens were deposited in the Herbarium of Arunachal University (HAU) and the Delhi University Herbarium (DUH), following the classification system by Crandall-Stotler et al. (2009).

RESULTS

Throughout the study, 20 liverwort species from 15 genera and 11 families were documented in the Tirap district of Arunachal Pradesh, representing the initial record of bryophytes in this area (Table 1).

Among the recorded species, three species, viz, Plagiochila himalayana Schiffn., P. khasiana Mitt., and Solenostoma lanigerum (Mitt.) Váňa & D.G.Long., are noteworthy as they are recorded for the first time from Arunachal Pradesh.

A majority of these species were observed in damp, shady locations, thriving on both soil and rocks (e.g. Solenostoma lanigerum, Notoscyphus darjeelingensis Udar & Ad. Kumar var. darjeelingensis, Plagiochila uniformis, P. khasiana). Few species were epiphytic (Frullania arecæ, Spruceanthus semirepandus), while some could be found on multiple substrates, including soil, rocks, and the roots and debris of other plants (Riccardia inconspicua (Steph.). Reeb & Bardat, Heteroscyphus argutus (Reinw., Blume & Nees) Schiffn.). The frequently recorded species in the study area are Dumortiera hirsuta (Sw.) Nees and Targionia hypophysa L., followed by Ptychanthus striatus (Lehm. & Lindenb.) Nees, Riccardia inconspicua (Steph.) Reeb & Bardat and Solenostoma lanigerum (Mitt.) Váňa & D.G. Long. The species, which were found only in small patches are Lejeunea tuberculosa Steph. and Notoscyphus darjeelingensis var. darjeelingensis. Image 1–Image 5. The reported species are enumerated here.

ANEURACEAE


Habitat: Terrestrial and epilithic, growing on soil and...
rock in association with moss species in moist and shady areas. The species was in the vegetative stage.

**Specimen examined**: India, Arunachal Pradesh, Tirap District, Khonsa Circle. Lapnan–Hydel Road. 26.996 °N; 95.489 °E; elevation 580 m. HAU/AN- 1866; DUH15116.

**Distribution**: India [Andhra Pradesh, Arunachal Pradesh, Assam, Himachal Pradesh, Kerala, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttarakhand, West Bengal], Indonesia, Malaysia, Nepal, Singapore (Sahu & Asthana 2022; Sahu et al. 2023).


**Habitat**: Epiphytic, growing on rotten wood. The species was found in the reproductive stage with gynoecium and androecium branches.

**Specimen examined**: India, Arunachal Pradesh, Tirap District, Namsang Circle. 27.099 °N; 95.472 °E; elevation 265 m. HAU/AN- 1868; DUH15521.

**Distribution**: India [Arunachal Pradesh, Assam, Chhattisgarh, Goa, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Tamil Nadu, Uttarakhand, West Bengal], Africa, Europe, Hawaii, Japan, Nepal, New Zealand, North America (Singh & Singh 2023).

**DUMORTIERACEAE**


**Habitat**: Terrestrial, growing on soil in moist and shady areas. The species was in the reproductive stage.

**Specimen examined**: India, Arunachal Pradesh, Tirap District, Khonsa Circle. Lapnan Village. 26.988 °N; 95.487 °E; elevation 809 m. HAU/AN- 1939; DUH15128.

**Distribution**: India [Arunachal Pradesh, Assam, Chhattisgarh, Goa, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Tamil Nadu, Uttarakhand, West Bengal], Africa, Europe, Hawaii, Japan, Nepal, New Zealand, North America (Singh & Singh 2023).

**FRULLANIACEAE**

*Frullania arecae* (Spreng.) Gottsche Mexik. Leverm. 236. 1863 var. *arecae*

**Habitat**: Epiphytic, growing on bark of *Saurauia roxburghii* Wall. together with *Psychostomum capillare* (Hedw.) D.T.Holyoak & N.Pedersen, *Porella caespitans* var. *cordifolia* (Steph.) S.Hatt. ex T.Katag. & T.Yamag, *Spruceanthus semirepandus* (Nees) Verd. The species was found in the vegetative stage.
Specimen examined: India, Arunachal Pradesh, Tirap District, Dadam Circle. Moktowa Village. 26.871° N; 95.457° E; elevation 1,805 m. HAU/AN-1940; DUH15513.

Distribution: India [Arunachal Pradesh, Meghalaya, Sikkim - East, West, North and South districts, Tamil Nadu, West Bengal], Bhutan, China, Fiji, Indonesia, Malaysia, Myanmar, Nepal, New Guinea, Pacific Is., Philippines, Sri Lanka, Taiwan, Thailand, Africa, Australia, North America, South America (Majumdar 2017; Singh & Singh 2023).

**Notoscyphus darjeelingensis** Udar & Ad.Kumar, J. Hattori Bot. Lab. 49: 250.1981. var. darjeelingensis

Habitat: Terrestrial, growing on damp soil. The species was found in vegetative stage.

Specimen examined: India, Arunachal Pradesh, Tirap District, Dadam Circle. Dadam–Moktowa road. 26.926° N; 95.470° E; elevation 1,097 m. HAU/AN-1946; DUH15120.

Distribution: India [Arunachal Pradesh, Manipur, Sikkim, Tamil Nadu, West Bengal] (Singh & Singh 2023).


Habitat: Terrestrial, growing on soil. The species was found in vegetative stage.

Specimen examined: India, Arunachal Pradesh, Tirap District, Dadam Circle. Dadam–Moktowa road. 26.870° N; 95.457° E; elevation 1,097 m. HAU/AN-1946; DUH15120.

Distribution: India [Arunachal Pradesh, Nagaland, Sikkim - East, West, and North districts], Indonesia, Malaysia, Papua New Guinea, Philippines, Thailand, Vietnam (Singh & Singh 2023).


Habitat: Epiphytic, growing on tree bark of Saurauia roxburghii Wall. in association with Ptychostomum capillare (Hedw.) D.T.Holyoak & N.Pedersen, Porella caespitans var. cordifolia (Steph.) S.Hatt. ex T.Katag. & T.Yamag, Frullania arecae (Spreng.) Gottsche var. arecae. The species was found in vegetative stage.

Specimen examined: India, Arunachal Pradesh, Tirap District, Dadam Circle. Moktowa Village. 26.871° N; 95.457° E; elevation 1,805 m. HAU/AN-1945; DUH15515.

Distribution: India [Arunachal Pradesh, Kerala, Manipur, Meghalaya, Odisha, Sikkim, Tamil Nadu, Uttarakhanda, West Bengal], Bhutan, Cambodia, China, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Taiwan, Thailand (Singh & Singh 2023).

**Lejeunea tuberculosa** Steph., Sp. Hepat. 5: 790. 1915.

Habitat: Epilithic, growing on rock. The species was found in vegetative stage.

Specimen examined: India, Arunachal Pradesh, Tirap District, Dadam Circle. Dadam–Moktowa road. 26.922° N; 95.456° E; elevation 1,205 m. HAU/AN-1944; DUH15119.

Distribution: India [Andaman & Nicobar, Arunachal Pradesh, Assam, Kerala, Madhya Pradesh, Manipur, Meghalaya, Sikkim, Tamil Nadu, Uttarakhand, West Bengal], Africa, Bhutan, China, Indonesia, Nepal, Philippines, Sri Lanka, Taiwan, Vietnam (Singh & Singh 2023).

**Bazzania sumbavensis** (Gottsche ex Steph.) Steph., Hedwigia 32: 204. 1893.

Habitat: Epiphytic, growing on tree bark of Saurauia roxburghii Wall. in association with Ptychostomum capillare (Hedw.) D.T.Holyoak & N.Pedersen, Porella caespitans var. cordifolia (Steph.) S.Hatt. ex T.Katag. & T.Yamag, Frullania arecae (Spreng.) Gottsche var. arecae. The species was found in vegetative stage.

Specimen examined: India, Arunachal Pradesh, Tirap District, Dadam Circle. Namsang Village. 27.100° N; 95.472° E; elevation 257 m. HAU/AN-1938; DUH15516.

Distribution: India [Arunachal Pradesh, Assam, Goa, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttarakhand, West Bengal], Africa, Australia, Bhutan, China, Fiji, Indonesia, Japan, Laos, Malaysia, Nepal, New Zealand, Papua New Guinea, Philippines, Samoa, Sri Lanka, Taiwan, Thailand, Vietnam (Singh & Singh 2023).
LOPHOCOLEACEAE


**Habitat:** Epilithic and Terrestrial. Growing on rock, soil and roots of ferns, and debris of other plants, in association with hornwort sp. and moss spp. at moist and shady area. The species was found in vegetative stage.

**Specimen examined:** India, Arunachal Pradesh, Tirap District, Khonsa Circle. Khonsa–Hydel Road. 26.996 °N; 95.489 °E; elevation 580 m. HAU/AN- 1947; DUH15113.

**Distribution:** India [Andaman & Nicobar, Andhra Pradesh, Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Manipur, Meghalaya, Odisha, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal], widely distributed throughout the globe (Singh & Singh 2023).

**MARCHANTIACEAE**


**Habitat:** Growing on soil and rock.

**Specimen examined:** India, Arunachal Pradesh, Tirap District, Khonsa Circle. Lapnan village. 26.989 °N; 95.483 °E; elevation 901 m. HAU/AN- 1949; DUH15519.

**Distribution:** India [Andaman & Nicobar, Arunachal Pradesh, Assam, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Indonesia, Japan, Korea, Malaysia, Maldives, Nepal, New Caledonia, New Zealand, Papua New Guinea, Singapore, South America, Sri Lanka, Thailand, Tonga, Vietnam] (Singh & Singh 2023).


**Habitat:** Growing on black, hard, rock-like soil together with *Pohlia crudoides* (Sull. & Lesq.) Broth. The species was found in the reproductive stage with male and female thalli bearing matured antheridia and archegonia.

**Specimen examined:** India, Arunachal Pradesh, Tirap District, Laju Circle. On the way to Pongkong village. 26.893 °N; 95.540 °E; elevation 1,337 m. HAU/AN- 1950; DUH15125.

**Distribution:** India [Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Kerala, Manipur, Meghalaya, Sikkim, Uttar Pradesh, West Bengal], widely distributed throughout the globe (Singh & Singh 2023).


**Habitat:** Epilithic, growing on rock. The species was found in the vegetative stage.

**Specimen examined:** India, Arunachal Pradesh, Tirap District, Dadam Circle. Moktowa Village. 26.870 °N; 95.452 °E; elevation 809 m. HAU/AN- 1957; DUH15518.

**Distribution:** India [Arunachal Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Sikkim, Uttar Pradesh, West Bengal], widely distributed throughout the globe (Singh & Singh 2023).
Image 2. Liverwort species collected from Tirap district. *Lejeunea tuberculosa* Steph.: a—Whole plant | b—whole mount of leaf | c—whole mount of underleaf; *Ptychanthus striatus* (Lehm. & Lindenb.) Nees | d—Whole plant | e—whole mount of leaf | f—whole mount of underleaf; *Pruceanthus semirepandus* (Nees) Verd. | g—Whole plant | h—whole mount of leaf | i—whole mount of leaf underleaf; *Frullania arecae* (Spreng.) Gottsche var. arecae | j—Whole plant | k—whole mount of leaf | l—whole mount of underleaf. © Nonya Chimyang.
Image 3. Liverwort species collected from Tirap district. *Bazzania sumbavensis* (Gottsche ex Steph.) Steph.: a—Whole plant | b—whole mount of leaf | c—whole mount of underleaf; *Herbertus arminatus* (Steph.) H.A. Mill.: d—Whole plant | e—whole mount of leaf | f—leaf cells; *Heteroscyphus argutus* (Reinw., Blume & Nees) Schiffn: g—Whole plant | h—whole mount of leaf | i—whole mount of underleaf; *Porella caespitans* var. *cordifolia* (Steph.) S. Hatt. ex T. Katag. & T. Yamag.: j—Whole plant | k—whole mount of leaf | l—whole mount of underleaf. © Nonya Chimyang.
Image 5. Liverwort species collected from Tirap district. *Dumortiera hirsuta* (Sw.) Nees (a) Thallus, (b) T.S of thallus, (c) spores and elater; *Notoscyphus darjeelingensis* Udar & Ad. Kumar var. *darjeelingensis* (d) Whole plant, (e) whole mount of leaf, (f) leaf cells; *Solenostoma lanigerum* (Mitt.) Váňa & D.G. Long (g) Whole plant, (h) whole mount of leaf, (i) leaf cells; *Targionia hypophylla* L. (j) Habit; (k) Thallus; (l) A portion of thallus showing air pores. © Nonya Chimyang.
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Sikkim, Uttarakhand, West Bengal, Bhutan, Myanmar, Nepal, Pakistan, Thailand (Majumdar 2017; Singh & Singh 2023).

PORELLACEAE


**Habitat:** Epiphytic, growing on the bark of *Saurauia roxburghii* Wall. together with *Frullania arceae* (Spreng.) Gottsch. var. *arecea*, *Rosulabryum capillare* (Hedw.) J.R. Spence, *Spruceanthus semirepandus* (Nees) Verd. The species was in the vegetative stage.

**Specimen examined:** India, Arunachal Pradesh, Tirap District, Dadam Circle. 26.904 °N; 95.458 °E; elevation 1,070 m. HAU/AN- 1960; DUH15132.

**Distribution:** India [Andhra Pradesh, Arunachal Pradesh, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Odisha, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, Uttaranchal, Uttarakhand, West Bengal], widely distributed throughout the globe (Singh & Singh 2023).

SOLENOSTOMACEAE


**Habitat:** Terrestrial, growing on soil. The species was in the vegetative stage.

**Specimen examined:** India, Arunachal Pradesh, Tirap District, Dadam Circle. 26.904 °N; 95.458 °E; elevation 1,070 m. HAU/AN- 1960; DUH15132.

**Distribution:** India [Andhra Pradesh, Arunachal Pradesh, Jammu & Kashmir, Kerala, Sikkim, Uttarakhand, West Bengal], China, Nepal, Pakistan (Singh & Singh 2023).

TARGIONIACEAE


**Habitat:** Terrestrial and epilithic, growing abundantly on soil and rock. The species was in the vegetative stage.

**Specimen examined:** India, Arunachal Pradesh, Tirap District, Dadam Circle. Dadam Village. 26.938 °N; 95.577 °E; elevation 1,527 m. HAU/AN-1961; DUH15124.

**Distribution:** India [Andhra Pradesh, Arunachal Pradesh, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Odisha, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, Uttaranchal, Uttarakhand, West Bengal], widely distributed throughout the globe (Singh & Singh 2023).

**DISCUSSION**

The study area represents a diverse species of liverworts, owing to its mild temperature, high humidity, and frequent rainfall. *Dumortiera hirsuta* and *Targionia hypophylla* were the most frequently recorded species in the area, while *Lejeunea tuberculosa* and *Notoscyphus darjeelingensis* var. *darjeelingensis* were found only in small patches. The species were found inhabiting different habitats, for example, in damp shady locations, thriving on various substrates such as soil, rocks plant debris, etc. The prevalence of species in various habitats highlights the adaptability and resilience of liverworts in diverse environmental conditions. The observation of epiphytic species and those found on multiple substrates further emphasizes the ecological versatility of liverworts in colonizing different microhabitats. The frequently recorded species indicate their ecological importance and potential role in the local ecosystem. In addition, the species found in small patches signal the necessity to take conservation actions in order to safeguard them from the risk of extinction.

Many of the presently collected bryophyte samples were found growing exclusively on certain

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**Table 1. Liverwort species of Tirap District, Arunachal Pradesh, India.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Riccardia inconspicua (Steph.) Rhee &amp; Bardat</td>
<td>Aneuraceae</td>
</tr>
<tr>
<td>2 Riccardia multifida (L.) Gray</td>
<td>Aneuraceae</td>
</tr>
<tr>
<td>3 Dumortiera hirsuta (Sw.) Nees</td>
<td>Dumortieraceae</td>
</tr>
<tr>
<td>4 Frullania arceae (Spreng.) Gottsche var. arceae</td>
<td>Frullaniaceae</td>
</tr>
<tr>
<td>5 Notoscyphus darjeelingensis Udar &amp; Ad.Kumar var. darjeelingensis</td>
<td>Geocalycaceae</td>
</tr>
<tr>
<td>6 Herbertus armitatus (Steph.) H.A.Mill.</td>
<td>Herbertaceae</td>
</tr>
<tr>
<td>7 Lejeunea tuberculosa Steph.</td>
<td>Lejeuneaceae</td>
</tr>
<tr>
<td>8 Ptychanthus striatus (Lehm. &amp; Lindemb.) Nees</td>
<td>Lejeuneaceae</td>
</tr>
<tr>
<td>9 Spruceanthus semirepandus (Nees) Verd.</td>
<td>Lejeuneaceae</td>
</tr>
<tr>
<td>10 Bazzania sambovensis (Gottsche ex Steph.) Steph.</td>
<td>Lepidioziaceae</td>
</tr>
<tr>
<td>11 Heteroscyphus argutus (Reinw., Blume &amp; Nees) Schil.</td>
<td>Lophoziaceae</td>
</tr>
<tr>
<td>12 Marchantia linearis Lehm. &amp; Lindemb.</td>
<td>Marchantaceae</td>
</tr>
<tr>
<td>13 Marchantia polyomorpha L.</td>
<td>Marchantaceae</td>
</tr>
<tr>
<td>14 Plagiochila himalayana Schilfn. *</td>
<td>Plagiochilaceae</td>
</tr>
<tr>
<td>15 Plagiochila khasiana Mitt. *</td>
<td>Plagiochilaceae</td>
</tr>
<tr>
<td>16 Plagiochila sciophila Nees ex Lindemb.</td>
<td>Plagiochilaceae</td>
</tr>
<tr>
<td>17 Plagiochila uniformis Mitt.</td>
<td>Plagiochilaceae</td>
</tr>
<tr>
<td>18 Porella caespitans var. cordifolia (Steph.) S.Hatt. ex T.Katag. &amp; Yamag.</td>
<td>Porellaceae</td>
</tr>
<tr>
<td>19 Solenostoma lanigerum (Mitt.) Váňa &amp; D.G.Long *</td>
<td>Solenostomaceae</td>
</tr>
<tr>
<td>20 Targionia hypophylla L.</td>
<td>Targioniaceae</td>
</tr>
</tbody>
</table>

Note: The superscript “*” in the names of some bryophytes represents the new records for the state.
tree species. These host trees must be considered in conservation efforts as they serve as essential habitats for various species. Bryophytes enhance water-holding capacity, nutrient status, and soil particle aggregation. Consequently, other plant species associated with bryophytes may also benefit from them. Additionally, Tirap's hilly terrain makes it highly susceptible to landslides. The widespread practice of Jhum cultivation in the area leads to deforestation, destroying natural habitats, and increasing soil erosion. Bryophytes, with their ability to naturally cover and restore disturbed habitats, can potentially play a crucial role in mitigating these environmental challenges in the region.

Therefore, this study contributes to the scientific understanding of liverwort diversity as well as the ecological importance of these understudied bryophytes in maintaining the balance and resilience of the region's ecosystem. Continued research and conservation efforts are crucial to further unravel the intricate relationships between liverworts and their environment, ensuring the preservation of this unique botanical heritage in the eastern Himalaya.

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First nesting record of Black-necked Stork Ephippiorhynchus asiaticus (Aves: Ciconiformes) in Kumana National Park, Sri Lanka

Mugger Crocodile Crocodylus palustris (Lesson, 1831) predation on Brown Fish Owl Ketupa zeylonensis (J.F. Gmelin, 1788), with notes on existing literature regarding their predation on birds

New distribution records of two jumping spiders of the genus Stenaelurillus Simon, 1886 (Araneae: Salticidae) from Gujarat, India