

CONTRIBUTION TO THE BRYOPHYTE FLORA OF INDIA: SILENT VALLEY NATIONAL PARK IN THE WESTERN GHATS, INDIA

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Abstract: The bryophyte flora of the Silent Valley National Park is catalogued. The catalogue consists of 148 taxa (109 mosses, 36 liverworts, 3 hornworts), of which nine species viz., *Chrysocladium flammeum* (Mitt.) M.Fleisch., *Gymnostomum calcareum* Nees & Hornsch., *Glossadelphus bilobatus* (Dix.) Broth., *Hypnum flaccens* Besch., *Notoscyphus paroicus* Schiffn., *Macromitrium turgidum* Dix., *Calyptothecium pinnatum* Nog., *Brotherella amblystegia* (Mitt.) Broth. and *Wijkia deflexifolia* (Ren. & Card.) Crum. are newly reported for Peninsular India. Another four species viz., *Lejeunea cavifolia* (Ehrh.) Lindb., *Radula obscura* Mitt., *Radula meyeri* Steph. and *Barbella turgida* Nog. are new record of occurrence for Kerala State. *Trichostelium stigmatosum* (Manju et al., 2012) and *Aerobryopsis wallichii* (Brid.) Fleisch. (Prajitha et al., in press), has been reported as new records for India from Silent Valley.

Introduction

The Silent Valley National Park, also known as *Sairandhri Vanam*, located in the Nilgiri Hills of Palakkad District in Kerala state, is one of the

most popular protected areas in India. It raised as a legend of conservation and environmental protection movement in India and elsewhere. It forms the part of the Nilgiri Sub-Cluster of Western Ghats World Heritage Site designated by UNESCO. The National Park spreads over an area of 91 km² forms the major part of the Nilgiri International Biosphere Reserve.

The area in this National park was historically explored in 1847 by the botanist Robert Wight. The Park is one of the last undisturbed tracts of the South Western Ghats montane rain forests and tropical moist evergreen forest in India. Contiguous with the proposed Karimpuzha National Park (225 km²) to the north and Mukurthi National Park (78.46 km²) to the north-east, it is the core of the Nilgiri Biosphere Reserve.

It rises abruptly to the Nilgiri Plateau in the north and overlooks the plains of Mannarkkad in the South forming the core area of Nilgiri Biosphere Reserve. Silent Valley perhaps, is one among the most magnificent gifts of nature to mankind. The mean annual temperature is 20.2°C. The hottest months are April and May when the mean temperature is 23 °C and the coolest months are January and February when the mean temperature is 18° C.

The great diversity in ecological factors and high range of altitudinal variation have been responsible for the very rich and diverse vegetation of the area. It belongs to the Indo-Malayan eco-region (Olson *et al.*, 2001) and the major vegetation types include North Western Ghats montane rain forests (IM0135) (Tropical wet evergreen forests), North Western Ghats moist deciduous forests (IM0134) (Tropical Moist deciduous forests (300-800 m)), South Western Ghats montane rain forests (IM0151) (Sub-tropical montane forest (1400-1868) and grass lands. These grass lands of the higher altitudes are seen over the crest of the Silent Valley National Park and at the Poochipara area. The soil is very shallow and vegetation comes after the monsoon. There is a clear demarcation of vegetation types based on the altitudinal range.

Manoharan (1999) edited a book on the Silent Valley Whispers of Reason, which contains 38 articles on various aspects of Silent Valley such as on the historical and managerial evolution of Silent Valley National Park as well as on its biodiversity. The first major attempt to document the bryophyte diversity of the area has been made by Vohra *et al.* (1982). Later some other authors such as Asthana and Srivastava (1986), Srivastava & Sharma (2000) reported the occurrence of some more species. Daniels *et al.* (2010) reported a new endemic genus, *Indopottia* with

the species *I. zanderii*. Manju *et al.* (2012) reported the occurrence of *Trichostelium stigmosum* from Silent Valley as a new record for India. However, a comprehensive account on the bryophyte diversity of this area is still lacking, which is attempted here. This paper tries to present a detailed account on the bryophyte diversity, mainly based on the recent collections, and also incorporating earlier accounts. Some of the taxa reported earlier such as by Vohra *et al.* (1982) were now sunk into the synonymy, and which are mentioned under respective species.

Enumeration of species

The specimens were collected by Manju C.N. (MCN), Rajilesh, V.K. (RVK), Anoop, K.P. (AKP) and Hareesh (HA) between 2001-2011 and were identified and confirmed by Manju C.N. (first author), L.T. Ellis of British Natural History Museum (BM) during 2001-2012. The specimens are deposited in the Calicut University Herbarium (CALI) and the Malabar Botanical Garden (MBG). Each species is listed with author citation followed by the observations on the substrate/s on which it was found growing in the study area, the locality, altitude, the collector's name, collection number, and with comments on the distribution of species; (species not found in Tropicos is given the sign !),. Microphotographs of new records of species were provided.

List of Species

Marchantiophyta

Aytoniaceae

Asterella leptophylla (Mont.) Pande,- This is an Indian endemic species. (Based on Srivastava and Sharma, 2000).

Marchantiaceae

Dumortiera hirsuta (Sw.) Nees- On rocky patch near streams were water drips regularly. Silent Valley National Park (1500 m), RVK & *al.* 5026, 5525, 5526 (*MBG*). This is widely distributed in the high altitude areas of the Western Ghats. It has wide distribution in Southern India (Tamil Nadu, Kerala, Karnataka), Northern India (Simla, Mussoorie, Kumaon, Pachmahri), Nepal, Japan, Brazil, Mexico, Jamaica, North &

South America, Europe, New Zealand, Hawaii and Africa. (Srivastava and Sharma, 2000 also collected this species).

Targioniaceae

Cyathodium cavernarum Kunze- On moist soil, rocks and on concrete walls. Silent Valley National Park (1000 m), RVK & al. 5480 (MBG). This is a widely distributed species from low to high altitude areas. (Srivastava and Sharma, 2000 also reported this species)

Targionia hypophylla L.- On rocky patch. Silent Valley National Park (1600 m), RVK & al. 5406 (MBG). Distributed in India (Kerala, Tamil Nadu) China, Australia, Europe, Ireland, Madagascar, Mexico, New Zealand, South Africa and South America. (Srivastava and Sharma, 2000 also reported this species).

Targionia indica Udar & Gupta,- On rocky patch and crevices of rocks. This is an Indian endemic species. (Based on Srivastava and Sharma, 2000).

Pallaviciniaceae

Pallavicinia indica Schiffn.- On land cuttings and on soil covered rocks; Silent Valley National Park (1500 m), RVK & al. 5532 (MBG). It is distributed in India (Eastern Himalayas, Meghalaya, Khasi hills, Kerala), Nepal, Java, Sumatra and Tahiti. Manju and Rajesh (2011) reported this species from Parambikulam Tiger Reserve as new record of occurrence to the Peninsular India.

Pallavicinia lyellii Schiffn., on base of tree trunks and on rhizome of ferns near stream. Silent Valley National Park (1200-1500m), RVK & al. 5529, 5528, 5339, 5398a (MBG). It is distributed in Southern India (Kerala, Karnataka), North-east India (Assam, Gauhati, Shillong, Pachmahri), Sri Lanka, Europe, Jamaica, Cuba, Brazil, Java, Singapore, Philippines, Japan (Ryukyu), Moluccas, New Zealand, Africa and America.

Fossombroniaceae

Fossombronia cristula Austin- On land cuttings, and on moist rocks near stream. Silent Valley National Park (1600 m). RVK & al. 5402 (MBG). It is distributed in India (Kerala), Japan and America. (Srivastava and Sharma, 2000 also reported this species).

Fossombronia indica Steph.- On moist soil in association with other bryophytes. This is an Indian endemic species. (based on Srivastava and Sharma, 2000)

Calypogiaceae

Calypogia khasiana Singh et Nath, On bark, Siruvani (1200 m) *RVK & al.* 5527, 5370b (MBG). It is distributed in India (Eastern Himalaya, Meghalaya, Kerala).

Geocalycaceae

Heteroscyphus argutus (Nees) Schiffn.- On land cuttings and on roots of higher plants near streams. Silent Valley National Park (1200 – 2000 m) *RVK & al.* 5390b, 5533b, 5359a, 5349, 5503, 5345 (MBG). A widely distributed species in India in the high altitude areas of Kerala, Tamil Nadu & Karnataka and North-eastern India (Darjeeling, West Himalaya, Pachmahri, Assam, Sikkim, Manipur, Meghalaya). distribution extends to Borneo, Brazil, Myanmar, China, Java, Japan, New Guinea, New Zealand, Philippines, Sumatra and Taiwan.

Lophocolea minor Nees- On land cuttings where water drips regularly, Silent valley tower area (1200 – 2000 m) *RVK & al.* 5350 (MBG). Distributed in India (Eastern Himalayas, Meghalaya, East khasi Hills, Mawphlong forest), Europe, America, Asia, China, Nepal, Japan, Siberia and Korea.

Aneuraceae

Riccardia tenuicostata Schiffn.- On moist rocks. Silent Valley National Park (1200 – 1500m) *RVK & al.* 5533a, 5353 (MBG). Widely distributed species in Kerala, Tamil Nadu, Darjeeling, Eastern Himalaya and Western Himalayas in India and distribution extends to Singapore and Java.

Riccardia levieri Schiffn.- On moist soil and on rocks. Silent Valley National Park (1500 m) *RVK & al.* 5404 (MBG). Distributed in India (Kerala, Tamil Nadu, Western and Eastern Himalayas), Bhutan. (Srivastava and Sharma, 2000 also reported this species).

Riccardia multifida (L.) Gray.- On rocky patch and on land cuttings near stream. Distributed in India (Kerala, Tamil Nadu, Western and Eastern Himalayas), Sri Lanka, Japan, Taiwan, Australia, Ireland, Scotland and Netherlands. (based on Srivastava and Sharma, 2000).

Cephaloziellaceae

Cephaloziella kiaerii (Austin) Arnell.- On moist soil along with other liverworts. Silent Valley National Park (1500m) *RVK & al.* 5401 (*MBG*). Distributed in India (Kerala, Tamil Nadu, Western Himalayas), Sri Lanka, China, Java, Malaysia, New Caledonia, Taiwan and Africa. (Srivastava and Sharma (2000) also reported this species).

Plagiochilaceae

Plagiochila devexa Steph., On tree trunk, Silent Valley (1200-2000m) *RVK & al.* 5341 (*MBG*). It is distributed in North-eastern India (Sikkim, Himalaya), South India (Kerala), China, Bhutan, Nepal and Sri Lanka.

Jungermanniaceae

Notoscyphus paroicus Schiffn.- On rocks, Silent Valley (1200-2000 m) *RVK & al.* 5381, 5390a, 5392 (*MBG*). It is distributed in India (Eastern Himalaya, Meghalaya), Java, Japan, Vietnam, Luzon, Sumatra and Banca. The present collection is a new record for the Peninsular India (Plate 3 H-Q).

Jungermannia tetragona Lindenb.- On moist soil and on land cuttings. A widely distributed species in high altitude areas. (based on Srivastava and Sharma, 2000).

Jungermannia truncata Nees, Terrestrial on moist soil. Distributed in India, Borneo, Myanmar, Sri Lanka, China, Taiwan, Java, Korea, Malaysia, New Guinea, Philippines, Indonesia and Thailand. (based on Srivastava and Sharma, 2000).

Jubulaceae

Frullania acutiloba Mitt.- On bark. It is distributed in India and Sri Lanka. (based on Srivastava and Sharma, 2000).

Frullania tamarisci (L.) Dumort. subsp. *obscura* (Verd.) S.Hatt., On bark. Silent Valley (1450 m) *MCN 70080 (CALI)*. It is a widely distributed species in Southern India (Kerala, Tamil Nadu), Northern India (Himalaya), Sri Lanka, Malaysia, China, Taiwan, Korea, Japan and Europe.

Lejeuneaceae

Archilejeunea apiculifolia Steph., Epiphytic. Endemic to India. (based on Srivastava and Sharma, 2000).

Dicranolejeunea gilva Steph., Epiphytic. Distributed in India and Nepal (based on Srivastava and Sharma, 2000).

Lejeunea cavifolia (Ehrh.) Lindb., Grows on soil covered rock, Silent Valley (1200–2000 m) RVK & al. 5359b (MBG). It is distributed in India (Tamil Nadu, Uttar Pradesh, Sikkim Himalaya, Assam-Shillong), Nepal, China, Siberia, Caucasus, Europe and United States. The present collection is a new record for Kerala State (Plate 4. A-E).

Lejeunea flava (Sw.) Nees- Epiphytic and also terrestrial, Silent Valley (1200–2000m), RVK & al. 5399b (MBG). It is distributed in India (Eastern Himalayas, Meghalaya, Kerala), China, Taiwan, Philippines, Thailand, Nepal and Sri Lanka. Widespread Pantropical species. Srivastava and Sharma (2000) also reported this species.

Lopholejeunea abortiva (Mitt.) Steph., Epiphytic. (based on Srivastava and Sharma, 2000).

Lopholejeunea javanica (Nees) Schiffn.- On rocky soil and boulders. This species is distributed in India, Java, Japan and Philippines. (based on Srivastava and Sharma, 2000).

Lopholejeunea sikkimensis Steph.- Epiphytic. Distributed in India and Nepal. (based on Srivastava and Sharma, 2000).

Lopholejeunea subfusca (Nees) Steph.- Epiphytic, Silent Valley (1200–2000 m), RVK & al. 5375b (MBG). Widely distributed species. Srivastava and Sharma (2000) also reported this species.

Microlejeunea ulicina A.Evans, Epiphytic. Distributed in India, Japan and North America. (based on Srivastava and Sharma, 2000).

Taxilejeunea indica A. Agarwal, Epiphytic. Indian endemic species (based on Srivastava and Sharma, 2000).

Radulaceae

Radula obscura Mitt.- on bark of trees, Silent Valley (1200–2000m), RVK & al. 5399a (MBG). It is distributed in India (Eastern Himalayas, Meghalaya), China, Taiwan, Philippines, Thailand, Nepal and Sri Lanka. The present collection is a new record for Kerala (Plate 4. F-H).

Radula meyeri Steph.- On rocky patch, Silent Valley (1200–2000 m), RVK & al. 5375 (MBG). It is distributed in India (Eastern Himalayas,

Meghalaya), China, Taiwan, Philippines, Thailand, Nepal and Sri Lanka. The present collection is a new record for Kerala (Plate 4. I-K).

Radula kurzii Steph.- On rocky patch. (based on Srivastava & Sharma, 2000).

Radula pandei Udar & Kumar, On rocky patch and on bark. (based on Srivastava & Sharma, 2000).

Anthocerotophyta

Anthocerotaceae

Anthoceros crispulus (Mont.) Douin,- On land cuttings near stream. Silent Valley National Park (1500-1600 m) RVK. & al. 5407 (MBG). Distributed in India (Kerala, Tamil Nadu, Western & Eastern Himalayas), Sri Lanka, Japan, Korea, Malaysia, Europe and United States of America. (Srivastava and Sharma, 2000 also collected this species).

Folioceros udarii Asthana & Srivastava,- Terrestrial. This is an Indian endemic species. (Based on Asthana and Srivastava, 1986; and Srivastava and Sharma, 2000).

Phaeoceros laevis (L.) Prosk. subsp. *laevis* Prosk.- Terrestrial. Distributed in India (Kerala, Tamil Nadu, Western Himalayas) North America and Britian. (Based on Srivastava and Sharma, 2000).

Bryophyta

Polytrichaceae

Atrichum pallidum Renauld & Cardot- On land cuttings. Silent Valley National Park (1300-1600 m) RVK & al. 5409 (MBG). This species is distributed in India (Kerala, Darjeeling, Khasia, Western Hiamalaya), Nepal and Tibet. Vohra *et al.* 1982 reported this species as *Atrichum aculeatum* (Card. & Vard.) Broth.

Pogonatum microstomum (Schwaegr.) Brid.- On land cuttings. Silent Valley (1200-1500 m), RVK & al. 5334a (MBG). This species has wide distribution in the Western Ghats. It is a South-east Asiatic species reported from Southern India (Kerala, Tamil Nadu, Karnataka), North-eastern India (Darjeeling, Western Himalaya, Meghalaya, Sikkim), Sri Lanka, Bhutan, Taiwan, Nepal, Philippines, Setchwan, Vietnam and Yunnan. (Vohra *et al.* 1982 also reported this species).

Pogonatum hexagonum Mitt.= *P. patulum* (Harv.) Mitt.- On earth bank. (based on Vohra, et. al., 1982).

Diphysciaceae

Diphyscium involutum Mitt., on rocky patch, Silent Valley (1300-1500m), *RVK & al.* 5330 (MBG). It is distributed in India (Khasia Hills, Palni Hills) Sri Lanka and the Philippines.

Dicranaceae

Campylopus flexuosus (Hedw.) Brid.- On rocks and soil, Silent Valley (1250 m), *RVK & al.* 5334, 5342 (MBG). This is a cosmopolitan species mostly occurring in high altitude areas. It has been reported earlier from Southern India (Kerala; Eravikulam National Park), North India (Western Himalaya), China, East Nepal, Algeria, Abyssinia, Madagascar, New Zealand, Oceania and Siberia.

Campylopus involutus (C.Mueller) A.Jaeger. On rocky patches. Silent Valley (1200m), *RVK & al.* 5517a, (MBG). An Indo-Malesian species distributed in North India (Darjeeling), Southern India (Tamil Nadu: Nilgiri hills; Kerala: present collection). Vohra *et al* (1982) reported this species as *Campylopus erythrognaphalus* (C.Mueller) A.Jaeger.

Campylopus schmidii (C.Mueller) A.Jaeger- on tree trunks. (based on Vohra *et al.* 1982).

Dicranella divaricata (Mitt.)A.Jaeger- on earth bank. (based on Vohra *et al.* 1982).

Leucoloma taylorii (Schwaegr.) Mitt., On bark, Silent Valley (1250m), *RVK & al.* 5517, 5346, 5341, 5358a, 5386, 5393, 5394, (MBG). It is a South-east Asiatic species distributed in India (Kerala), Nepal, Malaya and Myanmar.

Calymperaceae

Calymperes lonchophyllum Schwaegr.- Epiphytic. Silent Valley National Park (1300 m) *RVK & al.* (MBG). A widely distributed pantropical species (Vohra *et al.* 1982 also reported this species).

Calymperes tortelloides Broth. & Dix.- on tree trunks (based on Vohra *et al.* 1982).

Syrrhopodon gardneri (Hook.) Schwaegr., On bark, Silent Valley (1500 m), *RVK & al.* 5393a (MBG). Pantropical species. India (North-western Himalayas, West Bengal, Khasia hills), Sri Lanka, Bhutan, Bor-

neo, Indonesia, Nepal, Philippines, Sumatra and Vietnam. (Vohra *et al.* 1982 also reported this species).

Leucobryaceae

Leucobryum mittenii Besch.-On logs, Silent Valley (1200–1500 m), *RVK & al.* 5502, 5516, 5521 (MBG). It is distributed in India (Khasia Hills, Kerala) and Japan.

Leucobryum nilghiriense Müll. Hal.-On tree trunk, Silent Valley (1200–1500m), *RVK & al.* 5329 (MBG). It is distributed in India (Darjeeling, Tamil Nadu, Kerala), East Nepal, Bhutan, Khasia Hills, Sri Lanka, Myanmar, Thailand, Vietnam, Sumatra, Java, Borneo, Celebes, Philippines, China, Korea, Japan and Fiji.

Fissidentaceae

Fissidens asperisetus Sande-Lac.-On earth bank, Silent valley (1200-1500m) *RVK & al.* 5524 (MBG). It is distributed in South India (Tamil Nadu, Kerala), Andaman Island, Sri Lanka, Celebes, Java and Philippines. (Vohra *et al.* 1982 also reported this species).

Fissidens crispulus Brid.- On soil, rocks and bases of tree trunks, Silent valley (1200-1500 m) *RVK & al.* 5360,5372 (MBG). A widely distributed species in India (North-east, Kerala, Tamil Nadu), China, Malaysia, Madagascar and Cameron. Vohra *et al.* (1982) reported this species as *Fissidens sylvaticus* Griff.

Fissidens firmus Mitt.- on submerged rocks. (*based on* Vohra *et al.* 1982).

Fissidens virens Thwait. ex Mitt., On earth bank near stream, Silent Valley (1500 m) *RVK & al.* 5360 (MBG). Asiatic mainland species distributed in North-eastern India (Assam, West Bengal), South India (Kerala) Nepal and Vietnam. (Vohra *et al.* 1982 also reported this species).

Pottiaceae

Gymnostomum calcareum Nees & Hornsch., On rocks, Silent valley (1200 m); *RVK & al.* 5366 (MBG). It is distributed in India (Eastern Himalaya, Western Himalaya), Western Tibet, Europe, Caucasus, Siberia, Tajikistan, China, Japan, N.&S. Africa, Australia, New Zealand, N.&S. America and Oceania. The present collection is a new record for Peninsular India (Plate 1 G-L).

Hyophila involuta (Hook.) A. Jaeger, seen on wide variety of habitats such as on rocks, soil, bark, etc. Silent Valley (1200-1500m), *RVK & al.* 5343, 5366a (MBG). It is a widely distributed species. (Vohra *et al.* 1982 also reported this species).

Hyophila mollifolia Dix. & Vard.- on rocks. (*based on Vohra et al.* 1982).

Hyophila nymaniana (M.Fleisch.) Menzel, On rocky patch. Silent Valley (1500 m) *RVK & al.* 5375a. This is an Indo-Pacific species distributed in Peninsular India (Kerala, Tamil Nadu, Gujarat), North-east India (Western Himalaya, Orissa) and Philippines. Vohra *et al.* (1982) reported this species as *Hyophila comosa*.

Hymenostylium recurvirostre (Hedw.) Dixon, on rocks, Silent valley (1500 m), *RVK & al.* 5375 (MBG). it is distributed in South India (Kerala), north-east India (Western Himalaya, Kashmir, Kumaon, Khasi Hills, Kangra, Ladakh, Mussorie, Sikkim), Afganistan, China, Japan, Korea, Myanmar, New Zealand, New Guinea, Philippines, Pakistan and Western Tibet.

Indopottia zanderi A.E.D. Daniels, R.D.A. Raja & P. Daniel- Lignicolous, in association with *Syrrhopodon spiculosus*. Endemic to Silent Valley National Park in Kerala (980–1070 m). (*based on Daniels et al., 2010*).

Pseudosymblepharis indica Dix. & Vard. = *P. bombayensis* (C.Mueller) P.Sollman, On tree trunks and rocks. (*based on Vohra et al.* 1982).

Barbula indica (Hook.) Spreng., Syst. Veg. 2: 72. 1824.
On rocks. (based on Vohra et al. 1982).

Funariaceae

Funaria hygrometrica Hedw., on rocks and on earth bank, Silent Valley (1600 m), *RVK & al.* 5344b (MBG). A cosmopolitan species. (Vohra *et al.* 1982, also reported this species).

Bryaceae

Anomobryum auratum (Mitt.) A.Jaeger, on moist rocks and soil, Silent Valley (1200–1500 m) 5343a, 5347a (MBG). It is distributed in South India (Kerala: Eravikulam National Park; Karnataka: Mahabaleswar; Tamil Nadu), North-east India (Darjeeling, Western Himalayas, Kashmir, Meghalaya, Naga Hills, Sikkim), Sri Lanka, China, Bhutan,

Nepal, Korea, Japan, Philippines, Tanzania, Kenya and Madagascar. (Vohra *et al.* 1982 also reported this species).

Brachymenium nepalense Hook., on bark, Silent Valley (1300) RVK & al. 5347c (MBG). *B. nepalense* is an Afro-Asiatic species distributed in South India (Kerala, Karnataka, Tamil Nadu), North-east India (Simla, Kumaon, Garhwal), Sri Lanka, Thailand, Sumatra, Java, Borneo, Celebes, New Guinea, Myanmar, China, Taiwan, Indonesia, Japan, Philippines and Africa. (Vohra *et al.* 1982 also reported this species).

Bryum apalodictyoides Müll. Hal.- On wet soil. (based on Vohra *et al.* 1982).

Bryum coronatum Schwaegr.- On concrete walls. (based on Vohra *et al.* 1982).

Bryum capillare Hedw., On rocky patch, Silent Valley (1200–1500 m) 5352 (MBG). It is a cosmopolitan species found distributed in South India (Tamil Nadu: Palni hills, Kerala), North India (Western Himalaya, Kashmir), China, Thailand, Vietnam, Taiwan, Korea, Japan, Siberia, Central Asia, Europe, North and Central Africa, North and South America, Australia and New Zealand.

Bryum cellulare Hook., On earth bank, Silent Valley (1200–1500 m) 5519, 5338, 5344a, 5383 (MBG). This is distributed widely in North India (Western Himalayas, Kerala) Myanmar, China, Japan, Sumatra, Java, Philippines, Taiwan, Europe, North and Central Africa and Australia.

Bryum curyphyllum Dix. & P.Vard.- On soil near stream. (based on Vohra *et al.* 1982).

Bryum rugosum Müll. Hal.- = *Brachymenium pendulum* Mont.- On submerged rocks. (based on Vohra *et al.* 1982).

Bryum vellei Card. & P. Vard. var. *robustum* Dix. & Vard. = *B. billardierei* var. *billardierei* Schwaegr. (based on Vohra *et al.* 1982).

Bryum wightii Mitt.-On rocky patch, Silent Valley (1300-1500m) 5383 (MBG). It is distributed in Eastern India, South India (Mahabaleswar, Nilgiri, Palni), Sri Lanka, East Nepal.

Pohlia flexuosa (Hook.) Mitt.- On earth bank. (based on Vohra *et al.* 1982).

Bartramiaceae

Bartramidula dispersa Card. & Vard.= *Philonotis dispersa* (Cardot & P. de la Varde) D.G. Griffin & W.R. Buck.- On earth bank. (based on Vohra *et al.* 1982).

Philonotis anisoclada Card. & Vard.= *P. falcata* - On earth bank. (based on Vohra *et al.* 1982).

Philonotis hastata (Duby) Wijk. & Marg., on soil and rocky patches, Silent Valley (1200–1500 m) 5366a (MBG). It is a pantropical species earlier reported from South India (Kerala, Tamil Nadu, Karnataka) North-East India (Calcutta, Assam, Sikkim), Sri Lanka, Borneo, Bolivia, Java, Thailand, Celebes, Philippines, Japan, Taiwan, Chile, Oceanic island, Peru, Venezuela, Africa, South America and Australia. (Vohra *et al.* 1982 reported this species as *Philonotis heterophylla* Mitt.).

Philonotis mollis (Dozy & Molk.) Mitt., On rocky patch, Silent Valley (1500 m) 5352 a (MBG). Distributed in South India (Karnataka, Kerala), Central India (Rajasthan), Andaman Islands, Sri Lanka, Borneo, Java, Indonesia, Japan, Madagascar, Philippines, Sumatra and Vietnam. (Vohra *et al.* 1982 also reported this species).

Philonotis thwaitesii Mitt., on soil cuttings and moist rocks, Silent Valley (1200–1500 m) 5519b, 5343b (MBG). Distributed in South India (Kerala, Tamil Nadu; Palni hills), North India (Western Himalaya), Sri Lanka, China, Borneo, Bolivia, Colombia, Japan, Korea, New Guinea and Taiwan.

Orthotrichaceae

Macromitrium calimperidium Mitt.- Epiphytic. (Based on Vohra *et al.* 1982).

Macromitrium moorcrofti (Hook & Grev.) Schwaegr., On bark, Silent Valley (1200–1500 m) 5347b (MBG). It was earlier reported from South India (Karnataka: Coorg, Kerala), North-East India (Western Himalaya, Khasi hills, Sikkim, Darjeeling) Andaman and Nicobar Islands, China, Nepal, Myanmar, Bhutan and Bangladesh.

Macromitrium perrottetii Müll. Hal.- Epiphytic. (Based on Vohra *et al.* 1982).

Macromitrium sulcatum (Hook.) Brid., on bark, Silent Valley (1200–1500 m) 5365 (MBG). It is widely distributed in South India (Kerala, Maharashtra, Tamil Nadu), Sri Lanka, Nepal, Borneo, Kampuchea, Madagascar, Malaysia, Myanmar, Philippines, Thailand and Vietnam.

Macromitrium turgidum Dix., on bark, Silent Valley (1200–1500 m) 5364 (MBG). It is distributed in India (Naga Hills, Arunachal) and Thailand. The present collection is a new record for Peninsular India (Plate 2 H-L).

Myuriaceae

Myurium rufescens (Reinw. et Hornsch.) Fleisch., on bark, Silent Valley (1350 m) *RVK & al.* 5384 (MBG). It is distributed in India (Darjeeling, Khasia Hills), Sri Lanka, Myanmar, Thailand, Sumatra, Java, Malacca, Celebes, Borneo, New Guinea, Philippines, China, Japan, Australia and New Caledonia.

Racopilaceae

Racopilum cuspidigerum (Schwaegr.) Angstr., earth bank and on soil covered rocks; Silent Valley National Park (1500 m) *RVK & al.* 5532a (MBG). Distributed in South India (Tamil Nadu, Kerala), Myanmar, Thailand, Philippines, Vietnam, Borneo, Indonesia, Malaysia and Papua New Guinea.

Racopilum schmidii (Müll. Hal.) A.Jaeger- On earth bank. (Based on Vohra *et al.* 1982).

Trachypodaceae

Diaphanadon blandus (Harv.) Renauld & Cardot., on bark, Silent Valley (1350 m) 5361 (MBG). It is distributed in South India (Kerala, Karnataka Tamil Nadu), North-east India (Mussoorie, Simla, Kumaon, West Bengal, Sikkim, Assam, Dargeeling), Sri Lanka, Nepal, Bhutan, Borneo, Ceram, Halmahera, Indonesia, Myanmar, Taiwan, Sumatra and Yunnan.

Trachypus bicolor Reinw. & Hornsch., On bark, Silent Valley (1250m) *RVK & al.* 5346a (MBG). Widely distributed species in high altitude areas. (Vohra *et al.* 1982 also reported this species).

Trachypodopsis crispatula (Hook.) Fleisch.- On tree trunks and rocks. (based on Vohra *et al.* 1982).

Pterobryaceae

Pterobryopsis orientalis (Müll. Hal.) M.Fleisch.- On bark, Silent Valley (1200 -1500 m) 5515b (MBG) It is a south -cost Asiatic species found distributed in South India (Kerala, Tamil Nadu), North – East India (Mussoorie, Kumaon, Darjeeling, Sikkim, Naga hills), Myanmar, Thailand, North Vietnam and Yunnan.

Pterobryopsis schmidii (Müll. Hal.) Fleisch.- Epiphytic. (based on Vohra *et al.* 1982).

Pterobryopsis tumida (Dicks. Ex Hook.) Dixon- Epiphytic. (based on Vohra *et al.* 1982).

Symphysodontella involuta (Mitt) Fleisch., on bark, Silent valley (1200-1500m) 5508 (MBG). It is distributed in Eastern India and Arunachal. (Vohra *et al.* 1982 also reported this species).

Meteoriaceae

Aerobryopsis longissima (Dozy & Molk.) M.Fleisch., hanging from the branches of trees, Silent Valley (1200–1500 m) 5341 (MBG). It is distributed in South India (Tamil Nadu, Karnataka, Kerala), Eastern India (Sikkim), Sri Lanka, China, Caroline Islands, Indian Archipelago, Madagascar, Malaysia, New Guinea, Philippines, Pacific Ocean Island, Sumatra, Taiwan, Vietnam, Australia and Yunnan (Vohra *et al.* 1982 also reported this species).

Aerobryopsis wallichii (Brid.) Fleisch., On branches, Silent Valley (1200–1500 m) RVK & al. 5337 (MBG). Distributed in East Nepal and Sri Lanka. Gangullee (1971) commented that this species is endemic in these areas. The present collection from Silent Valley NP extends its distribution and it is a new record for India. (Prajitha *et al.* in press).

Aerobryum speciosum Dozy & Molk., on base of tree trunk, Silent Valley (1200–1500 m) 5396 (MBG). An east and South east Asiatic species earlier reported from South India (Western Ghats of Tamil Nadu, Kerala), North – Eastern India (Darjeeling, Arunachal Pradesh, Khasi hills, Manipur, Meghalaya, Sikkim), Sri Lanka, Bhutan, Celebes, China, Taiwan, Indonesia, Japan, Philippines, New Guinea and Vietnam.

Aerobryidium filamentosum (Hook.) Fleisch.-On tree trunks. Silent Valley National Park (1500 m) RVK & al. 5410 (MBG). A South east Asiatic species distributed in India (Kerala, Tamil Nadu, Coorg, Western & Eastern Hiamalayas, Darjeeling), Nepal, Bhutan, Sri Lanka, Myanmar, Thailand, Vietnam, Sumatra, Java, Borneo, Celebes and Philippines. (Vohra *et al.* 1982 also reported this species).

Barbella convolvens (Mitt.) Broth.- On branches of trees. (based on Vohra *et al.* 1982).

Barbella turgida Nog., on tree trunk, Silent Valley (1200–1500 m) 5336 (MBG). It is distributed in India (Western Himalaya, Tamil Nadu), East Nepal. The present collection is a new record for Kerala (Plate 4. L-P).

Barbella flagellifera (Card.) Nog.- On branches of trees. (based on Vohra *et al.* 1982).

Chrysocladium flammeum (Mitt.) M. Fleisch.- On bark, Silent Valley (1200–1500 m) 5515a (MBG). It is distributed in Eastern India, Sikkim, Darjeeling, East Nepal. The present collection is a new record for Peninsular India (Plate 1 A-F).

Cryptopapillaria chrysoclada (Müll. Hal.) A.Jaeger- On tree trunks. (based on Vohra *et al.* 1982).

Cryptopapillaria feae (M.Fleisch.) M.Menzel – On tree trunks (based on Vohra *et al.* 1982)

C. Mueller et Fleisch.- on tree trunks. (based on Vohra *et al.* 1982)

Cryptopapillaria fuscescens (Hook.) A. Jaeger- On tree trunks and on logs, Silent Valley (1200-1500m) 5523 (MBG). It is a widely distributed in species in high altitude areas of South India (Kerala, Goa, Karnataka, Tamil Nadu), North–East India (Kumaon Himalaya, West Bengal, Arunachal Pradesh, Manipur, Meghalaya, Sikkim), Sri Lanka, Bhutan, Indonesia, Indian Archipelago, Myanmar, Nepal, Philippines, Thailand, Vietnam and Yunnan. (Vohra *et al.* 1982 also reported this species).

Floribudaria floribuda (Doz. & Molk.) Fleisch.- on branches, Silent Valley (1200–1500m), 5376 (MBG). It is distributed in India (Sikkim, Darjeeling, Bhutan, Arunachal, Assam, Khasia Hills, Manipur) and East Nepal. (Vohra *et al.* 1982 also reported this species)

Floribudaria sparsa (Mitt.) Broth.- On branches, Silent Valley (1200–1500 m), 5358b (MBG). It is distributed in India (Sikkim, Darjeeling, Khasia Hills), East Nepal, Bhutan, Thailand, Java and Taiwan.

Floribudaria walkerii (Renauld & Cardot) Broth., on branches and on rocky patch, Silent Valley (1200m). 5395 (MBG). It is an Indian endemic species distributed in Eastern Himalayas, West Bengal and Kerala. (Vohra *et al.* 1982 also reported this species).

Meteoriopsis reclinata (Müll. Hal.) M.Fleisch., on tree trunks and on branches, Silent Valley (1200–1500m) 5377 (MBG). It was earlier recorded from South India (Tamil Nadu, Karnataka, Kerala), North–east India (Mussoorie, Kumaon, Bihar, Meghalaya, Sikkim), Sri Lanka, China, Japan, Indonesia, Malacca, Myanmar, Thailand, Laos, Celebes, Nepal, New Guinea, Sumatra and Australia.

Meteoriopsis squarrosa (Hook) M.Fleisch., on bark and on small branches, Silent Valley (1200–1500m) 5514 (MBG). It is distributed in South India (Tamil Nadu, Karnataka, Kerala), North–east India (Sikkim, Darjeeling, Himalaya, Arunachal Pradesh, Khasi hills, Manipur), Sri

Lanka, Nepal, Bhutan, Myanmar, Thailand, Vietnam, Sumatra, Java, New Guinea, Philippines, Taiwan and Yunnan. (Vohra *et al.* 1982 also reported this species)

Papillaria crocea (Hamp.) A.Jaeger, on bark, Silent valley (1250m) RVK & al. 5397a (MBG). Distributed in *South India (Tamil Nadu, Kerala), Sri Lanka, China, Japan, New Zealand and Australia.*

Pseudobarbella compressiramea (Ren.& Card.) Nog.- On branches, Silent Valley (1450 m) 5522, 5385 (MBG). It was earlier recorded from Eastern India (Sikkim, Darjeeling and Naga Hills) and East Nepal.

Neckeraceae

Calypothecium pinnatum Nog., hanging from bark and branches, Silent Valley (1250 m) 5379 (MBG). An east Asiatic species distributed in Eastern India (Sikkim, Darjeeling, Khasia Hills), Eastern Nepal, Taiwan and Myanmar, Taiwan. The present collection is a new record for Peninsular India (Plate 2 A-G).

Cryptolepton flexuosus (Harv.) Ren. & Card. – On tree trunks. (based on Vohra *et al.* 1982).

Handeliobryum setschwanicum Broth. = *H. sikkimense* (Paris) Ochyra.- On tree trunks and on rocks. (Based on Vohra *et al.* 1982).

Himantocladium rugulosum (Mitt.) Fleisch. = *H. cyclophyllum* (C.Mueller) Fleisch.- On tree trunks. (based on Vohra *et al.* 1982).

Himantocladium plumula (Nees) M.Fleisch., base of tree trunk, Silent Valley (1400 m) RVK & al. 5535 (MBG). An Indo–Pacific species found distributed in North–east India (Arunachal Pradesh, Assam, Khasi hills), Bangladesh, China, Taiwan, Japan, Sumatra, Indonesia, Borneo, Philippines, New Caledonia, New Guinea, Australia and Pacific Ocean Islands.

Homaliodendron flabellatum (Sm.) M.Fleisch., on tree trunks and on rocks, Silent Valley (1200–1500m) RVK & al. 5378 (MBG). It was earlier reported from South India (Kerala, Tamil Nadu: Nilgiri hills, Madurai, Thirunelveli, Kanyakumari, Karnataka). North – East India (West Bengal, Sikkim, Darjeeling, Arunachal Pradesh, Meghalaya), Sri Lanka, Java, Borneo, Philippines, Japan, Pacific Ocean Island Sumatra, Tailand and Australia. *et al.* (1982) also reported this species.

Pinnatella foreauana Ther. & Vard.- On tree trunks. (Based on Vohra *et al.* 1982).

Leskeaceae

Rhegmatodon orthostegium Mont.- Epiphytic. (Based on Vohra *et al.* 1982).

Thuidiaceae

Claopodium assurgens (Sull. & Lesq.) Card.- On tree trunks. (Based on Vohra *et al.* 1982).

Claopodium nervosum (Harv.) Feisch. = *C. prionophyllum* (Müll. Hal.) Broth. On wet rock. (Based on Vohra *et al.* 1982)

Haplocladium vestitum Dix. et Vard. = *Haplocladium microphyllum* subsp. *virginianum* (Brid.) Reimers – On tree trunks. (Based on Vohra *et al.* 1982).

Thuidium pristocalyx (Müll. Hal.) A.Jaeger., on rocks near stream, Silent Valley (1200–1500 m) 5534, 5357 (MBG). It is distributed in India (Eastern Himalayas, Kerala) Thailand, Vietnam, Indonesia, Malaysia and Philippines. Vohra *et al.* (1982) reported this species as *Thuidium glaucinum* (Mitt.) Bosch & Sande Lac

Thuidium cymbifolium (Dozy & Molk.) Dozy & Molk., on rocks, Silent valley (1200-1500m) RVK & al. 5373 (MBG). A widely distributed very common species in the tropics at high altitude areas. (Vohra *et al.* 1982 also reported this species).

Plagiotheciaceae

Stereophyllum tavoyense (Hook.) A.Jaeger = *Entodontopsis tavoyensis* (Hook. Ex Harv.) W.R. Buck & Ireland. On tree trunks. (based on Vohra *et al.*, 1982).

Brachytheciaceae

Eurhynchium swartzii (Thurn.) Curnow., on rocky patch, Silent Valley (1300–1500m), 5370a (MBG). It is distributed in East India, East Nepal, Darjeeling, Sri Lanka, China, Japan, Siberia, Kurdistan, Caucasus, Europe, Azores, Algeria, Central and South Africa, Canada and United States of America.

Sematophyllaceae

Brotherella amblystegia (Mitt.) Broth., on bark, Silent Valley (1200–1500 m) RVK & al. 5400a (MBG). It is distributed in Eastern India (Dar-

jeeling, Arunachal Pradesh, Naga Hills). The present collection is a new record for Peninsular India (Plate 2 M-Q).

Clastobryum patentifolium Dix. & Vard.- On tree trunks. (Based on Vohra *et al.* 1982).

Chionostomum rostratum (Griff.) Müll. Hal., on bark, Silent Valley (1200–1400 m) RVK & al. 5335, 5391 (MBG). It is distributed in Eastern India (Darjeeling, Khasia Hills, Coorg), Sri Lanka, Thailand, North & South Vietnam, Philippines and Taiwan.

Glossadelphus bilobatus (Dix.) Broth.- On wet rocks, Silent Valley (1200–1500 m) RVK & al. 5526, 5339b (MBG). It is distributed in Eastern India (Naga Hills), Sri Lanka and Moluccas. The present collection is a new record for Peninsular India (Plate 1 M-R).

Sematophyllum phoeniceum (Müll. Hal.) M. Fleisch.- On logs, Silent valley (1400m), 5346b (MBG). It is distributed in Eastern India, South India, Andaman Island, Thailand, Vietnam, South China and Bangladesh.

Taxiphyllum taxirameum (Mitt.) M.Fleisch.- On logs. Silent valley (1400m), 5346b (MBG). Widely distributed in the tropics including North-east India (Mussoorie, Simla, Nainital, Ranikhet, Almora, Sikkim, Abor, Assam, Khasi hills), Southern India (Tamil Nadu, Kerala), Sri Lanka, Nepal, Bhutan, Indonesia, Japan, Myanmar, New Guinea, Philippines, Sumatra, Taiwan and Vietnam. (Vohra *et al.*, 1982 also reported this species).

Trichosteleum stissophyllum (Hamp.) A.Jaeger = *Papillidiopsis stissophylla* (Hampe & C.Mueller) B.C. Tan & Y.Jia- On tree trunks. (based on Vohra *et al.*, 1982).

Trichosteleum stigmosum Mitt., on bark, Silent Valley (1300–1500 m) RVK & al. 5332, 5333 (MBG). Manju *et al.* (2012) recorded this species as new record for India.

Wijkia deflexifolia (Ren. & Card.) Crum., on bark, Silent Valley (1500 m) RVK & al. 5520 (MBG). It is distributed in Eastern India, Darjeeling and Bhutan. The present collection is a new record for Peninsular India (Plate 3 A-G).

Entodontaceae

Entodon obtusatus Card. & Vard.= *Entodon obtusatus* Broth.- On tree trunks. (based on Vohra *et al.* 1982)

Entodon perplicatus Ther. & Vard. = *!Campylopodium perplicatum* - On tree trunks (based on Vohra *et al.* 1982).

Hypnaceae

Bryosedgwickia kirtikarii (Bel.) Mitt.= *Platygyriella kirtikarii* (Cardot & Dixon) W.R. Buck- On tree trunks. (based on Vohra *et al.* 1982)

Ectropothecium cyperoides (Hook.) A. Jaeger- On submerged stones. (based on Vohra *et al.* 1982).

Ectropothecium drepanocladoides Broth. & Vard.- On tree trunks. (based on Vohra *et al.* 1982).

Hypnum macrogynum Besch., on rocky patch and on roots of higher plants, Silent Valley (1200m) *RVK & al.* 5369 (MBG). It is distributed in Eastern India, East Nepal, Myanmar, South China and Taiwan.

Hypnum flaccens Besch.- on roots of higher plants, Silent Valley (1400 m) *RVK & al.* 5388 (MBG). It is distributed in India (Easty Nepal), Sikkim, Bhutan . The present collection is a new record for Peninsular India (Plate 1 S-X).

Vesicularia vesicularis (Schwaegr.) Broth.- On rocks, Silent Valley (1350–1500 m) *RVK & al.* 5348 (MBG). It is distributed in North–east India (Western Himalaya, West Bengal, Arunachal Pradesh), South India (Kerala), China, Thailand, Vietnam, Sumatra, Java, Borneo, Philippines, Australia and Oceania.

Vesicularia reticulata (Dozy & Molk.) Broth. - on rocks, Silent valley (1500 m) *RVK & al.* 5373 (MBG). Distributed in India (Sikkim, Arunachal, Assam, Naga hills, Kerala) Sumatra, Java, Celebes, Philippines, Japan, Oceania and New Zealand. Vohra *et al.* (1982) reported this species from Silent Valley NP.

Conclusion

A preliminary report of the bryophytes of Silent Valley National Park is presented here. The catalogue consists of 148 taxa including 109 mosses, 36 liverworts and 3 hornworts. Of these nine species *viz.*, *Chrysocladium flammum* (Mitt.) M. Fleisch., *Gymnostomum calcareum* Nees & Hornsch., *Glossadelphus bilobatus* (Dix.) Broth., *Hypnum flaccens* Besch., *Macromitrium turgidum* Dix., *Calyptothecium pinnatum* Nog., *Brotherella amblystegia* (Mitt.) Broth., *Notoscyphus paroicus* Schiffn. and *Wijkia deflexifolia* (Ren. & Card.) Crum. are newly reported for Peninsular India. Another four species *viz.*, *Lejeunea cavifolia* (Ehrh.) Lindb., *Radula obscura* Mitt., *Radula meyeri* Steph. and *Barbella turgida* Nog. are new record of occurrence for Kerala State. *Trichostelium stigmosum*

(Manju *et al.*, 2012) and *Aerobryopsis wallichii* (Brid.) Fleisch. (Prajitha *et al.*, in press), has been reported as new records for India from Silent Valley.

Vohra *et al.* (1982) reported a preliminary checklist of mosses of Silent Valley National Park. They reported 70 species of mosses from the area, but in the present collection, we could locate only 28 species, reported by Vohra *et al.* (1982). Among these 70 species 21 were synonymised under different names. Vohra (1981) reported *Pogonatum hexagonum* an endemic moss to India from Silent Valley, which is now synonymised under *P. patulum* (Harv.) Mitt. Srivastava and Sharma (2000) also reported 24 species of Liverworts and three species of hornworts from Silent Valley National Park. In the present collection we could locate eight species of liverworts and one species of hornwort reported by Srivastava and Sharma (2000). Asthana and Srivastava (1986) described a new *Folioceros* species, as *F. udarii* Asthana & Srivastava from Silent Valley. Recently a new genus *viz.*, *Indopottia* along with its species *I. zanderii* has been described from Silent Valley (Daniels *et al.*, 2010). Hence in a preliminary survey we could report 148 species of bryophytes from the area. Explorations of smaller areas are often found very effective in biodiversity documentation, especially when searching cryptogrammic groups such as bryophytes. This report also suggest to study the area more in detail.

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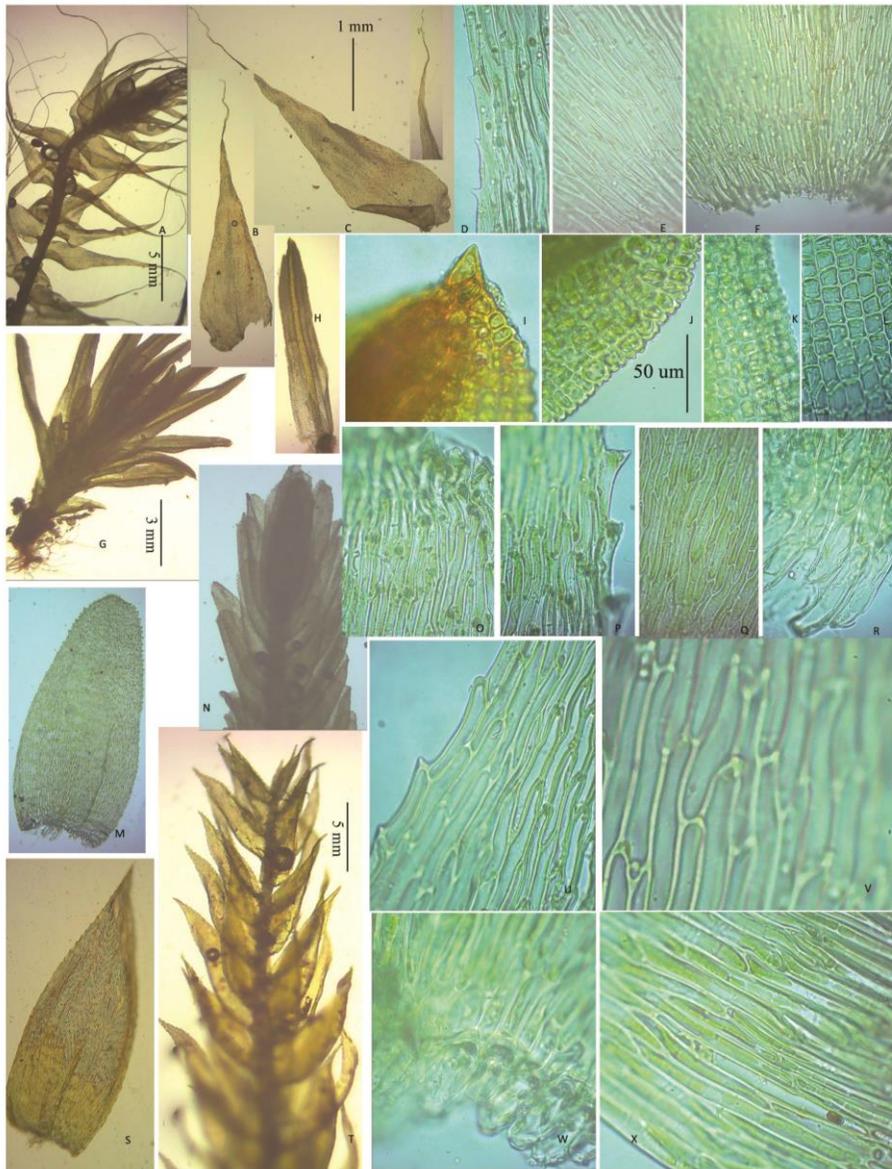


Plate 1. A-F; *Chrysocladium flammeum*, A. branch, B&C. Leaf, D. Leaf tip, E. Leaf middle cells, F. Leaf basal cells; G-L; *Gymnostomum calcareum*, G. Habit, H. Leaf, I. Leaf tip, J&K. Leaf marginal cells, L. Leaf basal cells; M-R; *Glossadelphus bilobatus*, M. Leaf, N. Branch, O. Leaf tip, P. Leaf marginal cells, Q. Leaf middle cells, R. Leaf basal cells; S-X; *Hypnum flaccens*, S. Leaf, T. Branch, U. Leaf marginal cells, V&X. middle cells, W. basal cells (B,C,D,H,M,S same length; all cells same length as J)

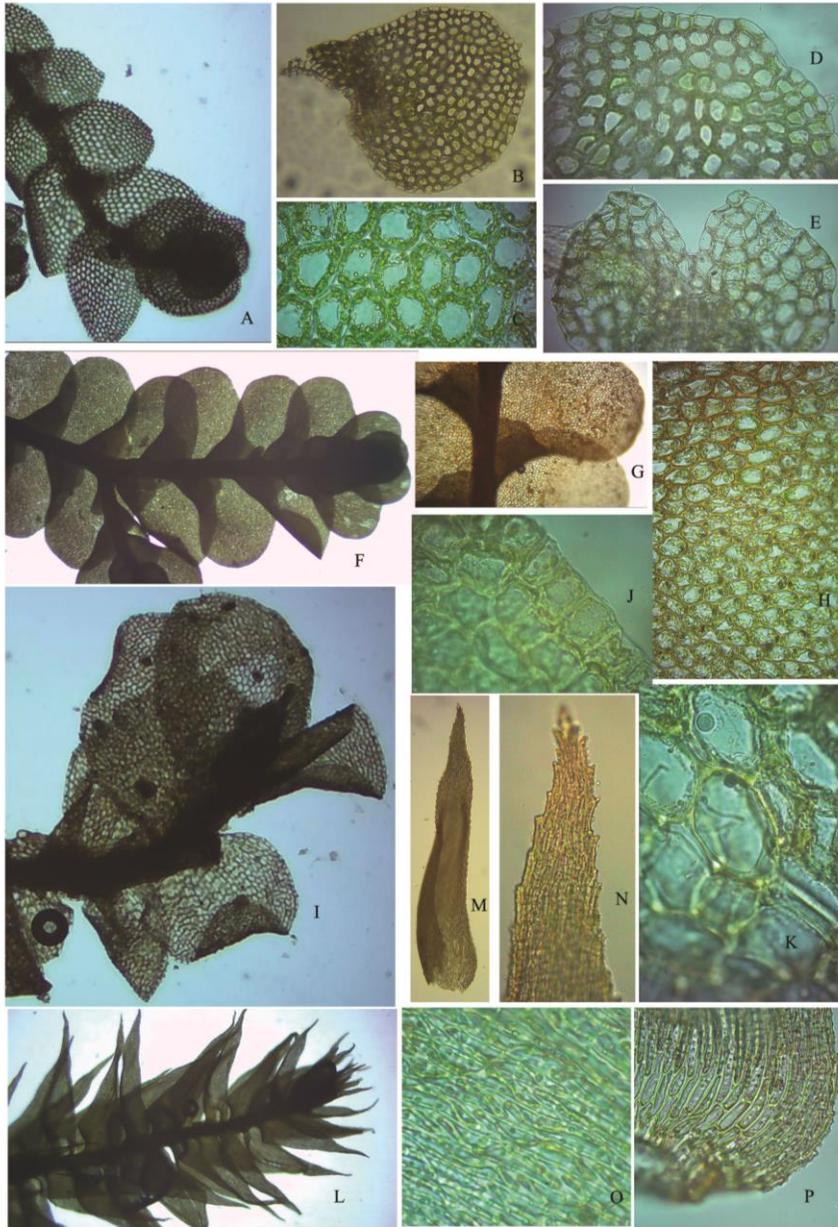


Plate 4. A-E; *Lejeunea cavifolia* , A. Branch, B. Leaf, C. Basal cells, D. Marginal cells, E. Underleaf; F-H; *Radula obscura*, F. Branch, G. Branch showing the leaf lobule, H. Leaf cells; I-K. *Radula meyeri*, I. Branch, J. Leaf marginal cells, K. Basal cells; L-P. *Barbella turgida* , L. Branch, M. Leaf, N. Leaf tip cells, O. Middle cells, P. Basal cells

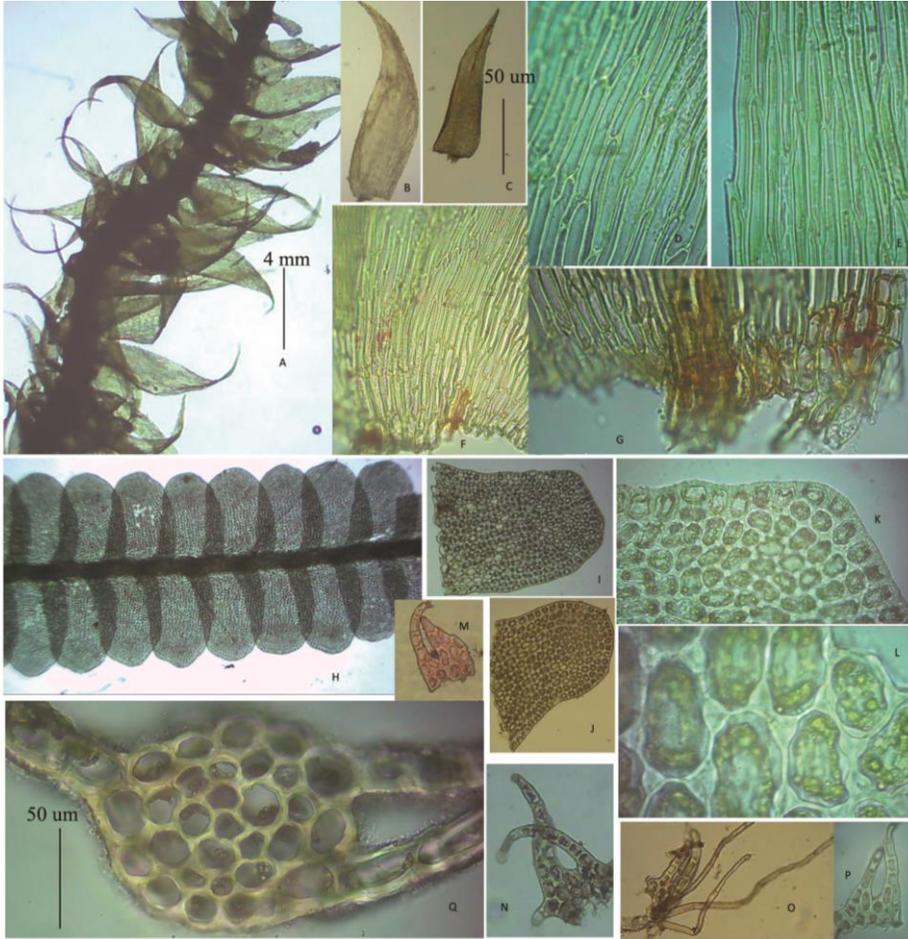


Plate 3. A-G. *Wijkia deflexifolia*, A. Branch, B&C. Leaves, D&E. Leaf middle & marginal cells, F&G. Basal cells; H-Q; *Notoscyphus paroicus*, H. Branch, I&J. Leaves, K. Leaf margin, L. Basal cells, M-P, Underleaves, Q- C.S. of stem (A&H same length; B,C,I,J, same length; all cells same length as G)



Plate 4. A-E; *Lejeunea cavifolia* , A. Branch, B. Leaf, C. Basal cells, D. Marginal cells, E. Underleaf; F-H; *Radula obscura*, F. Branch, G. Branch showing the leaf lobule, H. Leaf cells; I-K. *Radula meyeri*, I. Branch, J. Leaf marginal cells, K. Basal cells; L-P. *Barbella turgida* , L. Branch, M. Leaf, N. Leaf tip cells, O. Middle cells, P. Basal cells (A,F,I,L, same length; all same length as B)