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MORPHOTAXONOMY OF GENUS *Targionia* L. (MARCHANTIALES) FROM NILGIRI HILLS (INDIA)

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Abstract

Studies on the order Marchantiales of Nilgiri Biosphere Reserve (NBR), Western Ghats, India, have revealed the occurrence of three taxa of genus *Targionia* L., namely *Targionia hypophylla* L., *Targionia lorbeeriana* K. Müll., and *Targionia indica* Udar et A. Gupta, belonging to the family Targioniaceae (Hepaticopsida). Due to rapid habitat loss the genus is under threat of extinction, like the previously known species, *Targionia indica*. Now only two species are found to be scattered in a few localities of NBR, as terrestrial form. Hence, the present paper provides the complete morphotaxonomic account of these two existing species along with SEM details of spores. This would be helpful for proper identification of these taxa in future.

Key words: Bryophyta, Marchantiales, Nilgiri hills, morphotaxonomy, *Targionia*, Western Ghats.

Introduction

The liverworts of Nilgiri Biosphere Reserve (NBR) have received considerable attention in recent years by providing substantial accounts of the hepatic flora. Based on these studies, it is evident that many of the thalloid forms become vanished from NBR (Alam and Srivastava, 2012). Usually thalloid liverworts are more susceptible to disappear than the corticolous and epiphyllous forms due to various anthropogenic activities. Primarily, habitat loss is the major biotic threat to the thalloid liverworts in India due to ever increasing population (Alam, 2014). For that reason, several of the earlier reported taxa have become extinct from their natural habitats (Alam, 2009; 2011). In the present study efforts have been made to provide morphotaxonomic account of two such terrestrial taxa of the genus *Targionia* L., that are also believed to be under threat of extinction in the Nilgiri Hills (Western Ghats). *Targionia* L., is represented in India with 3 species viz. *Targionia lorbeeriana* K. Müll, *T. hypophylla* L., and *Targionia indica* Udar et A. Gupta. Among these *Targionia hypophylla* L. is widely distributed in Eastern Himalayas, Western Himalayas and South India. However, *Targionia lorbeeriana* Müll has been found only in south India and *Targionia indica* Udar et A. Gupta has not been reported again from south India after its original discovery, hence, excluded in the present study. On the basis of recent collections to the NBR, *Targionia lorbeeriana* K. Müll and *Targionia hypophylla* L., have been collected from few localities only. It seems that habitat loss challenging their survival and in the near future these two representatives of the family Targionaceae become extinct in NBR. Therefore, in the present study both the existing species have been described with complete morphotaxonomic detail. A key has also been provided for easy identification.

Materials and Methods

Study area

Nilgiri hills (as shown in figure A) range with an elevation of 1200-2500 m is spread over a stretch of 2600 km². It forms the center of diversification and is considered as India's oldest 'Biosphere Reserve'. It is an antique land mass that plunge upwards at the junction of two major mountain ranges near the southern end. It is situated at 10°1'-11°45' N latitude, 76°-77°15' E longitude. The vegetation of the Nilgiris is influenced by the southwestern monsoon, corresponds to southern Indian moist deciduous forest type, and consists of moist, teak-bearing forests, moist mixed deciduous forest without teak, and secondary moist mixed deciduous forests. Characteristic species include *Tectona grandis*, *Grewia tiliaefolia*, *Lagerstroemia lanceolata*, *Dillenia pentagyna*, *Kydia calycina*, *Bambusa arundinacea*, *Dalbergia latifolia*, *Adina cordifolia*, *Pterocarpus marsupium*, *Xylia xylocarpa*, *Wrightia tinctoria*, and *Schleichera oleosa* (Champion and Seth, 1968). The topography and ambiance of the region make the area as a significant hub for diversification of the species (Alam and Srivastava, 2012).

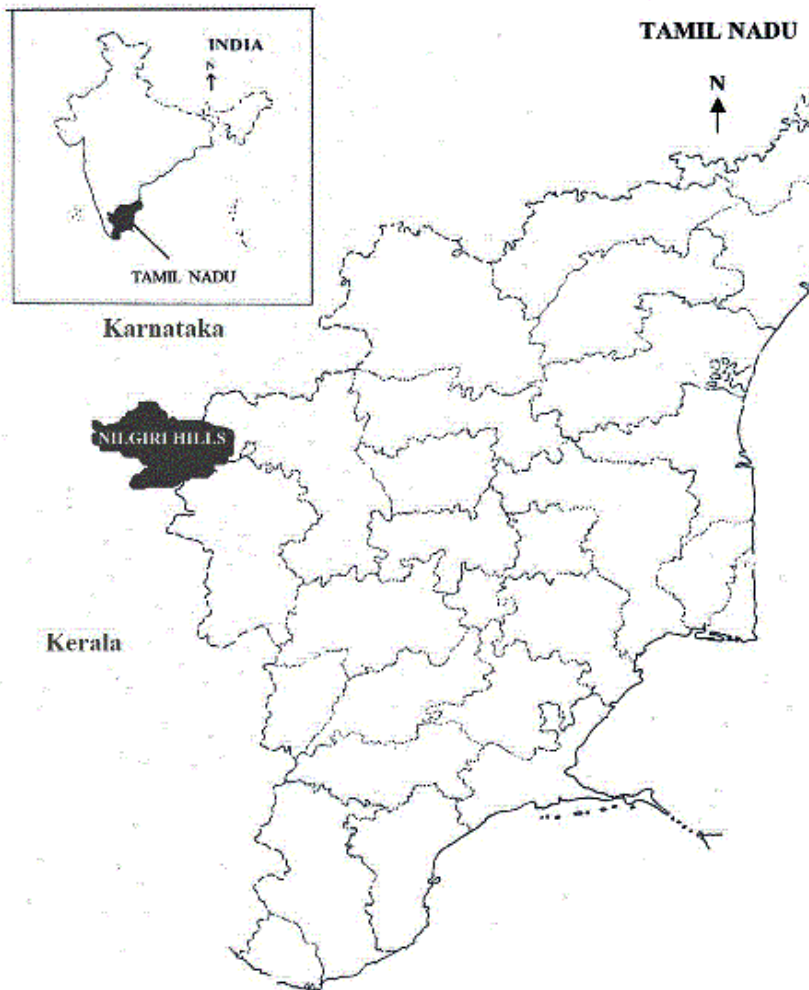


Figure A: Map showing location of study area

Materials:

The specimens were collected during the years 2000 to 2009 from various localities of NBR covering an altitude range of 800 to 2200 meters. The plant material was studied in detail and the taxonomic observations were recorded to perform the identification.

Methods: The specimens were collected from terrestrial habitats such as soil covered rocks, damp rocks, sheltered rocks, etc. and have been deposited in the Lucknow University Hepatic Herbarium (LWU). The study area has been shown in the Map.

Observations

Identification key to the species of *Targionia* in Nilgiri hills

1. Thallus bluish green, scale appendage (2-awl shaped); Monoicous; Distal face has largely reticulate apparent sculpturing, the reticulations are complete; proximal face with irregular folds and small reticulations, rarely the folds sinuate at a middle portion give a tri-radiate shape..... *Targionia lorbeeriana*

1. Thallus green to yellowish green, scales appendage triangular; Dioicous; Distal surface of spores double sculptured both large and small reticulations present; proximal face with irregular folds and minute reticulations.....*Targionia hypophylla*

TARGIONIA LORBEERIANA K. MÜLL.

Targionia lorbeeriana K. Müll., *Rabenh. Krypt*; fl. Ed. 3, 6: 761-320. (1940); Udar & Gupta, *J. Indian Bot. Lab.* 6(2); 215-219 fl 43 (1983).

Thallus bluish green, 1.0-1.5 cm long 0.3-0.4 cm wide, simple, dichotomously branched, margin slightly wavy, apex cordate. Midrib distinct. Dorsal surface of thallus with closely arranged pores, about 3-4 on one side of the midrib, pores compound, elevated, about 83x99.8 µm in size with 4 concentric rings, inner most ring made up of 6-7 cells. Rhizoids are of two types: smooth and tuberculate restricted mainly in the mid rib region, 16.28-19.0 µm in width. Ventral scales numerous, blackish brown, arranged in one rows, one on each side of midrib, with single, awl-shaped appendage, body of scale 0.94-1.8 mm long and 0.63-0.78 mm wide, appendage 0.40-0.45 mm wide, margins with numerous outgrowths. Assimilatory zone having air chambers in single row with 3-6 celled assimilatory filaments. Storage zone present up to the margin of thallus. Monoicous, Male receptacle near the apex, small disc like, on ventral shoots, small papillae present on the disc. Sporophyte covered by bilipped, boat shaped involucre present on the ventral surface of thallus, the free margin of each valve contain prominent roundish to enlarged teeth. Capsule wall is single layered, cells 30.00-40.0x12.50-20 µm with nodular and complete or incomplete annular thickening bands. Spores are spherical to sub spherical, 57.50x58.50- 67.50x67.70 µm, both large and small reticulations. The sculpturing forms double pattern all over. Distal face has largely reticulate apparent sculpturing, the reticulations are complete, rarely incomplete lumina situated across the surface are 3-6 in numbers and 14x14-33x32 µm in size, the surface of the partition of the walls of large reticulations and the peripheral portion of lumina have minute sculpturing, the middle portion of lumina is granulate, proximal face with irregular folds and small reticulations, rarely the folds sinuate at middle portion give a triradiate shape. Elaters are of two types free and fixed elaters, free elaters are elongated 275-330 µm long with bispiral to trispiral thickening bands. The fixed elaters 57-75 µm long and 19-36µm broad and stumpy, annular to semi annular to spiral thickening, present at the inner surface of the lid and occasionally at the middle portion of the capsule wall (Plate: 1, Figs.:1-20).

Spores under SEM

The sculpturing form double pattern all over. Distal face has largely reticulate apparent sculpturing, the reticulations are complete, rarely incomplete lumina situated across the surface are 3-6 in numbers the surface of the partition of the walls of large reticulations and a peripheral portion of lumina has minute sculpturing, the middle portion of lumina is granulate; proximal face with irregular folds and small reticulations, rarely the folds sinuate at a middle portion give a tri-radiate shape. (Plate: 3; Fig.: 1, 2).

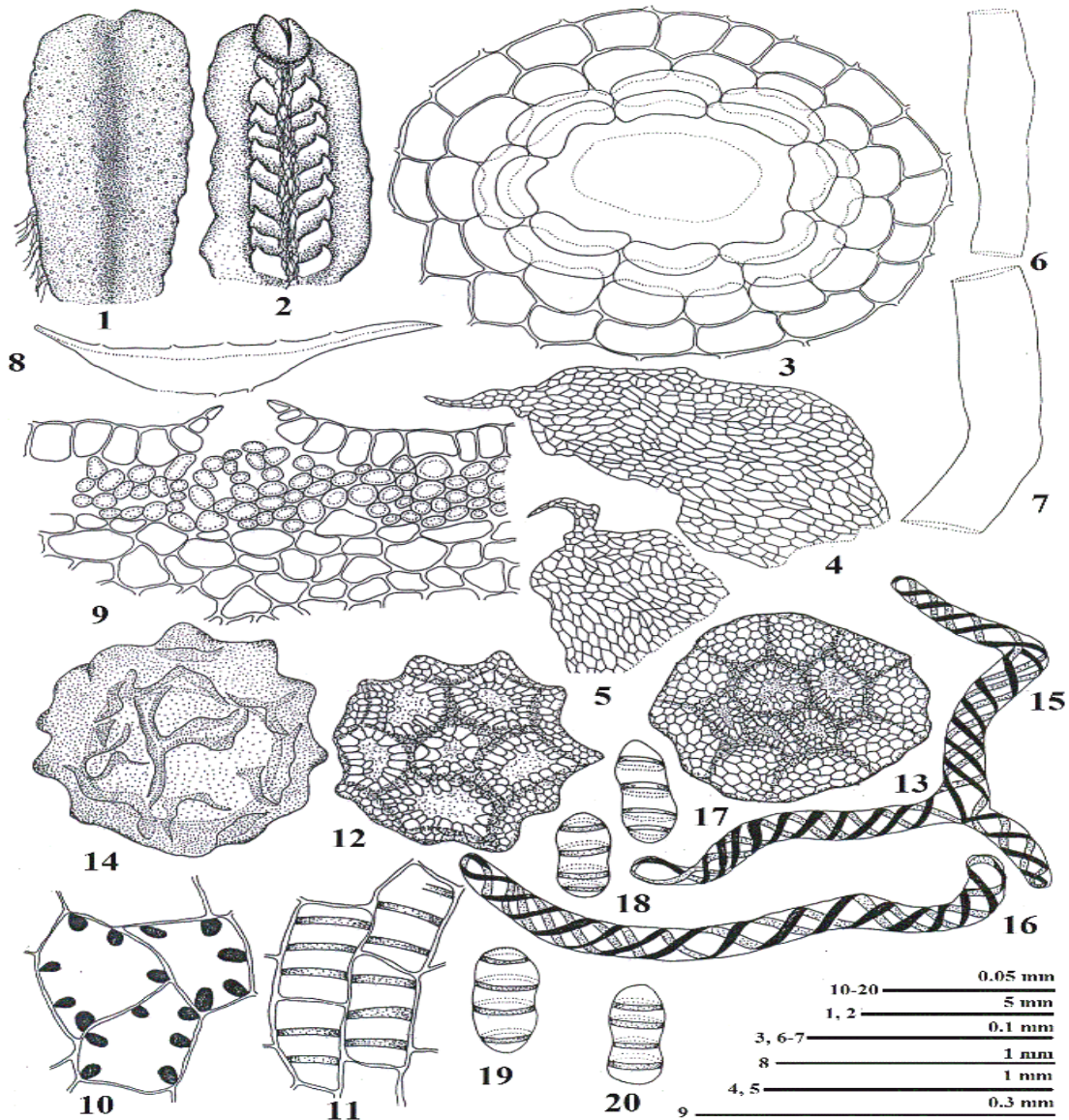


Plate: 1. *Targionia lorbeeriana* K. Müll. **Figs. 1-20.** 1. Female plant (dorsal view), 2. Female plant (ventral view), 3. Epidermal pore (dorsal view), 4-5. Ventral scales (cellular), 6-7. Rhizoids, 8. V.T.S. of thallus (semi-diagrammatic), 9. V.T.S. of thallus (magnified), 10. Outer layer cells of capsule wall, 11. Inner layer cells of capsule wall, 12,13. Spores (proximal view), 14. Spore (distal view), 15. Branched elater, 16. Simple elater, 17-20. Stumpy elaters. (Figures drawn from LWU- 12840/2000).

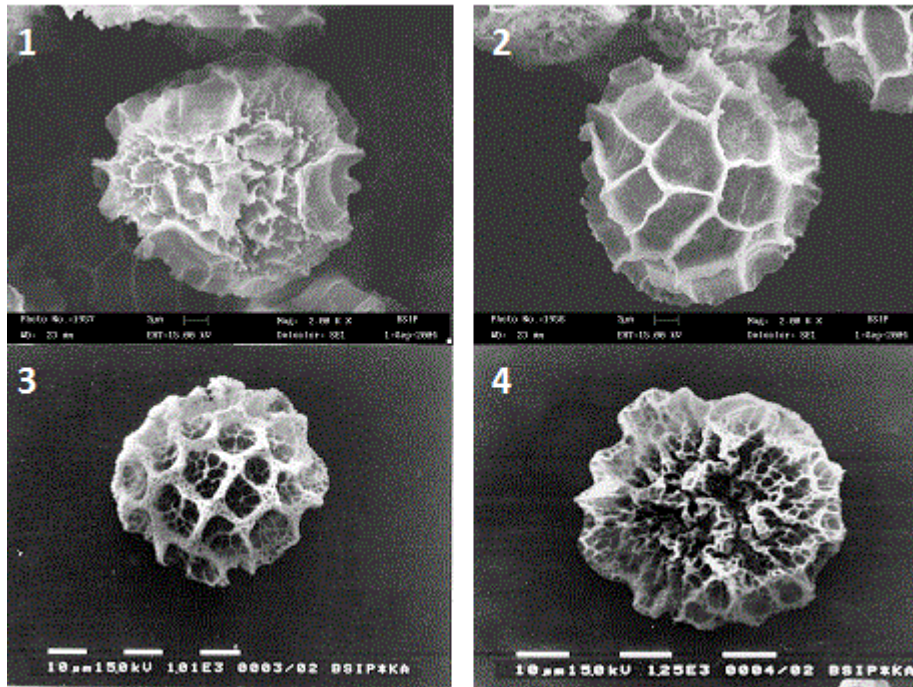


Plate- 3. Figs.: 1-4. 1. *Targionia lorbeeriana* (distal view), 2. *Targionia lorbeeriana* (proximal view), 3. *Targionia hypophylla* (distal view), 4. *Targionia hypophylla* (proximal view).

Type Locality: Europe.

Sexuality: Monoicous.

Ecology: Terrestrial.

Range: Asia: India; Europe: Sicilia, Sardinia, Portugal, France; Canaries, S. Africa, Morocco.

Distribution in India: South India: Tamil Nadu- Nilgiri Hills- Coonoor (Singara Tea Estate, Droog); Gudalur (Yellamalai) and Palni hills- Kodaikanal (Udar and Gupta, 1983).

Specimen examined:South India: Tamil Nadu: Nilgiri Hills-Coonoor (Singara Tea Estate); ca. 1850 m; 12.10.2000; S.C. Srivastava and Party, 12840/2000, 12844/2000, 12845/2000 (LWU); Gudalur (Yellamalai); ca. 1200m; 29.09.2002; P.K.Verma and Afroz Alam; 16139/2002 (LWU). Coonoor (Droog); ca. 1800m; 07.10.2002; P.K.Verma and Afroz Alam; 16532/2002, 16534/2002, 16535/2002 (LWU).

Characteristics of species:

1. Thallus bluish green, 1.0-1.5 cm long 0.3-0.4 cm wide, 2. Monoicous, 3. Scales tough, appendage (2-awl shaped), 4. Involucres ventral oval, the free margin of each valve contains prominent roundish to enlarged teeth.

TARGIONIA HYPOPHYLLA L.

Targionia hypophylla L., *Spec. Plant* 1136. (1753); Steph., *Spec. Hep.* 1: 61:1(1900); Macv., *Std. Handb. Brit. Hep.* 1: 33. F. 1-3. 1926; Kashyap, *Livr. W. Himalaya & Punjab Pl.* 1: 57 (1929). –*Targionia michellii* Corda in *Opiz Beitr.* 1: 649 (1829).

Thallus dark green, 1.2-1.6 cm long 0.3-0.5 cm wide, simple, unbranched-dichotomously branched, margins somewhat undulate, apex notched. Midrib is distinct. Dorsal surface of thallus is with closely arranged pores, about 4-6 on one side of the midrib. Pores compound, elevated, about 79.80x34.20µm in size with 4 concentric rings, inner most ring made up of 6-7 cells. Rhizoids are of two types: smooth and tuberculate restricted mainly in the mid rib region, 11.40 µm in width. Ventral scales numerous, purple, closely arranged in two rows, one on each side of midrib, with single, somewhat triangular appendage body of scale 0.90-1.93 mm long and 0.56-0.74 mm wide, appendage 0.32-0.41.0 mm wide. Assimilatory zone having air chambers in single row with 3-5 celled assimilatory filaments. Storage zone present up to the margin of thallus. Dioicous. Male receptacle near the apex, small disc like, on ventral shoots, small papillae present on the disc. Sporophyte covered by bilipped, boat shaped involucre exists on the ventral surface of thallus. Capsule wall single layered cells, 30.0-47x17.60-22.50 µm with nodular and complete or incomplete annular thickening bands. Spores spherical, 38-44x28-38 µm, both large and small reticulations present. Proximal face is with irregular folds and small reticulations. Distal face double sculptured, both large and small reticulations present. Elaters are of two types free and fixed elaters, free elaters are elongated 90-315 µm long with bispiral thickening bands. The fixed elaters 37.50-52.50 µm long and 17-32 µm broad and stumpy, annular to semi annular to spiral thickening, present at the inner surface of the lid and occasionally at the middle portion of the capsule wall (Plate: 2, Figs.:1-23)

Spores under SEM:

The distal face has double sculpturing; a large network consists of strongly elevated rounded ridges which forms polygonal walled enclosures, a reticulum of smaller ridges superimposed on and between these large ridges. The alveoli of fine reticulum are large within the enclosures walled by the primary ridges and smaller on the sides of ridges. The surface texture is smooth within the alveoli and granulates on the small ridges. Proximal face is less rounded and has long, sinuous, closely set, reticulated ridges. An undulating wing is formed at the juncture of the proximal and distal faces (Plate: 3; Fig.: 3, 4).

Type Locality: Europe.

Sexuality: Dioicous.

Ecology: Terrestrial.

Range: Asia: China, India, Japan, Korea, Nepal, Taiwan; Europe; Australia (Tasmania), New Zealand; Africa; North and South America- Chile, Ecuador, Madagascar, Hawaii, Peru, Tenerife.

Distribution in India: Eastern Himalaya: West Bengal- Darjeeling; Assam- Khasia hills; Meghalaya- Cherrapunji, Sikkim; Western Himalaya: Himachal Pradesh- Simla & Dalhausie;

Uttranchal- Mussoorie; Central India: Madhya Pradesh- Pachmarhi, Rajasthan- Mt. Abu; South India: Tamil Nadu- Nilgiri Hills- Kotagiri (Sholarmattum), Madras.

Specimens examined: South India: Tamil Nadu: Nilgiri Hills- Kotagiri (Sholarmattum); ca. 1900 m; 05.04.2002; P. K. Verma and Afroz Alam; 15073/2002 (LWU).

Characteristics of species:

1.Thallus simple, sometimes dichotomously branched, smaller, green to yellowish green, 2.Scales hyaline, 3.Dioicous, 4.Sporophyte terminal, present on ventral surface, 5.Sporophyte covered by bi-lipped, boat shaped involucre, 6.Androecia on ventral shoots, 7.Distal surface of spores double sculptured both large and small reticulations present, 8.Proximal face with irregular folds and minute reticulations.

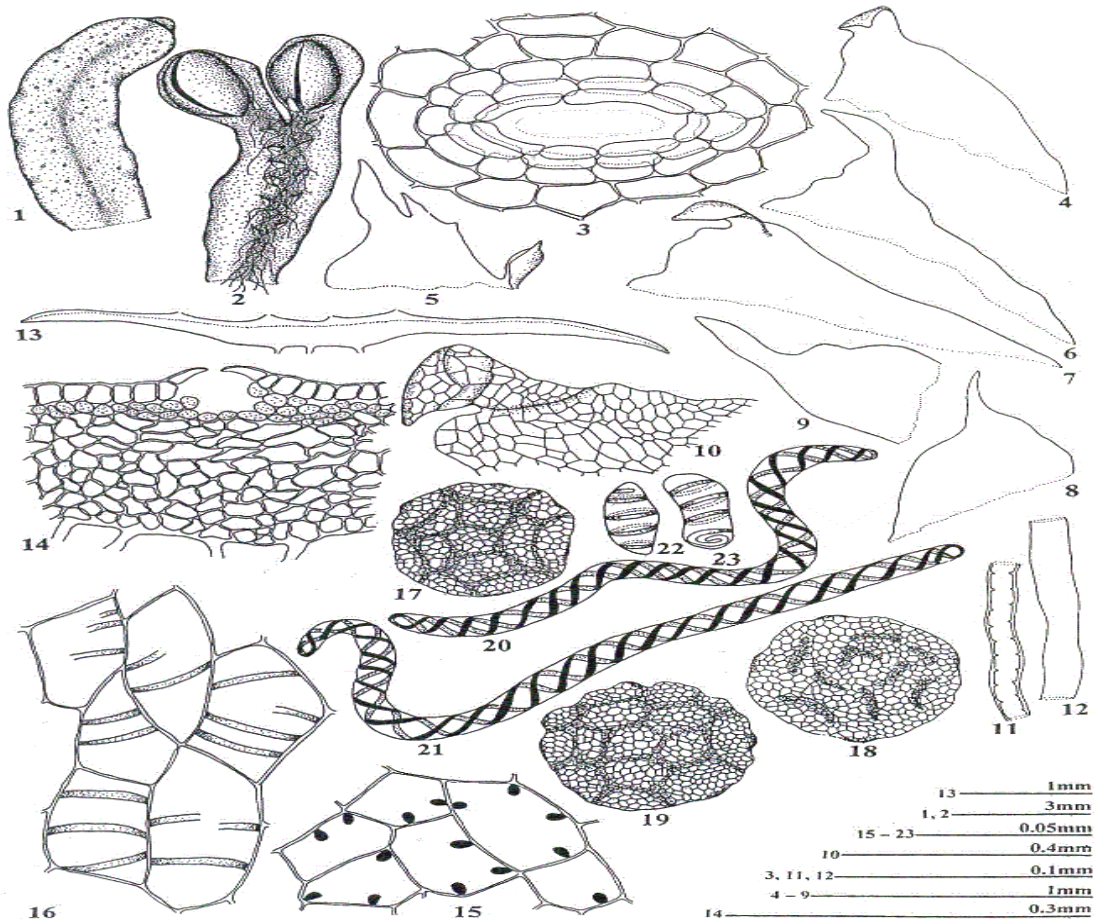


Plate: 2. *Targionia hypophylla* L., Figs. 1-23. 1. Female plant (dorsal view), 2. Female plant (ventral view), 3. Epidermal pore (dorsal view), 4-9. Ventral scales, 10. A portion of ventral scales (magnified), 11. Tuberculate rhizoids, 12. Simple rhizoid, 13. V.T.S of thallus (semi-diagrammatic), 14. V.T.S of thallus, 15. Outer layer cells of capsule wall, 16. Inner layer cells of capsule wall, 17, 19. Spores (proximal view), 18. Spore (distal view), 20, 21. Elaters, 22, 23. Stumpy elaters. (Figures drawn from LWU- 15073/2002).

Discussion

Targionia certainly is a difficult genus when one attempts to take on identification, as even under a single species, there are considerable variations at times. Udar and Gupta (1983) had reported the occurrence of three species from South India with very close characters viz. *Targionia hypophylla*, *T. lorbeeriana* and *T. indica*. One of the related species *Targionia hypophylla* has green to yellowish green thallus, hyaline scales; dioicous sexuality and distal face of spores double sculptured showing both large and small reticulations. Proximal face of spores has irregular folds and minute reticulations. Whereas, in *Targionia lorbeeriana* the thallus is bluish green, scale appendaged (2-awl shaped); monoicous sexuality; the distal face of spores with large and complete reticulations; proximal faces with irregular folds and small reticulations, rarely the folds become sinuate in the middle portion making the tri-radiate mark conspicuous.

Targionia lorbeeriana was instituted by Müller (1940) and later it was reported from Kodaikanal, South India (Udar and Gupta, 1983). The other species, i.e. *Targionia hypophylla* L., was established by Linnaeus (1753). However, Kashyap (1929) described this species for the first time from India from Mussoorie, Simla, Dalhousie. Afterward, it was reported in India, from Darjeeling (Chopra (1938); Sikkim (Hattori, 1966, 1975); Eastern Himalayas (Parihar et al., 1994). Bapna and Kachroo (2000) reported this species from Western Himalayas, South India and Central India. The only report of this species from south India is from Madras. During the present study this has been reported for the first time from Nilgiri hills. Therefore, the two existing species of this genus show marked disparity in their distribution pattern as *Targionia hypophylla* is frequently distributed while *Targionia lorbeeriana* has restricted distribution. This shows that the first one is more flexible to the surrounding macro and microclimates than the later.

Conclusion

On the basis of this study, it is evident that due to its flexible environmental need, *Targionia hypophylla* has thrived very well in the varied climatic conditions and existing in almost all bryo-geographical regions of the world, including India [South India (Kerala; Tamil Nadu; Karnataka), Central India (Mt. Abu), Eastern and Western Himalayas], Nepal, Japan, Chile, Korea, Taiwan, China, Hawaii, Peru, Europe, North and South America and Australia. Whereas, *Targionia lorbeeriana* needs relatively specific environmental conditions, therefore, has limited distribution in Europe (Sicilia, Sardinia, Portugal, France); Canaries, South Africa, Morocco. In Indian context, it is again restricted to very few regions of South India only. Thus, this particular species needs optimum conservation strategies so that it doesn't get extinct in the near future from its known habitat like other vanished species viz. *Targionia indica*.

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