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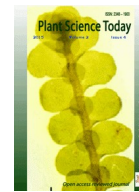
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Research Article

Species diversity of genus *Riccia* (Mich.) L. in Satara district (Maharashtra) India

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Article history

Received: 18 September 2015
Accepted: 20 September 2015
Published online: 1 October 2015

© Bagwan and Kore (2015)

Editors

Afroz Alam
Dipjyoti Chakraborty

Publisher

Horizon e-Publishing Group

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Abstract

Satara district (Maharashtra), part of central Western Ghats exhibits unique topographical and climatic conditions that support rich bryoflora. This paper describes species diversity of genus *Riccia* (Mich.) L. along with the distributional pattern in the studied area. Key to the existing species and description with field photographs are also provided.

Keywords

Bryoflora; Maharashtra; *Riccia*; Satara district

Bagwan, S. A. and Kore, B. A. 2015. Species diversity of genus *Riccia* (Mich.) L. in Satara district (Maharashtra) India. *Plant Science Today* 2(4): 187-191. <http://dx.doi.org/10.14719/pst.2015.2.4.160>

Introduction

The genus *Riccia* (Mich.) L. (family Ricciaceae; order Marchantiales) was established by Micheli in 1729 'Nova Plantarum Genera' in honour of an Italian Botanist, P.I. Ricci. Thereafter it was validated by Linnaeus in 1753 (Bag *et al.*, 2007). *Riccia* is frequently distributed thallose liverwort throughout the world. Genus *Riccia* is typical rosette forming and diversified terrestrial liverwort (except some aquatic forms), exhibits very simple and primitive morphological and anatomical characters. *Riccia* comprises 150 species worldwide (Daniel *et al.*, 2014) at present 36 valid species of this genus are reported from India (Singh, 2014) of these only 8 species are known to occur in Maharashtra (Shirke, 2002).

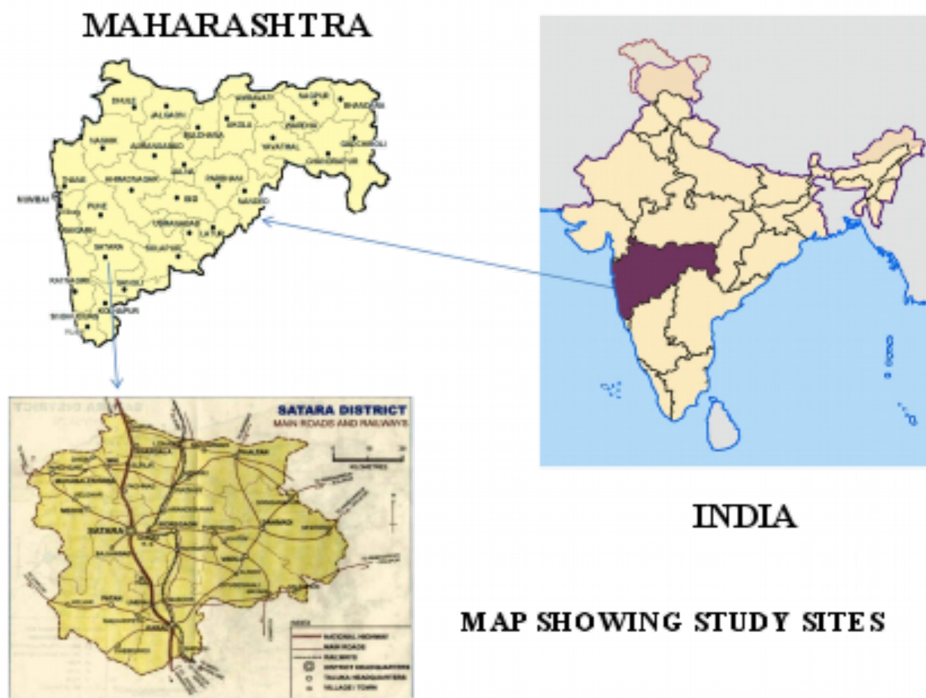
Satara district of Maharashtra is the western edge of the great western ghats. It is located at 17.68°N at 73.98°E with an average elevation of 2434 ft. The area receives about 2000-2500 mm rainfall during rainy season with 90% humidity and 24±4°C to 34±2°C temperature throughout year. Hence the climate is supportive to the luxuriant growth of bryophytes. The

present work deals with the species diversity of *Riccia* in this district (Map 1).

Material and method

The specimens were collected from various localities from Satara district during monsoon and post monsoon seasons during 2012-2014. Collected material was preserved in dry and wet form as well. External morphology was studied under Stereoscopic binocular microscope. For morpho-anatomical study dried herbarium specimens were soaked in water for about 2 hours prior to their microscopic study. Hand cut sections were mounted in 50% aqueous glycerin and anatomical features were studied under compound microscope.

Identification of specimens was carried out with relevant available literature (Kashyap, 1929, 1932; Bapna and Kachroo, 2000; Chaudhary *et al.*, 2008). Preserved specimens were deposited in Bryological Herbarium of Botany Department of Yashwantrao Chavan Institute of Science, Satara (Maharashtra) India.



Map 1: Showing Study sites

Taxonomic treatment

Riccia L.

Thallus monoecious or dioecious. Gametophyte is prostrate and dorsiventral. Thallus dichotomously branched forming rosette like appearance, terrestrial or rarely floating on water. On ventral surface scale and rhizoids are present. Scales mostly purple sometimes hyaline, at margin of thallus. Rhizoids both tuberculate and smooth walled. Photosynthetic regions mostly *Euriccia* types (more or less vertical filaments separating narrow air space) or *Ricciella* types (unistratose wall inclosing large, polyhedral air chamber). Sex organ present dorsally and at maturity embedded in thallus. Antheridial and archegonial chambers open through ostioles at the upper surface of thallus. The capsules are embedded in the thallus. At maturity the capsule and overlying thallus tissue disintegrate, leaving the spores exposed within a depression. Spore large tetrahedral, brown to black, and dispersed by wind or water.

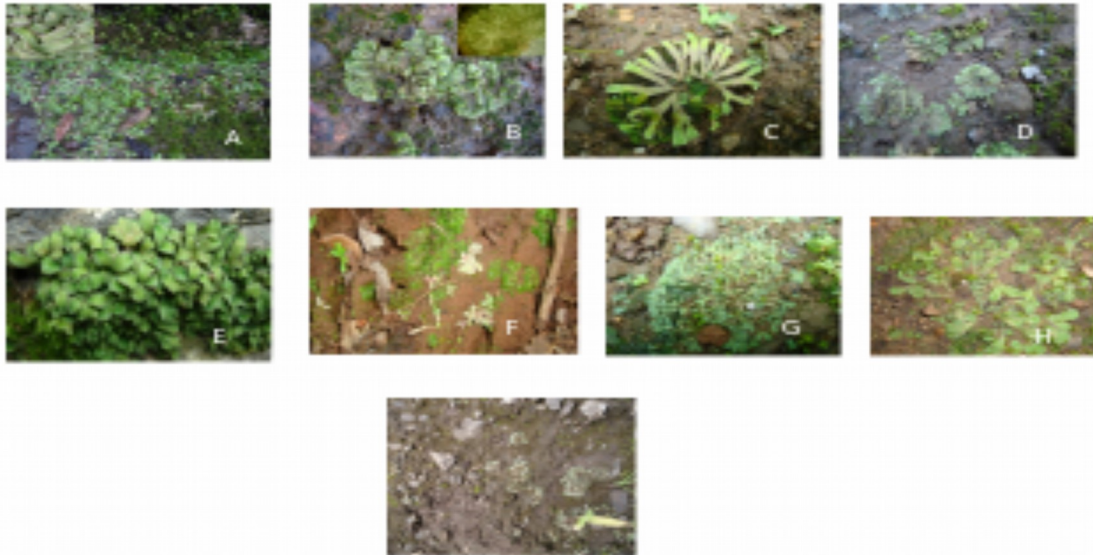
Key to genus *Riccia* from Satara district

- 1a. Thallus dioecious.....2
- 1b. Thallus monoecious.....3
- 2a. Male thallus red, female plant green, ventral scales absent.....*R. frostii*
- 2b. Male and female thalli bluish- green, ventral scales semilunar, purple.....*R. discolor*
- 3a. Sporophyte on ventral side of thallus.....4
- 3b. Sporophyte on dorsal side of thallus.....5
- 4a. Thallus crystalline, dorsal pores narrow, margin turned upwards..... *R. crystallina*
- 4b. Thallus spongy, dorsal pores large, margin not as above..... *R. cavernosa*

- 5a. Thallus ciliate, cilia few, restricted to margin*R. melanospora*
- 5b. Thallus ciliate, cilia many, curve over the thallus.....*R. crozalsii*
- 5c. Thallus non ciliate.....6
- 6a. Thallus glaucous green, rosettes.....*R. glauca*
- 6b. Thallus bluish green, overlapping or some time forming definite rosette.....7
- 7a. Thallus 1-3 times dichotomously branched, Scale hyaline, tubers absent.....*R. gangetica*
- 7b. Thallus 4-5 times dichotomously branched, Scale purple, tuber present at apex.....*R. billardieri*

1) *Riccia billardieri* Mont. & Nees in Gottsche, Lindenberg & Nees, Syn. Hepat. 4: 602. 1846. *R. bulbifera* Steph., Sp. Hepat. 1: 24. 1900. *R. bengalensis* Khan in Bryologist 60: 28. 1957. *R. pimodii* Kachroo in J. Indian Bot. Soc. 38: 216. 1959. *R. himalayensis* auct. non Kashyap 1916 sensu Kashyap, Liverw. W. Himal. 1 (Suppl.): 7. 1932. *Riccia poihaiana* A.E.D. Daniels & P. Daniel, Bull. Bot. Surv. India 44: 135. 2002. syn. nov. (Plate 1; Fig. A)

Thallus monoecious, once or twice forked, overlapping. Thalli usually 4-12 mm long, 2-3 mm broad. Dorsal groove narrow anteriorly gradually become flat on posterior side. Epidermal cells hyaline and oval. Ventral scale prominent purple, semilunar. Rhizoids many, arising from mid ventral side, both the types of rhizoids smooth and tuberculate, Cross section of thallus 4-6 time as broad as high, Antheridia in 1-3 rows, ostioles conspicuous. Archegonia in rows projecting above the thallus. Capsule sunken in the thallus tissue. Spore 90-100µm diameter, brown, reticulate.



Photoplate 1: Showing genus *Riccia* in their habitat: (A) *R. billardieri*, (B) *R. cavernosa*, (C) *R. crozalsii*, (D) *R. crystallina*, (E) *R. discolor*, (F) *R. frostii*, (G) *R. gangetica*, (H) *R. glauca*

Collection sites:- Ajinkyatara, Pateghar, Pateshwer, Bhekawli, Pasarnighat, Kas, Dahiwadi, Mahableshwar.

Habitat:- Terricolous

Distribution in India:- Tinnevely hills, Tiruchirapalli dist., Puliyalam hills, Kurumballou hills, Kanyakumari, Western Ghats, Tirunelveli, Mundanthurai, Himachal Pradesh, Mumbai (Singh *et al.*, 2010).

Distribution in Maharashtra:- Mulshi Ane Malshej Ghat Khandala.

Field notes:- Overlapping thalli with prominent scale at margin easily detectable this species.

Specimens examined:- India: Maharashtra: Satara - (Bryological herbarium of Botany Department of Yashwantrao Chavan Institute of Science), 2013/9/11

2) *Riccia cavernosa* Hoffm., *Deutschl. Fl.* 2: 95.1796 emend. Raddi, *Opusc. Sci. (Bologna)* 12: 351. 1818. *R. robusta* Kashyap, *J. Bombay Nat. Hist. Soc.* 24: 348. 1916. (Plate 1; Fig. B)

Thallus monoecious, dichotomously branched, overlapping with linear to obcordate segments, terrestrial. Dorsal surface olive green up to 3-6 mm long; lobes oblong, obtuse, 1-2 mm broad. Dorsal surface porous, appears spongy with large cavities, probably due to increase in air space. Air chambers in 2-3 strata, wide and polyhedral, epidermis soon prominently lacunose, ventral tissue present in median of thallus, flanked by large air chambers. Ventral scales absent, rhizoids both tuberculate and smooth. Gametophytic stages are not visualized. Sporophytes are projecting ventrally. Spores light brown to dark brown, reticulate, triradiate mark on proximal view, 80-100µm in diameter. Very few 1-2 thalli in rainy season are observed. Frequently occurs in the region. Restricted to some spots in field may be endemic.

Locality:- Botanical garden of Yashwantrao Chavan Institute of Science Satara, Sadar Bazar.

Habitat:- Terricolous

Distribution in India:- INDIA (Western Himalaya: Himachal Pradesh; Eastern Himalaya: West Bengal Hills; Gangetic plains: Uttar Pradesh; Central India: Madhya Pradesh; Punjab & West Rajasthan: Rajasthan ((Singh *et al.*, 2010).

Distribution in Maharashtra:- There was no record from Maharashtra. Hence new report for the state.

Field notes:- Thallus spongy, larger than *Riccia crystallina* easily detected with the help of hand lens.

Specimen examined:- India: Maharashtra: Satara - Sadar Bazar, (Bryological herbarium of Botany Department of Yashwantrao Chavan Institute of Science), 2012/9/18

3) *Riccia crozalsii* Lev., *Rev. Bryol.* 73. 1902; K. Mull., *Rabenh. Krypt. Fl. Leb.* 1:169.1907; Udar, *Current Sci.* 26.287.f 1-5.1957; Macvicar, *Stud. Handb. Brit. Hep.* 16.f 1-4.1926. (Plate 1; Fig. C)

Thallus monoecious; rosettes, long, dichotomously branched at apex, epidermal cells hyaline, Spherical; cilia hyaline, Sharp pointed cilia projecting from margin, cross section is nearly twice broad as high; Scales small purple. Sporangia on dorsal surface, in one row. Spore 60-80µm, black triradiate, reticulate.

Locality:- Walmiki Plateau.

Habitat:- Terricolous

Distribution in India:- Ootacamund (Schwarz, 2013)

Distribution in Maharashtra:- The species is new record for Maharashtra.

Field notes:- Dichotomous apex of thallus easily identified in field.

Specimens examined India: Maharashtra: Satara (Walmiki Plateau), Bryological herbarium of Botany

Department of Yashvantrao Chavan Institute of Science), 2014/8/20.

4) *Riccia crystallina* L., Sp. Pl 1138. 1753. emend. Raddi, Opusc. Sci. (Bologna) 12: 353. 1818. *Riccia plana* Taylor, London J. Bot. 5: 414. 1846; Macvicar, Std. Handb. Brit. Hep. 26.f 1-3 1926; Chopra, J Indian Bot.Soc.22:238.1943;Udar, Curr. Sci.26:22.1957. (Plate 1; Fig. D)

Thallus monoecious, forming complete rosette 10-25mm, generally yellowish green, crystalline, spongy, dichotomously branched, margin turn upward, scale hyaline at the apex, rhizoids mostly simple, few tuberculate. Dorsal surface porous. Cross section 2-3 times broader than high; Sporangia numerous projecting ventrally. Spores tetrahedral 75-90 μ , light brown, irregularly reticulate.

Collection sites:- Open grassland plains near Godoli

Habitat:-Terricolous

Distribution in India:-Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Punjab, Uttar Pradesh; Rajasthan, West Bengal (Singh, 2014).

Distribution in maharashtra:- Lenyadri, Kalsubai.

Field notes:-Thallus pits quite visible with naked eye, forming complete rosette.

Specimens examined:- India: Maharastra: Satara (Open grassland plains near Godoli), Bryological herbarium of Botany Department of Yashvantrao Chavan Institute of Science)/ 2015/9/44.

5) *Riccia discolor* Lehm. & Lindenb. in Lehmann, Nov. Stirp. Pug. 4: 1. 1832. *R. himalayensis* Kashyap, J. Bombay Nat.Hist. Soc. 24: 349. 1916. *R. gollanii* Lev. ex Steph., Sp. Hepat.6: 2. 1924. (Plate 1; Fig. E)

Thallus dioecious, overlapping, bluish green 1-2 forked with median groove along whole thallus, lobes oblong. Female thallus larger than male. 4-15 mm long; 2-8 mm broad. Male thallus 2-8 mm long; 2.5 mm broad. Air space narrow, epidermal cells oval, papillate. Thallus 4 times broad as high; Ventral scale small, semilunar, purple beyond the thallus margin. Rhizoids both simple and tuberculate. Archegonia on median furrow, protruding out from thallus. Capsule in 1-2 rows. Spores brown 80-120 μ in diameter, reticulate,6-10 areole on outer surface, tri-radiate mark inconspicuous.

Collection sites: - Ajinkyatara, Pateghar, Pateshwer, Wardhangad, Thoseghar, Mahableshwar

Habitat:-Terricolous

Distribution in India:- Western Himalaya: Uttarakhand; Eastern Himalaya: West Bengal-hills, Assam, Meghalaya; Punjab & West Rajasthan: Rajasthan; Central India: Madhya Pradesh; Gangetic Plains: Uttar Pradesh; Western Ghats: Karnataka) (Singh et al., 2010; Singh, 2014).

Distribution in Maharashtra:- Mahableshwar, Bhimashankar.

Field notes:- Archegonial neck on median furrow, protruding out from thallus, scales on marginal scales are easily observed from dorsal surface.

Specimens examined:- India: Maharastra: Satara, Bryological herbarium of Botany Department of Yashvantrao Chavan Institute of Science)/ 2013/8/12

6) *Riccia gangetica* Ahmad ex L.Söderstr., A.Hagborg et von Konrat, Phytotaxa 65: 57. 2012. (Plate 1; Fig. G)

Thallus monoecious, bluish green, 1-3 dichotomously branched, dorsal median groove prominent, lobes linear, thallus 2-3 mm long and 1-3 mm broad; epidermal cell hyaline oval. Scale hyaline. Sporangia on dorsal side, Spore black 110-130 μ m reticulate and margin dentate.

Collection Sites:- Ajinkyatara, Pateghar, Jarandeshwar, Ramacha dongar

Habitat:-Terricolous

Distribution in India:-Western Himalaya: Himachal Pradesh, Uttarakhand; Eastern Himalaya: Meghalaya; Punjab & West Rajasthan: Rajasthan; Gangetic plains: Uttar Pradesh, West Bengal-plains; Central India: Madhya Pradesh; Western Ghats: Maharashtra, Tamil Nadu (Singh et al., 2010)

Distribution in Maharashtra:- Trimbak, Bhimashankar

Field notes:- Thallus bluish green with prominent groove.

Specimens examined:- India: Maharastra: Satara Bryological herbarium of Botany Department of Yashvantrao Chavan Institute of Science) 2015/9/43.

7) *Riccia frostii* Austin, Bull. Torrey Bot. Club 6: 17. 1875. *R. sanguinea* Kashyap, J. Bombay Nat. Hist. Soc. 24: 349. 1916. *R. microspora* Steph., Sp. Hepat. 1: 43. 1900. (Plate 1; Fig. F)

Thallus dioecious, in rosette; male pinkish; female thallus larger than male. 3-6mm broad 1-2 mm wide. Rhizoids both simple and tuberculate. Scale absent, Cross section three times broader than high, air chambers elongate, epidermal cells thin walled. Antheridia in 1 or 2 rows. Sporangium not observed. Female plants not seen.

Collection sites: - Ajinkyatara, Pateghar, Pateshwer, Lingmala, Walmiki Plateau.

Habitat:- Terricolous

Distribution in India:- Assam, Bihar, Delhi, Jharkhand, Jammu & Kashmir, Kerala, Maharashtra Manipur, Madhya Pradesh, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttarakhand, Uttar Pradesh, West Bengal (Singh, 2014)

Distribution in Maharashtra:-Katraj, Lonawala, Sinhgarh.

Field notes:-Male Thallus easily identified due to complete rosette and pink-red color scales absent.

Specimens examined:- India: Maharastra: Satara, Bryological herbarium of Botany Department of Yashvantrao Chavan Institute of Science)/ 2012/7/40

8) *Riccia glauca* L., Sp. Pl.1139.1753. K. Mull., Rabenh. Krypt.Fl. 183.f.97.123.1907; Hatt., Nat. Sci. Mus. Tokyo 14:142 f.1.g.h.z.1943; Kachroo, J. Univ. Gauhati 5:131.f. 6A-B.1954. (Plate 1; Fig. H)

Thallus monoecious, usually in rosette, glaucous green, up to 10 mm long and 2-3 mm broad, mid dorsal groove prominent, apex emarginated, epidermal cell 5-7 angled, rounded, Air space in longitudinal row, separating walls usually one cell thick densely chlorophyllose. Scale prominent along the margin. Rhizoids both simple and tuberculate. Sporangia on dorsal surface. Spore sub spherical, black 75-95µm triradiate mark distinct, 6-8 reticulation.

Collection sites: - Ajinkyatara, Pateghar, Pateshwer, Sijaangadh, Thoseghar, Bamnoli

Habitat:- Terricolous.

Distribution in India:- Assam, Odisha (Singh, 2014)

Distribution in Maharashtra:- The species is a new addition to Western Ghats, collected from Maharashtra.

Field notes: - Broad thallus on moist soil help to identification in field.

Specimens examined:- India: Maharashtra: Satara, Bryological herbarium of Botany Department of Yashvantrao Chavan Institute of Science), 2015/8/42

9) *Riccia melanospora* Kashyap, Liwerw. W. Himal. 1: 94. 1929 . Pl. 1: 94. Pl.19.6-7.1; Pande and Udar, Proc. Natl.Inst.Sci.India.248.80 f.1-16,1959.

Thallus monoecious, blue green, small.2-4 mm long and 1-2 mm broad; cilia few restricted to margin, Scale along margin. Rhizoids mostly smooth. Cross section twice broad than high; epidermal cell oval; semicircular. Sporangia embedded in thallus on dorsal side. Spore dark brown 60-80µm, triradiate mark prominent, wings absent in mature spore.

Collection Sites: - Ajinkyatara, Pateghar, Pateshwer, in botanical garden of Yashvantrao Chavan Institute of Science Satara

Habitat:- Terricolous

Distribution in India:- Jammu & Kashmir; Maharashtra Madhya Pradesh, Punjab Rajasthan [79,103], Tamil Nadu, Uttarakhand, Uttar Pradesh, West Bengal (Singh 2014)

Distribution in Maharashtra:- Purandhar.

Field notes:- Presence of cilia on thallus easily detected with the help of hand lens.

Specimens examined:- India: Maharashtra: Satara, Bryological herbarium of Botany Department of Yashvantrao Chavan Institute of Science), 2012/7/14

Discussion

Riccia is the largest genus among thallose hepaticae in India and found on damp loamy and sandy soil in different localities of Satara during study. Total 9 species are occurring in this region, of which *R. cavernosa* reported new to Western Ghats. While *R. crozalsii* and *R. glauca* are reported for the first time from Maharashtra. Three species (*R. billardieri*, *R. gangatica*, *R. frostii*) are widely distributed and *R. melanospora* is reported most frequent in the region, and 5 species are rare (*R. cavernosa*, *R. crystalina*, *R. crozalsii*, *R. discolor*, and *R. glauca*).

Due to human interference, anthropogenic activities and grazing animals the bryoflora from Satara district get disturbed. Considering the ecological importance, sensitivity and vulnerability of bryophytes to changing environment, it is most essential to enlist bryophyte through periodical survey and revision. Therefore proper documentation is needed for conservation of these ecologically important plants before their extinction.

Acknowledgements

Authors are thankful to Dr. D.K. Singh, Former Director-In-Charge, BSI, Kolkata and Dr. Praveen Kumar Verma, Forest Research Institute, Dehradun, Uttarakhand for the help in the identification of the taxon and providing relevant literature. Thanks are also due to Principal and Head, Department of Botany Yashvantrao Chavan Institute of Science, Satara for providing necessary laboratory facilities.

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