



ISSN NO. 2320-5407

Journal Homepage: - [www.journalijar.com](http://www.journalijar.com)

## INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/6274  
DOI URL: <http://dx.doi.org/10.21474/IJAR01/6274>



### RESEARCH ARTICLE

#### SEVEN NEW ADDITIONS TO THE MARCHANTIOPHYTA (LIVERWORTS) BRYOFLORA OF MANIPUR, INDIA.

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#### Manuscript Info

##### Manuscript History

Received: 10 November 2017  
Final Accepted: 12 December 2017  
Published: January 2018

##### Key words:-

Marchantiophyta, Manipur, New addition, Thalloid.

#### Abstract

Seven (7) thalloid liverworts under two (2) genera belonging to two (2) families viz., *Marchantia papillata* Raddi subsp. *grossibarba* (Steph.) Bischl. and *M. polymorpha* subsp. *ruderalis* Bischl. & Boisselier–Dubayle of Marchantiaceae and *Riccia beyrichiana* Hampe ex Lehm., *R. cavernosa* Hoffm., *R. huebeneriana* Lindenb., *R. cruciata* Kashyap and *R. sorocarpa* Bisch. of Ricciaceae are recorded for the first time from Manipur. Correct nomenclature, taxonomic description, habitat, distribution and photographs are provided for each species.

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#### Introduction:-

The Bryophytes consist of tiny poikilohydric haploid dominant (n) non-tracheophyte cryptogams which have three divisions, namely, Marchantiophyta (Hepaticae or Liverworts), Bryophyta (Mosses) and Anthocerotophyta (Hornworts). More than 3000 bryophyte species have been described, thus representing the most diverse plant group after the angiosperms and it is also accepted as the oldest living land plants (Mishler & Churchill 1984; Shaw & Ranzaglia 2004; Ranzaglia *et al.* 2007). Majority are found cosmopolitan on terrestrial ecosystem in shaded humid microenvironment, wetland, and mountain ecosystems and a few on aquatic ecosystem forming an essential component of global biodiversity (Hällingback & Hotgetts 2000).

The liverworts have two varied morphological forms—Foliose and Thallose. In foliose, the plants are differentiated into stem with two or three rows of leaves while in thalloids, the plants possess dorsal air-pores, ventral scales, pegged rhizoids, photosynthetic and storage zones. From the phylogenetic viewpoint, they are considered as the first land plants on earth with fascinating role in pollution monitoring, plant succession, microhabitation of unicellular eukaryotes, water retention, nutrient cycling and global carbon budget serving an indicator of climate change (Gignac 2001; Azeulo *et al.* 2011, Glime 2007). In spite of having great ecological role, this plant group have been paid very less attention worldwide because of its miniature size, difficult taxonomy, degrading habitat, less economic importance and easily non-recognizable. However, investigations on their ethnic uses and application in herbal medicine, agriculture, aquarium and horticultural purposes have been carried out in few countries (Pant & Tewari 1989; Kumar *et al.* 2000; Glime 2013).

In terms of species richness, the liverworts come after the mosses and followed by the hornworts. A total of 7274 liverwort species have been listed in the most recently published world checklist of hornworts and liverworts (Söderström *et al.* 2016). To assess the diversity of bryoflora, many phytogeographic regional zones have been divided throughout the world. In India, there are eight (8) bryogeographic zones viz., Western Himalays [WH],

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Eastern Himalayas [EH], Punjab and West Rajasthan [PWR], Gangetic Plains [GP], Central India [CI], Western and Eastern Ghats [WEG], Deccan Plateau [DP] and Andaman and Nicobar Islands [ANI] (Pandè 1958, Singh & Semwal 1995). Altogether, 891 species under 134 genera in 56 families have been reported from India (Singh *et al.* 2016). Major contributions to the liverwort flora of India include Mitten (1861), Kashyap (1929, 1932), Pande (1936), Chopra (1943), Pande & Udar (1958a, 1958b), Kachroo (1969), Udar (1976), Srivastava (1964), Parihar *et al.* (1994), Singh (1999), Dey & Singh (2012), Singh & Barbhuiya (2012), Singh & Singh (2009) and Singh *et al.* (2016).

The first ever collection of plants including liverworts from Manipur state was done by George Watt in 1881–82. Besides these, some collectors like Biswas & Calder (1936), Deb (1954) and Lal (1979) reported few bryophytes from the state. However, these collectors are not bryophyte specialists and their collections were very limited. One of the most notable contributions to the state flora was made by Singh *et al.* (2010) and listed 111 liverworts under 46 genera in 20 families. Apart from these, no botanical exploration and assessment by any hepaticologists regarding the liverwort flora of Manipur has been made so far. During the present investigation, seven (7) interesting taxa which are not recorded in the earlier studies were collected from the study site.

### Materials and Methods:-

**Study site:** Manipur, a Northeastern state of India, lies between (23°59') N latitudes and (92°59'–94°46') E longitudes and covers a total geographical area of 22,327 km<sup>2</sup>. The altitudinal variation ranges between 700–3,600 meters above the mean sea level (mmsl). It shares national boundary with Nagaland, Mizoram and Assam to the North, South and West respectively while bordered by the international boundary of Burma to the East. The state is blessed with a unique topography of having a small lacustrine oval shaped alluvial valley encircled by ninety percent tract of hilly terrains that belong to the alpine system of the young fold mountains of Himalaya. It has nine political districts viz., Churachandpur, Ukhrul, Tamenglong, Chandel, Senapati, Imphal West, Imphal East, Thoubal and Bishnupur. The later four districts belong to the valley. The southwest monsoon is the primary source of determining the rainfall and climatic patterns throughout the state. It receives an average annual rainfall of 1600–3430 mm and is characterized by pleasant sub-tropical monsoon type of climate with temperature ranging from sub-zero to 36°C. Seventy percent of the rainfall is restricted to the hilly areas. Considering the topography, physiognomy and climatic conditions, Manipur comes under the EH Bryo-geographic zone of India which is also a global biodiversity hotspot.

**Data collection:** Samples were collected from the valley region of the study site during repeated field surveys conducted from June 2015 to June 2017. Photographs were taken in their natural habitat. A small knife and a spatula were used to peel off the specimens. The specimens were carefully observed and examined while fresh. Record-keeping, making herbarium packets and preservation was done by using the simple methodology of Vanderpoorten *et al.* (2010). Species were identified by consulting various relevant literature and publications (Srivastava 1964; Lal & Parihar 1979; Udar & Jain 1984; Bischler-Causse 1989; Sinha *et al.* 1990; Singh & Singh 2009; Singh *et al.* 2010; Singh & Singh 2013; Singh 2014). Classification by Crandall-Stotler *et al.* (2009) is followed for the present study. Microphotographs were taken by using Phase-Contrast Microscope *MOTIC BA210*. The herbarium packets as well as wet specimens of all the collected taxa were deposited in the Manipur University Museum of Plants (MUMP), Department of Life Sciences, Manipur University, Canchipur.

### Enumeration:-

***Marchantia papillata*** Raddi subsp. ***grossibarba*** (Steph.) Bischl. Cryptog. Bryol. Lichenol. 10:78. 1989 & Bryophyt. Biblioth. 38: 210. 1989. [Plate-I, a–c]

Plants thick, light green–dark green, dichotomous repeated, profusely branching, air-pores visible; Thallus 20–50 mm long, 3–5 mm wide, dorsal dark median band, margin entire, apex notch; Ventral scales 4 rows, median two rows appendiculate, appendages ovate–subrotund and toothed with 1–2 uniseriate cells towards apex, brownish to reddish colour; Laminar scales slightly ligulate; Rhizoids pegged and smooth, hyaline; Air-pores simple, small with 5–8 superimposed concentric rings, inner pore quadrate bounded by 4 cells; Gemma cup fringed on the margin; Gemmae discoid, biconvex; Dioecious; Male receptacles stalked, hemispherical disc with 5–8 lobed, stalk 10–15 mm long; Female receptacles stalked, discoid with 6–9 lobed, stalk 20–30 mm long; Capsules yellow, ovate (1×0.7) mm; Spores brown colour, walnut shape, elaters long, bispiral.

**Habitat:-** Terricolous and saxicolous.

**Fertile period:-** May–July.

**Status in Manipur:-** Very common.

**Distribution:-**

**India:-**

Himachal Pradesh, Kashmir [WH] Punjab [PWR]; Arunachal Pradesh, Assam, Meghalaya, Nagaland, Sikkim, West Bengal, Manipur [EH]; Madhya Pradesh [CI]; Tamil Nadu [WEG]; Afghanistan, Pakistan, Nepal, Bhutan, China, Bangladesh, Myanmar, Sri Lanka, Thailand.

**Exsiccatae:-**

INDIA: Manipur, Imphal East, Singjamei, 732 m, 24°82'75" N & 93°87'95" E, on moist exposed area at the interface between soil and cemented wall, 07.05.2016, N. P. Devi, 003406 (MUMP).

**Marchantia polymorpha** subsp. **Ruderalis:-**

Bischl. & Boisselier–Dubayle in J. Bryol. 16:364, 1991. [Plate–I, d–g]

Plants thick, dark green, dichotomous repeated, air–pores inconspicuous but visible, rosette while young; Thallus 30–60 mm long, 7–12 mm wide, dorsal discontinuous dark median band, margin crenulate, apex notch; Ventral scales 6 rows, median scales large, appendiculate, appendages subrotund and toothed, purplish to reddish colour; Laminar scales ligulate; Rhizoids pegged and smooth, hyaline; Air–pores simple, small with 5–7 superimposed concentric rings, inner pore quadrate–cruciate bounded by 4–6 cells; Gemma cup lobed on the margin; Gemmae discoid, biconvex; Dioecious; Male receptacles stalked, flat disc with shallow 5–10 lobed, stalk 15–20 mm long; Female receptacles stalked, discoid with deep 9–11 slender lobes, stalk 15–20 mm long; Capsules yellow, ovate (1.5×1) mm; Spores brown colour, no elaters.

**Habitat:-** Terricolous & saxicolous.

**Fertile period:-** April–June.

**Status in Manipur:-** Uncommon.

**Distribution:-**

INDIA: Himachal Pradesh, Jammu and Kashmir, Uttarakhand [WH]; West Bengal (Darjeeling), Sikkim, Assam, Meghalaya, Manipur [EH]; Punjab, Rajasthan [PWR]; Uttar Pradesh [GP]; Tamil Nadu [WEG]; Pakistan, Afghanistan, Nepal, Bhutan, China, Sri Lanka, Myanmar, Japan, Korea, Vietnam, Turkey, Iran, Iraq, Israel, Indonesia, Malaysia, Philippines, Melanesia, New Zealand, Australia, Europe, North & South America.

**Exsiccatae:-**

INDIA: Manipur, Imphal West, Thumbuthong, 726m, 24°44'22" N & 93°35'78" E, on very moist exposed thick soil near river bank, 10.04.2016, N. P. Devi, 003405 (MUMP).

**Riccia beyrichiana** Hampe ex Lehm., Nov. strip. Pug. 7:1. 1838. [Plate–I, h; PlateII, a–b]

Plants glaucous green, rosette diameter upto 3 cm, dichotomous 2–4 times furcate; Thallus 5–10 mm long, 2–3 mm wide, apex obtuse or rounded, lobes linear, margin swollen, entire; Dorsal median groove deep and narrow at anterior region, shallow and broad in middle, absent in posterior region; Ventral scales hyaline or violet, inconspicuous; Rhizoids pegged and smooth, hyaline; Cross section of thallus differentiated into upper compact photosynthetic zone with pyriform–rotundate epidermal cells and lower parenchymatous, storage cells arranged in vertically oriented rows with canal–like air chambers between them (Euriccia–type), anterior concavo–convex, posterior plano–convex; Monoecious; Capsules protruded on dorsal surface; Spores brown–dark brown, tetrahedral, globose, 80–93 µm, distal surface imperfectly reticulate, with 7–9 reticulations across, margin crenate.

**Habitat:-** Terricolous.

**Fertile period:-** June–August and December–March.

**Status in Manipur:-** Common.

**Distribution:-** INDIA: Himachal Pradesh [WH]; Meghalaya, Manipur [EH]; Pakistan, Macronesia, Europe, North Africa, North America.

**Exsiccatae:-** INDIA: Manipur, Imphal East, Singjamei, 732 m, 24°82'80" N & 93°87'90" E, on moist thick exposed alluvial clayed soil, 20.06.2016, N. P. Devi, 003409 (MUMP).

*Riccia cavernosa* Hoffm. Deuschl. Fl. 2 (Cryptog.): 95. "1796" 1796. emend. Raddi, Opusc. Sci. (Bologna) 2: 351. 1818. Deuschl. Fl., Theil 2 (Hoffm.): 95, 1795 [1796] (Hoffmann 1795). [**Plate-I, i-j; Plate-II, c-d**]

Plants glaucous green–reddish green, spongy, rosette diameter 1.5–2 cm, dichotomous crowded and overlapping; Thallus 5–9 mm long, 2–4 mm broad; Dorsal groove prominent only at apex; Ventral scales absent; Epidermal cells globose; Rhizoids pegged and smooth, hyaline; Cross section of thallus differentiated into upper photosynthetic zone with large air chambers, pores and lower compact, parenchymatous storage zone (Ricciella-type); Monoecious; Capsules slightly protruding on ventral side, 1–3 rows; Spores brown, globose to subglobose, 70–87 µm, anisopolar, distal surface have incomplete reticulations of lamellae incrustated with granules, reticulations widely spaced and occasionally form continuous ridge along the periphery at inner side of wing, proximal surface have prominent triradiate mark, each faces bear granules forming simple or branching and anastomosing ridges which occasionally form complete reticulum, wing broad, margin crenate.

**Habitat:-** Terricolous.

**Fertile period:-** December–February.

**Status in Manipur:-** Uncommon.

**Distribution:-** INDIA: Himachal Pradesh [WH]; West Bengal Hills [EH]; Uttar Pradesh [GP]; Madhya Pradesh [CI]; Rajasthan [PWR]; Pakistan, Russia, North America, Europe, Australia.

**Exsiccatae:-** INDIA: Manipur, Thoubal, Kakching, 766 m, 24°30'29"N & 93°58'25"E, on thick exposed alluvial clayed soil of river bank, 05.12.2016, N. P. Devi, 003429 (MUMP).

*Riccia cruciata* Kashyap, J. Bombay Nat. Hist. Soc. 24: 349. 1916. [**Plate-I, k; Plate-II, e-f**]

Plants pale green–yellowish green, shiny, little spongy, rosette diameter 12–15 mm, dichotomous 1–2 furcate; Thallus obovate, cruciate, 6–7 mm long, 5–6 mm broad; Dorsal groove shallow and prominent towards apex; Ventral scales inconspicuous; Epidermal cells globose; Rhizoids pegged and smooth, hyaline; Cross section of the thallus differentiated into upper photosynthetic zone with large air chambers, pores and lower compact, parenchymatous storage zone; Monoecious. Capsules prominent on the ventral surface, 1–2 rows; Spores golden brown, globose–triangular, 59–72 µm, anisopolar, distal surface with 4–5 reticulations across diameter, each reticulum complete with low short papilla at centre, partition wall of the reticulum crenulate or with minute puncti, proximal surface with prominent triradiate mark, each face with 7–12 angular reticulations with no central papilla, wing broad, margin slightly undulate–crenate.

**Habitat:-** Terricolous.

**Fertile period:-** January–March.

**Status in Manipur:-** Uncommon.

**Distribution:-** INDIA: Kerala, Maharastra [WEG]; Nagaland, West Bengal, Manipur [EH], Uttar Pradesh [GP]; Punjab [PWR]; Uttaranchal [WH]; Indonesia, Pakistan.

**Exsiccatae:-** INDIA: Manipur, Thoubal, Keirak, 766 m, 24°30'50"N & 93°57'46" E, on thick exposed alluvial clayed soil of river bank, 05.12.2016, N. P. Devi, 003433 (MUMP).

*Riccia huebeneriana* Lindenb., Nova Acta Phys.–Med. Acad. Caes. Leop.–Carol. Nat. Cur. 18: 504. 1836. [**Plate-I, l; Plate-II, g-h**]

Plants light green, semi–rosette not compact, dichotomous 2–3 furcate; Thallus narrow, 8–10 mm long, 1–1.5 mm wide, linear, ribbon–shaped, apex rounded, margin entire; Dorsal median groove continuous, shallow at apex; Ventral scales inconspicuous; Epidermal cells elongated pentagonal to hexagonal; Rhizoids pegged and smooth, hyaline; Cross section of thallus differentiated into upper photosynthetic zone with large air chambers and pores and lower compact, parenchymatous highly reduced storage zone (Ricciella-type); Monoecious; Capsules prominent on ventral surface right below the dichotomous point, arranged in single row; Spores golden yellow, subglobose to

triangular, 50–75 µm, anisopolar, distal surface with 6–8 reticulations across diameter, proximal surface show prominent triradiate mark with incomplete reticulations, wing broad, margin entire to crenate.

**Habitat:-** Terricolous.

**Fruiting period:-** July–August and November–February.

**Status:-** Very common.

**Distribution:-** INDIA: Uttar Pradesh [WH]; Assam, Sikkim, West Bengal [EH]; Chattisgarh, Madhya Pradesh [CI]; Karnataka, Kerala [WEG]; China, Japan, Korea, Europe, Africa, North America.

**Exsiccatae:-** INDIA: Manipur, Thoubal, Tentha, 802m, 24°57'22" N & 93°97'68" E, on iron rich red soil of small hillocks, 02.07.2016, N. P. Devi, 003410 (MUMP).

*Riccia sorocarpa* Bisch., Nova Acta Phys.–Med. Acad. Caes. Leop.–Carol. Nat. Cur. 17: 1053. 1835. [**Plate–I, m; Plate–II, i–j**]

Plants glaucous green, white margin in matured plants, dichotomous 2–3 furcate, gregarious branching; Thallus 5–7 mm long, 2 mm wide, oblong–ovate, apex subacute, margin entire; sulcus very prominent upto the middle; Ventral scales small and colourless, along margin; Epidermal cells oval, soon invisible, subepidermal cells persisting; Rhizoids pegged and smooth, hyaline; Cross section of thallus differentiated into upper compact photosynthetic zone (Euriccia–type); Monoecious; Capsules prominent on the ventral side, arranged in 2–3 rows; Spores black to dark brown, globose to subglobose, 62–83 µm, anisopolar, distal surface with 8–11 reticulations, proximal surface have inconspicuous triradiate mark with complete to incomplete reticulations; Wing broad, margin crenulate to serrulate.

**Habitat:-** Terricolous.

**Fruiting period:-** November–February.

**Status in Manipur:-** Very Common.

**Distribution:-** Himachal Pradesh, Uttarakhand [WH]; West Bengal Hills, Manipur [EH]; Tamil Nadu [WEG]; Japan, China, Africa, Europe, North America.

**Exsiccatae:-** INDIA: Manipur, Thoubal, Kakching, 767 m, 24°30'29" N & 93°58'25" E, on moist exposed alluvial clayed soil, 27.11.2016, N. P. Devi, 003417 (MUMP).

**Notes:** Most of the *Riccia spp.* occurred singly on the moist exposed thick alluvial clayed soil at the river bank with no other associated plants. *R. huebeneriana* and *R. sorocarpa* sometimes clustered together as mixed population and are also found in shaded iron rich red soil of small hillocks at a higher altitude as compared to other *Riccia spp.*



**Plate-I:- Habit.** a–c. *Marchantia papillata* subsp. *grossibarba*. a. Gametophyte bearing gemma cups (encircled); b. Male plants; c. Female plants with dehiscing capsule. d–g. *M. polymorpha* subsp. *ruderalis*. d. Gametophyte bearing gemma cups; e. Male receptacle; f. Female plants showing female receptacle (arrowheads); g. Female receptacle with sporophyte capsules (arrowhead) h. *Riccia beyrichiana* Hampe ex Lehm. i–j. *R. cavernosa* Hoffm. i. Glaucous green thallus j. Reddish green thallus. k. *R. cruciata* Kashyap. l. *R. huebeneriana* Lindenb. m. *R. sorocarpa* Bisch.



**Plate-II:- Spores of Riccia sp. a–b. Riccia beyrichiana** Hampe ex Lehm. **a.** Distal surface; **b.** Proximal surface. **c–d. R. cavernosa** Hoffm. **c.** Distal surface; **d.** proximal surface. **e–f . R. cruciata** Kashyap. **e.** Distal surface **f.** Proximal surface; **g–h. R. huebeneriana** Lindenb. **g.** Distal surface **h.** Proximal surface; **i–j. Riccia sorocarpa** Bisch. **i.** Distal surface **j.** Proximal surface.

### Acknowledgements:-

The authors are thankful to Dr. A. A. Mao, Scientist–F and Head of Office, Botanical Survey of India, Eastern Regional Centre, Shillong for giving permission to consult herbarium specimens. Special thanks to Dr. S. K. Singh, Scientist–D of the same institute for his co–operation and assistance in identification and authentication.

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