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RICCIA OF WEST BENGAL

A. K. BAG[1], S.K.SINGH[2] AND S.G. BHATTACHARYA[1]
[1]*Bose Institute, Department of Botany, 93/1 A.P.C. Road, Kolkata-700 009*
[2]*Botanical Survey of India, Central National Herbarium, Howrah 711 103*
e-mail : sksbsinc@rediffmail.com

ABSTRACT

Six species of the genus *Riccia,* from West Bengal have been studied critically from histomorphological stand point. Of them, *Riccia plana* Taylor is a new record for Gangetic Plains and two species viz. *Riccia crispatula* Mitt. and *Riccia cruciata* Kashyap are recorded for the first time from West Bengal. Relationship among the species have also been studied and discussed on the basis of computed Dendrogram.

INTRODUCTION

Changes in bryophyte cover in forest ecosystems in response to air pollution have been reported in developed countries. As the most bryophytes appear to absorb water and mineral nutrients directly into leaves and stems, a fact that makes them extremely vulnerable to air-borne pollutants in solution (Longton, 1980). However, in the context of our country and the increasing air pollution, the importance of study of bryophyte has been felt.

Basic floristic inventories are an essential part of any assessment of the role of bryophytes in natural ecosystems. However, in the Indian context inventories are needed to identify the areas where many rare bryophytes occur. The reports of bryophytes, particularly of the genus *Riccia* from West Bengal are very few and scattered (Kachroo, 1959; Pande and Udar, 1959; Kachroo and Bapna, 1963; Srivastava, 1964; Bhattacharya, 2005). Moreover, during rainy season it has been noticed that many species of *Riccia* grow every where in West Bengal. Plenty of the materials of *Riccia* and its importance as a pollution indicator have created our taxonomic interest.

The genus *Riccia* was established by Micheli (1729) in his 'Nova Plantarum Genera' in honour of an Italian Botanist P.F. Ricci. Thereafter, it is validated by Linnaeus (1753). Since then about 200 species have been described from various part of the globe (Perold, 1989) with preponderance in Mediterranean type of climate. The study on the genus in India dates back to Griffith (1849), who described *Riccia* sp. (=*Riccia frostii* Austin) on the basis of his own collection from the bank of river Brhammaputra in Assam. Since then many species have been described from various part of the country (Mitten 1861; Stephani, 1998-1900, 1917-24; Kashyap, 1916, 1929; Pande, 1924, 1933; Ahmad, 1942; Pande and Ahmad, 1944; Kachroo, 1950, 1952, 1954, 1959; Udar, 1959; Pande and Udar (1957a, b, 1958, 1959; Bapna, 1961; Kanwal, 1979; Udar and Gupta, 1984; Daniel & Daniel, 2002). Apart from

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above, Udar (1956, 1957a, b), Bapna (1958, 1961, 1962), Kachroo (1959), Bapna and Vyas (1962) Kachroo and Bapna (1963) Srivastava (1964), Gupta and Udar (1986) made significant contributions on the genus in India. In the present state of our knowledge the genus is represented by ca 38 species, of which eight species viz. *Riccia billarderi* Mont. & Nees, *R. crystallina* L., *R. ciliata* Hoffm. *R. discolor* Lehm. & Lindenb., *R. frostii* Austin, *R. gangetica* Ahmad, *R. huebeneriana* Lindenb., *R. sorocarpa* Bischoff known to occur in the state of West Bengal.

The present investigation deals with the morphology, histology of the gametophytic and sporophytic structures of six species of *Riccia* growing in different places of West Bengal which includes *Riccia plana* Taylor as a new record for Gangetic Plains and two species viz. *Riccia crispatula* Mitt. and *Riccia cruciata* Kashyap as new records for the West Bengal. More emphasis has been given on the spore characters because they furnish diagnostically reliable taxonomic characters in the variable ecological conditions for definite identification of the taxon. Phylogenetic relationship among the species have also been studied and discussed on the basis of computed Dendrogram using morphological observations.

MATERIALS AND METHODS

The materials for the present study were collected during monsoon and post monsoon seasons of the years 2003 – 2005, from different localities of West Bengal. The collected materials were fixed in FAA. for overnight and preserved in 70% alcohol for further studies.

For histological studies, both hand sections and microtome sections were used. For Microtome section fixed materials were dehydrated through alcohol series embedded in paraffin and sections were cut with a Rotary microtome and stained in Bismark Brown following routine procedure. For studying spore morphology, observations were made mostly from temporary preparations. Suitable capsules were dissected out from the thalli and the spores taken on the slide by rupturing the capsule wall. The total number of spores in each capsule was counted with Haemocytometer and the spore morphology was studied under compound microscope. For each sample at least 10 counts were scored. Photographs were taken at different magnifications and suitably enlarged. Temporary preparations were later made permanent by inverting the slides in tertiary butyl alcohol till the cover slips were detached and mounting in DPX.

All the materials studied are deposited at Cryptogamic Section of the Botanical Survey of India, Central National Herbarium, Howrah (CAL).

Phylogenetic analysis was performed using morphological observations (Table 1). Same characters shared by all the taxa were also considered for analysis. On the basis of presence or absence of a particular character in all the species a similarity matrix was prepared. Giving each character a definite number, pairing affinity values between different combinations of species pair were calculated from the similarity matrix (Table 2) by the following formula:

$$PA = \frac{\text{Characters common to species A and B}}{\text{Total no. of characters in species A and B}}$$

From the pairing affinity values a dendrogram was computed following UPGMA (Unweighted Pair Group Method with Average) method using software EASE.

KEY TO THE SPECIES

1a. Thallus with large air cavitities, spongy ... 2

1b. Thallus without large air cavitities, compact ... 4

2a. Thalli thick, obovate, cruciate, 6-8 mm long, 5-6 mm wide ... *R. cruciata*

2b. Thalli thin, oblong, ribbon shaped, 7-10 mm long, up to 1 mm wide ... 3

3a. Thalli 2-3 furcately branched; spores 290-304 per capsule, 61.6-82.9 × 54.5-75.8 μm with 5-6 reticulations across diameter, wing margin entire ... *R. huebeneriana*

3b. Thalli 3-4 furcately branched; spores 36-60 per capsule, 85.3-90.1 × 68.7-85.3 μm with 10-13 reticulations across the diameter, wing margin slightly undulate ... *R. plana*

4a. Dioecios; spores isopolar, 82.9-92.4 × 73.5-85.3 μm with 4-5 reticulations across the diameter, wing 4.7-7.1 μm wide ... *R. crispatula*

4b. Monoeciuos; spores aniso or isopolar, larger than above with 7-10 reticulations across the diameter, wing 7.1-10 μm wide ... 5

5a. Spores anisopolar, 85.3-97.2 × 75.8-87.7 μm, wing margin entire to slightly undulate ... *R. gangetica*

5b. Spores isopolar, 99.5-125.6 × 97.2-120.9 μm, wing margin highly attenuated ... *R. billarderi*

OBSERVATION AND DISCUSSION

Riccia billardieri Mont. & Nees, Syn. hepat.: 602. 1846. (Fig. 1A, 2A, 3A).

Monoecious. Plants deep green, overlapping in large patches, dichotomously branched, 1-2 furcate; thalli oblong-obovate, 10 – 11mm long, about 2 mm broad, apex rotundate, apical notch indistinct, occasionally distinct, sometimes with stalked bulb-like structures, sulcus prominent only on upper portion of thalli, margin undulate. Ventral scales small, along the thallus margin, purple, semilunate. Thallus in cross section differentiated into upper compact photosynthetic zone with globose epidermal cells and slit like pores and lower compact parenchymatous, multilayered storage zone. Capsules prominent on the ventral surface, 2-4 per thallus, arranged in 1-2 rows, golden brown, globose, dehisce irregularly, 107-170 spores in each capsule; capsule wall unistratose without thickening. Spores golden brown to blackish, isopolar, globose to subglobose, 99.5-125.6 × 97.2-120.9 μm, reticulate; reticulations 7-9 across the diameter, sometimes prominent projections present at the corners of reticulations, heterobrochate, 11.8-23.7 × 9.5-16.6 μm, triradiate mark indistinct, winged; wing 7.1-9.5 μm wide, attenuated.

Specimen examined: Terrestrial, growing on exposed moist soil, Howrah, Indian Botanic Garden, Charak Udyan, 10.8.2004, *A.K.Bag* 03; 24-Paraganas, Titagarh, 01.9.2004, *A.K. Bag* 05; Hooghly, Konnagar, 20.9.2004, *A.K.Bag* 06; Burdwan, Tarabag, 04.8.2005, *A.K.Bag* 08; Jaynagar, 31.8.2005, *A.K.Bag* 10; Darjeeling, Bejanbari, 20.10.2005, *A.K.Bag* 12.

Distribution: India (Western Himalaya: Uttaranchal; Eastern Himalaya: West Bengal-hills, Assam; Punjab & West Rajasthan: Rajasthan; Central India: Madhya Pradesh; Gangetic Plains: Uttar Pradesh,

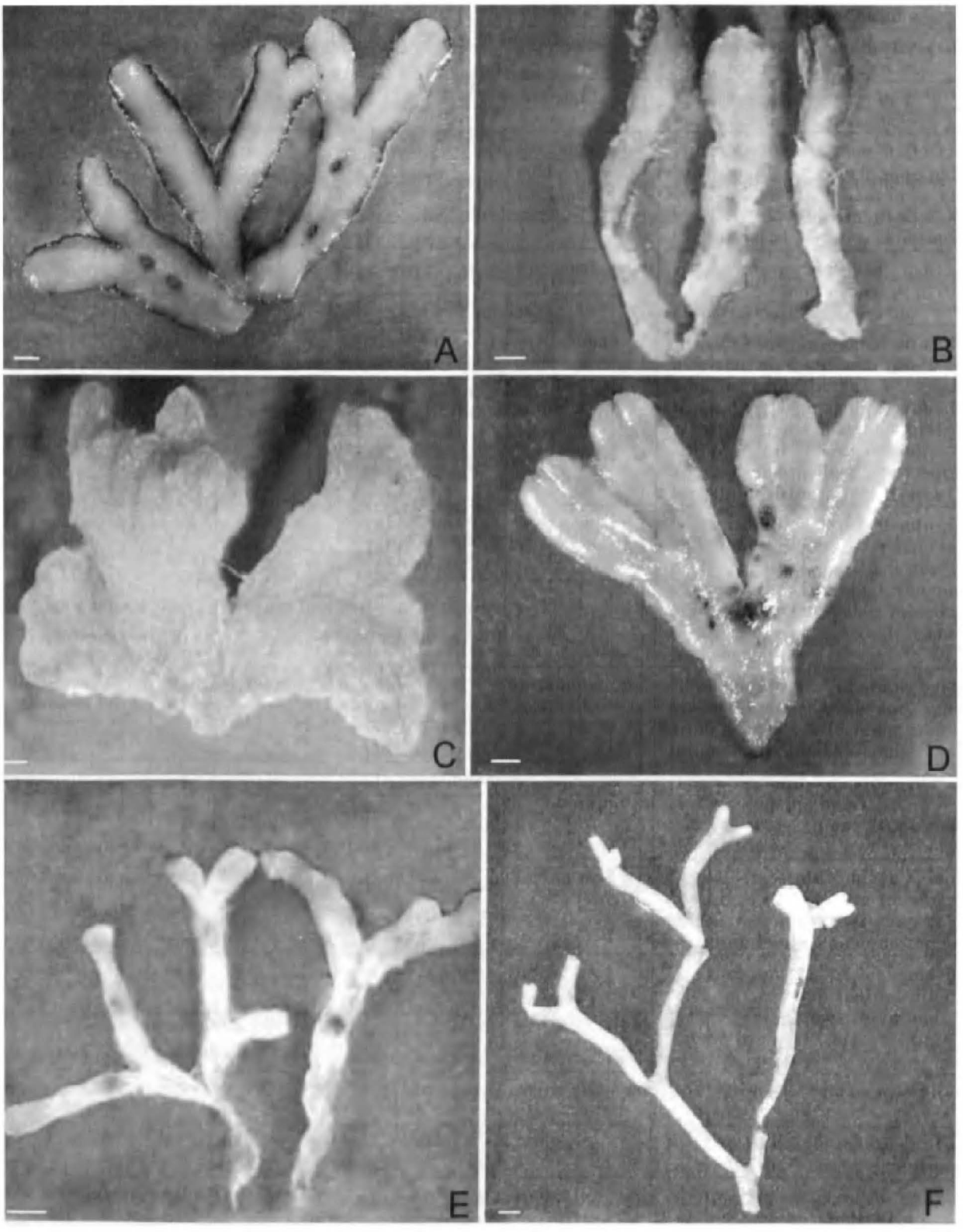

Fig. 1. Thallus of six species *of Riccia* in dorsal view : **A.** *Riccia billardieri;* **B.** *R. crispatula;* **C.** *R. cruciata;* **D.** *R. gangetica;* **E.** *R. huebeneriana;* **F.** *R. plana.* (Scale bars A-F= 1mm).

Bihar, West Bengal Plains; Western Ghats: Maharashtra, Karnataka); Pakistan, Sri Lanka, Indonesia, (Udar, 1957a, 1959; Meijer, 1958; Srivastava, 1964; Kachroo and Bapna, 1963; Parihar & al., 1994; Bapna and Kachroo, 2000).

Riccia crispatula Mitt. in J. Proc. Linn. Soc., Bot. 5: 127. 1861. (Fig. 1B, 2B, 3B).

Dioecious, plants dark green with brownish margin, caespitose in large patches, dichotomously branched, 1-2 furcate; thalli oblong-obovate, 12-15 mm long, 2-3 mm broad, apex rotundate, apical notch indistinct, sulcus prominent to the base of the thallus, margin entire-sligtly undulate. Ventral scales small, deep purple, semilunate along the margin of the upper portion of the thalli. Thallus in cross section differentiated into upper compact photosynthetic zone with globose epidermal cells and slit-like pores and lower compact, parenchymatous, multilayered storage zone. Capsules more prominent on the ventral surface, 3-6 per thallus arranged in 1-2 rows, dark brown, globose, dehisce irregularly, 192-264 spores in each capsule; capsule wall unistratose without thickening. Spores dark brown, isopolar, globose to subglobose, 82.9-92.4 × 73.5-85.3 μm, reticulate, reticulations 4-5 across the diameter, heterobrochate 14.2-33.2 × 7.1-21.3 μm, partition walls with sinuate protuberances, winged; wing 4.7-7.1 μm wide, margin attenuated.

Specimen examined: Terrestrial, growing on rock soil, Darjeeling, Bejanbari, 20.10.2005, *A.K.Bag* 13.

Distribution: India (Gangetic Plains: Orissa); Sri Lanka (Mitten, 1861; Chopra, 1943; Pande and Udar, 1957a; Srivastava, 1964; Parihar & al, 1994).

R. crispatula was instituted by Mitten (1861) on the basis of specimen collected by Gardner from Matale in Ceylon. Stephani (1898) studied the original specimen and provided details of this plant. Since then this liverwort has not been reported from any other place except Chilka Lake (Chopra, 1943). Therefore the present study extends the range of distribution of this rare species.

Riccia cruciata Kashyap in J. Bombay Nat. Hist. Soc. 24: 349. 1916. (Fig. 1C, 2C, 3C, D).

Monoecious. Plants yellowish green, in rosettes, dichotomously branched, 1-2 furcate; thalli spongy, obovate, cruciate, 6-8 mm long, and 5-6 mm broad, apex truncate, apical notch distinct, sulcus prominent at the apical portion, margin entire to slightly undulate. Ventral scales not prominent, delicate. Thallus in cross section differentiated into upper large, chambered, photosynthetic zone with globose epidermal cells and storage zone highly reduced, sometimes almost absent. Capsules prominent on the ventral surface, 2-4 per thallus, in 1-2 row, dark brown, globose, dehisce irregularly, 964-1144 spores in each capsule; capsule wall unistratose without thickening. Spores golden brown, anisopolar, globose-triangular, 59.3-71.1 × 54.5-63.9 μm, reticulations with raised partition walls, 4-5 across the diameter, heterobrochate 9.5-19 × 7.1-14.2 μm, triradiate mark prominent on proximal surface, winged; wing 7.1-9.5 μm wide, margin slightly undulate.

Specimen examined: Terrestrial, growing on exposed moist soil, Darjeeling, Bhutia basti, 25.10.2005, *A.K.Bag* 14.

Distribution: India (Eastern Himalaya: Sikkim, Assam, Meghalaya; Gangetic Plains: Uttar Pradesh; Punjab & West Rajasthan: Punjab, Rajasthan; Western Ghats: Kerala); Pakistan (Kashyap, 1916, 1929; Kachroo and Bapna, 1963; Sivastava, 1964; Kachroo & al., 1977; Bapna and Kachroo, 2000). New to West Bengal.

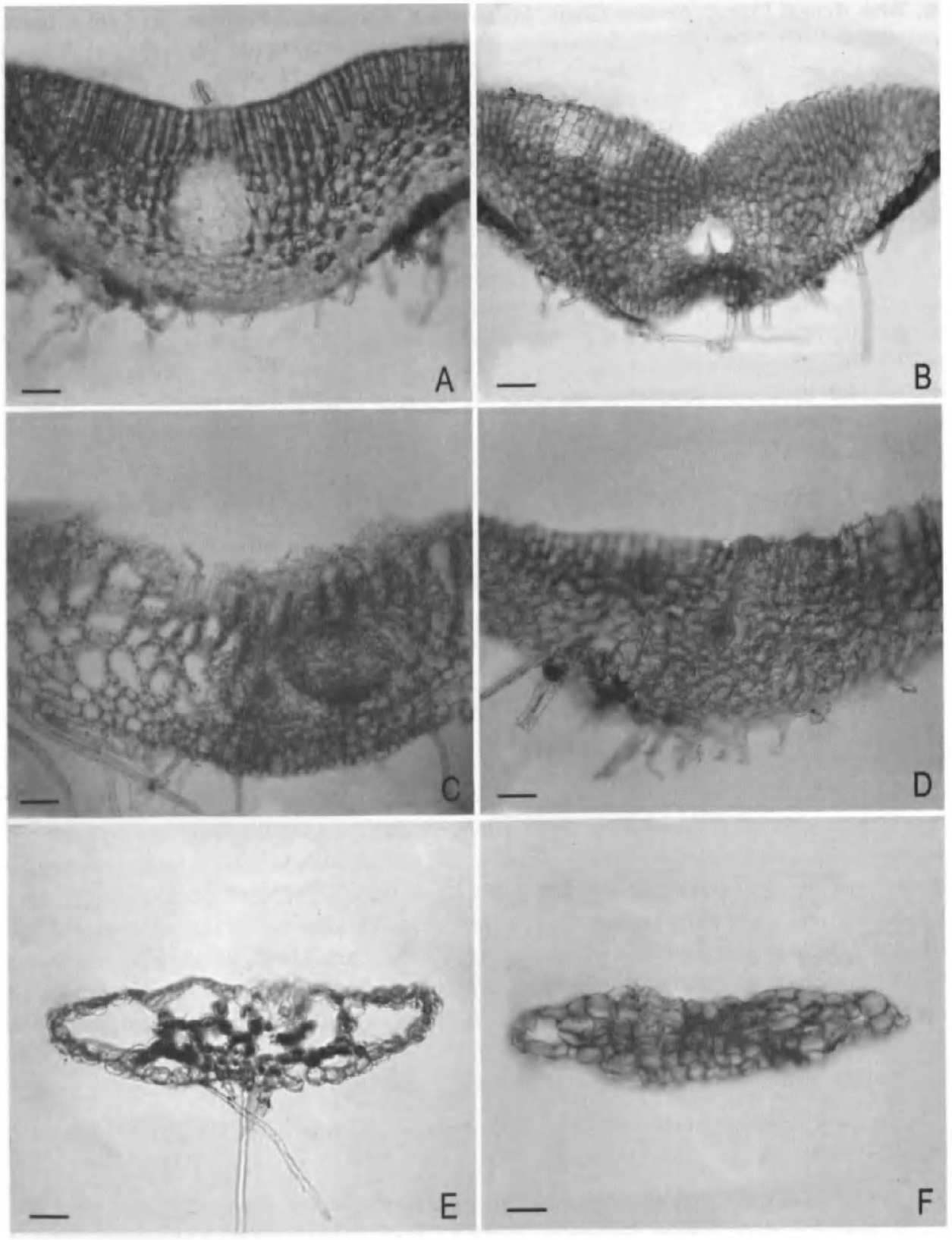

Fig. 2. Transverse section (*T.S.*) of thalli of six species *of Riccia* showing compact (A,B, D) and chambered (C, E, F) photosynthetic regions: **A.** *Riccia billardieri;* **B.** *R. crispatula;* **C.** *R. cruciata;* **D.** *R. gangetica;* **E.** *R. huebeneriana;* **F.** *R. plana.*(Scale bars =0.1mm).

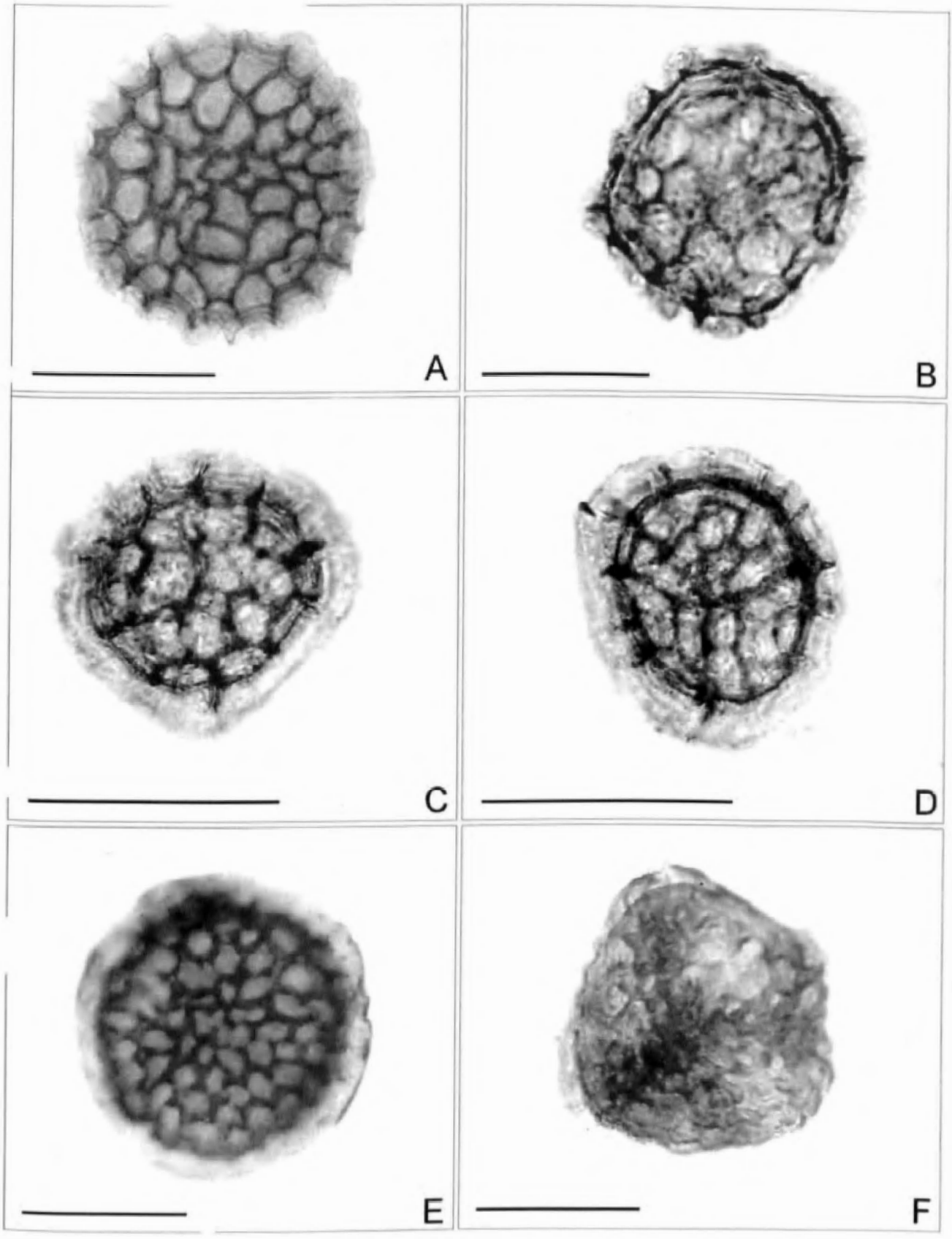

Fig. 3. Spores: **A.** *Riccia billardieri;* **B.** *R. crispatula*; **C.** *R. cruciata* (distal view); **D.** The same (proximal view); **E.** *R. gangetica* (distal view); **F.** The same (proximal view). (Scale bars =50 μm).

Riccia gangetica Ahmad in Curr. Sci. 11: 433. 1942. (Fig. 1D, 2D, 3E, F).

Monoecious. Plants deep green, in semirossettes, dichotomously branched, 1-2 furcate; thalli oblong to oblong-obovate, 8-11 mm long, 2-3 mm broad, apex obtuse, notched deeply, sulcus prominent almost up to the base of the thallus, margin entire to slightly undulate. Ventral scales small, purple, semilunate, along the margin of the thallus. Thallus in cross section differentiated into compact upper photosynthetic zone with globose to subglobse upper epidermal cells and slit-like pores and compact parenchymatous, multilayered storage zone. Capsules prominent on the ventral surface, 4-8 per thallus arranged in 1-2 rows, dark brown, globose, dehisce irregularly, 156-261 spores in each capsule; capsule wall unistratose without thickening. Spores light brown – blackish brown, anisopolar, globose to subglobose, 85.3-97.2 × 75.8-87.7 μm, reticulations 7-10 across the diameter, heterobrochate, 7.1-18.9 × 4.7-9.5 μm, triradiate mark prominent on proximal surface, winged; wing 7.1-10.5 μm wide, margin entire to slightly undulate.

Specimen examined: Terrestrial, growing on moist garden bed, Howrah, 20.10.2003, *A.K.Bag* 01; Bankura, 28.10.2003, *A.K.Bag* 02; 24 Parganas, Titagarh, 29.09.2004, *A.K.Bag* 07; Jaynagar, 31.8.2005, *A.K.Bag* 09; Birbhum, Shantiniketan, 26.11.2004, *A.K.Bag* 04.

Distribution: India (Western Himalaya: Himachal Pradesh, Uttaranchal; Eastern Himalaya: Meghalaya; Punjab & West Rajasthan: Rajasthan; Gangetic Plains: Uttar Pradesh; Central India: Madhya Pradesh; Western Ghats: Maharashtra, Tamil Nadu); Indonesia (Ahmad, 1942; Udar, 1957a; Kachroo & al., 1977; Srivastava, 1964; Bapna and Kachroo, 2000).

Riccia huebeneriana Lindenb. in Nova Acta Phys.-Med. Acad. Caes. Leop. -Carol. Nat. Cur. 18: 504. 1836. (Fig. 1E, 2E, 4A, B).

Monoecious. Plants light green, forming semi rosettes, dichotomously branched, 2-3 furcate; thalli narrow, linear, ribbon-shaped, 8-10 mm long, about 1mm broad, apex obtuse, apical notch indistinct, sulcus shallow at apex, disappearing towards base, margin entire. Ventral scales not so prominent, delicate. Thallus in cross section differentiated into upper large, air chambered photosynthetic zone with globose upper epidermal cells and lower highly reduced storage zone. Capsules prominent on the ventral surface, 2-5 per thallus arranged in single row, dark brown, globose, dehisce irregularly, 290-304 spores in each capsule; capsule wall unistratose without thickening. Spores golden yellow, anisopolar, subglobose to triangular, 61.6-82.9 × 54.5-75.8 μm, reticulations 5-6 across the diameter, heterobrochate 10.7-18.9 × 7.1-11.9 μm, triradiate mark prominent on proximal surface, winged; wing 4.7-9.5 μm wide, margin entire.

Specimen examined: Terrestrial, growing on cultivated land, Darjeeling, Rimbik, 17.10.2005, *A.K.Bag* 11.

Distribution: India (Eastern Himalaya: Sikkim, West Bengal, Assam; Central India: Madhya Pradesh; Western Ghats: Karnataka); China, Japan, Korea, Europe, Africa, North America (Udar, 1956; Kachroo and Bapna, 1963; Srivastava, 1964; Piippo, 1990; Schuster, 1992; Yamada and Choe, 1997; Bapna and Kachroo, 2000; Grolle and Long, 2000; Yamada and Iwatsuki, 2006).

Riccia plana Taylor in London J. Bot. 5: 414. 1846. (Fig. 1F, 2F, 4C, D).

Monoecious. Plants bright green, forming semi rosettes on moist soil, dichotomously branched, branching frequent, 3-4 furcate; thalli narrow, linear, ribbon-shaped, 7-10 mm long, about 1 mm wide,

apex obtuse, sulcus prominent at the apical region, margin entire; cilia not seen. Ventral scales not very prominent, along the margin at the apical portion, semilunate. Thallus in cross section differentiated into upper small air chambered photosynthetic zone with globose upper epidermal cells and compact, parenchymatous, multilayered storage zone. Capsules prominent on the ventral surface, 2-5 per thallus, in 1 row, blackish, globose, dehisce irregularly, 36-60 spores in each capsule; capsule wall unistratose without thickening. Spores golden brown to black at maturity, anisopolar, subglobose to triangular, 85.3-90.1 × 68.7-85.3 μm reticulated; reticulations 10-13 across the diameter, heterobrochate, 4.7-16.6 × 4.7-7.1 μm, triradiate mark prominent on proximal surface, 3 pore-like structures preset on the margin at distal surface, winged; wing 4.7-9.5 μm wide, entire to undulate.

Specimen examined: Terrestrial, growing on shady garden bed, 24 Parganas(S), Jaynagar, 31.8.2005, *A.K.Bag* 09.

Distribution: India (Punjab & West Rajasthan; Rajasthan; Western Ghats: Karnataka; Central India: Madhya Pradesh); Macronesia, Africa, Australia (Ahmad, 1942 and Udar, 1957a as *Riccia manglorica*; Pande and Udar, 1958; Kachroo and Bapna, 1963; Srivastava, 1964; Bapna and Kachroo, 2000). New to Gangetic Plains.

The six species of the genus distinctly differ from each other in gametophytic as well as in sporophytic features. However, species like *R. huebeneriana* and *R. plana* show close affinity together in thallus morphology and anatomy but the latter differs from the former in having golden brown to black spores which are comparatively larger 82.9-90.1 × 68.7-85.3 μm in size and 10-13 reticulations across the diameter, (versus 61.6-82.9 × 54.5-75.8 μm and reticulations 5-6 across as in *R. huebeneriana*). Further *R. huebeneriana* was collected from high altitude (Darjeeling), whereas *R. plana* was from the plains. It is also interesting to note that among the investigated species, all are monoecious except *R. crispatula,* which is dioecious in sexuality. *R. crispatula* not only differs in sexuality but is also distinct from the all documented species in vegetative structures such as oblong-obovate thalli with rotundate apices bearing deep sulcus from apex to the base.

The dendrogram (Fig. 5) is revealing different character combinations at specific similarity level or genetic distance (D), indicating two major groups i.e., group 'A'and group 'B'. Group 'A' comprised of species namely *R. cruciata, R. huebeneriana* and *R. plana.* Similarly, group 'B' comprised of species namely, *R. gangetica, R. billardieri* and *R. crispatula.* Species of group 'A' are more similar at a similarity level or genetic distance (D) 3.11 and species of group 'B' are most similar at a similarity level or genetic distance (D) 3.15. Of the three species of group 'A' pairing affinity values for species pairs of different combinations ranging from 0.28-0.44 and in group 'B' pairing affinity values for species pairs of different combinations ranging from 0.53-0.62 (Table 2). Though, *R. crispatula* were collected from high altitude area (Darjeeling) along with *R. cruciata,* and *R. huebeneriana*, but the dendrogram shows its different genetic evolutionary line. The dendrogram also reveals clear separation of the species having air chambers like, *R. cruciata, R. huebeneriana, R. plana* and species having compact photosynthetic zones namely *R. gangetica, R. billardieri* and *R. crispatula* in two different groups.

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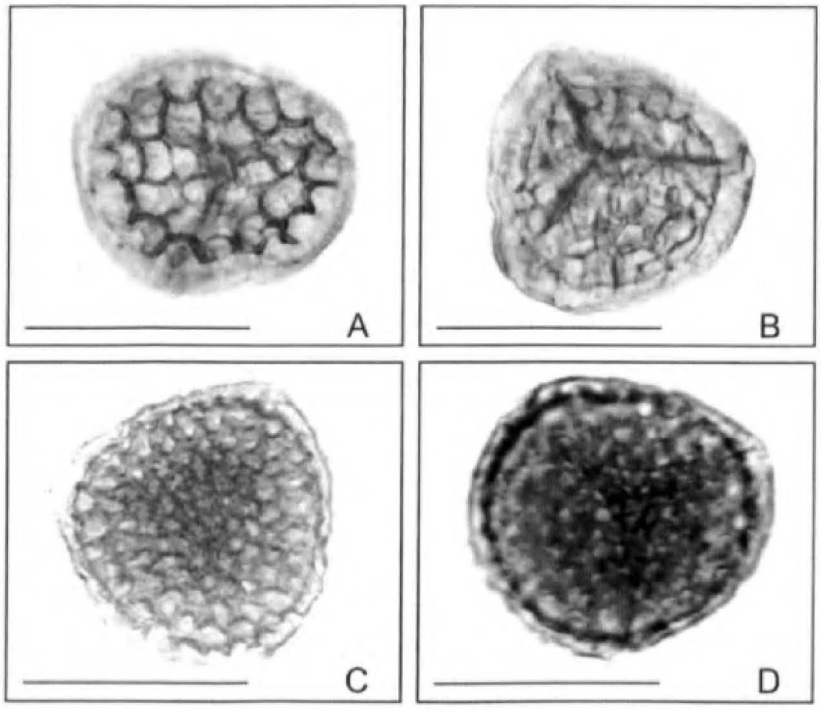
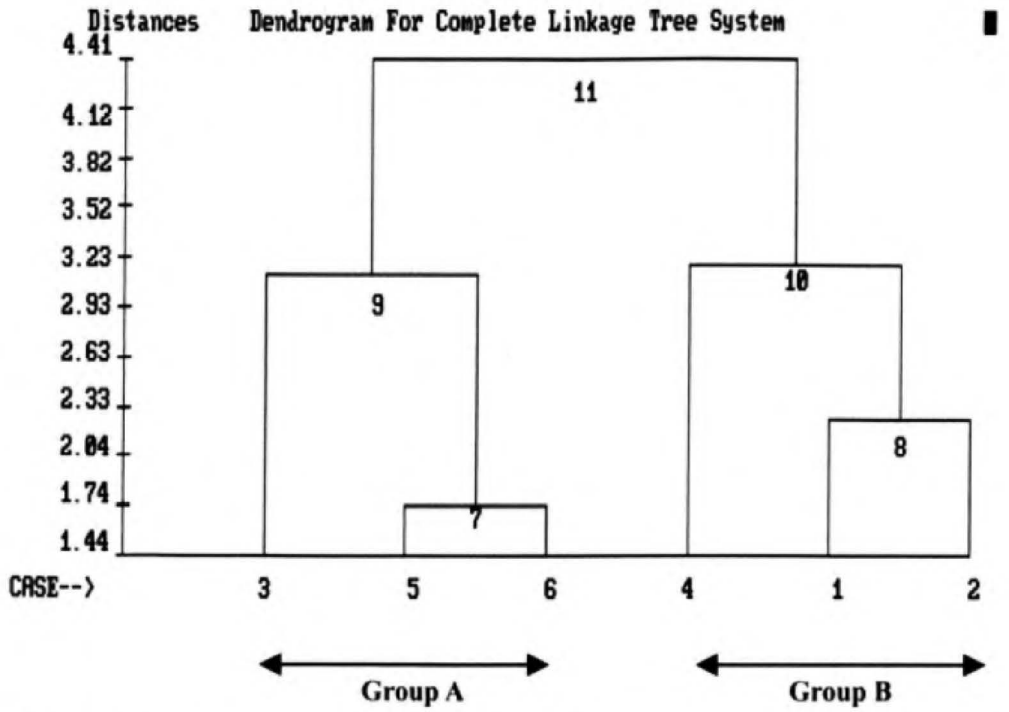


Fig. 4. Spores: **A.** *Riccia huebeneriana* (distal view); **B.** The same (proximal view); **C.** *R. plana* (distal view); **D.** The same (proximal view). (Scale bars = 50 μm).



1 = *R. billardieri*, 2 = *R. crispatula*, 3 = *R. cruciata*,
4 = *R. gangetica*, 5 = *R. huebeneriana*, 6 = *R. plana*.

Fig. 5. Dendrogram showing relationship between species of *Riccia*.

Table 1. Distribution of character states

Character	Genotype 1	Genotype 2	Genotype 3	Genotype 4	Genotype 5	Genotype 6
Sexualty of plants Mon=l, Dio=2	1	2	1	1	1	1
Thallus arrangment Rosette = 1, Semi-ros. = 2, Caes.=3	3	3	1	2	2	2
BranchingDichotomous=1	1	1	1	1	1	1
Branching nature 1-3 Furcate =1, 3-4 Furcate =2	1	1	1	1	2	2
Shape Obl. Obv.=l, Lin.- Ribb.=2, Obv. =3	1	1	3	1	2	2
Spongy nature, present=1, absent=2	2	2	1	2	1	1
Length 6-8 = 1,8-10=2, 10-12=3, 12-15=4 Breadth 1mm =1, 2-3 mm=2,	3	4	1	2	2	2
5-6 mm=3.	2	2	3	2	1	1
Outgrowth, Absent=1, present=2 Apical notch distinct=1,	2	1	1	1	1	1
indistinct =2	1	1	2	1	1	1
Sulcus Only at apex =1Up to base =2	1	2	1	2	1	1
Margin Entire =1 entire-undulate=2, Undulate=3	3	2	2	2	1	1
Scales prominent=1, not prominent=2	1	1	2	1	2	2
Photosynthetic zone compact=1, air chambered=2	1	1	2	1	2	2
Epidermal cells, globose=1, Globose–subglob.=2	1	1	1	1	1	2
Capsule No. 2-3=1,3-5=2, 5-8=3	1	2	1	3	2	2
Arrangement of capsule (no of row) l=l,>1-2=2	2	2	2	2	1	1
Capsule colourGold br=1, dark br=2, black=3	1	2	2	2	2	3
Shape of capsuleGlobose=1,	1	1	1	1	1	1
DehiscenceIrregular=1	1	1	1	1	1	1
Spore No. 01-100=1, 101-200=2, 201-300=3,> 1000=4	2	3	4	3	3	1
Capsule wallUnistratose=1	1	1	1	1	1	1
Spore polarity Isopol= 1 anisopol=2	1	1	2	2	2	2
Spore shape Glob=l,glo-subglob=2, glob-trian=3, subglob-trian=4	2	2	3	2	4	4
Spore pol axis 55-75 μm= 1,76-95μm=2, > 95=3	3	2	1	2	1	2

Character	Genotype 1	Genotype 2	Genotype 3	Genotype 4	Genotype 5	Genotype 6
Spore equ dist 55-70μm=l, 71-85μm=2, >85μm=3	3	2	1	3	1	2
No. reticulations 4-6=1,7-10=2, >10=3	2	1	1	2	1	3
Pore in spore present=1, absent=2	2	2	2	2	2	1
HeterobrochateType=1	1	1	1	1	1	1
Triradiate mark Distinct= 1 indistinct=2	2	2	1	1	1	1
Spore wingEntire =1slightly undulate=2, attenuated=3	3	3	2	2	1	2
Wing width 4-7μm= 1,7.1 -10.5μm=2	2	1	2	2	2	2

Table 2. Pairing affinity values between six species of *Riccia* based on histo-morphology similarity matrix, for six species of *Riccia*

	1	2	3	4	5	6
1.	1.00					
2.	0.62	1.00				
3.	0.44	0.44	1.00			
4.	0.53	0.59	0.50	1.00		
5.	0.37	0.47	0.62	0.53	1.00	
6.	0.28	0.31	0.50	0.47	0.75	1.00

1= *Riccia billardieri*, 2 = *R. crispatula*, 3 = *R. cruciata*, 4 = *R. gangetica*, 5 = *R. huebeneriana*, 6 = *R. plana*

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पश्चिम बंगाल की *रिक्सिया*

ए.के. बाग[1], एस.के. सिंह[2] एवं एस.जी. भट्टाचार्य

[1]बोस संस्थान, वनस्पति विज्ञान विभाग, 93/1 ए.पी.सी. रोड़, कोलकाता-700 009

[2]भारतीय वनस्पति सर्वेक्षण, केन्द्रिय राष्ट्रीय पादपालय, हावड़ा-711 103

सार संक्षेप

पश्चिम बंगाल से रिक्सिया कुल की 6 जातियों की आन्तरिक एवं बाह्य आकारिकी का गहन अध्ययन किया गया है। इनमें से रिक्सिया प्लाना गांगेय क्षेत्र से तथा रि. कृसपैटुला एवं रि. क्रूसियटा पश्चिम बंगाल से पहली बार अभिलिखित है। इसके साथ साथ जातियों के बीच पारस्परिक संबंध का अध्ययन कम्पूटेड डेंड्रोग्राम के आधार पर किया गया है।