STUDIES ON THE GENUS *RICCIA* OF BANGLADESH

GIFT

A thesis submitted for the degree of

DOCTOR OF PHILOSOPHY

in the Department

of

BOTANY

UNIVERSITY OF DHAKA

382410

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বিশ্ববিদ্যালয়
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by

MD. KAMRUZZAMAN

M. Sc. (Dhaka)

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DECLARATION

I hereby declare that this thesis entitled "Studies on the genus *Riccia* of Bangladesh" has been composed by myself and all the works presented herein are my own. I further declare that this work has not been submitted anywhere for any academic degree.

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April, 1995 (Md. Kamruzzaman)

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CERTIFICATE

This is to certify that this thesis contains the results of research on "Studies on the genus *Riccia* of Bangladesh" and has been carried out by Md. Kamruzzaman under my supervision. It is further certified that the work presented here is original and suitable for submission as a Ph.D. thesis.

April, 1995

382419

(Dr. Syed Hadiuzzaman)
Professor and Chairman
Department of Botany
University of Dhaka

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ABSTRACT

The present study under the title "Studies on the genus *Riccia* of Bangladesh" includes a taxonomic study of *Riccia* flora of Bangladesh to explore the floral position, which was almost virgin in this field of research. *Riccia* specimens were collected form all over the country by the author and his associates. All these gave 1550 specimens for the present study, of which a total number of 45 species have been described and illustrated. Taxonomic description with camera-lucida drawings, SEM of spores, distributional pattern, maps, ecological notes, distinguishing features and key for the species have been provided. Out of the total 45 taxa studied, 3 taxa have been reported for the first time from Bangladesh and 36 as new to science. The species have been described under three subgenera including subgenus I-*Euriccia*, II-*Ricciella* and III-*Ricciomamillosa*, of which *Ricciomamillosa* has been put forwarded as a new subgenus for the genus *Riccia*. The species under this subgenus are remarkably different from all other species of the genus, and having outstanding spiny spores cemented together in the tetrads in different plans. Under subgenus *Euriccia* 29 taxa including 24 as new to science, under *Ricciella* 12 species including 8 as new to science and under *Ricciomamillosa* 4 species including 2 as new to science have been putforwarded. Both thallus and spore characters have been considered in distinguishing the taxa. The latin diagnosis also have been provided for the new taxa.

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INTRODUCTION

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INTRODUCTION

This research scheme was undertaken to give a clear floristic idea of the genus *Riccia* available in Bangladesh. During British period extensive works on the exploration of bryophytes were done by many bryologist like Mitten (1861), Kashyap (1914-1932) etc. and most of them were engaged in the western part of India. The information about such works from the eastern part of India was very scanty. After the independence of India in 1947 the eastern part in Bengal (now Bangladesh) fall under East Pakistan and no information about bryological research was available here till 1955 and as such Bangladesh remained virtually almost virgin in this field of research so long.

It is worthy to mention that, S. A. Khan (1955, 1957), Hadiuzzaman and Chakraborty (1980) worked here on Liverworts. Khan (1955, 1957) reported eight species of *Riccia* including seven from Dhaka and *R. fluitans* from Sylhet only, of which three species were new to science and the rest five were reported for the first time from this part of the subcontinent.

The works of Hadiuzzaman and Chakraborty (1980) mainly enlightened the flora under Marchantiales excepting Riccia) of Bangladesh.

The genus *Riccia* is cosmopolitan and worldwide in distribution and is very much well known in tropical, subtropical and temperate regions. There are reports of more than 200 species of *Riccia* in the world of which 138 species were recorded in the "Species Hepaticarum" by Stephani (1889-1900, 1917-1924). In his work in the volume I, Stephani has given the Latin diagnosis and geographical distribution of 129 species of *Riccia*. Nine more species of *Riccia* were described by him in Volume VI. About more 100 species were described subsequently by different authors.

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Stephani evolved a new system of classification based entirely on vegetative characters. He devided the then known species into 13 small groups on the basis of thallus characters. These characters are variable due to ecological conditions and as such appeared less effective as the basis of a natural system of classification.

According to Duthie and Garside (1936) a natural classification of *Riccia* can be attempted only after the details of life history and structure of large number of species of different parts of the world have been worked out.

As stated earlier that the genus *Riccia* comprises over 200 species, much confusion persists with respect to the taxonomic limits of some of these.

In the study of *Riccia*, characters of thallus, spores, and chromosomes are generally taken into consideration. Most of the vegetative characters have been proved to be extremely plastic and unreliable. Because vegetative characters in general appear to show considerable variations even within the species due to influence of environment, though previously, the treatment of the genus to divide into species was mainly based on unstable vegetative characters.

The vegetative characters may be tremendously helpful if they are carefully studied under laboratory, growing in identical conditions or carefully observing the data taken from the comparative study on the plants growing on different habitats or in different geographical localities.

However early workers gave undue importance to the vegetative characters like length, breadth, and thickness of the thallus in differentiating one "group" of plant with their allied "groups".

Pande (1924) and Abeywickrama (1945) have examined the effect of light and moisture on colour, width and thickness of thallus and concluded that environment plays an important role in the expression of those characters.

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All the *Riccia* species except aquatic *Riccia fluitans* L. are terrestrial plant, usually growing on damp soil, bricks, and rock crevices. Some species are draught tolerent to some extent and can grow in exposed habitats.

In last 100 years much informations have been gathered in connection with the distribution, structure, cytology, life history and taxonomy of Ricciaceae, refering to the European, North and South American and Indian sub-continental representatives.

Taylor (1846) and Stephani (1898-1900, 1917-1924), did outstanding works on the genus *Riccia* of Australia. Later on Na-Thalang (1980) made a comprehensive revision on this genus of Australia.

Among other pioneer and outstanding works in this Indo-Pak Bangladesh sub-continent on *Riccia*, the works of Mitten (1861), Kashyap (1914, 1915, 1916, 1929, 1932), Pande (1924, 1933, 1957, 1958, 1959), Srinivasan (1940), Ahmad (1942), Abeywickrama (1945), Khan (1955, 1957), Udar (1956, 1959, 1960), Udar et. al. (1957, 1959), Kachroo (1954, 1959, Bapna (1958, 1961, 1962), Srivastava (1964), Chopra (1938, 1943) and Chopra et. al. (1984) are respectfully cited. Although only a few species have critically been studied by them, the informations have been of much value to the present study.

Riccia species were described as species having solid thallus and with large airchambers by Schemidel (1793-1797). Braun (1821) defined *Riccia* as *"Capsula frondi immersa stylo emergente fugaci coronata" and Ricciella as "Capsula in inferiori frondis pagina sessilis stylo destituta".*

Stephani (1898-1900), adopted for the first time the characters of thallus (solid or with large air chambers) to institute two sub-divisions : A. *Riccia* with solid thallus and B. *Ricciella* with chambered thallus. Most of the bryologists have accepted this division but they used the appellation *Euriccia* in place of *Riccia*.

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The tendency to bring chromosome characters in differentiating species have been attempted currently by different authors including Newton 1975 but its application especially in the context of number appeared less suitable in species level.

Palynologically liverworts are better known than mosses. Among them the order Marchantiales appeared more advance in their spore study data. Most of the spores in *Riccia* are arranged in tetrahedral, while some are in isobilateral and rhomboidal plans. They may be wing bearing or wingless, spiny or spineless.

In the present work spore morphology of the investigated species have been described in detail with regard to colour, symmetry, size, shape, characteristics of the laesura and nature of exine and perine both under the aid of light and scanning electron microscopes. These characters have been found to be reliable in sorting different species.

In fact, in this work both the vegetative and spore characters have been considered carefully in deducing their status. In the identification of the species, special emphasis has been given on spore characters since these are less plastic than that of vegetative ones. Characters like spore colour, shape, size, sculpturing on wall, presence or absence of wing, and pore were taken into consideration. These characters are stable and are reliable at species level regardless to habitats.

Among the earlier workers, spores of different species have been studied by Macvicar (1926), Schuster (1953, 1963, 1966), Muller (1951-57), Udar (1956, 1957, 1958), Pande and Udar (1957), Pande (1957, 1958, 1959) and Arnell (1963). According to Udar (1957), *R. gollani, R. bulbifera, R. crispatula and R. microspora* intergrade in their vegetative characters in such a way that the definite identification of the specimens could be ensured with the spores.

Accordingly, Pande and Udar (1957), reported on the basis of spores that:

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1. *R. gollani* is the synonym of *R. discolor*
2. *R. bulbifera* is the synonym of *R. billardieri*
3. *R. cryspatula* is a genuine name
4. *R. miscrospora* is the synonym of *R. frostii*

Steinkamp and Doyle (1979) studied the sculpturing of spore surface of *R. californica, R. trichocarpa, R. campbelliana* and *R. sorocarpa* with the help of Scanning Electron Microscope for the identification of these species.

The works on germination of *Riccia* spore were conducted by many bryologists. Among them Fellner (1875) worked on *R. glauca* spore, Campbell (1918) and Udar (1957a) on *R. trichocarpa*, Pande (1924) on *R. sanguinea*, Duthie and Garside (1936) on *R. plana, R. cupilifera, R. compacta and R. rautanii*, Srinivasan (1940a) on *R. crystallina* and *R. billardieri*.

According to them the germ tube emerges through the pore formed opposite to the tri-radiate mark except in the case of *R. trichocarpa*. In *R. trichocarpa* the germ tube emerges through the triradiate mark. According to Campbell (1918) the formation of the first rhizoid is delayed here which is separated by a septum from the germ tube.

Udar (1958a) reported that the development pattern of sporeling in *R. trichocarpa* do not exhibit the difference as ascribed to it by Campbell (1918).

In fine, in deducing a frame work on *Riccia* classification, careful study of vegetative, sex and spore characters, and other ecological perspectives should be taken into active consideration.

Of the items, consideration on vegetative characters which are less plastic or not at all plastic in nature viz. presence of cilia, smoothness and woolyness, colour wheather green, bottle green, bluish, greyish, yellowish-green etc.; assimillatory cells, scales, etc.; reproductive characters viz. uni or bisexuality of plants, sporangial position

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whether dorsal, ventral or pendulous, arrangement of spores in tetrad and its adherences, colour, wall sculpturing, presence or absence of spine, wing, perforations and triradiate markings have been taken under consideration.

Besides, information on closely related species along with their ecological and seasonal variations or in appearing and flourishing etc. also have been stated here. Although it was stated by earlier workers like Newton (1975) that chromosome count has less importance in differentiating species, yet detail ultramicroscopical investigations on chromosomal configuration may be helpful in this context. Considering the need of the country for exploring its flora in this field, this floristic work was done in assessing the species position of *Riccia* genus.

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BANGALDESH

(A Brief Introduction)

Location and Extent:

Bangladesh occupies an area of 1,43,900 square kilometers (55,549 sq. miles), has a unique tropical location between 20°35" to 26°75" North Latitude and 80°03" to 90°42" East Longitude with the Indian Ocean to the south through Bay of Bengal, the Himalayas to the north. A vast tract of land between the southern Himalayas and central India slopes down towards Bangladesh. The Ganges, the Meghna and the Brahmaputra govern the river system.

The country is bounded on the west, north and east by India and extreme south east by Burma. The Bay of Bengal lies to the south. About six percent of the land is covered by the permanent streams and estuaries. Bangladesh is a part of the largest delta in the world.

Climate:

The climate of Bangladesh is typical of the monsoon climate of Asia. It is characterized by high temperatures, heavy rainfall, often excessive humidity and fairly marked seasonal variations. Although more than half the area is north of the tropics, yet an effect of the Himalayan mountain chain has to make the climate tropical over most part of the country.

Bangladesh recieves 80 to 90 percent of its mean annual rainfall of 2,320mm during the five-month monsoon from May to September. The intermonsoon period, October to May has three seasons. The post-monsoon transition season October-November, is warm and humid with unstable atmospheric conditions which induce local thunder storms and cyclones from Bay of Bengal. The cool dry season, December - March is sunny with infrequent, scattered rainfall that seldom exceeds five percent of the annual total. The pre-monsoon season, April-May, is very hot and is characterized by thunder storm and squalls, called Nor-westers, with heavy localized rainfall and

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hail. Severe cyclones in the Bay of Bengal may affect the coastal area during the pre and post monsoon transition seasons.

Temperatures of Bangladesh ranges from less than 5^0C to more than 43^0C. The peak in the April-May but exceed 43^0C only in the western parts of the northwest region. Extreme minimum temperatures in January-February reach 1.7^0C Srimongal, Sylhet and 3.9^0C Rangpur and Faridpur but remain around 5^0C elsewhere. The thermal inertia of the Bay of Bengal maintains minimum temperatures about 7^0C in the coastal belt and the lower Meghna area.

Cylconic depressions form ± regularly in the Bay of Bengal, but storm tracks and frequency vary considerably throughout the year. Periods of peak activity are in May and September-November, and storm transactories during those periods vary from northeast.

However, during dry seasons water deficiency becomes acute in some parts of Bangladesh. Rainfall, river, and underground water are main sources of water here. The rainfall in Bangladesh originates from three sources: the western depressions of winter which account for about five percent of the total, the early summer thunder storms which account for about 15 percent of the total and the summer monsoons which account for about 80 percent.

The amount of rainfall in water availability has appeared as direct effective factor on the growth and development of *Riccia* Plant.

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Soil of Bangladesh

Most of the species of *Riccia* plants are inhabitant of soil. Soil along with water, air and sunlight are main essential factors which play significant role for successful growth and development of *Riccia*.

Except *R. fluitans* L. all other known species of *Riccia* grow on soil and allied substrates and it is essential to know the soil in regards to its physical chemical and other properties. Because, soil along with its other environmental influences have significant effect on the growth and development of the most of different species of *Riccia*.

The soil of Bangladesh has been described on the following heads: (a) soil formation, (b) climate, (c) biotic activities, (d) relief, (e) parent materials and (f) soil types.

a. Soil formation:

Soil is the largest available medium for plant growth on the earth surface. In Bangladesh, soil is the major natural resources to support agricultural crop alongwith other valuable flora including *Riccia*.

The capability of soil to support plant growth depends upon its physical and chemical properties along with its environments soil properties are the products of soil forming process and the environment is also the product of climate, topography and biosphere for which it is important to know about the process of soil formation. The soil genesis of Bangladesh can be explained as below:

According to Soil Resources and Development Institute (SRDI) of the country, a greater variety of soil occur in Bangladesh. The individual soil differ from one another in important morphological, physical and chemical properties due to the

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influencing factors like climate, biotic activity, relief and parent materials and the length of time through which these factors have been working together.

b. **Climate**:

It is the most important factor affecting soil formation through the actions of heat, moisture and air. Here both the physical and chemical weathering has got its tremendous effect. In Bangladesh the high temperatures, the high rain fall, the alternating wet and dry conditions between the monsoon and season provide highly favourable conditions for chemicals weathering. The effect of vegetation along with land level, differences in microclimate is also important in soil formation.

c. **Biotic activities**:

These activities, through the agencies of plants, insects, animals and man affect soil formation in various ways. Microbiol decomposition also setup various chemical changes of soil.

Through well management, the soil qualities can be improved and by faulty management practices man may cause extreme acidity, salinity, alkalinity or water logging in soils.

d. **Relief**:

It is important in soil formation as it affects the drainage. Due to flooding, biotic activities as well as both physical and chemical changes in soil depends. Bangladesh has been divided into three major physiographic units: the Northern and Eastern hill areas, the Madhupur and Barind Tracts and Flood Plane areas. Rain water cannot stand or accumulate on very steep to slopping lands of hill. Hill soils have got well to excessive drainage scope. The terrace edges with permeable clays have good

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external drainage. In Barind tract external drainage usually restricted and in some valleys seasonal water logging leads to hydromorphic soil formation.

In flood plain areas, with alluvial plains, river flood plains and tidal and estuarine flood plains and large extensive basin areas, usually having series of low ridges and basins. The ridges are usually intermittently or seasonally and shallowly flooded, while the basins are more deeply flooded for longer time and have accumulation of peat materials.

e. **Parent materials**:

In Bangladesh, parent materials are derived from various sources. In hills, it is derived from the broken or decomposed rocks of tertiary origin. Soil formed in high hill are usually shallow and richer in bases than the deep soils of low hills. Barind and Madhupur Tracts are underlain by a clay deposits, fairly homogeneous in mechanical composition. Here the clay has undergone a variable degree of weathering. The deeply weathered clay, grayer and imperviousness give rise to deep permeable and shallow imperviousness respectively. In flood plain area, Ganges sediments are calcarious, while the other deposits are relatively coarse textured on ridges and fine textured in basins. Most flood plains deposites are rich in weatherable minerals. Clay minerals are mainly of ill ties, except in the Ganges sediments. On the Brahmaputra-Jamuna flood plains important differences are detectable between soils less than 10-30 years and those upto 200 years old; between the later and those upto 2000 years or more old and also between the oldest flood plain soils and some old soils of Madhupur and Barind tracts that apperently have developed through many thousands of years. Most soils in Bangladesh, except a few developed in older parent materials of level terrace area and slopping or flat-topped low hills, are young in respect of soil formation. These are alluvial deposits of various floodplains. In floodplains areas the noncalcareous alluvium of young charland that seasonally emerges out of water is gradually ripened and quickly mottled in the upper part with gray to pale-brown soil mass colour. A seasonally flooded old flood plain normally

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has a fairly developed profile. On the other hand, a mature upland soil with better drainage has a well developed profile comprising strong weather soil materials. Soil forming process may be delineated in their simpleset like physical, chemical, bio-chemical and physi cochemical ways. Soil formation occures here under distinctly two conditions (1) Seasonally flooded or wet conditions as prevalent on most parts of the flood plain areas and (2) Non-flooded or intermittently wet or moist conditions as occur on the upland area of terraces and hills.

f. **Soil type**:

The soils of Bangladesh are developed under three physiographic positions viz. Northern and Eastern Hills (12%), Madhupur and Barind Tracts (8%) and Flood plain areas (80%). Depending on the differences in overall lithology, Hill area include two kinds of topography. They are low hills area formed of soft sand stones and shales mainly including steep to rounded topped low hills (15-100m above sea level). High hills ranges formed of harder rocks, mainly comprising shales, siltstones and sandstones. They form a relatively higher, very steeply dissected rugged tophography (100-1000m above MSL). Madhupur and Barind are consists of late tertiary and pleistocene tidal or marine alluvium. This clay varies in weathering conditions from little altered, grey compact and impervious clay to deeply weathered strongly mottled red, brown and grey, friable and pervious clay. These tracts include various kinds of tophography. The flood plain areas, the most extensive and important physiographic division of the country are formed by alluvial deposits of recent geological origin. They may be subdivided, on the basis of source and mode of deposition of their component sediment. Brammer (1971) made a simplified classification of the soil of the country on the basis of the reconnaissance soil survey. He recognized seventeen general soil types. These are Brown Hills Soil, Grey piedmont Soil, Acidic Basin Soil, Shallow Red-Brown Terrace Soil, Deep Red-Brown Terrace Soil, Grey Terrace Soil, Black Terai Soil, Noncalcareous Alluvium, Non-calcareous Brown Flood plain Soil, Grey Flood plain Soil, Calcerious alluvium, Calcaraous Brown Flood plain and Dark gray flood plain Soil Saline Phase, Peat and Acid Sulphate Soil.

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1. **Brown Hills Soils**: These soils occupy most of the northern and eastern, hills, and with gentle to very steep slopes, developed weathered, sands stones, silt stones and shales. The soil is acidic in reaction, well drained, usually have uniform brown colour sandy loam to loam,strongly acidic. pH 4.1-4.5.

2. **Grey Piedmont Soils**: These soils comprise seasonally intermittently to shallowly flooded soils developed in alluvial outwash materials at the foot of northern and eastern hills. They occur on the alluvial fans and also on the piedmont basins near the hills. Texture-mainly loams to clay loams. Reaction - medium to strongly acidic with imperfect to poor drainage conditions. pH 4.8-5.2.

Color: Ranges from olive-gray to grey with yellowish brown and dark brown mottles.

3. **Acid Basin Clays**: These soils include deeply seasonally flooded heavy clays. Occuring in the haor areas of Sylhet and Mymensingh districts, the Comilla basin, broad valleys within the Madhupur and Barind tracts and some basins in Rajshahi, Pabna and Southern part of Dhaka districts. These soils also cover about 8 percent area of Bangladesh.

Texture: Usually heavy clay but silty clay to clay in some other soils.

Reaction: Strongly acidic. pH: 4.5-5.6.

Colour: Grey to very dark grey with strong brown iron staining.

4. **Shallow Red-Brown Terrace Soils**: These soils are found to occur on the narrow terraces of the Madhupur tract. They are imperfectly to moderately well drained soils.

Texture: Usually loamy.

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Reaction: Strongly acidic. pH: 4.7 to 4.9.

Colour: Yellowish brown to strong brown often with dark brown and reddish yellow mottles.

5. **Deep Red-Brown Terrace Soils**: These soils are found to occur in the deeply weathered Madhupur clay and Dupi Tila deposits and extensively occur on better drained parts of Madhupur tract, Akhaura terrace areas, Lalmai Hills and lower parts of northern and eastern hills. Moderately well drained.

Colour: Red to brown, or brown to light yellowish-brown.

Texture: Clay loam to clay.

Reactions: Strongly acidic. pH: 5.1 to 5.6.

6. **Brown Mottled Terrace Soils**: These soils lie in between Deep Red-Brown Terrace Soils and Grey Terrace Soils of Madhupur and Barind Tracts. Poorly to imperfectly drained. Pale Brown to Grayish Brown in colour.

Texture: Loam to silt loam.

Reaction: Very strongly acidic. pH: 4.1-5.5.

7. **Grey Terrace Soils**: These are seasonally water logged soils of Barind and Madhupur Tracts and also of old piedmont deposits in the north of Jamalpur and Mymensingh districts. They are poorly or imperfectly drained. Colour of the soils varies from grey to pale brown with grey and yellowish brown mottle.

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Texture: Silt loam to silty clay loam. pH: 5.7-6.0.

8. **Black Terai Soils**. These are found to occur in mainly water logged of shallowly flooded and developed in sandy old Himalayan piedmont plain deposits and extensively occur in northern part of Dinajpur district. Very dark brown to black in colour with grey mottles. Texture varies from sandy loam to sandy clay loam,acidic. pH: 5.0-5.9.

9. **Non-calcarcous Alluvium**: These comprise recent deposite of active flood plain of Tista, Brahmaputra, Jamuna, Middle Meghna. Soil color is grey or olive-grey when dry and little darker when wet. Slightly acidic. pH: 6.1-6.5.

10. **Noncalcarious Brown Flood plain soils**: These are found in Himalayan piedmont and Tista flood plain deposits. They also occur locally in the old Brahmaputra flood plain and sandy piedmont deposits at the foot of northern and eastern hills. They include imperfectly to moderately well drained, greyish to dark brown soils. They are usually loamy, sandy loam or sand clay loam. These soils are acidic in reaction. pH: 5.3-5.9.

11. **The grey floodplain soils**: This type comprises intermittently to seasonally flooded soils developed in flood plains. They occupy mainly both the ridges and basins of most part of the Tista, Jamuna, Eastern Surma-Kushiara middle Meghna, Ganges, and Chittagong Coastal and Matamuhuri tidal floodplains and eastern minor river floodplain as well as important parts of old Brahmaputra and old Meghna esturine floodplain. Well drained. Grey or redish-brown when dry and darker when wet. The texture usually ranges from silt loam to silty clay loam on ridges and silty clay loam to silty in basin. The soils are neutral to alkaline in reaction and medium acidic soil are found in eastern Surma-Kushiara floodplains. pH: 5.4-5.6.

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12. **The non-calcareous Dark Grey Floodplain soils**: This type is found to occur widely in the old Brahmaputra, Old Meghna esturine and Ganges tidal floodplains and locally in Ganges river, Tista floodplains and old Himalayan piedmont plains. The soil is grey to dark in colour with brown to olive brown mottles. The substratum is usually near neutral to moderately alkaline. pH: 5.2-6.8.

13. **Calcareous alluvium**: This type of soil comprises recent deposits of active flood plains of the ganges and Meghna estuary They are seasonally flooded in Meghna River deposit but subject to tidal flooding in Meghna esturine deposite. These slightly to moderately calcareous deposits are olive grey to olive brown or grey in colour. General texture is sandy loam to silt loam and reaction is towards alkaline to neutral. pH: 8.0-8.4.

14. **Calcareous Brown flood plain soils**: These are seen to occur in the districts of Kushtia, Jessore, Faridpur and part of Rajshahi, Pabna, Khulna, Dhaka, Barisal and Noakhali. The calcareous soil is olive grey to dark greyish brown. The soil texture is loam to silty caly, moderately alkaline in nature. pH: 7.5 to 7.9.

15-A. **Calcareous Dark Grey Floodplains Soils**: These are intermittent to seasonally flooded. They occur in both ridges and basins of the Ganges river floodplains and also locally occur in the Ganges tidal old Meghna estuary floodplain. Greyish brown to dark grey in colour and silty clay to clay in texture. pH: 7.1-7.7.

15-B. **Dark grey floodplain soils (Saline phases)**: These are found to occur in Khulna, outside the embankment. Olive grey to grey in colour, clay, silty clay or loam. pH: 6.7-7.1.

16. **Peat and Muck Soils**: These are mainly found in Faridpur and Khulna basin area and also in Sylhet. The peat is derived from partly decomposed weeds and grasses. They are seasonally deeply flooded and usually remain wet all the dry season. Dark-grey to redish brown in colour. pH: 5.2-6.2.

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17. **Acid Sulphate Soils** occupy small areas of Ganges and Matamuhuri tidal floodplains. Particularly in the Khulna and Chakaria in Sundarbans they are mainly flooded by saline tidal water and also locally by the runoff from the adjoining hilly area. Soils are grey or dark grey, unripened silty or clayey mud and saline. Acidic in reaction. pH: 3.4-4.6.

Forest floors of Bangladesh is also rich in *Riccia* flora during the months of May to December. However in other months they appear only in damp shady places especially on the edges of hills, slopes, cannals (Chhara) in small scale. This is controlled by the availability of water i.e. suitable micro climatic conditions where-ever prevail are seen to help in flourishing *Riccia* along with other Bryoflora.

Here the following factors were found to be responsible for regulating the forest microclimatic conditions and as such for the growth of *Riccia* and the dispersal of its spore; (a) Air temperature due to solar radiation, (b) wind velocity, (c) humidity, (d) soil temperature.

Forest part with low solar radiation moderate air temperature, sufficient humidity and comparatively less soil make the microclimatic condition suitable for the growth and development of *Riccia* plants along with other allied plant species. In this context the the forest edges were found suitable for growing winter and early summer species, but during rainy season the direct solar radiation and the other factors become less important in growth and distribution of *Riccia* in forest floor.

Vegetation:

Soil, temperature and rainfall has got a great impact over the growth, development of vegetation of an area. Accordingly in Bangladesh there are different types of natural vegetations, viz. grass land, deciduous, mixed-evergreen. The gangetic plain is fertile and constitute the major area of the country and very much suitable for cultivation of jute and rice. The major forests are Sundarbans, Chittagong and

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Madhupur. The Sundarbans is a mangrove forest, the Chittagong forest includes evergreen, mixed evergreen and deciduous plants. The Madhupur forest is a deciduous forest. Besides minor forests are Sylhet and Dinajpur forests.

In addition hydrophytes of planktonic and attached form are abundantly available in rivers, lake, beels, jheels, haor, ponds and ditches. In islands different types of plants are also found as per its environmental suitability.

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ADMINISTRATIVE DIVISIONS OF BANGLADESH

Dhaka Division	Dist. Code
Dhaka	1
Gazipur	2
Narsingdi	3
Narayanganj	4
Manikganj	5
Munshiganj	6
Faridpur	7
Rajbari	8
Gopalganj	9
Madaripur	10
Shariatpur	11
Mymensingh	12
Netrokona	13
Kishoreganj	14
Tangail	15
Jamalpur	16
Sherpur	17

Chittagong Division	Dist. Code
Chittagong	18
Cox's Bazar	19
Rangamati	20
Bandarban	21
Khagrachhari	22
Noakhali	23
Lakshmipur	24
Feni	25
Comilla	26
Chandpur	27
Brahmanbaria	28
Sylhet	29
Sunamganj	30
Maulvi Bazar	31
Habiganj	32

Rajshahi Division	Dist. Code
Rajshahi	33
Nawabganj	34
Natore	35
Naogaon	36
Dinajpur	37
Panchagarh	38
Thakurgaon	39
Pabna	40
Sirajganj	41
Bogra	42
Jaipurhat	43
Rangpur	44
Gaibanda	45
Lalmonirhat	46
Nilphamari	47
Kurigram	48

Khulna Division	Dist. Code
Khulna	49
Satkhira	50
Bagerhat	51
Jessore	52
Jhenaidah	53
Kushtia	54
Chuadanga	55
Meherpur	56
Narail	57
Magura	58
Barisal	59
Patuakhali	60
Jhalakati	61
Pirojpur	62
Bhola	63
Barguna	64

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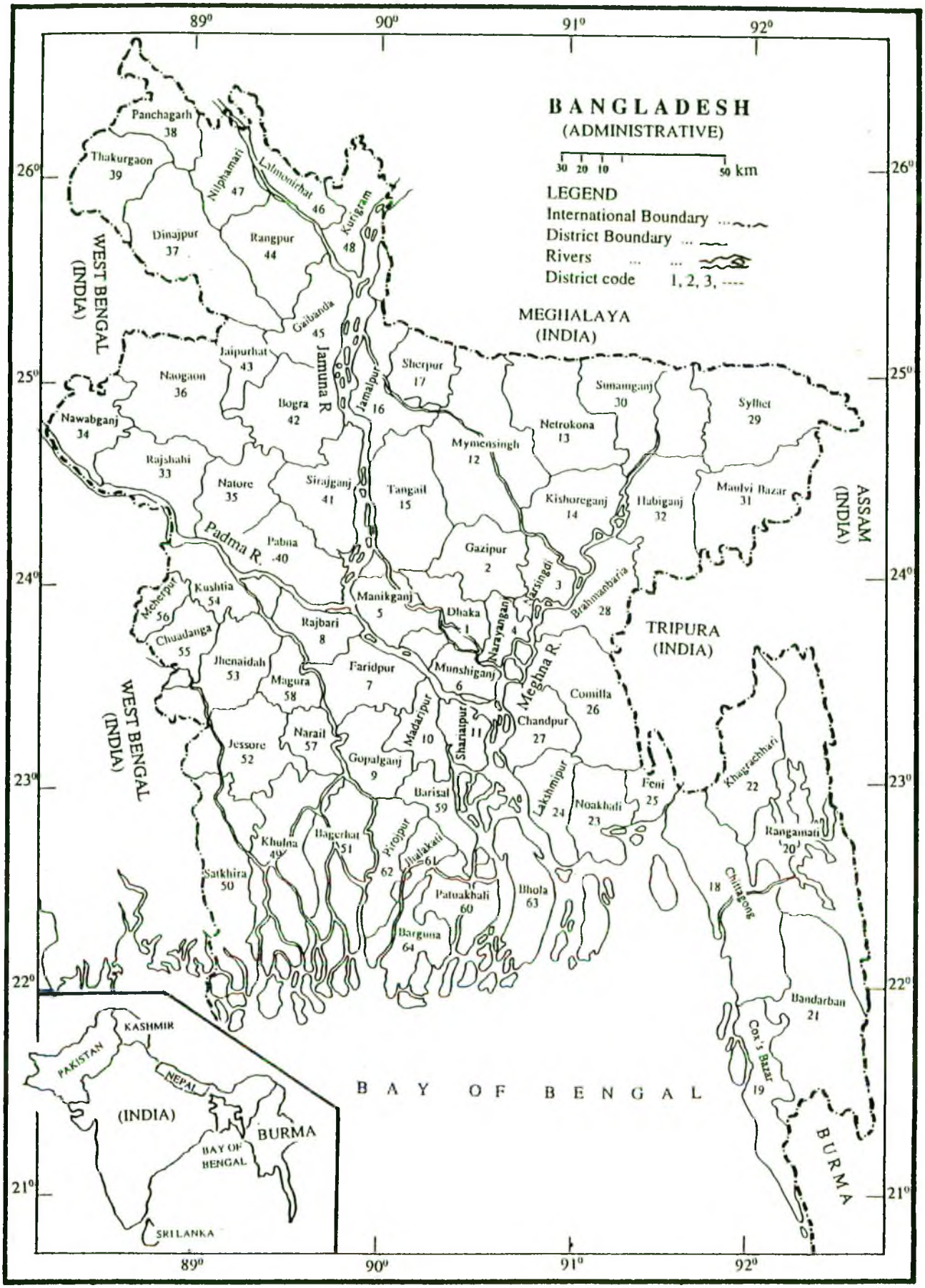

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LITERATURE REVIEW

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LITERATURE REVIEW

The genus *Riccia* (Mich.) L. is a member of bryophyta under the class Hepaticae. This well known liverwort genus belongs to the order Marchantiales and family Ricciaceae.

Ray (1696) mentioned about *Riccia* in his work under lichen for the first time. This was later on identified as *Riccia glauca* L. Many species of *Riccia* were described under generic names as *Lichen, Hepatica* etc. by Dillenius (1719, 1724) and many other workers as was stated by Ray previously.

Micheli (1729) established the genus *Riccia* in his Nova PlantarumGenera in honour of P.F.Ricci an eminent Italian botanist. Depending on the position of the sporangium, Micheli divided the genus into two groups viz. 1. *Ricciae fructoe remis foliorum surgente, et supra eorundem foliorum planum se extollente 2. Ricciae fructu in foliorum substantia contento"*. Plants with sporangia projecting above the thallus were taken in the first group and included two species viz. *Riccia piramidata* Willd. and *Riccia reticulata* Poir. The second group included seven species viz. *Riccia crystallina L., Riccia lamellosa* Raddi, *Riccia tumida* Lindenb, *Riccia minima* Bellard. *Riccia cavernosa* Raddi, *Riccia glauca* L. and *Riccia michelii* Raddi. But the species of the first group were later on raised to the generic rank as *Oximitria* Bisch. and *Corsinia* Berck, respectively.

In the first edition of Genera Plantarum, Linnaeus (1737) accepted Micheli's *Riccia*. Linnaeus (1753) included four species of *Riccia viz. Riccia crystallina L., Riccia minima* Lindenb., *Riccia glauca* L. and *Riccia fluitans* L. in his 'Species Plantarum'. The eighth edition of Linnaeus, Genera Plantarum (1789-1791) included the research results of Hedwig (1784) in the context of modifying the definition of *Riccia*.

Riccia species were discribed as species having solid thallus and species with large air chambers by Schmidel (1793-1797). *Riccia fluitans* was separated from other

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species of the genus by Braun (1821) and placed it under a new genus *Ricciella* on the basis of the position of sporangium and the presence or absence of archegonial neck. He defined *Riccia* as *capsule frondi immersa stylo emergence fugaci coronata* and *Ricciella as capsula in inferiori frondis pagina sessilis stylo destituta.*

Dumortier (1822) divided *Riccia* into two genera viz. *Riccia* and *Tessellina* on the basis of fructification position.

Bischoff (1829) substituted the name *Oximitria* for *Tessellina*. Corda (1829) in his Genera Hepaticarum divided the family Ricciaceae into three genera, viz. *Riccia* Mich, *Ricciella* Braun and a new genus *Riccio-carpus* Corda.

Riccia Mich.was divided into three sections (sub-genera) by Bischoff (1835) viz. section-1. Lichenoides, Section-2. Ricciella and Section-3 Hemiseuma. Section Lichenoides was subgrouped as (a) *Fronde margine glabra* (thallus margin plain) *Riccia sorocarpa* Bisch. and *R. glauca* L. (b) *Fronde margine ciliate* (thallus margine ciliate) *Riccia ciliata* Hoffm.and *R. bischoffii*,.*Riccia fluitans* L. were taken under section 2 *Ricciella* and *R. natans* under section 3 *Hemiseuma*. Lindenburg (1936) divided the family *Ricciaceae* into four genera viz. *Riccia* (Mich) L. *Corsinia* Raddi, *Oximitria* Bisch. and *Sphaerocarpus* Mich. *Ricciella (R. fluitans)* and *Ricciocarpus* Corda *(Riccio-carpus natans)* were not given generic status by him and their sporangium was not well known at that time. Lindenburg did not devide *Riccia* into sub-genera and his key to species is based on ventral scale.

The genus *Riccia* was divided on the basis of air chambers and the mode of spore dehiscence wheather through the ventral or dorsal surface by Nees (1838) in his monograph on the Liverworts of Europe. He accepted the three sections of Bischoff (1835) and also added one more section "Spongides". According to Nees, section-1. Lichenoides included 11 species e.g. *R. glauca* L. Section-2. Spongides - with two species viz. *Riccia crystallina* L. and *Riccia bullosa* Link. Section-3. *Ricciella* with three species e.g. *Riccia fluitans* L., *Riccia nodosa* DeC. Section-4. Hemiseuma- with

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one species only *R. natans* L. Taylor (1846) described 8 new species of *Riccia* from Australia with only superficial descriptions. Mitten (1861) reported *R. ciliata* Hoffm. from Bengal, *R. crystallina* L. from Bengal on the banks of Brahmaputra, *R. discolor* L. et L. from central Himalayas, Nepal, Kumaon and Nilgiris and *R. squamata* Nees from India.

Stephani (1898-1900, 1917-1924) in a sensus of world hepatics reported total 138 *Riccia* species of which 129 in Vol. I and rest 9 species in Vol. VI of "Species Hepaticarum".

Lindberg (1879) divided the *Riccia* genus into two sub-genera viz. A - *Ricciocarpus* (Corda) Lindb. and B-*Euriccia* Lindb. Under this *Euriccia* Lindb., Section (a) Terrestres Lindb. included *R. sorocarpa, R. glauca* etc. Section (b) *Spongides* Nees with *R. crystallina* L. Section (c) *Ricciella* (Brown) Bisch. e.g. *R. canaliculata* var. *b fluitans*. etc. The taxonomic position of some of the species of *Riccia* and other related genera was not clear to them and felt the needs of details and critical study. One of these is *Riccia curtisii* (Austin) James. Austin (1864) regarded it as a form and intermediate between *Riccia* and *Sphaerocarpus* and treated as a new genus *Cryptocarpus*. Lindberg (1874) changed this name to *Thallocarpus*, because *Cryptocarpus* was already known as a genus of Chaenopodiaceae. Trevisan (1877) gave the name *Angiocarpus* to this liverwort.

Schiffner (1909) accepted the genus *Thallocarpus* and kept it along with *Sphaerocarpus*. Mc Allister (1916) studied the plant and treated it as a species of *Riccia*. Proskauer (1961, 1962) stressed the urgent need of taxonomic and nomenclatural revision on *Riccia curtisii*. Douin and Trabut (1919) discovered that *R. perenis* St., a tuber forming species from Algeria has characters common to *Riccia* and *Corsinia* and therefore instituted a new genus *Riccinia* for it.

Duthie and Garside (1936) expressed their doubt about the generic status of *Riccinia* and advised to keep it under *Riccia* untill the life history of it has been fully studied.

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Kashyap (1919) described a new liverwort with character in between *Riccia* and *Corsinia*. He instituted a new genus *Fysinia* for it. Later on Kashyap (1929) found that it was a form of *Riccia fluitans*.

Among the pioneer workers on Australian *Riccia* Taylor, Baily and Stephani are most noted. Taylor (1846) described 8 new species with only superficial descriptions. Carrington and Pearson (1902) recorded 3 *Riccia* species including 2 new species form New South Wales. Stephani (1898-1924) recorded a total of 23 species of *Riccia* from Australia. A further 5 unpublished species appeared in the Icones Hepaticarum and in his letter to Levier, Stephani (1898) described an interesting species having the then uncommonly known characters like spiny spores under the name *R. curtisii*. (Aust.) Steph.

Among the early outstanding workers on the genus in Indian sub-continent Kashyap's work is important. Kashyap (1916) reported *Riccia robusta* Kash., *R. pathankotensis* Kash., *R. cruciata* Kash. and *R. sanguinea* Kash. as the new species from India and stated that the species were found to occur together during winter where *R. cruciata* however is rare. He also reported *R. melanospora* Kash. as another new species in 1929. Kashyap also gave opinion that the genus *Riccia* may be derived from a genus like *Targionia*, in which the vegetative tissues of the thallus has still further increased at the expense of the sex organs as given under the genera *Targionia* and *Cyathodium*. He also reminded that some species of the genus *Riccia* (specially the subgenus *Ricciella*) may have arisen by reduction from the types like *Boschia* and *Corsinia*. The two species generally near to *Riccia* and seem to have arisen along more than one line. According to him this genus therefore, is the last form in a long ascending series. Besides, Kashyap (1929) put forward a key to identify all new species of *Riccia*. In a monograph entitled "Liverworts of the Western Himalayas and the Panjab Plain", Kashyap (1929) reported some new *Riccia* species including *R. malanospora* Kash. in addition to early reported species by him. Kashyap (1932, 1932a) published his elaborate works on liverworts of Western Himalayas and the Panjab Plain.

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Campbell (1918) worked on the germination of spore of *R. trichocarpa*. Pande (1924) critically reviewed the morphology and biology of *R. sanguinea*. Nicholson (1932) reduced *R. robusta* Kash. as the synonym of *R. crystallina* L. and also pointed out the close similarity between *R. sanguinea* Kash. and *R. frostii* Aust. Pande (1933) worked on the morphology of *Riccia robusta* Kash. and showed some variation of original description in plants growing in his collecting places especially in the context of scale and rhizoids. Chopra (1938a,b) reported the distribution of *Riccia* species from same parts of India. Bold (1938) found the presence of chlorophyll in capsule of a good number of liverwort species including *R. natans* Bisch. Evans (1939, 1940) published a list of Hepaticae of Europe and North America. The list included a complete enumeration of all genera of the Hapaticae of the time and is of some significance from the stand point of classification, because the families so far as possible, were arranged in a phyllogenetic sequence. This sequence represents a compromise between Verdoorn (1932) and Buch's *et. al.* (1938) earlier classification except that the Anthocerotales are not separated as a sub-class from the rest of the Hapaticae. In this classification *Ricciaceae* was placed in last position and just before the Anthocerotae. As per Evans (1939) the position of *Riccia* genus in Hepaticae belongs to the family No. 31-*Ricciaceae*. Accordingly he divided the family *Ricciaceae* into three genera viz. *Oxymitra* Biscoff., *Ricciocarpus* Corda and *Riccia* (Mich.) L.

Evans (1939) worked extensively on the classification system of the Hepaticae. He also cited the views of the earlier writers that the Hepaticae arose as a monophyletic group from the green algae and that they gave rise by further differentiation to the Musci, Pteridophytes and other more highly organized groups of terrestrial plants. He also added some assumptions of previous authors as that certain representatives of the present day hepatic flora might be looked upon as the actual ancestors of certain other, more complex representatives under such circumstances the evolutionary progress of the simpler type would have come to an end at a definite stage, where as of the more complex type would have advanced more beyond that stage. He also illustrated the earlier conceptions by a definite examples taking as *Riccia*, the

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sporphytic generation of *Riccia* exhibits the simplest types of structure found in the group, where the spherical form of the sporophyte, the non-differentiation into organs, and the slight cell differentiation exists. It was assured that the sporophyte of higher Marchantiales and of Jungermanniales arose through it.

In the gametophytic generation of the Hepaticae there is nothing quite so simple as sporophyte of *Riccia* but the dorsiventral thalloid structure found in *Sphaerocarpus* and *Pellia* may be selected as exceedingly simple types. Such a genus of *Riccia* was supported to represent an intermediate stage in this evolutionary progression and as such genera as *Pressia* and *Marchantia* are the culmination of the process. According to modern views the mosses, are markedly reduced and simplified, and the process of reduction reaches its culmination in the sporophyte of genus like *Riccia*.

Ahmad (1942) proposed three new species of *Riccia* from India viz. *Riccia gangetica* Ahmad, *Riccia manglorica* Ahmad and *Riccia orientales* Ahmad. According to him the monoecious *R. gangetica* was in association with *R. himalayensis* and *R. melanospora* Kash. with characters like thallus bluish-green, long, dorsal sulcas and prominent ventral scale, antheridia and archegonia uni or biseriate, spore ellipsoid, black, 117-134 μ diameter, margin obscurely dentate and triradiate marking obscure. He reported *Riccia manglorica* was also as a monoecious species, plant light green, thalli overlapping with divergent lobes. Spore winged, dark brown. 80-87 μ in diameter. Wing 3.6-7.3 μ broad, margin crenate, papillae arises from the angles of areolae. His another new species *Riccia orientales* is also monoecious, isolated or crowded, margin with both straight and hooked cilia, spore triangular, triradiate marking conspicuous, spore surface reticulate with inconspicuous papillae.

Chorpa (1943) in his census of Indian Hepatics included 14 species of *Riccia* viz. *R. bulbifera* St., *R. ciliata* Hoff., *R. crispatula* Mitt., *R. cruciata* Kash., *R. crystallina* L., *R. fluitans* L., *R. frostii* Aust., *R. golanii* Lev., *R. himlayensis* St., *R. manglorica* Ahmad., *R. melanospora* Kash., *R. orientales* Ahmad., *R. pathankotensis* Kash. and *R. squamata* Nees. Chorpa (1943) also gave a key for the genera and species.

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Riccia eldeeniae is likely to be confused with *R. hirta* and *R. bifurca* Hoffm. (*R. arvensis* Aust). A tabular comparison of these species was also given by the author. The review works of Steree (1954, 1971) on bryophyte is also important to note.

Khan (1955) described *Riccia perssonii* Khan as a new and interesting species from earstwhile East Pakistan. Here, the species, unlike traditional tetrahedral arrangement of spores, exhibits isobilateral type of spores arrangement, where spiny spores remain permanently attached together in tetrads. Ram Udar (1956) reported *R. sorocarpa* and *R. huebeneriana* as two species of *Riccia*, new to Indian flora. Ram Udar (1957a) also published his work on the synonymy of some Indian species of *Riccia* and was of opinion that *R. himalayensis* is a composite plant embracing two much older species the synonym *R. discolor and R. billardieri.*

Khan (1957) reported seven species from East Pakistan. These were *R. fluitans* L.,*R. sanguinea* Kash. *R. discolor* L., *R. robusta* Kash., *R. melanospora* Kash., *R. perssonii* Khan, *R. arnelii* Khan and *R. bengalensis* Khan.

The first five species were reported for the first time from this area of the sub-continent and the last three were described as new species. Of the new species *R. arnelii* and *R. perssonni* are of interest because of the striking arrangement of the spore - tetrad. The spiny spores remain permanently attached together and each sporangium contains two types of arrangements of the tetrads in *R. arnellii* which include tetrahedral and rhomboidal and only isobilateral is *R. perssoni. Riccia bengalensis* Khan was described as a fairly large and robust thallus having long antheridial papillae, large archegonial neck visible over the thallus surface even by the naked eyes and thus can easily be separated from other species of *Riccia* available in Bangladesh.

Ram Udar (1957) added that *R. robusta* Kash is the synonym of *R. crystallina L.,R. sanguinea* Kash. of *R. frostii* Aust. and *R. manglorica* of *R. plana* Taylor. Udar *et. al.* (1957) published a work on the cytotaxonomic studies in the genus *Riccia* with

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According to him plant thallose with histological differentiation where lower storage, region of parenchymatous cells and upper assimilatory regions of chambers with or without assimilatory filaments, rhizoids both smooth and tuberculate, scale may or may not present, archegonia in linear rows-Marchantiales,Ricciaceae. With his logical differentiation, scale small,plant dichotomous *Riccia*; scales long, serrate, plants like *Lemna, Ricciocorpus*.

Jacobs (1949) reported *Riccia tenella* and *Riccia eldeeniae* as two new species of the genus. he pointed out that *R. tenella* is likely to be confused with *R. nigrella* D.C. or possibly poorly ciliated forms of *Riccia hirta* (Aust) Underw. The last species can be promptly separated by the more gibbous upper surface of its terminal segment, and apparently universal presence of atleast a few cilia and also has shorter terminal segments which tend to be obovate rather than linear or at least oblong as in *R. tenella*. The spores are similar but *R. hirta* has slightly smaller areolae and less strongly marked inner faces than *R. tenella*. In *Riccia hirta* the epidermal cells are more or less protuberant and surface becomes spongiose, it is never spongiose in *R. tenella*. He gave the following constrasting features for *R. tenella*.

	Riccia tenella	*Riccia nigrella*
Diameter of the spores	100 - 170 μ	60 - 90 μ
Diameter of areolae	12 - 20 μ	3 - 10 μ
Areolae	regular	irregular
Margin of thallus	Obtuse or rounded	acute or slightly membranous ·

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Srivastava (1964) gave an illustrated description of 17 species of *Riccia*. He arranged the species in alphabetic order under sections *Euriccia* and *Ricciella*.

Gunderson (1970) worked on the ecology of the Hepatics of Brown County, Wisconsin. The scanning electron micrographs of the spores of *Riccia campbelliana* was furnished by Doyle (1970), represented the first application of scanning electron microscopy to liverworts spores. It provided micromorphological information which confirms and extends in as much greater detail than the results of studies with optical miscroscope.

Newton (1975) added that chromosome number has systematic value in liverwort; however, is limited at genus and species levels by their comparative uniformity, although they are more useful at and above family levels. He showed 7xn=7+1m chromosome number present in *R. crystallina*. He cited that, although cells were very large in these plants but chromosomes were very small. At least four had median or semimedian centromeres, and the full complement covered a size range in which a smallest member was an m-chromosome. Apart from an early incidental record of n=4, this was in close agreement with previous reports for *R. crystallina* from Florida, Central Europe and India he added. Jobet-Ast (1973) described the spore characters of *Riccia crustata* Trabut as revealed under SEM.

Seppelt (1974) made critical survey of *R. crystallina* collecting from a number of localities in south Australia. According to him the species in south Australia shows similar trends in morphology, spore sculpturing and spore diameter range per capsule as do European plants within the limits of spore diameter record for the species and shows a negative correlation between spore size and rainfall. He also commented that the spore morphology provides the most useful taxonomic character of the species.

Guerke (1974) worked in Louisiana to deduce a floristic study of Hepaticae and Anthocerotae. In this work he included 9 *Riccia* species viz. *R. albida, R. bifurca*

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special reference to *R. billardieri* Mont. et N. and *R. gangetica* Ahmad. Arnell (1957) published a paper on Hepaticae collected in South West Africa by Prof. Dr. O.H. Volk and reported *R. albolimbata* Arnell, *R. marginata* Bish., *R. perssonii* Khan, *R. plana* Teylor, *R. stricta* Duthie. Bapna (1958) worked on the hepatic flora of Mt. Abu which appeared as the richest spot for this vegetation in Rajasthan and cited the presence of *R. himalayensis (R. discolor* L. et. L.), *R. fluitans* L., *R. frostii* Aust., *R. crystallina* L., *R. gangetica* Ahmad, *R. plana* Taylor and *R. billardieri* Mont. et.N.

Pande and Udar (1958) worked on 11 *Riccia* species of South India and also presented a detail description of a new speices *R. tuberculata* Pande et.Udar and gave notes on the synonymy of some early described species. Pande and Udar (1958) also gave a key to the species including *R. melanospora, R. warnstorfii, R. crozalsii, R. tuberculata, R. discolor, R. billardieri, R. gangetica, R. huebeneriana, R. plana, R. cruciata and R. frostii.* Pande and Udar stated that the statement of Khan (1957) on *R. discolor* as monoecious species is not correct but it might be such that monoecious *R. billardieri* were grown in association with the species and have been confused. Besides, the authors opined that *R. bengalensis* is identical with *R. billardieri.*

Bapna (1958) reported 8 species of *Riccia* and later on Bapna and Vyas (1962) reported two more species. Bapna (1961) established a new species like *R. jodhpurensis* Bapna from Jodhpur. Bapna (1962) also established *R. abuensis* as new species which was collected from Mount Abu and added that the species was associated with *R. fluitans* L.

Ram Udar (1960) worked on the enyzmes of Hepatics. Among other hepatics he worked on *Riccia discolor* L. et. L. and *R. billardieri* Mont. et. N. He used the tips of vigorously growing healthy young plant of approximately same size and found the presence of lipase, buterase, acid phosphatase, amilase, invertase, maltase, urease, proteolytic enzymes, ribonuclease, catalase and lactase, in both male and female plant

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of *R. discolor* and all enzymes in *R. billardieri* except acid phosphatase, phosphorylase and ribonuclease. He however, concluded that the metabolic process in hepatics may closely correspond to those obtained in green tissues of higher plants.

Pande (1959) made extensive collections of Bryophytes from the Indian territory and communicated eleven species of *Riccia* including one new species. The species were *R. frostii, R. crystallina, R. ciliata, R. glauca, R. huebeneriana, R. sorocarpa, R. gangetica, R. billardieri, R. beyrichiana* and the new species *R. attenuata* Pande. *R. attenuata* Pande was discovered from Kamakhya Hills, Assam. It belongs to the *Ricciella* section of the genus and is characterised by its membranous thalli with strongly attenuate wings, and with the spores having complete reticulations on the outer surface and incomplete and irregular reticulations on the inner faces.

Mc Gregor (1960) reported *R. ozarkiana* from Ozarks. The ciliated *Riccia* plant was first collected by him from a sandy alluvial deposite on the bank of White river in Arkans in 1959. Here the spores were reported as angular type, having 60-90 μ in its longest diameter and the areolae 6-12 μ wide. According to him *Riccia ozarkiana* defers from *R. beyrichiana* in having prominent dorsal cilia; marginal and dorsal cilia longer and straight, thalli dioecious, spore smaller and smoother and antheridial ostiole much less prominent. Spores of *R. ozarkiana* mature in the falls, while those of *R. beyrichiana* mature in the spring.

Redfearn (1961) reported *R. sullivantii* Aust as a new state record of South-West Missouri. The plant was collected from the bank of a creek.

Schuster (1953) reported on the Hepaticae of Minnesota, Newzealand and Tasmania. In her paper she commented that "these species all needed carefull revision". Schuster (1951, 1963, 1966) worked on Hepaticae of East coast of Hudson Bay, NewZealand, Tasmania and North America. Watson (1968) in his book also included key to the British *Riccia* spp.

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Hoffm., *R. curtisii* James, *R. donnellii* Aust., *R. fluitans* L., *R. hirta* Aust., *R. membranacia* Cott. and *Lindenb.*, *R. sorocarpa* Bisc. and *R. sullivantii* Aust.

Taylor *et. al.* (1974) published detailed structural characteristics of spores and elaters of liverwort as revealed under Electron Microscope. In their paper on S.E.M. analysis of sporoderms and elatoderms of 20 species of liverworts under 20 genera, 17 families and 5 orders were presented in a series of electron micrographs (including sterio pairs) to reveal a direct positive result. In the species studied, sporoderms exhibit a broad range of morphology and have taxonomic specificity. The structurally rigid sporoderms have bold sculpturing. Sporopollenin as a component of both sporoderm and elatoderms also included in the paper but no work on *Riccia* was conducted by them. The workers also reiterated that in the life cycle of the liverwort, the spore (meiospore) is the initial cell of free-living gametophyte. The protective and the stratified wall of the spore usually designated by microscopists as the sporoderm, has a specific patern and often elaborately sculptured exteriorly and generally is made of a highly resistant material, the sporopollenin. Spore size and a distinctive morphology of sporoderm have long been used as a basis for identification of species in certain genera, e.g. *Fossombronia* (Miller 1968) and in more recent years, the increased field activity of hepaticologists making available spores of species hetherto unknown in the sporophyte stage, has led to a number of morphological studies of spores.

On the basis of germination of spore pattern and polarity, Inue (1960) proposed a classification for Marchantiales, which was later on extended to the Jungermannialian spores as of Schuster (1966). Three types of spores, each with two sub-types, were recognized. Type 1A-indehiscent apolar, Type 1B-irregular dehiscing apolar; Type 2A- tangential dehiscing cryptopolar, Type 2B - proximal dehiscing cryptopolar; Type 3A- distal dehiscing polar and Type 3B - proximal dehiscing polar.

Ono (1966) using the criteria of size, shape and pattern, classified Jungermannialian spores into four basic types: (1) the *Cephalozia* type with irregular reticulation, (2)

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Herberta type with papillate spore coat, (3) the *Porella* type with echinulated spore coat and (4) the *Frulania* type with rosettes distributed on granulate sporoderm.

In the first comprehensive study of spore types of liverworts, Miyoshi (1966) using tetrad scar, polarity and cell stage, disinguished five basic types of spores, Type-1, trilete; Type-2, deform trilete,Type-3 cryptopolar, Type-4 apolar and Type-5, multilocular. He recognized 10 sculpture types (silate, granute, verrucate, baculate, echinulate, echinate, reticulate, bullate, saccate and polyferate) and found considerable taxmonic specificity but he had difficultyin refering small jungermanniali an spores to genera or even to family. Another significant light microscopy study devoted to morphology of a broad spectrum of liverwort spores (and an occasional elater) is that of Erdtman (1957). He effectively applied his LO (Lux observation) technique which depends upon the interpretation of the defraction image produced during downward focusing through the wall. His illustrations are remarkable for the wealth of morphological details. Watson (1968) presented key to the British *Riccia* species along with other liverwort and mosses.

In 1973 Steinkamp, made a comprehensive study using scanning and transmission E. microscopy, and published a paper on the comparison of some macronutrient media used in the culture of bryophytes and structure of spore walls of 20 liverwort species. She found a high degree of taxonomic specificity in both surface and internal morphology of the sporoderms in her investigation of some members of Sphaerocarpales and Marchantiales including *R. californica, R. campbelliana, R. sorocarpa and R. tricocarpa.*

Selkirk (1979) worked on the effect of nutritional conditions on sexual reproduction in *Riccia*. Crandall-Stotler (1980) putforwarded the morphogenetic designs and a theory of bryophyte origins and divergency. Na-Thalang (1980) did a revision work on the genus *Riccia* of Australia. He took spore characters as most reliable for taxonomic enumeration of different species because these were taken as most stable characters in this genus.

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He made detail descriptions, illustrations, drawings etc. of 33 species. He also provided scanning electron micrographs of spores of 29 species. In his revision he described nine species of *Riccia* new to science. Jobet-Ast (1981) described the *Riccia* spp. from tropical America.

Bischler and Jobet-Ast (1981) published their works on biological significance of morphological characters in the order Marchantiales.

Country monograph detailing the state of floristic and chorologic investigations of bryophytes in Poland was propounded by Ochyra (1982). Koponen (1982) reported on the bryosystematic and bryofloristic resources and research in Finland with a motto to ventilate the taxonomical and geographical state of the plants through a monograph. A detailed study on the bryophytic flora in South-West Sweden through a country monograph was presented by Gradstein et. al. (1982). Present and future aspects of bryophyte in Germany F.R. as a country monograph was also stated by Duell (1982).

An outline on the current state of floristic and chorological studies on bryophytes in Europe specially in Romania was published by Stefureac in 1982. Smith (1982) worked on the bryophytes in Great Britain and Ireland where he also emphasised on the study of the then state of floristic and chorological point of view.

Sergio (1982) investigated the bryophytes of Portugal and his line of works were floristic and chorological. Brown (1982) reported that the research into effect of mineral nutrition, physical factors such as temperature, light intensity and relative humidity on bryophyte growth has achieved much success in explaining the distribution and habitat preferences of certain species. Stark et. al. (1982) published a preliminary list of bryophytes including Hepaticae and Musci from the Organ mountains, New Mexico.

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The Czechoslovakian bryophytes with particular interest on the then state in research on its distribution along with floristic and chorological points were reported by Popsil (1982). Hungarian bryological investigation on floristic and chorological points of view were made by Orban (1982). Newman *et al*. (1982) reported modified and short protocol for the preparation of bryophyte materials for S.E.M. to study the morphological characters.

Suman Dua *et. al*. (1982) reported that the spores of *Riccia gangetica* Ahmad germinate only in light. They also added that the induction of reproductive phase was very satisfactory at 25^{0}C on 0.8% agar having 1% sucrose and glucose where as fructose and mannose elicit optical response at 0.5%.

Mayfield *et. al*. (1983) worked on *Ricciaceae* in Michigan and described *Ricciocarpus natans* and many *Riccia* species from the state. Mishler *et. al*. (1983) made a distributional study of Massachusetts bryophytes and gave a list of the species.

Kumara and Chopra (1984) showed the effect of 2, 4-D, IAA, NAA and B-Napthoxy acid (NOA) and 6- benzyl aminopurine (BAP), Zeatin on growth and spore formation in *Riccia gangetica*. They provided that 2, 4-D and IAA stimulate vegetative growth, induce the formation of spore and shorten the time required for gametangial formation.

Chopra and Kumara (1984) reported the significant effect of Fe-EDDH and Fe-EDTA the two chelating agents in enhancing antheridial formation of *Riccia gangetica* Ahmad. They also added that salicylic acid, another chelating agent increase antheridial formation but its effect on archegonial formation is very very slight.

Bopp *et. al*. (1984) in their book on cell culture and somatic cell genetics of plants showed working procedure to cultivate bryophytes in in-vitro condition. Chopra and Suman Kumara (1985) showed the hormon regulation of growth and gametangial formation in *R. gangetica* Ahmad. According to them GA_3 enhances normal

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vegetative growth, increases antheridial production and decreases archegonium formation. Progesterone and testosteron markedly increase antheridial production and their effect on archegonial number is marginally favourable.

Shaw (1985) presented a paper on the tradition of make-do taxonomy at a symposium on species concepts in Bryophytes. Kumara and Chopra (1986) worked on the combined effect of IAA-kinetin, IAA-GA and GA-IBA interaction on the growth and gametangial formation in *R. gangetica* in vitro. They showed the interaction of IAA and Kinetin has an additive effect on archegonium formation. Co-operation of IAA and GA decreases the production of archegonium and antheridium as compared to those produced in combination of GA and IBA reduces vegetative growth as well as number of antheridia and archegonia.

Harlimann (1986) reported *Riccia hawaiiensis* Hurl. as new species of the genus from Hawaii. Patidar *et. al.* (1987) studied spore output in Marchantiales.

Vashista and Chopra (1987) showed the effect of some aminoacids and complex organic nitrogenous substances on vegetative growth and gametangial formation in the female clone of *Riccia frostii* Aust. Aminoacids, aspertic acid and thionine stimulate vegetative growth as well as archegonial production at all levels. Casein hydrolysate, peptone and yeast extract in general did not favour normal growth and development. Peptone proved inhibitory in archegonia formation, whereas casein hydrolysate and yeast extract stimulated production of archegonial production at 50 ppm and 0.5% (W/V) respectively.

Jagdish Lal (1979) worked on the Indian liverworts, his contribution on *Ricciocarpus*, deserves special citation.

The contribution of Corda (1829) in editing Genera Plantarum and Johansen's (1940) works on plant microtechnique deserves special citation.

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Besides works of Basile (1964, 1975), Suman at. al. (1982), Kumara (1984, 1986), Chopra at. al. (1985) on bryophyte culture media, research works of Richard (1964), Bates (1982), Proctor (1982), Magdefrace (1982) on bryological ecology are very enthusiastic. Bold's (1938) report on the nutrition of sporophyte of bryophyte, Berrie's views on polyploidy of *R. fluitans* are notable. Fulford (1963, 1964, 1965) expressed his comment on the species concept. Besides the works of Mc Gregor (1961) on *R. rhenana* and *R. albida* and bryological researches of Persson (1963), Bir (1970) and Crum (1985) on traditional make-do taxonomy are also noteworthy.

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MATERIALS AND METHODS

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MATERIALS AND METHODS

1.MATERIALS: The research material is a well known bryoflora-genus *Riccia*. The study of the genus *Riccia* of Bangladesh was conducted to find out a clear floristic picture of the plant in the country.

Riccia specimens belonging to different localities covering all 64 districts of the country from all available spots of both terrestrial and aquatic habitats were collected, preserved and studied. During collection and subsequent advancement in study, stresses were given to ecological and taxonomical points of views mainly.

Riccia specimens were collected round the year from all three geographic positions including Northern and Eastern hills, Madhupur and Barind Tracts and Floodplains areas of the country especially from the most accessable places.

Most of the terestrial *Riccia* species are more or less cosmopolitan here where as *Riccia fluitans* the only known aquatic member of the genus is comparatively rare in availability. However, this aquatic species were collected from Dhaka, Tangail, Patuakhali, Noakhali and Narayanganj districts in different months of the year. Both young and mature plants were taken into consideration but better emphasis were given to mature ones.

2.METHODS: Clearing and preservation

Riccia specimens were collected and bagged in polythene, paper or in other suitable containers made of plastic or glass. Especially in case of aquatic species, *Riccia fluitans* L. the use of glass or plastic container were most suitable. In most cases the specimens which were collected in paper envelopes were marked for herbarium material to use lateron as reference, type specimen or to get spores for culture or SEM study. The materials were generally air dried, or sometimes freeze drying were done for SEM study.

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Clearing: An appropriate care was exercised in handling the delicate thallus of *Riccia*. The terrestrial specimen with mud or wet soils were put into clean water for sometime to release soil particles clamped in rhizoids. After sometimes the specimens were subjected carefully to running water or other water source taking them into suitable container especially "tea-seive" or other bamboo or plastic made seives to avoid the loss or escape of small thallus of *Riccia* during washing. (The system of using a suitable seive during cleaning the soil particles from rhizoid, have got another benefit that it saves the delicate thallus from breaking during this washing or handling process especially in large scale condition). However, in small scale condition, soil particles or other debrises were separated by the help of camel brush following weting in water for sometimes, taking them in petri plates.

After washing, specimens were preserved in both dry and wet conditions. For dry materials, paper, envelope or blotting paper mainly filter papers were used to use the plant or its parts later on. For wet preservation the specimen were kept in suitable air tight plastic or glass containers. Suitable preservative or fixative including chemicals and liquid parafine were used for long time and efficient storage.

In field conditions, habitat, associates, soil conditions, period or time of occurence, abundance, mode or growth, colony character, colour of the plant etc. were noted.

pH of the soil and water substratum were determined by the help of both standard pH paper in the spot of collection and electronic pH meter in the laboratory to findout the pH or pH range prefered by a particular *Riccia* species or group of species for its growth and development.

During chemical fixing or preserving the whole plant, materials were taken into a clean container. As the plant is smaller and soft, better killing and fixing were possible for its direct exposure to the chemicals. Of the killing and fixing agents,

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Acetic-alcohol and Acetic-alcohol-formalin (F.A.A.) were found most suitable for its rapid penetration into the material than that of weekly penetrating chormic acid containing fixing mixture.

Acid fixing for general studies were most satisfactory.

a. **Killing and fixing fluid reagents employed:**

Fromalin Aceto-Alcohol (A standard preservative) F.A.A.

i.	50% Ethyl Alcohol	90 cc
	Glacial acetic acid	5 cc
	Formalin	5 cc (For 100 cc solution)
ii.	70% Ethyl alcohol	90 cc
	Glacial acetic acid	5 cc
	Formalin	5 cc (For 100 cc solution)

The above fluids were used for general preservation and fixing especially for external and internal morphological studies. The reagents appeared very satisfactory to use in the trip and as well as to preserve the specimen for long time without any appreciable damage.

To preserve specimens in this fluid for long time, a few drops of 40% glycerine solution was added to it to avoid easy evaporation of the preservatives.

METHODS OF STUDY

As *Riccia* is a small and delicate plant, so both living and preserved specimens were handled very carefully. Both living and preserved specimens cleaned in

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running water were used in study. For morphological observations in laboratory conditions, preserved specimens were mounted on clean slide or watch glass having water or 10% glycerine and living materials only in water.

Depending on the condition of specimen the use or non use of cover slip for carrying camera-lucida drawings or other microscopical studies were considered. Hard specimens appeared suitable to draw its sketch under a cover slip than that of very soft specimen.

For whole mount thallus, camera-lucida drawing at magnifications of 10x in simple microscope and 18x in compound microscope were generally made to bring almost all external morphological data under account.

Freehand thin section of the thallus T.S and L.S were taken to observe the reproductive structure, arrangement of the internal tissues, and the general shape of the specimen in the plans. To make ordinary spore slide, sporangium was takenout carefully from the mature thallus with the aid of suitable needle or forceps. The capsule was washed carefully in clean water to avoid any traces of soil or debris particles. Then the mature capsule was taken on a clean slide in distilled water or 10% aqueous glycerine solution and spores were taken out by the help of needle or forceps, then the spores were covered with a suitable and clean coverslip and were observed under a compound microscope; measured with the help of a previously calibrated oculometer and camera-lucida drawings were done.

Photographs of spores were taken by microscope having photo taking devices. Photographs of the spores mounted in 10% glycerine solution on slide under coverslip were taken by the Ortholux Photomicroscope, West Germany, using Kodak and Fuji (Black and White) films and the camera used was Leica III G (35 mm). The photomicrographs were taken in transmitted light and a blue/green filter was used during this process.

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Preparation of permanent/semi-permanent slides of spores:

a. **Spore Processing**

Air or freeze dried *Riccia* thallus with mature capsules were selected. Spores were separated from the capsule of the thallus either with the help of forceps, needle, mesh spreadingout on a funnel standing on a test tube traditionally.

To the test tube with spores an acetolysis mixture consisting of 9 parts accetic acid and one part concentrated H_2SO_4 was added and stired thoroughly with glass rod. In some cases acetic enhydride was also used as a substitute of acetic acid. Test tube with spores in the said acetolysis mixtures were heated cautiously to the boiling points in a water bath. The mixture was stired at intervals and was allowed to stand for few minutes to bring the solution light brown in colour. After sometimes the mixture was centrifused at a speed of 2000 rpm for five minutes. The supernatent of the mixture was decaned carefully and a little water was added to the sediment and was shaken thoroughly. To it, a few drops of acetone or alcohol was added to remove any debris if present.

The mixture was filtered through a suitable brass mesh for twice and the solution with spores was centrifused again for a while.

After centrifugation, the supernatent was decaned and 10 cc distilled water was added to it and was shaken. Half portion of the solution was allowed for chlorination and a few drops of dilute glycerine was added to it.

For chlorination 5 cc of glacial acetic acid and five drop conc. sodium chlorate solution was added to the test tube with spores scheduled for chlorination and stired thoroughly with the help of a glass rod. Both bleaching and chlorination held immediately. This solution with spore was centrifused, decanted and washed thoroughly with distilled water to eliminate all traces of chlorine. Again the

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solution with chlorinated and acetolysed spores were centrifused and a few drops of glycerine (50%) was added to it and was heated gently in water bath for about five minutes to recover the shape of the spores. The solution was again centrifused for 10 minutes and the supernatent was decanted, after which the test tube was taken in an inverted position on a filter paper to leave all traces of liquid if present, in it.

b. **Slide preparation**

A small piece of glycerine jelly was taken at the tip of a platinum needle and was inserted into the test tube bearing the acetolysed spores and the jelly cube was taken out by touching spore and was placed on a clean slide. This was covered with a coverslip and was sealed up with solid paraffin (mp 58^0-72^0C) by the application of gentle heat.

The Glycerine jelly was prepared by heating 7 gram of powder glelatin in 93 cc distilled water and a little amount of 4% phenol and a few drops of glycerine were added to it as preservatives. For transparent spores, saffranin jelly appeared helpful for which a tinge of saffranin was added in the jelly during its preparation for colour.

c. **Scanning Electron Microscope study (SEM)**:

For ultramicroscopic study of plant parts especially for spore details, ultra photograph of the delicate sporodermal sculpturing, SEM was employed. SEM helps in getting correct and $\pm$ three dimentional effective immage demonstrating photographs of an object. To use spore sculpturing character, the most stable and usable points in differentiating one species from another the SEM photographs of the spore sample were felt very important and accordingly a good number of sporodermal sculpturing were photographed by the help of Scanning Electron Microscope.

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Processing of spore sample for SEM photograph and study:

Both freeze and or air dry spore samples could be used for this purpose. Both acetolysed and non-acetolysed spores were photographed. Spores with surface ornamentation impregnated with thick sporopollenin generally required clearing by acetolysis.

Mature, clean dry spores were taken on a slide under simple microscope with the aid of needle, and these were transferred to a metalic stab having attaching materials on it with the help of a suitable device.

This attached spore on the stab were subjected to fine gold coating machine. On successful completion of fine thin gold coating on the spore surface the stabs were taken out. The gold coated spores bearing stab was put into the vacuum chamber of Scanning Electron Microscope-JEOL-10. The sporeswere seen through field screen of the SEM and selected. The subject was observed in SEM at 10 KV accellarating voltage. The SEM photo was taken on 120 SS Fuji film at desired magnifications.

After taking the photograph the negative was washed and developed and printed in traditional ways to get the picture of the spores.

SCANNING ELECTRON MICROSCOPES

SEM: MODEL-JEOL-10. Made in Japan, at IPSA, Salna, Gazipur and Bose institute Calcutta were used.

SCHEME-1. MATERIALS : RICCIA PLANT WITH MATURE SPORES

a. Desired *Riccia* plant was washed throughly in running water to eliminate unwanted solid particles and debrises.

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b. The specimens were air or freeze dried.

c. The spores were taken out from the plant by suitable forceps and needles under the aid of dissecting microscope.

SCHEME-2. TREATMENT OF SPORE SAMPLE BEFORE SUBJECTING INTO SEM

a. Spores were placed on metalic (copper or Alluminium) stab having glue tap for attachment of spore sample.

b. Spores on the stab were subjected for ultra thin gold coating in a sofisticated device for 5 minutes to make the spore surface suitable for electron flow.

SCHEME-3. S.E.M. OPERATION

a. Stabs with desired spore samples were taken to vacuum chamber of the SEM.

b. Chamber was evacuated.

c. Specimen was observed in T.V. screen of SEM under a electron flow source from 10/15 KV.

d. Best and suitable spores were selected for photograph.

SCHEME-4. PHOTOGRAPH

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a. Scanned photograph of the desired sample was taken with the help of the attached camera of the SEM.

b. The film used was Fuji SS 120 (Black and White).

SCHEME-5. DEVELOPING, WASHING, PRINTING AND DRYING OF FILMS

a. In dark room, film was subjected to developing chemicals for a required period.

b. Washed throughly at least for half an hour in running water.

c. Dried in air.

d. Printed and washed.

e. Dried in air or by air drier.

SCHEME-6. SELECTION

a. Best photographs were selected for presentation in the thesis.

SEHEME-7

Preserved the photos in suitable photo carrier before providing those in the thesis.

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CLASSIFICATION

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CLASSIFICATION

The genus *Riccia* was primarily divided into two sections: viz. Section-1 *Euriccia* and Section-2 - *Ricciella* as below:

Section-I: *Euriccia*

Chlorophyll bearing cells are in vertical columns surrounding a narrow vertical air space.

Riccia B. *Euriccia* a. *Terrestres et.* b. *Spongides* Lindb. *Musc. Scand*: 2 (1879).

Riccia Sect. 1. *Euriccia* Schfftn. (excluding *Riccia crystallina*), in Engl. u. Prantl *Nat. Pflanzen*. 1 (3) 14, 1983.

Riccia A. Steph. *Spec. Hepat.* 1:6, 1898.

Riccia. Subgen. *Euriccia* Boulay, *Musc. de la France* 2: 165, 1904.

Section-II: *Ricciella*

Chlorophyll bearing cells are not in column but appeared arround the irregularly developed air chambers.

Riccia Gen. Braun, in *Bot. Zeit.* : 757, 1821. Warnst., Krypt. *Fl. Mark Brand.* 67, 1902.

Riccia Sect. 2. *Ricciella* Bisch., *Bemark, March.*, u. *Ricc.* 1040, 1835.

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Riccia-B. *Ricciella* Steph. *Spec. Hepat.* 1 : 36, 1898.

Ricciella Boulay, *Musc. de la Franch* 2: 164, 1904.

But in this present work the genus *Riccia* is being described under three subgenera treating Section-I and II as subgenus-I *Euriccia*, subgenus-II - *Ricciella* respectively and including a new subgenus III - *Ricciomamillosa*.

Subgenus - III : *Ricciomamillosa*

Five species have been included under this subgenus of which *Riccia perssonii* khan, and *Riccia arnellii* khan were described from Bangladesh in 1950s (Khan 1955, 57), *Riccia variantes* and *Riccia centroporii* are being introduced as new to science and the fifth one is *Riccia curtisii* (Aust.) Steph. (1898).

All the five species are easily and distinctly distinguishable from *Euriccia* and *Ricciella* groups of the genus *Riccia*. These are unisexual, wooly in texture, spores in tetrads are permanently attached in different plans and have got distinct mammillæor spines, these spines help in spore dispersal. As the plants are unisexual in nature and develop well in comparatively dry winter season, so such adaptation of permanent attachement of tetrad with two spores to give rise male and two to give rise female plants, atleast to facilitate the maximum chance of fertilization. The plants are preferably found to grow in ± shady damp places especially in drying paddy fields and along and under shade of other herbacious plants including grasses. The adaptation of spiny nature of spores also help in its dispersal from one place to other. The plan of attachment of spores, its mamillate characters and irregularly chambered thallus help in separating species distinctly from *Euriccia* and *Ricciella* group.

It is noted that spores in such permanently attached tetrad with mamilla could only be seen in *Riccia curtisii* (Aust.) Steph. which was reported from Europe only.

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Austin (1864) treated it as a form in between *Riccia* and *Sphaerocarpus* and instituted the genus *Cryptocarpus* for the plant, having unique spore arrangement along with spiny characters. Lindberg (1874) changed this name to *Thallocarpus* because *Cryptocarpus* was already known as a genus of Cinopodiaceae. Trevisan (1877) gave the name *Anisocarpus* to this liverwort. Schiffner (1909) accepted the genus *Thallocarpus* and kept it along with *Sphaerocarpus*. Mc Allister (1916) opined it as a species of *Riccia*. Proskauer (1961) remarked that *Riccia curtisii* required an urgent taxonomic and nomenclatural revision.

Riccia curtisii (Austin) Steph. *Riccia perssonii* khan, *Riccia arnellii* khan, *Riccia varientes* sp. nov. and *Riccia centroporii* sp. nov. are remarkably different from all other species of *Euriccia* and *Ricciella* groups in both vegetative and reproductive characters.

Important characters of *Ricciomamillosa*

a. Plant dioecious, male and female thalli occur in same colony, plant wooly. Female plant both forked, unforked, ± fleshy, bright green, mostly situated in the peripheral region of the colony, male plant mostly unforked, thin, green or yellowish green in colour.

b. Spores in the tetrad are permanently attached in different plans. Spines develop from the exine of the spore.

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GENUS-RICCIA
(GENERAL CHARACTERS)

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Genus - *Riccia (Mich.) L.*

Micheli, Nov. Plant. Gen. 106, 1729.
Linnaeus, Spec. Plant. 1138, 1953.

Sporophyte without an involucre, embeded in thallus tissue, air chambers simple, not stellate. Epidermis with air pore, antheridia and archegonia scattered in thallus - *Riccia*.

General characters:

a. Most species are terrestrial, except *R. fluitans* which is aquatic and sterile.

b. Plant both monoecious and dioecious.

c. Segment linear or obcordate.

d. Both unbranched or branched dischotomously to form rosette colony or patches.

e. Thallus green, bluish or yellowish green, generally with dorsal furrow.

f. Margin both smoothly running or undulating, may or may not be covered by cilia or scales.

g. Ventral scale both hyaline or coloured, well developed, rudimentary or absent.

h. Rhizoids absent in aquatic species, and both smooth or tuberculate in terrestrial species.

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i. Photosynthetic region with narrow deep air spaces or with large polyhedral airchambers or having a lacunose appearance. Basal or storage region nonchlorophyllous, may be well developed or reduced.

j. Archegonia scattered, antheridia both restricted in anterior region or scattered on thallus tissue.

k. Archegonial neck long and generally projecting, antheridial papillae are short, may or may not be projected above thallus surface.

l. Capsule simple and devoid of involucre.

m. Sporangium without foot and seta, wall consists of two layers of which inner one gets absorbed before its maturity.

n. Spores both permanently attached in tetrad or separating after maturity.

o. Sterile nurse cells absent.

p. Spore tetrahedral, isobilateral or rhomboidal in arrangement, exine generally sculptured or spiny.

q. Nature of sculpturing on spore wall generally reticulate in both regular and irregular ways.

r. Wing both present and absent.

The genus was first established by Micheli (1729) and named after P.F. Ricci, an eminent Italian Botanist.

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TAXONOMY

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SUBGENUS - EURICCIA

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OCCURANCE OF SPECIES UNDER SUBGENUS - I : *EURICCIA*

SPECIES		DISTRICT CODE
Riccia bandarbanensis	:	21
Riccia barabaidensis	:	2, 15
Riccia bengalensis	:	1, 7
Riccia billardieri	:	1, 2, 5, 10, 13, 15, 16, 17, 19, 20, 21, 33, 36, 37, 38, 39, 40, 42, 45, 49, 55, 59, 60, 61
Riccia bogransis	:	42, 44
Riccia brunnea	:	21, 22
Riccia chittagongensis	:	18, 19
Riccia compaginata	:	33, 34
Riccia crundwellii	:	1, 15
Riccia discolor	:	1, 16, 37
Riccia elliptica	:	7, 10, 40
Riccia frostii	:	1, 5, 7, 10, 12, 13, 15, 16, 21, 29, 30, 32, 33, 37, 40, 41, 42, 45, 59, 60, 61
Riccia gangetica	:	1, 33
Riccia gangulii	:	14
Riccia gopalpurensis	:	15
Riccia hasnabadii	:	1
Riccia jamalpurensis	:	16, 41
Riccia kagmariensis	:	15, 16
Riccia lithophillii	:	19, 21
Riccia lunata	:	12, 15
Riccia madhupurensis	:	12, 15
Riccia mogransis	:	1, 13
Riccia nathurcharensis	;	1, 15
Riccia parvulii	:	15
Riccia rangpurensis	:	37, 38, 44
Riccia shankhii	:	21
Riccia sorocarpa	:	41, 15
Riccia tangailensis	:	15
Riccia tubulosa	:	15

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Genus - *Riccia*

Sub-genus - I: *Euriccia*

Key to the species:

1. Plant dioecious - 2

   Plant monoecious - 7

2. Sporangium dorsal - 3

   Sporangium ventral, spore 95-135 μ in diameter, wing thin - *R. crundwellii*

3. Spore wingless - 4

   Spore winged - 5

4. Spore wall reticulation thin walled, 90-130 μ in diameter, 6-8 areolae across dorsally - *R. discolor*

   Spore wall reticulation thick walled, 85-140 μ in diameter, 7-10 areolae across dorsally - *R. hasnabadii*

5. Thallus crowded, forming irregular colony, male and female plant growing together - 6

   Thallus forming regular rosette colony, male and female plants forming separate regular colony, male colony redish - *R. frostii*

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6.	T.s. of the thallus nearly double as broad as high. Spore 78-90 μ in diameter	- *R. compaginata*
	T.s. of the thallus $\pm$ as broad as high. Spore 40-60 μ in diameter	- *R. tubulosa*
7.	Sporangium dorsal	- 8
	Sporangium ventral	- 14
8.	Spore winged	- 9
	Spore wingless	- *R. bengalensis*
9.	Thallus very small, 1-2 mm long, 0.5-1 mm broad and unbranched	- *R. parvullii*
	Thallus bigger, 4 mm - 1.5 cm long, 1-3 mm broad, branched	- 10
10.	Spore wall reticulate, wing cartwheel like	- *R. billardieri*
	Spore wall reticulate, wing otherwise	- 11
11.	Thallus ciliated	- *R. gangulii*
	Thallus non-ciliated	- 12
12.	Thallus dichotomy irregular, upper epidermal cells $\pm$ oval	- *R. kagmariensis*

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	Thallus dichotomy ± regular, epidermal cells ± cresent shaped	- *R. mogransis*
13.	Spore winged	- 14
	Spore wingless	- 28
14.	Spore wall reticulation thin dorsally	- 15
	Spore wall reticulation thick dorsally	- 21
15.	Sporophyte in one row	- *R. gopalpurensis*
	Sporophyte in more than one row	- 16
16.	Scale present	- 17
	Scale absent	- 20
17.	Scale hyaline and ill developed	- *R. sorocarpa*
	Scale coloured	- 18
18.	Thallus rarely branched, scale brown	- *R. brunnea*
	Thallus branched	- 19
19.	Dichotomy irregular, scale pinkish	- *R. chittagongensis*
	Dichotomy irregular, scale both hyaline and purple	- *R.shankhii*

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20. Thallus thin, surface smooth, spore wall reticulation complete dorsally and incomplete ventrally, triradiate mark absent - *R. barabaidensis*

Thallus thick, surfaces pitted, spore wall reticulation both complete and incomplete on both surfaces, triradiate mark distinct - *R. rangpurensis*

21. Scale absent - 22

Scale present - 24

22. Thallus always branched, dichotomy regular, T.s. of the thallus lunar shaped, spore wall reticulation complete dorsally and incomplete ventrally - *R. lunata*

Thallus dichotomy irregular, may be unbranched, T.s. of thallus otherwise - 23

23. Thallus small thick, less branched, sporangium many, crowded. Triradiate marking ill developed - *R. bogransis*

Thallus large, thin, well branched, sporangium production low per thallus, Triradiate marking distinct - *R. madhupurensis*

24. Scale dark brown to blackish - 25

Scale hyaline or light coloured - 26

25. Spore areolae 7-12 across dorsally - *R. jamalpurensis*

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	Spore areolae upto 6 across dorsally	- *R. tangailensis*
26.	Scale only hyaline	- *R. bandarbanensis*
	Scale light coloured	- 27
27.	Thallus both unbranched and branched, spore 85-100 μ diameter, wall reticulation complete dorsally, 7-9 areolae across	- *R. lithophillii*
	Thallus always branched, spore 66.6-95 μ diameter, reticulation both complete and incomplete dorsally	- *R. nathurcharensis*
28.	Thallus distinctly elliptic, without apical notch	- *R. elliptica*
	Thallus not elliptic, with apical notch	- *R. gangetica*

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Riccia bandarbanensis sp. nov.

PLATE I
SEM PLATE **1 A**

Monoica, pallide viridis, colonia magna superposita, aggregata, vel irregularis.
Thallus dichotome ramosus ad uni vel diplex, sulcus dorsalis distinctus, usque 9.5mm longus et 2.5mm latus.
Thallus in sectione transversa duplex vel 2.5 latior quam alta.
Squame hyalinae.
Antherdia in 1-2 seriebus dispositus.
Archegonia in 1-2 seriebus dispositus.
Sporangia ventralia, fusca, aggregata.
Sporae nigrobrunneae, 72-86 μ in diam. Paries reticularis, perfectus, 6-8 areolae dorsales.
Ala crenata, 3-7 μ lata.
Signa triradiates non-conspicua.

Monoecious, plant light green, colony large, overlapping, crowded or irregular patches.
Thallus branched dichotomously for 1-2 times, dorsal furrow distinct, upto 9.5mm long and 2.5mm broad.
T.S. of thallus 2-2.5 times as broad as high.
Scales hyaline.
Antheridia 1-2 seriate.
Archegonia 1-2 seriate.
Sporangia ventral, dark, very close to one another.
Spore blackish brown, 72-86 μ in diameter, wall reticulate, complete, 6-8 areolae across, dorsally.
Wing crenate, 3-7 μ broad.
Triradiate marking not distinct.

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Specimens examined:

Bandarban : Near town side forest checkpost at hill slope on damp soil, October, 1985. 99, Md. Kamruzzaman, Holo type (DUH).

Bazar road, on house side shady place, October 1985. 109, Kamruzzaman (DUH).

Distinguishing characters:

1. Green thallus forming irregular colony or over-lapping patches with large number of distinctly visible sporangium.

2. Sporangium dark, mostly very close to one another, ventral.

3. Spore black or blackish-brown, reticulation complete or incomplete, wing crenate and dentate.

The species was named after the name of the district Bandarban from which it was collected for the first time.

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PLATE I

Riccia bandarbanensis sp. nov.

a & b.	Thalli	10 x
c & d.	T. S. of thalli showing sporangial position	18 x
e & f.	Spores	300 x

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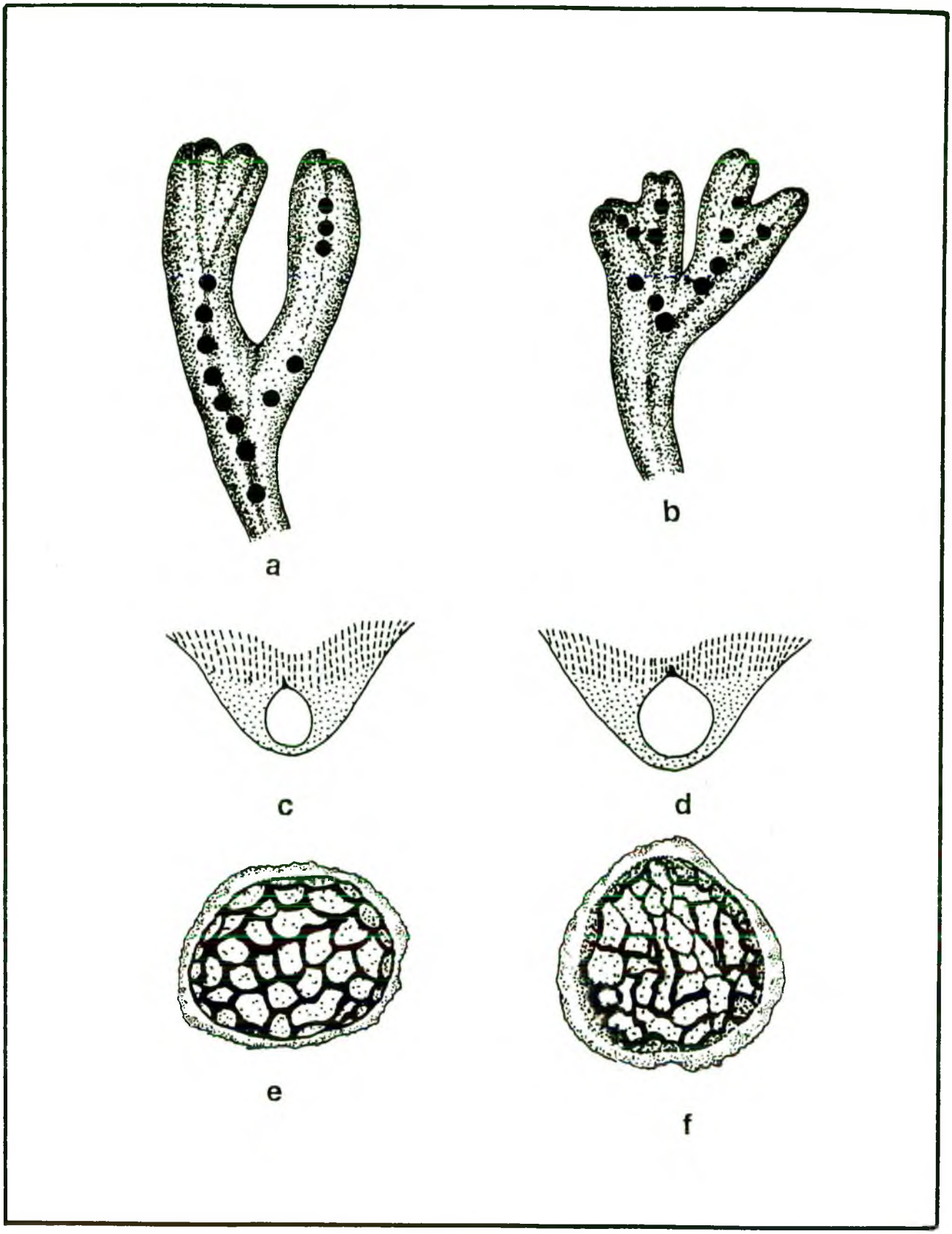
PLATE I



Riccia bandarbanensis sp. nov.

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Riccia barabaidensis sp.nov.

PLATE II

SEM PLATE **1 B**

Monoica, herba pallide viridis, in colonia irregulare.

Thallus gracilis, dichotome ramosus uni vel diplex, usque 7mm longus et 2.5mm latus, margo plasminusve sinuatus.

Squamae absentes.

Thallus in sectione transversa latior quam alta.

Antheridia in 2-3 seriebus disposita.

Archegonia in 1-2 seriebus disposita.

Sporangia ventralia.

Sporae nigro brunneae, vel nigroae, 74-88 μ in diam, paries reticulatus, 6-8 areolae dorsales.

Ala crenata, non uniformiter lata, usque 6.5μ lata. Signa triradiates absentes.

Monoecious, plant light green, not in regular colony.

Thallus thin, branched, dichotomously for 1-2 times, upto 7mm long and 2.5mm broad, margin ± wavy.

Scale absent.

T.S. of thallus as broad as high.

Antherida 2-3 seriate.

Archegonia 1-2 seriate.

Sporangium ventral.

Spores blackish brown or black, 74-88 μ in diameter, wall reticulate, 6-8 areolae across dorsally.

Wing crenate, not uniformly wide, upto 6.5 μ broad. Triradiate marking absent.

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Specimens examined:

Tangail : Madhupur, forest, near Barabaid, Sayed Ahmadia Yatimkhana on soil, July 1985. 03, Md. Kamruzzaman, Holo type (DUH).

Gazipur : Bhawal Sal forest, near Chandra Picnic Centre, January 1986. 87, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus thin, not forming any organized colony.
ii) Sporangium ventral.
iii) Spore on maturity becomes black and highly opaque.
iv) Reticulation ± complete on outer face, incomplete in inner face of the spore breadth of the crenate wing not uniform, Triradiate marking absent.

The species has been named after the name of the locality (Barabaid) from where it was collected for the first time.

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PLATE II

Riccia barabaidensis sp. nov.

a & b.	Thalli	10 x
c	T. S. of thallus showing sporangial position	45 x
d, e & f.	Spores	300 x

d, e - dorsal view, f - ventral view)

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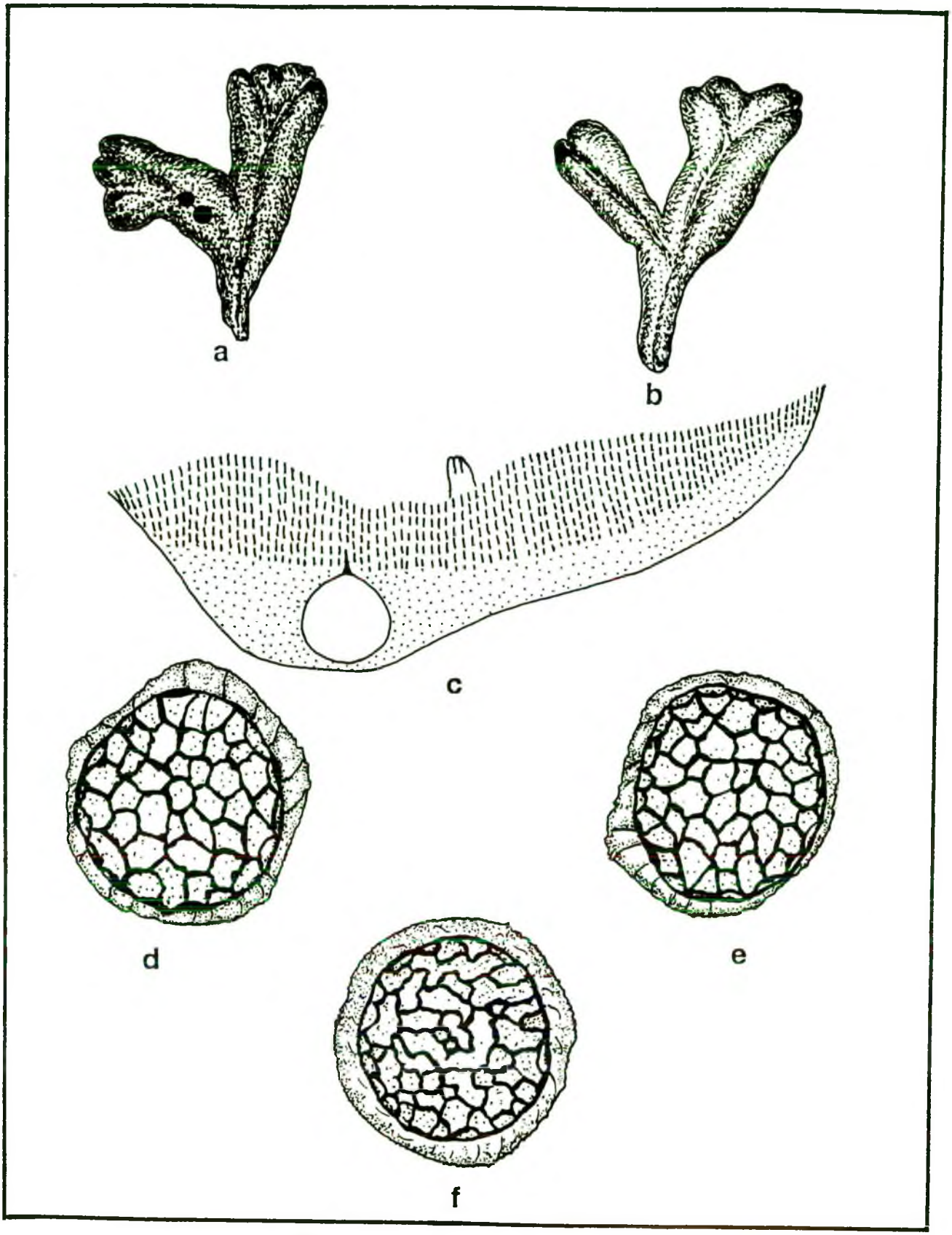
PLATE II



Riccia barabaidensis sp. nov.

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Riccia bengalensis Khan

Riccia bengalensis Khan, The Bryologist 60: 29-31, 1957.

PLATE III

SEM PLATE **1 C**

Plant monoecious, green appearing as crowded, dense overlapping patches or sometime forming rosette colony of 1.5-5 cm in diameter. Thallus compact, thick, apex obtuse, margin undulating, median sulcus distinct, broad, flat anteriorly and narrow posteriorly, branched dichotomously upto three times, individual segment 6-18mm long and 2-7mm broad, airpores distinctly seen from dorsal surface. Scales both purplish and hyaline, semilunar, develops only in the ventral side. T.S. of the thallus 3-5 times as broad as high, margin sometime curved ventrally, epidermal cells hyaline, dome shaped, assimillatory cells in column. Antheridia develop near apex, 2-3 seriate. Sporangia dorsal large, many, brown to blackish brown, round to oval. Spore tetrahedral, yellowish brown to opaque brown, ± round to oval, reticulate, 7-12 areolae across the diameter, end of the reticulation projected, triradiate markings inconspicuous. Spore 105 μ to 120 μ in diameter, wing absent, spores liberate dorsally.

Specimens examined :

Dhaka : Balda garden; on road side damp soil, August, 1985. 57, Md. Kamruzzaman (DUH).

Faridpur : Near Faridpur Polytechnic Institute, in a fallow damp land, December, 1986, 283, Md. Kamruzzaman (DUH).

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Distinguishing characters :

i) Thallus margin undulating, median sulcus distinct and thin at the margin, convex ventrally.

ii) Spore wall reticulate, end of reticulation projected, wing absent.

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PLATE III

Riccia bengalensis Khan

a & b.	Thalli	10 x
c.	T. S. of thallus showing sporangial position	18 x
d & e.	Spores	270 x

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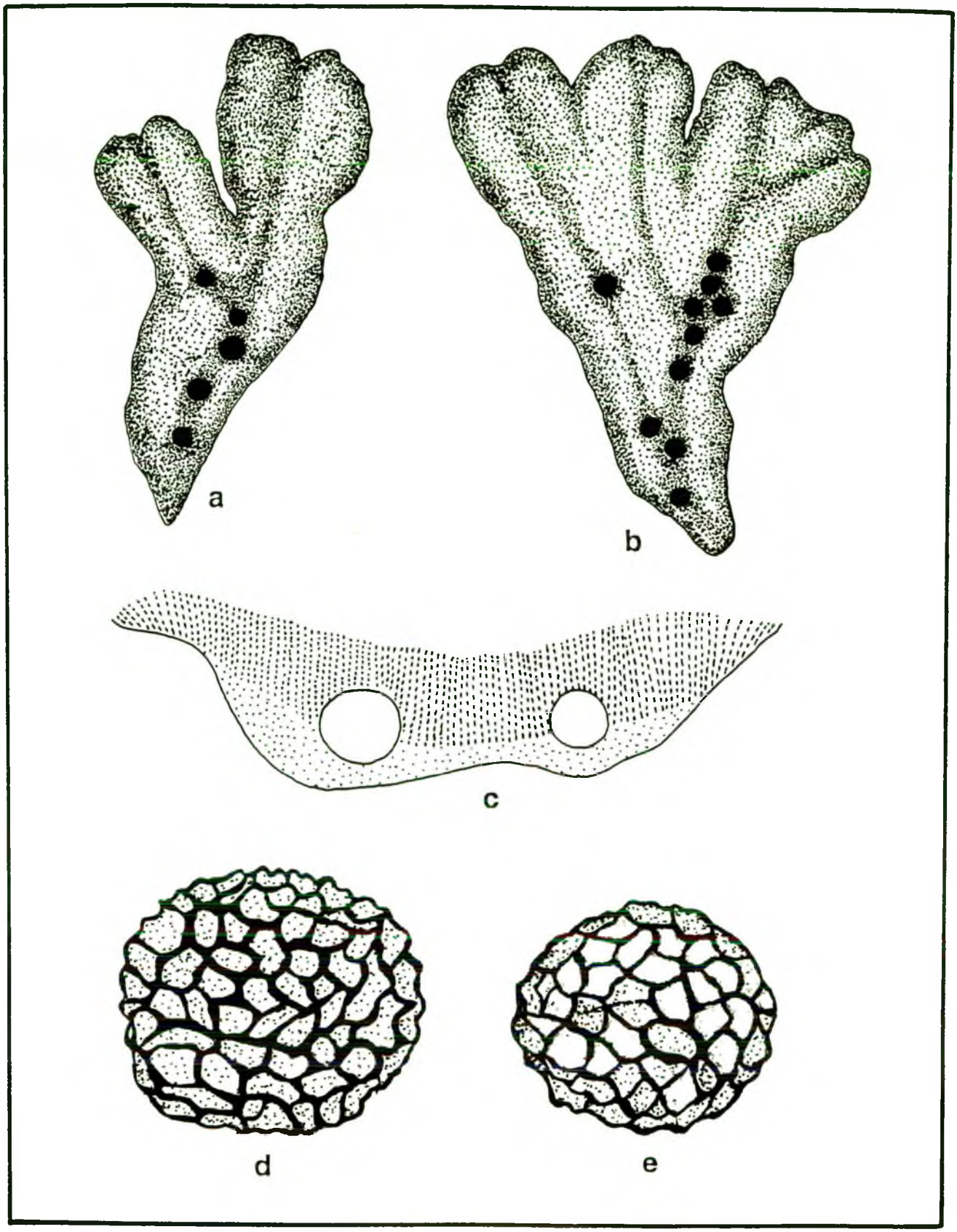
PLATE III



Riccia bengalensis Khan

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Riccia billardieri Mont. et N.

Riccia billardieri Mont. et N. Sp. Hep. 602, 1844-1847.
Riccia bulbifera St. Sp. Hep. 1: 24, 1898.

PLATE IV

SEM PLATE **1D**

Plant monoecious, both green and pale green, crowded together forming overlapping patches or incomplete rosette. Thallus both unbranched and branched dichotomously upto twice, branched with divergent lobes, thin, compact, margin wavy, dorsal groove narrow anteriorly and inconspicuous posteriorly, 6-12mm long and 2-5mm broad. Ventral scale redish, violet and distinct, semilunar, forming wave like thickening with some intervals. T.S. of the thallus 4-6 times as broad as high, convex ventrally, epidermal cells thin walled, ovoid, hyaline, cells in the assimillatory region are in column, with narrow air space. Anthereridia 1-3 seriate, projecting papilla. Archegonia also in 1-3 seriate with distinctly projecting neck. Sporangia ± dorsal, exposed by the rupture of the dorsal tissue. Spore purple redish, brown or opaque brown, 80-130μ in diameter, wall ornamentation thickly reticulate cart wheel like and forming 6-9 areolae across, wall not uniform throughout but projected distinctly, projection truncate or emerginate, covered by a delicate undulating membrane. Triradiate markings indistinct.

Specimens examined :

R. billardieri is a cosmopolitan species, abundantly found in the Bangladesh during rainy season.

Tangail : Santosh on drying ditch side soil, November 1984, 40, Md. Kamruzzaman (DUH).Microwave garden bed, July 1985, 159, Md. Kamruzzaman (DUH). Gopalpur, on Katcha plinth of a

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dwelling house, September 1985, 228, Md. Kamruzzaman (DUH). Madhupur, Barabaid Syed Ahmadia Orphanage's Agri-farm. November 1985, 244, Md. Kamruzzaman (DUH).

Dhaka : D.U. Science library approach road, Botany Department garden, Curzon Hall campus, July 1985, 219, Md. Kamruzzaman (DUH). Bakshibazar on damp soil of a house garden, August 1985,220, Md. Kamruzzaman (DUH). Wari, on garden soil, October 1985.

Jamalpur : Sharishabari, on damp soil on a bank of a river. February 1985, on fallow land, August, 1985; Agri-farm at Jamalpur town on Katcha road side soil, August 1985, 153, Md. Kamruzzaman (DUH).

Bandarban : Near bus stand, on damp soil, Meskichara side damp soil, and on the hill base damp soil of Meskichara; Near forest Banglow, on fallow land soil, October 1985, 168, Md. Kamruzzaman (DUH).

Rangamati : On lake side damp soil, on Mahalchari Road, on Manikchari and Shap chari on hill base, Ghagra near Army Check post on a drying chara; Kaptai, on garden soil of Forest Research Institute, October 1985, 100, Md. Kamruzzaman (DUH).

Gazipur : Kaliakoir, on house garden, October 1985, 84, Md. Zahid Hossain (DUH). Bangladesh Agricultural Research Institute garden on damp shady soil, January 1986, 226, Md. Kamruzzaman (DUH) Kashimpur, on the bank of the river Turag, January 1986, 227, Md. Kamruzzaman (DUH).

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Rajshani : Rajshahi town, on garden soil, November 1985, 81, Syed Hadiuzzaman (DUH).

Dinajpur : Ghoraghat, Rajbari, on fallow fields, December 1985, 109, Md. Kamruzzaman (DUH).

Panchagarh : Karotoa river side, on fallow land, near a bridge, December 1985, 110, Md. Kamruzzaman (DUH).

Thakurgaon : On garden soil near Sonali Bank main branch, December 1985, Md. Kamruzzaman (DUH). Tetulia bazar, on a Katcha plinth of dwelling house, December 1985, 127, Md. Kamruzzaman (DUH).

Bogra : Mohasthangarh, on shady damp soil, December 1985, 130, Md. Kamruzzaman (DUH).

Gaibandha : At Palashbari, on a fallow field and also in a mango garden, December 1985, 131, Md. Kamruzzaman (DUH).

Sirajganj : Near Bus stand, December 1985, 191, Md. Kamruzzaman (DUH).

Manikganj : On house garden soil, December 1985, 203, Abdul Mannan (DUH).

Pabna : On road side, partially shady slope near town, February 1986, 281, Md. Kamruzzaman (DUH).

Netrokona : Town side, Baraghat bridge side, March 1986, 282, Md. Kamruzzaman (DUH).

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dwelling house, September 1985, 228, Md. Kamruzzaman (DUH). Madhupur, Barabaid Syed Ahmadia Orphanage's Agri-farm. November 1985, 244, Md. Kamruzzaman (DUH).

Dhaka : D.U. Science library approach road, Botany Department garden, Curzon Hall campus, July 1985, 219, Md. Kamruzzaman (DUH). Bakshibazar on damp soil of a house garden, August 1985,220, Md. Kamruzzaman (DUH). Wari, on garden soil, October 1985.

Jamalpur : Sharishabari, on damp soil on a bank of a river. February 1985, on fallow land, August, 1985; Agri-farm at Jamalpur town on Katcha road side soil, August 1985, 153, Md. Kamruzzaman (DUH).

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Thakurgaon : On garden soil near Sonali Bank main branch, December 1985, Md. Kamruzzaman (DUH). Tetulia bazar, on a Katcha plinth of dwelling house, December 1985, 127, Md. Kamruzzaman (DUH).

Bogra : Mohasthangarh, on shady damp soil, December 1985, 130, Md. Kamruzzaman (DUH).

Gaibandha : At Palashbari, on a fallow field and also in a mango garden, December 1985, 131, Md. Kamruzzaman (DUH).

Sirajganj : Near Bus stand, December 1985, 191, Md. Kamruzzaman (DUH).

Manikganj : On house garden soil, December 1985, 203, Abdul Mannan (DUH).

Pabna : On road side, partially shady slope near town, February 1986, 281, Md. Kamruzzaman (DUH).

Netrokona : Town side, Baraghat bridge side, March 1986, 282, Md. Kamruzzaman (DUH).

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Sherpur : On Katcha plinth of a dwelling house at Bagdasha, March 1986, 283, Md. Kamruzzaman (DUH).

Khulna : Khalishpur, on damp soil of a house garden July 1986, 287, Md. Kamruzzaman (DUH).

Barisal : Shikerpur, Kashinathpur on both road sides, and in garden soil, December 1986, 253, Md. Kamruzzaman (DUH).

Madaripur : Panichatra Dakbanglow campus on garden soils, December 1986, 259, Md. Kamruzzaman (DUH).

Jhalakathi : In Women's college campus, December 1986, 271, Md. Kamruzzaman (DUH).

Patuakhali : Circuit house campus, on garden soil, December 1986, 272, Md. Kamruzzaman (DUH).

Chuadanga : In the college campus, on damp soil near a hand tubewell, May, 1988, Md. Kamruzzaman (DUH), Jadabpur, on the bank of the river Mathabhanga, May 1988, 261, Md. Kamruzzaman (DUH).

Cox's Bazar : Cox's Bazar, Govt. college side fellow damp soil, February 1989, 460, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Monoecious plant with ± dorsal sporangium.

ii) Spore large, 80-130 μ in diameter.

iii) Spore wall sculpturing reticulate, cart wheet like, end of reticulation projected and covered by thin membrane.

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PLATE IV

Riccia billardieri Mont. et. N.

a,b,c & d.	Thalli	10 x
e.	T. S. of thallus showing sporangial position	18 x
f & g.	Spores	300 x

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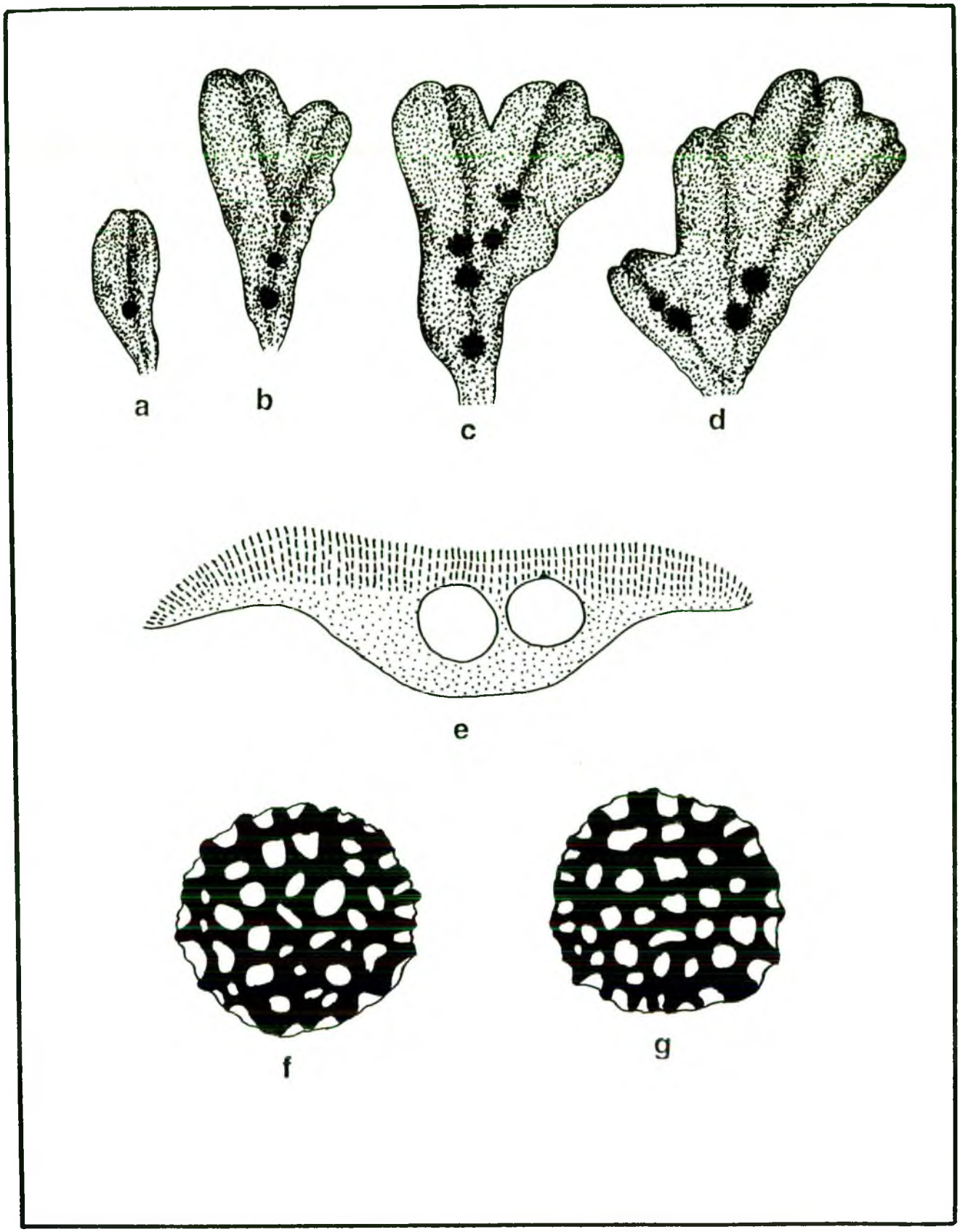
PLATE IV



Riccia billardieri M et. N.

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Riccia bogransis sp. nov.

PLATE V

SEM PLATE **2 A**

Monoica, herba viridis, irregulariter.

Thallus succulentus, sulcus dorsalis distinctus, nonramosus vel dichotome ramosus ab uno, usque 6mm longus et 2mm latus.

Thallus in sectione transversa plusminusve latior quam alta. Regio penaria tenuis, spatium intercellulosum distinctum.

Squamae absentes.

Antheridia biseriata

Archegonia uniseriata, aliquando biseriata.

Sporangia ventralia, sporae atrobrunneae, 70-85 μ in diam, ± triangulares, paries reticularis, reticulum latum, projectum 7-9 areolae dorsales.

Ala sinuata et crenata, usque 7 μ lata, perforata distincta, signa triadiates nondistincta.

Monoecious, plant green, in irregular patches.

Thallus fleshy, dorsal furrow distinct, unbranched or branched dichotomously for once, upto 6mm long and 2mm broad.

T.S. of thallus nearly double as broad as high. Storage region thin, intercellular space distinct.

Scales absent.

Antheridia biseriate.

Archegonia uniseriate, rarely biseriate.

Sporangia ventral, spores dark brown, 70-85 μ in diameter, ± triangular, wall reticulate, reticulation broad, projecting, 7-9 areolae across dorsally.

Wing wavy and crenate, upto 7 μ wide, distinctly perforated, triradiate marking not distinct.

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Specimens examined:

Bogra : Mahasthangarh, on damp soil, December, 1985. 167, Md. Kamruzzaman,Holotype (DUH).

Rangpur : Town side damp, fallow field, December 1985. 170, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus short, broad, fleshy, oval ventrally, with prominent dorsal furrow.

ii) Antheridial ostioles mostly curved and markedly projecting.

iii) Sporangium crowded, spore dark brown, reticulation thick walled, complete dorsally, ± thin walled reticulation ventrally and projecting at end. Wing wavy, crenate, having three perforations, one at each corner, of which one may break the outer border of the wing.

The species was named after the name of the district Bogra from which it was collected for the first time.

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PLATE V

Riccia bogransis sp. nov.

a, b, c & d.	Thalli	10 x
e & f.	T. S. of thalli showing sporangial position	36 x
g, h & i.	Spores	300 x

(g - ventral view, h & i - dorsal view)

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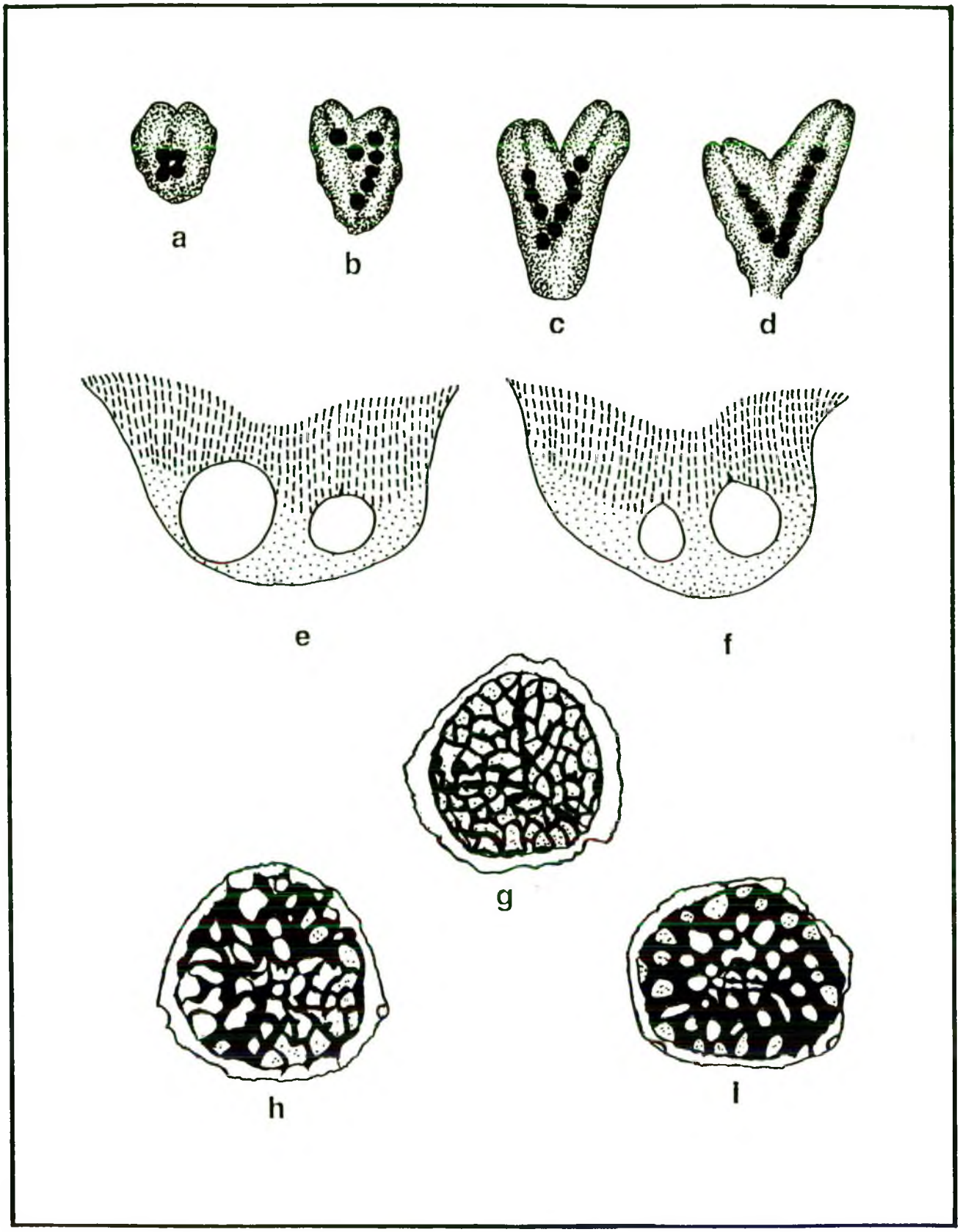
PLATE V



Riccia bogransis sp. nov.

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Riccia brunnea sp. nov.

PLATE VI

SEM PLATE

Monoica, herba rubro vel brunneo viridis, in colonia laxa.

Thallus succulentus, margio tenuis, laevis, nonramosus vel irregulare ramosus vel unidichotomus, 3-7mm longus et 0.75-1mm latus.

Squamae brunneae.

Thallus in sectione tranversa diplex vel triplex latior quam alta.

Antheridia in 1-2 seriebus disposita. Archegonia uniseriata.

Sporangium ventrales, atrobrunneum.

Sporae nigro-brunneae, 70-85 μ in diam, paries reticulum irregulare, 5-7 areolae dorsales.

Ala crenata, aliquando sinuata, usque 6 μ lata, signa triradiates distincta.

Monecious, plant redish or brownish green, colony loosely arranged.

Thallus flashy, margin thin, smooth, unbranched or branched irregularly or dichotomously once, 3-7mm long and 0.75-1mm broad. Scales brown.

T.S. of thallus 2-3 times as broad as high.

Antheridia 1-2 seriate. Archegonia uniseriate.

Sporangium ventral, dark brown.

Spore blackish brown, 70-85 μ in diameter. Wall reticulation irregular, 5-7 areolae across dorsally.

Wing crenate, sometimes wavy, upto 6 μ broad, triradiate marking distinct.

Specimens examined

Bandarban : Near Hilltop rest house, on hill side damp sandy soil, October, 1985. 90, Md. Kamruzzaman, Holo type (DUH).

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Rangamati : Near D.F.O. office, on damp soil, October, 1985. 93, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus distinctly redish or brownish green mostly unbranched, not forming any rosette or crowded patch.

ii) Hyaline scales in apical region and above reproductive structure distinct, brown scale prominent and encircling the margin of the thallus.

iii) Archegonia in single line and only 1-3 sporangia per thallus.

iv) Spore blackish, brown 70-85 μ in diameter. Triradiate markings very conspicuous, two arms of which shorter than that of the third.

The species was named after the brown colour character of the thallus.

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PLATE VI

Riccia brunnea sp. nov.

a, b & c.	Thalli	10 x
d & e.	T. S. of thalli showing sporangial position	18 x
f.	Scale	90 x
g,h,i & j.	Spores	300 x

(g, h - dorsal view, i & j - ventral view)

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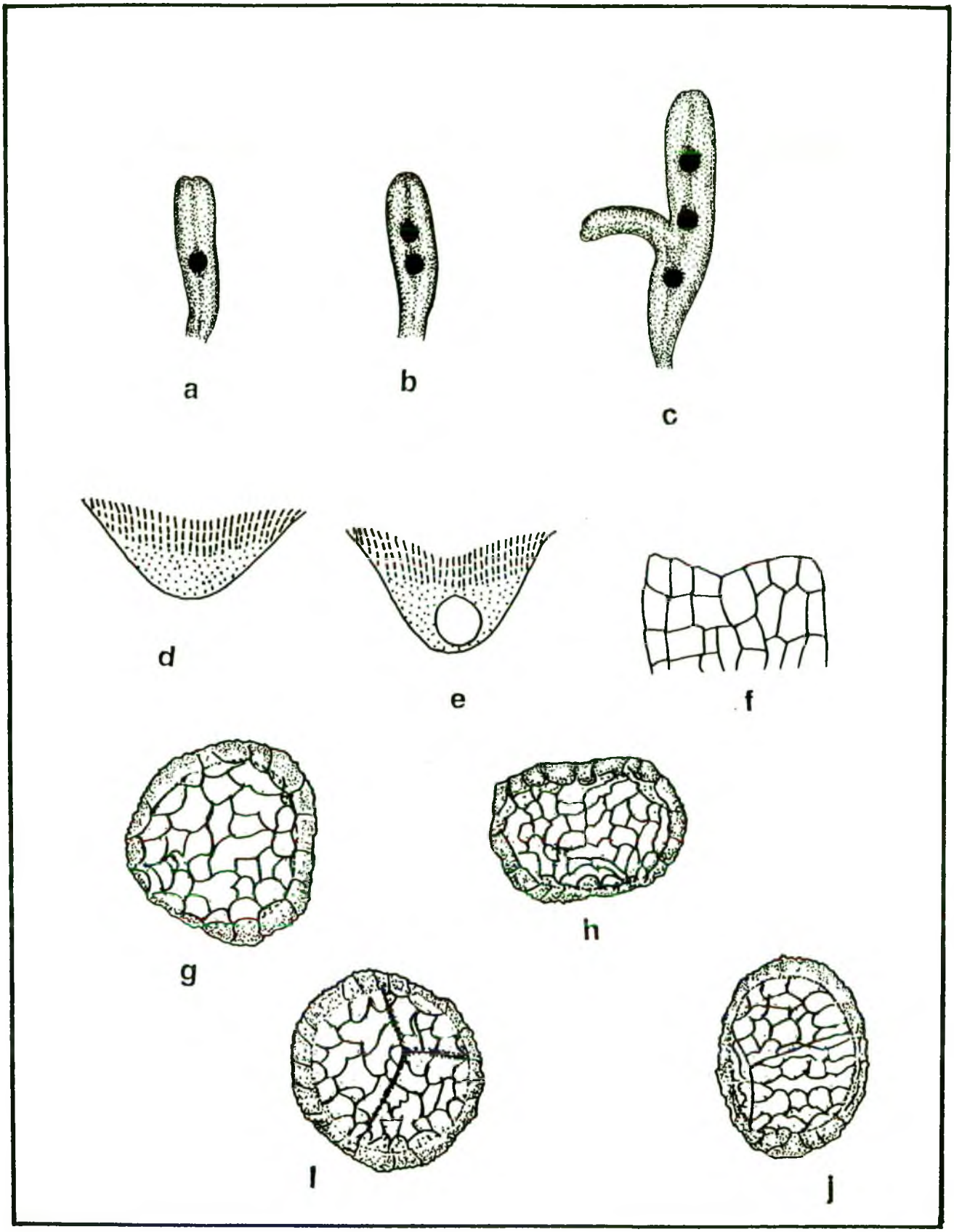
PLATE VI



Riccia brunnea sp. nov.

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Riccia chittagongensis sp. nov.

PLATE VII
SEM PLATE

Monoica, herba viridis, in colonia rosulata
Thallus succulentus, dichotome ramosus diplex, rare triplex, usque 6mm longus et 2mm latus.
Squamae hyaline, sub-roseae vel violaceae.
Thallus in sectione transversa latior quam alta.
Antheridia in 1-2 seriebus dispositus.
Archegonia in 1-2 seriebus dispositus.
Sporangia dorsalia, sporae atrobrunneae, 65-90 μ in diam.
Paries irregulare reticulatus, 5-8 areolae dorsalis.
Ala dentata, sinuata, usque 12 μ lata, perforata in angulis, signa triradiates non-distincta.

Monoecious, plant green, in rosette colony.
Thallus fleshy, branched dichotomously twice, rarely thrice, up to 6mm long and 2mm broad.
Scale hyaline, pinkish or violet in colour.
T.S. of thallus as broad as high.
Antheridia 1-2 seriate.
Archegonia 1-2 seriate.
Sporangia dorsal, spores dark brown, 65-90 μ in diameter.
Wall irregularly reticulate, 5-8 areolae across dorsally.
Wing dentate, wavy, up to 12 μ broad, perforated at corners, triradiate marking not distinct.

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Specimens examined :

Chittagong : Hat Hazari, on red damp soil, March 1988. 415, Professor Syed Hadiuzzaman, Holotype (DUH).

Cox's Bazar : Near Cox's Bazar Govt. College, on fallow land, April 1988. 436, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus short, broad, dorsal furrow prominently broad and deep. Scales hyaline, pinkish, violet, brittle and forming globose swollen mass.

ii) Air space broader at upper area and narrower below. Sporangium dorsal, sunken deeply in thallus tissue.

iii) Spore wall irregularly reticulated. Wing dentate wavy and irregularly perforated.

The species has been named after the port city Chittagong from which it was collected for the first time.

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PLATE VII

Riccia chittagongensis sp. nov.

a,b	Thalli	10 x
c, d	**T. S.** of thallus showing sporangial position	18 x
e	Scale	120 x
f, g	Spores	300 x

(f - dorsal view, g - ventral view)

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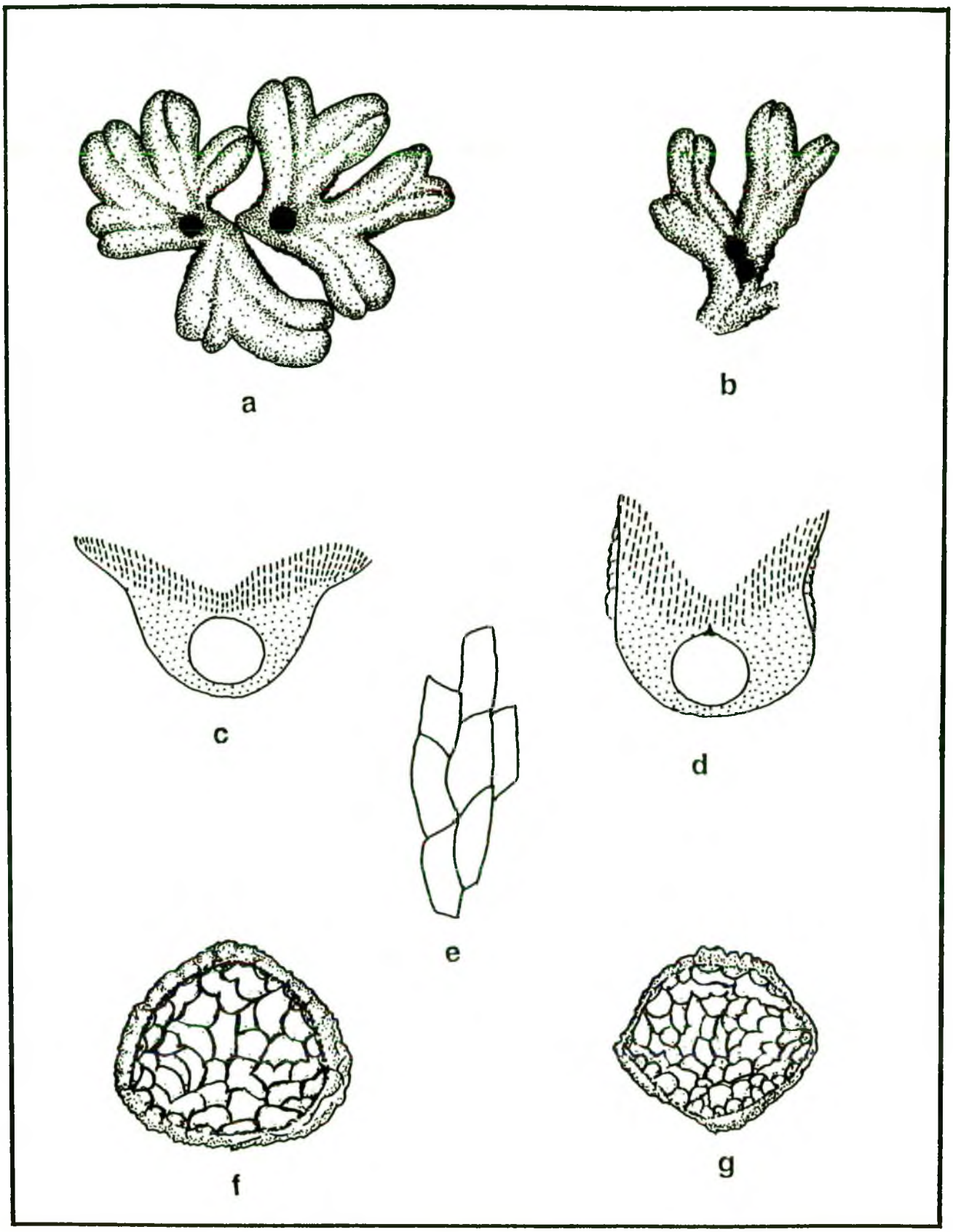
PLATE VII



Riccia chittagongensis **sp. nov.**

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Riccia compaginata sp. nov.

PLATE VIII

SEM PLATE **2 B**

Dioica, herba viridis, colonia superposita, irregularis.

Thallus linearis, planus.

Nonramosus vel ramosus usque duplex, usque 6mm longus et 1mm lata.

Squamae absente.

Thallus in sectione transversa plusminusve duplex latior quam alta. Regio assimilone crassior quam regio penaria.

Planta mascula plerumque nonramosus, cum plantis feminis consociata.

Antheridia in 2-3 seriebus disposita.

Archegonia 1-2 seriebus disposita.

Sporangia dorsalia, pauca.

Sporae variabilles, 78-90μ in diam, plerumque ± triangulares vel plusminusve ellipticae, brunneae vel flavobrunneae.

Paries linearis, ramosus, funiculosus, parum projectus, irregulare crassatus.

Signa triradiates conspicua. Ala crenata, dentatà, sinuata, 2-4μ lata non-equalis.

Dioecious, plant green, colony overlapping, irregular.

Thallus linear, flat.

Unbranched or branched upto 2 times, upto 6mm long and 1mm broad.

Scale absent.

T.s. of thallus nearly double as broad as high. Assimillatory region thicker than storage region.

Male plants mostly unbranched, grows in association with female plants.

Antheridia 2-3 seriate.

Archegonia 1-2 seriate

Sporangia dorsal, few in number.

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Spores variable, 78-90μ in diameter, mostly $\pm$ triangular, roughly elliptical, brownish or yellowish brown.

Wall linear, branched, looks like twisted rope, slightly projected a irregularly thickened.

Triradiate marking conspicuous, wing crenate, dentate, wavy, 2-4μ wide, uneven in thickness.

Specimens examined :

Rajshahi : Rajshahi Town - on old tubewell, tube surface as thick plant mass, March, 1987. 404, Professor Syed Hadiuzzaman, Holo-type (DUH).

Nawabganj : On brickroad, March 1987. 409, Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Dioecious green plants forming crowded mat like mass. Thallus crowded, the anterior parts distinctly errect, tough to separate one from neighbouring thallus of the colony.

ii) Male and female thalli grow in same colony.

iii) Sporangia dorsal, very few per colony.

iv) Spore yellowish brown, mostly triangular, wall ornamentation linear with rope like thickening, wing margin crenate, dentate, much broader in corner forming beak like extension.

The species has been named on the crowdy nature of thalli in the colony, and tough to separate one from the neighbouring thallus.

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PLATE VIII

Riccia compaginata sp. nov.

a.	Colony	10 x
b.	Male thallus	10 x
c, d & e.	Female thallus	10 x
f.	Female thallus	18 x
g.	T. S. of thallus showing sporangial position	36 x
h & i.	Spores	675 x

(h - ventral view, i - dorsal view).

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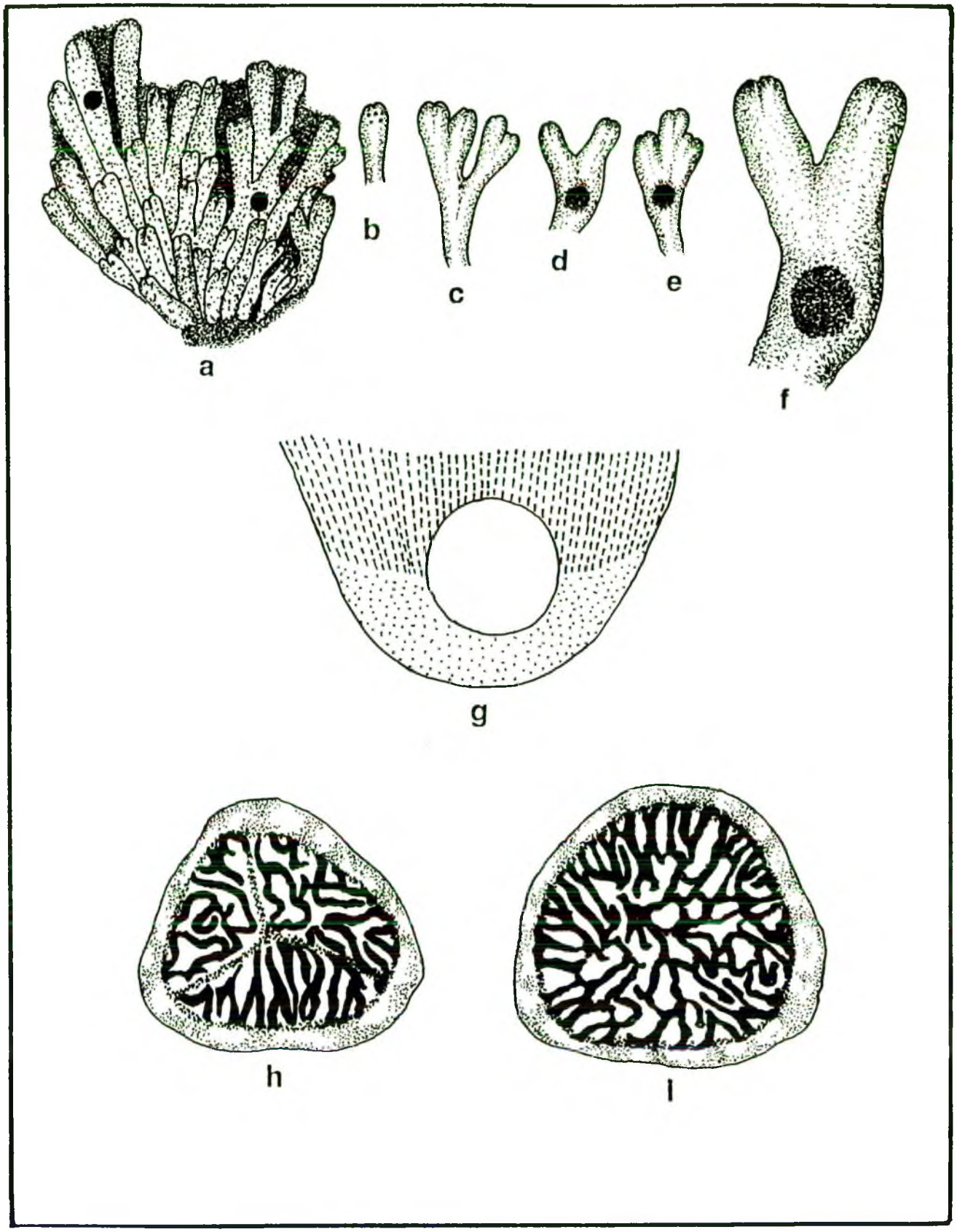
PLATE VIII



Riccia compaginata sp. nov.

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Riccia crundwellii sp. nov.

PLATE IX

SEM PLATE **2C**

382419

Dioica, herba ravidus viridibus, compacta, tagetes formane coloniae consociatae in una colonia magna usque unem metre.

Thallus linearis, ambo nonramosus et ramosus dichotome ab 1-2, usque 12mm longus et 2.5mm latus, sulcus dorsalis latus.

Tuberosus, margo sinuatus. Squamae brunneae.

Thallus in sectione transversa 3-5 latior quam alta, concavo-convex.

Antheridia 1-3 seriebus disposita, planta mascula plerumque non ramosa.

Archegonia uniseriebus disposita, papillae persistentes.

Sporangia ventralia, sporae paucae.

Sporae brunneae vel atrobrunneae, ± rotundae vel ovales, 95-135 μ in diam, paries reticularis, 5-9 areolae dorsales, ala tenuis et angusta.

Dioecious, plant greyish green, crowded, forming mat of very large colony extending upto a meter due to coalescence of colonies.

Thallus linear, both unbranched and branched dichotomously for 1-2 times, upto 12mm long and 2.5mm broad, dorsal furrow broad.

Tuber forming, margin wavy. Scales brown.

T.s. of thallus 3-5 times as broad as high, concavo convex.

Antheridia 1-3 seriate, male thallus mostly unbranched.

Archegonia uniseriate, papillae persistent.

Sporangia ventral, spores very few in number.

Spores brown to dark brown, ± round or oval, 95-135 μ in diameter, wall reticulate, 5-9 areolae across dorsally, wing thin and narrow.

ঢাকা
বিশ্ববিদ্যালয়
গ্রন্থাগার

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Specimens examined:

Dhaka : Wari - on damp soil in house garden as mat like growth, September, 1985. 36, Md. Kamruzzaman, Holotype (DUH).

Municipal Corporation campus on both damp and drying soil, December 1987. 397, Md. Kamruzzaman (DUH).

Tangail : In Shantikunja an old fallow house on damp soil, July, 1988. 413, Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Plant dioecious, greyish green, mat like colony, thallus linear, margin wavy, forming tuber both at apical and posterior regions, length of the thallus is very long due to addition of more segments from tubers.

ii) Sporangium ventral, very few in number, spore dispersal dorsally leaving shothole. Spore large, 95-135 μ in diameter.

iii) Spore wall reticulation shallow, end slightly projected, wing thin.

The species has been named in honour of the A.C. Crundwell, the well known bryologist of U.K.

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PLATE IX

Riccia crundwellii sp. nov.

a,b,c & d.	Thalli	10 x
a -	thallus without sporangium,	
b -	female thallus with sporangium,	
c -	thallus with terminal tuber and	
d -	male thallus .	
e.	Scale	120 x
f.	T. S. of female thallus showing sporangial position	36 x
g & h.	Spore	300 x

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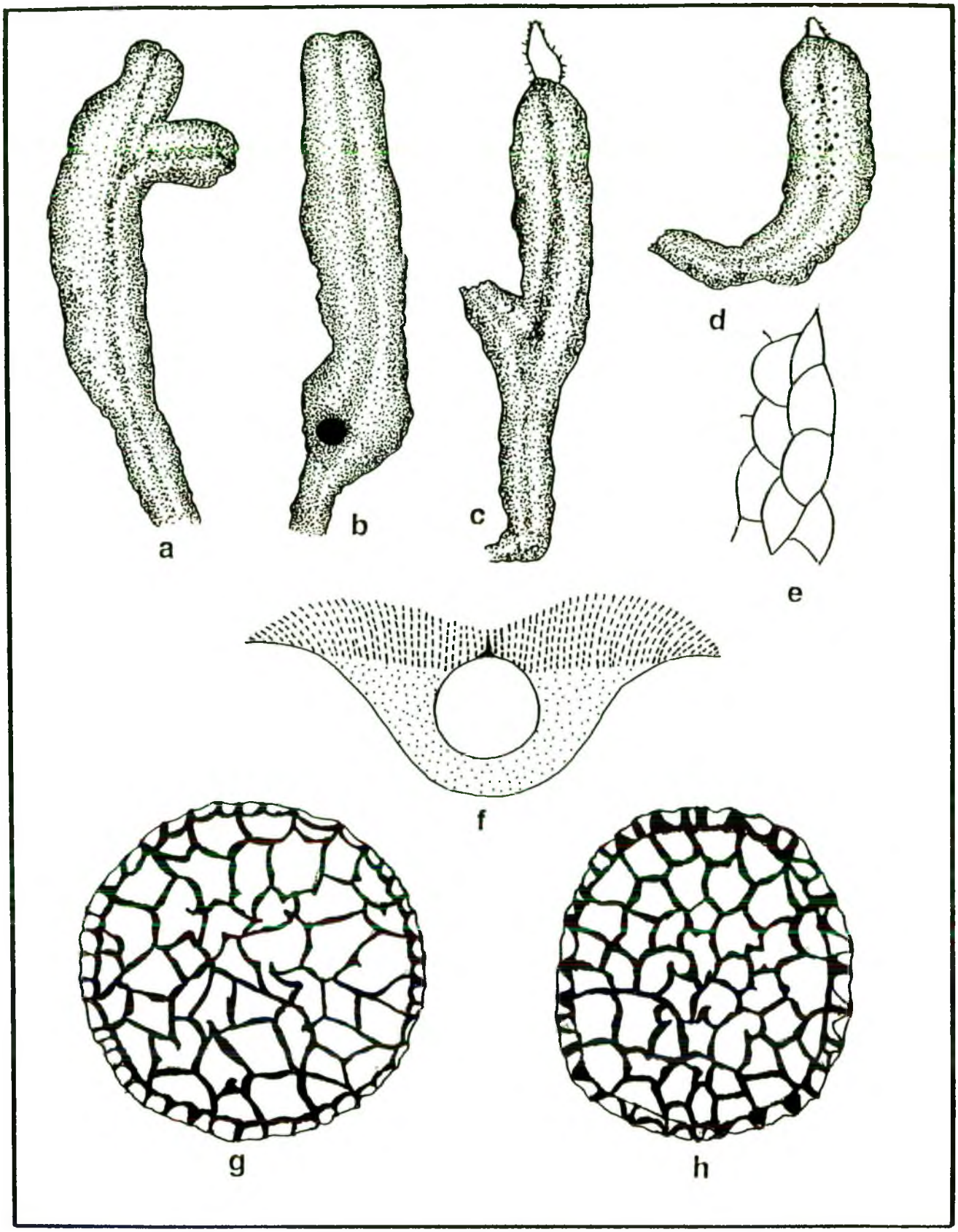
PLATE IX



Riccia crundwellii sp. nov.

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Riccia discolor L. et. L.

Riccia discolor L. et L. Pugill. 4:1. 1832.

Riccia golani Levier, Sp. Hepat. 6: 2, 1917-1924.

Riccia himalayensis St.(Ms) J. Bomb. Nat. Hist. Soc. 24: 349, 1916.

Riccia intermedia Jones, Trans. Brit. Bryol. Soc. 3: 208, 1957.

PLATE X

SEM PLATE **2 D**

Plant dioecious, dark green, compact, colony large, rosette, irregular, overlapping patches or forming compact mat on brick or soil, small colony also appear on brick road and fallow fields. Plant become pale green with brownish old part when dry. Female plant branched dichotomously for 2-3 times, 5-12 mm long, 15mm - 2mm broad, linear, obovate or oblong, lobes divergent. Dorsal furrow prevails throughout the length of thallus, margin wavy. Male plant smaller than female, 3-7mm long, 2-3.5mm broad, both unbranched and branched ± for once, dorsal groove present only in anterior region, margin both wavy and smoothly running. Scale violet, purple or hyaline, semilunar and bend over the margin resulting its purple color. Rhizoids numerous, both smooth and pegged walled. T.S. of thallus 2-4 times as broad as high. Air space narrow and slit like, epidermal cells hyaline. Vertical air space clearly found in between the columns of assimilatory cells. Storage region with parenchymatous cells without intercellular space, lower epidermis hyaline. Antheridia develop in the anterior region of the male thallus in 1-3 rows, pear shaped, ostiole long, hyaline, distinctly projecting above the surface of the thallus surface. Archegonia in one row on the dorsal furrow. Sporangium dorsal. Spore tetrahedral ± round,brown or opaque brown, reticulate, forming, 6-8 areolae. Triradiate marking inconspicuous or absent. Spore 90 μ to 130 μ in diameter, dehiscence dorsally.

Specimens examined:

Dhaka : Dhaka University Curzon Hall Campus: On damp brick and

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brick road. July 1985. 296, Md. Kamruzzaman; Dhanmondi: On damp garden soil, July 1985, 195 Md. Kamruzzaman (DUH).

Three Leader's Mazar side mosque campus: On brick and soil, July 1986. 298, Md. Kamruzzaman (DUH).

Jamalpur : Sharishabari bus stand, on fallow land, February, 1985. 126, Md. Kamruzzaman (DUH).

Dinajpur : Rajbari, on damp shady soil, February, 1986. 214 Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Plant dioecious with smaller, male plant, dorsal groove present only in the anterior region of the thallus in male plant and throughout the entire length of the female plant.

ii) Sporangium dorsal and in single row.

iii) Spore reticulate, wing absent.

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PLATE X

Riccia discolor L. et. L.

a, b, c	Female thalli	10 x
	d - Male thallus	10x
e.	T. S. of thallus showing sporangial position	18 x
f & g.	Spores	200 x

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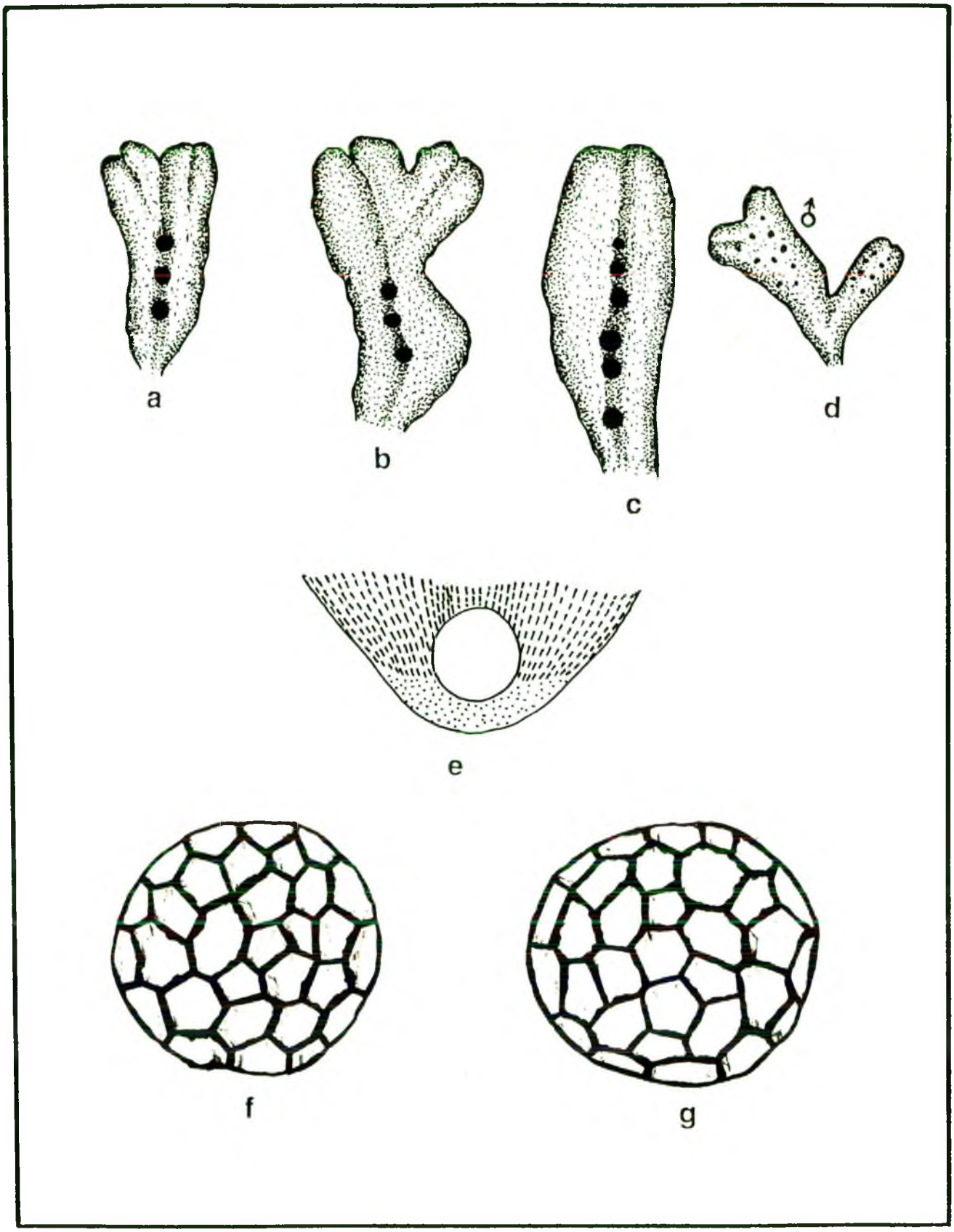
PLATE X



Riccia discolor L.

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Riccia elliptica sp. nov.

PLATE XI

SEM PLATE **3 A**

Monoica, herba brunneo-viridis, colonia non formans.

Thallus incrassatus, ± ellipticus, ± acutus ad apicem, margo-atrobrunneus, dentatus, non-ramosus vel ramosus, irregularis, usque 9.5mm longus et 3mm latus.
Squamae hyalinae et brunneae.
Thallus in sectione transversa triplex latior quam alta.
Antheridia in 2-3 seriebus disposita.
Archagonia in 1-2 seriebus disposita.
Sporangia ventralia, Sporae nigrobrunneae, rotundae vel ovales, 90-105 μ in diam, reticulatae, 5-9 areolae dorsales. Signa triradiates absens. Ala absens.

Monoecious, plant brownish green, not in colony.
Thallus thick, ± elliptic, apex ± pointed, margin deepbrown, toothed, unbranched or branched, branching unequal. Upto 9.5mm long and 3mm broad.
Scale hyaline and brown.
T.S. of thallus 3 times as broad as high. Storage region thicker than assimilatory region.
Antheridia 2-3 seriate.
Archegonia 1-2 seriate.
Sporangia ventral. Spores blackish brown or ± oval, 90-105 μ in diameter, reticulate, 5-9 areolae across dorsally. Triradiate marking absent. Wing absent.

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Specimens examined:

Madaripur : Road side and old house campus near C&B office on damp soil, December 1986. 117, Md. Kamruzzaman, Holotype (DUH).

Faridpur : Near bus-stand, on road side damp soil, January 1989, 475, Md. Kamruzzaman (DUH).

Pabna : Near Cadet College on damp soil, January 1989, 491, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Plant not forming any organized colony, thallus ± elliptical, broadly linear, ovate, ± pointed at apex, margin dentate.

ii) Sporangium ventral.

iii) Spore wall reticulate, forming many honey-comb like structure, reticulation projecting and blunt ended.

iv) No wing and triradiate markings.

The species has been named on the elliptical shape of the thallus.

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PLATE XI

Riccia elliptica sp. nov.

a, b, c & d.	Thalli	10 x
e.	Scale	120 x
f.	T. S. of thallus showing sporangial position	36 x
g & h.	Spores	300 x

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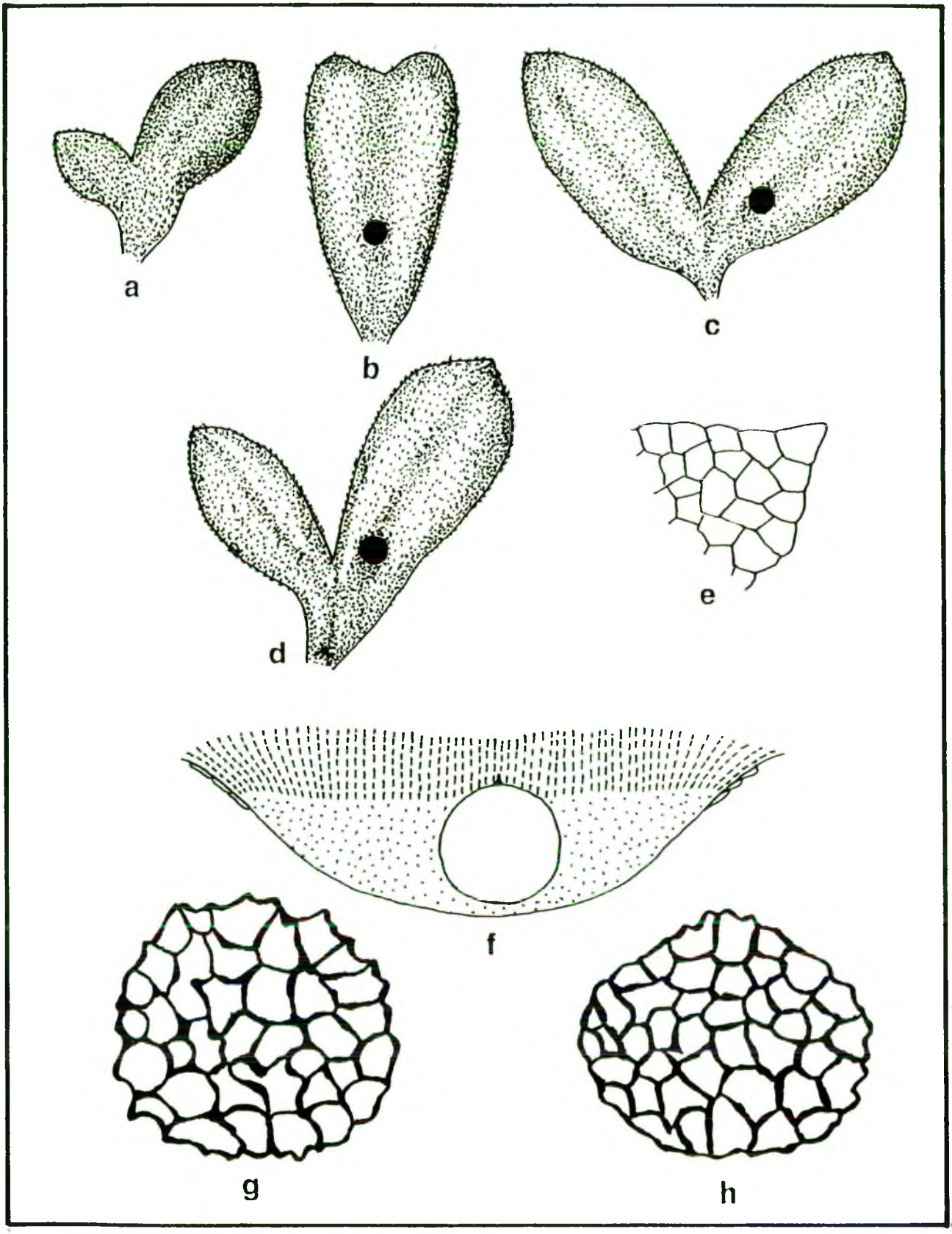
PLATE XI



Riccia elliptica sp. nov.

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Riccia frostii Aust.

Riccia frostii Aust. Bull. Torrey Bot. Cl. 6:17,1875.
Riccia watsonii Aust. Bull Torrey Bot. Cl. 6:17,1875.
Riccia frostii var. major Undrew, Bot. Gaz. 19: 273, 1894
Riccia beclaeriana St. Spec. Hepat. 1: 49, 1898.
Riccia sanguinea Kash, Jour., Bomb, Nat. Hist. Soc. 24: 1916.

PLATE XII
SEM PLATE **3 B**

Dioecious, Male plant light redish or yellowish green, forming rosettes, irregular patch due to coalesce of more than one colonies, some times growing in association with female plants as an individual thallus or as less developed colony or as overlapping patches. Colony 0.5 cm - 1.2 cm in diameter. Thalli small, thick, fleshy, linear, club shaped, branched, dorsal furrow shallow and situated at the anterior region, scale absent. Antheridia distinctly visible, 2-4 seriate, oval or round with distinct ostiole and distinct spotted mark area visible from where an antheridia recently has discharged its antherozoids. Female plants mainly olive green, green or yellowish green forming button like beautiful complete rosette and larger than that of the redish green male colony. Some times a good number of colony remains crowded together to form irregular patch and generally up to 3 cm or sometimes more in diameter. Thallus linear upto 5mm long thick fleshy, oblong or obovate, forked for 1-3 times, lobes divergent, dorsal groove shallow, occasionally narrow and short, surface flat or slightly convex ventrally. Scale absent. T.S. of the thallus 2-4 times or more as broad as high with broad and thick margin, assimillatory cells in column, with slit like air chambers alternating assimillatory filaments. Epidermal cells are hyaline, single layered, some times disrupted, cells in the storage region are also parenchymatous.

Archegonia 1-2 seriate, neck prominently projecting, sporangia dorsal, brown to blackish brown and on maturity distinctly visible from dorsal surface, capsule wall

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brittle when mature, dehiscence of spores through dorsal surface by the rupturing of the dorsal tissue. Spore tetrahedral, small, dark brown or opaque, many in number per capsule, not uniform in shape, mostly and broadly pentagonal, some are also ± round or roughly triangular, 45-55 μ in diameter, wall ornamentation on dorsal surface is of different types to that of ventral face due to flatness as well as presence of projecting angle like area in ventral surface, linear, very irregularly developed and also inconspicuous, spore winged, wing crenate or smooth at margin, 2-3.5 μ wide, mostly broader at the corners. Triradiate marking conspicuous.

Riccia frostii Aust. commonly available in the country during the months of October to June, of the year. It prefers sandy, alluvial or alluvial-sandy soils and flourish at such a style and number as if the stars spreading in the sky, especially on the river banks, charland, drying fallow lands etc.

Specimens examined:

Jamalpur : Sharishabari, on a canal side damp soil near bazar, October 1984, 52, Md. Kamruzzaman (DUH). On the bank of the river Subarnatali, June 1986, 171, Md. Kamruzzaman (DUH). Near Jamalpur Circuit House on the bank of the river Brahmaputra. Nov. 1986, 187, Md. Kamruzzaman (DUH).

Dhaka : Kashimpur at wheat field edge, February 1984, 06, Md. Kamruzzaman (DUH). Kashimpur on old irrigation Katcha drain. February 1985, 17, Md. Kamruzzaman (DUH). Kashimpur on the cutting edge of wheat field, March 1985,33, Md. Kamruzzaman (DUH). Tongi on the bank of the river Turag, February 1985, 21, Md. Kamruzzaman (DUH). Kaliganj - on road side damp soil, October 1985, 74, Md. Kamruzzaman (DUH).

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Tangail : Sonat, on drying field, February 1985, 24, Md. Kamruzzaman (DUH), near park maidan on sandy soil, February 1985, 25, Md. Kamruzzaman (DUH). Lauhajang river, on sandy soil, near Tangail Stadium, February 1985, 26, Md. Kamruzzaman (DUH). Ghatail, on the side of an irrigation drain February 1985, 41, Md. Kamruzzaman (DUH). Karatia canal side. February 1986, 111 Md. Kamruzzaman, Santosh, Paulpara on canal bed damp soil, October 1985, 112, Md. Kamruzzaman (DUH). Bhuapur, at ferryghat on sandy soil, November 1986, 233, Md. Kamruzzaman (DUH). Elasin, on the bank of the river Dhaleswari and at Dharabari on the bank of the branch of the river Dhaleswari, December 1986, 235, Md. Kamruzzaman (DUH).

Bandarban : On the bank of the river Shankha, near bazar ghat, October 1985, 157, Md. Kamruzzaman (DUH).

Rajshahi : On the bank of the river Padma, near Rajshahi town Mukhdum Shah Mazzar, January 1986, 206, Md. Rafiqul Islam (DUH).

Dinajpur : Tetulia, on sandy drying bed of a ditch, December 1985, 124, Md. Kamruzzaman (DUH).

Sirajganj : On the bank of the river Jamuna at Ferry ghat point, December 1985, 232, Md. Kamruzzaman (DUH).

Bogra : Nalka Ferry ghat point on damp sandy soil, February 1985. Md. Kamruzzaman (DUH). Karatiabari, on the river side damp soil, February 1985, 145 Md. Kamruzzaman (DUH).

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Rangpur : Ghoraghat, on the side of a drying ditch, December 1985, 146, Md. Kamruzzaman (DUH).

Manikganj : Town side, on drying ditch bed sandy soil, Mr. A. Mannan, February 1985, 41, (DUH). Ferryghat soil, December 1986, 164 Md. Kamruzzaman (DUH).

Pabna : Pabna town side, on the bank of a derilinked pond, February 1986, 201, Md. Kamruzzaman (DUH).

Mymensingh : On the bank of the river Brahmaputra at ghat point, March 1986, 210, Md. Kamruzzaman (DUH).

On the bank of the river Dasha, March 1986, 211 Md. Kamruzzaman (DUH).

Netrokona : On the bank of the river Mogra, March 1986, 235, Md. Kamruzzaman.

Barisal : Shikarpur, on the river bank, November 1986, 241, Md. Kamruzzaman (DUH).

Madaripur : Panichatra, near mosque, under a culvert, November 1986, Md. Kamruzzaman (DUH).

Faridpur : Daulatdia ghat, on sandy soil, November 1986, 171, Md. Kamruzzaman (DUH); near V.T.I. on fallow jute field, November 1986, 172, Md. Kamruzzaman (DUH), on the river bank, November 1986, 173, Md. Kamruzzaman (DUH).

Patuakhali : On the katcha plinth of a house in the town near Banani Hotel,

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December 1986, 155, Md. Kamruzzaman (DUH).

Jhalakathi : Sadar upazila - complex, on shady damp soil, December 1986, 162, Md. Kamruzzaman (DUH).

Sylhet : On the bank of the river Surma at Surma bridge point, February 1986, 261, Md. Kamruzzaman (DUH). Fenchuganj - In Hakaluki Haor, near village - Gillachara on damp soil, February 1986, 262, Md. Kamruzzaman (DUH). Zaflong: on the drying river bed of the river Bhalla, February 1986, 263, Md. Kamruzzaman (DUH). Zaintapur, near village Uzan Nagar on drying beel basin, February 1986, 264, Md. Kamruzzaman (DUH).

Sunamganj : Hasan Nagar on damp soil of a drying ditch, February 1986, 271, Md. Kamruzzaman (DUH).

Habiganj : On the bank of the river Khowai near Khowai bridge, February 1986, 277, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Dioecious plants forming button like complete rosette or irregular patch of redish green male colony and yellowish olive green or olive green female colony in large number on drying river basin and embankments, fallow lands especially on sandy alluvial soil substrata.

ii) Male plant redish, antheridia in 2-5 lines, and distinctly visible on dorsal side.

iii) Female plant bears clear blackish brown sporangia dorsally, spore sculpturing linear, anastomosing. Triradate extension well developed ventrally.

PLATE XII

Riccia frostii Aust.

a & b.	Thallus	10 x
c.	Colony	10 x
d.	Male thallus	18 x
e & f.	T. S. of thallus showing sporangial position	36 x
g,h,i,j,k& l.	Spores	270 x

(g, h, i - ventral view. j, k & l - dorsal view)

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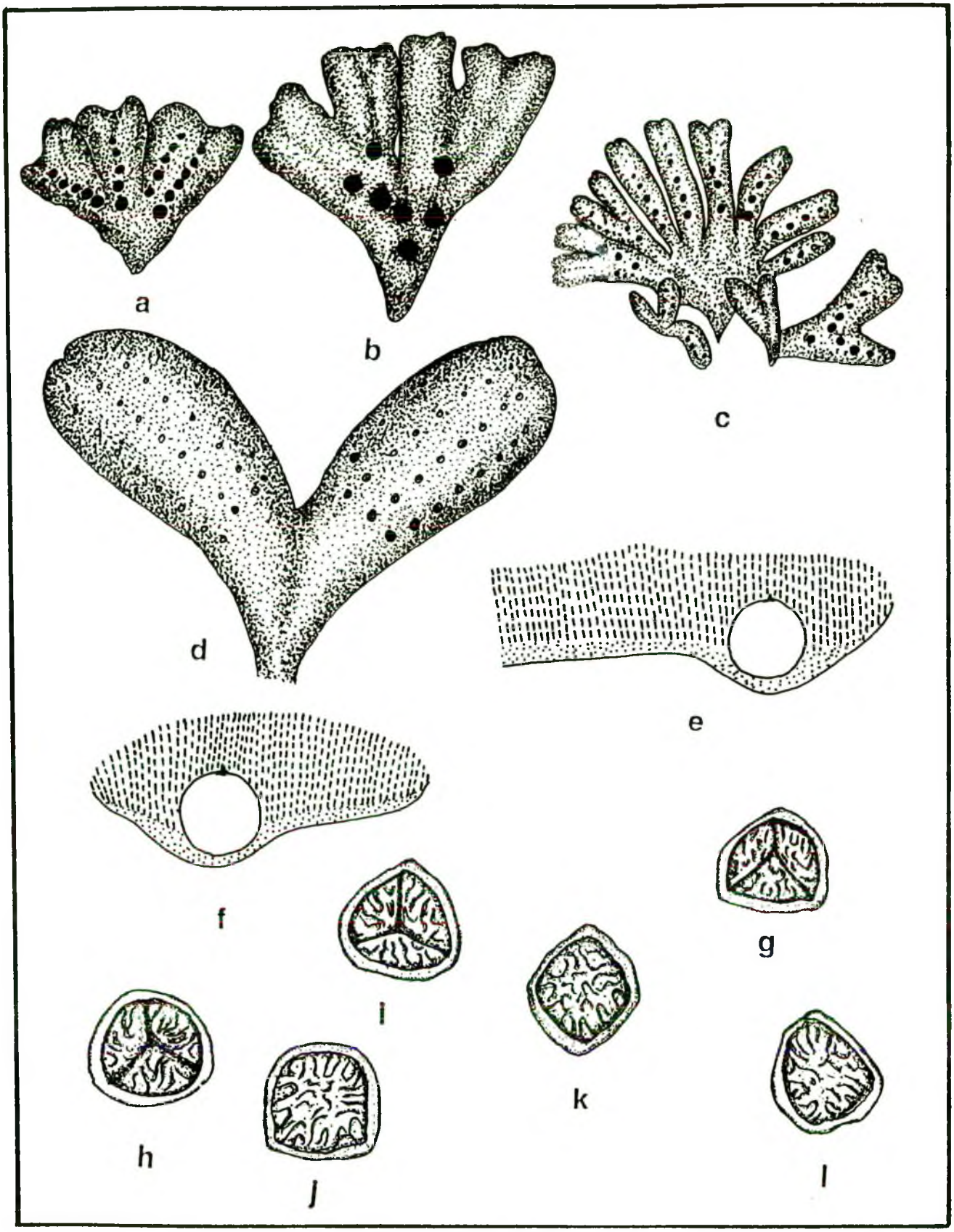
PLATE XII



Riccia frostii Aust.

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Riccia gangetica Ahmad

Riccia gangetica Ahmad.Curr. Sci.11: 433, 1942.

PLATE XIII

Plant monoecious, bluish green, growing both single or forming irregular patches and very rarely forming rosette. Individual segment fleshy, broader anteriorly, narrower posteriorly, dorsal furrow prominent and extending throughout the thallus length, margin brown, wavy, 0.4-1.1cm long and 2-4mm broad; thalli both unbranched or branched dichotomously for 1-2 times. Scale hyaline, violet or redish brown. T.s. of thallus broadly convex ventrally, 1.5-3 times as broad as high. Cells in the assimillatory regions in column, air space narrow, epidermal cells hyaline, oval, spherical or rarely flatened. Antheridia 1-3 seriate, ostiole conspicuously projecting along the dorsal furrow in anterior region. Archegonia also 1-3 seriate, but in most thallus in single row along the mid dorsal line with distinctly projecting neck. Sporangia ventral, blackish brown, deeply embedded in thallus tissue. Spores tetrahedral, blackish brown, $\pm$ round, triangular or oval, 5-9 areolae across; projection conspicuous at margin, reticulation both thick and thin walled, spore 90 μ to 120 μ diameter. Wing absent.

Specimens examined:

Rajshahi : Padma river bank on damp soil, November 1985. 137, Professor Syed Hadiuzzaman (DUH).

Dhaka : Balda Gardens on damp garden soil, July 1986. 285, Md. Kamruzzaman (DUH).

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Distinguishing characters

i) Thallus bluish green, fleshy, margin brownish & wavy, dorsal furrow distinctly developed throughout the thallus length.

ii) Spore with dentate projections, reticulation both thick and thin walled, 90 μ to 120 μ in diameter.

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PLATE XIII

Riccia gangetica Ahmad

a, b & c.	Thalli	10 x
d.	T. S. of thallus showing sporangial position	36 x
e & f.	Spores	270 x

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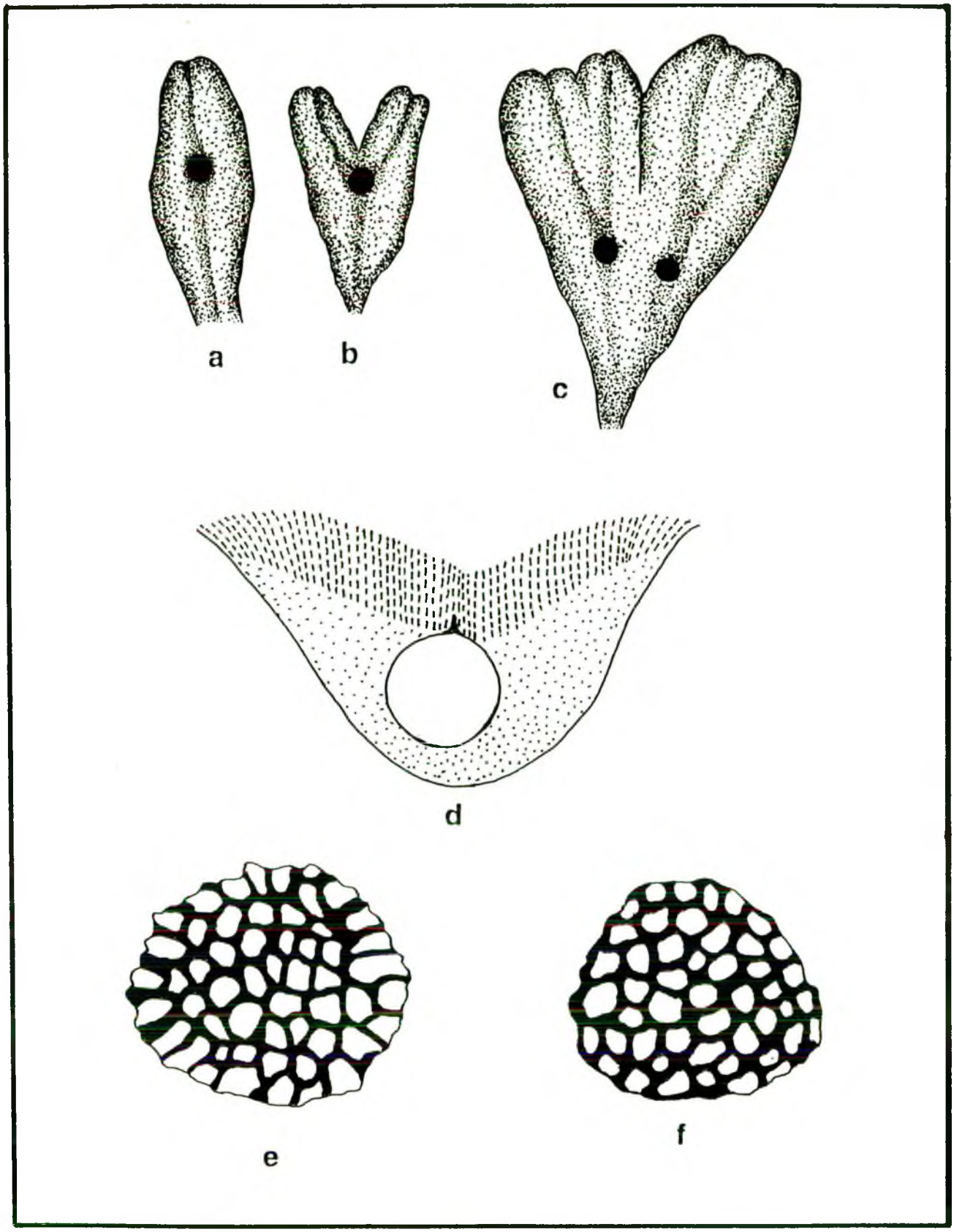
PLATE XIII



Riccia gangetica Ahmad

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Riccia gangulii sp nov.

PLATE XIV

SEM PLATE **3C**

Monoica, herba pallide viridis in colonia rosulata.

Thallus nonramosus vel ramosus, dichotomus usque duplex, 3-6.5mm longus et 1.5-3.5μ latus. Ciliatus, cilia fragilis, acutus ad apicem, hyalinus, 70-130 μ longus.

Squamae hyaline.

Thallus in sectione transversa 3-5 latior quam alta.

Antheridia in 2-3 seriebus disposita.

Archegonia 1-3 seriebus disposita.

Sporangia dorsales, flavo-brunneae, numerosa.

Sporae flavo-brunneae, 60-98μ in diam, paries reticulatus, 7-11 areolae dorsales, ala levis, et sinuata 7-12 μ lata.

Monoecious, plant light green in rosette colony.

Thallus unbranched or branched, dichotomy upto 2 times, 3-6 5mm long and 1.5-3.5μ broad. Ciliated, cilia brittle, pointed at tip, transparent, 70-130 μ long.

Scales hyaline.

T.S. of thallus 3-5 times as broad as high.

Antheridia 2-3 seriate.

Archegonia 1-3 seriate.

Sporangia dorsal, yellowish brown, many.

Spores yellowish brown, 60-98 μ in diameter, wall reticulate, 7-11 areolae across dorsally, wing smooth and wavy, 7-12 μ broad.

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Specimens examined

Kishoreganj : Near Gurudayal college, on drying ditch side damp soil, March, 1987, 451, Md. Abdul Hassan, Holo type (DUH).

Pakundia, on ditch side damp soil March 1987, 452 Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus broad anteriorly and gradually narrow posteriorly, dorsal furrow deep in anterior region and absent in posterior part, branched or unbranched, dichotomy upto twice.

ii) Thallus thin, 3-5 times as broad as high, cilia blunt.

iii) Sporangium distinct, both crowded and in lines, spore yellowish brown, reticulation thick, both complete and incomplete, 7-11 areolae across, wing both wavy and smoothly running, upto 12 μ broad.

The species has been named after the name of the famous Indian brylogist H.C. Ganguli.

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PLATE XIV

Riccia gangulii sp. nov.

a, b, c & d.	Thalli	10 x
e & f.	T. S. of thallus showing sporangial position	36 x
g & h.	Cilia	120 x
i.	Scale	90 x
j, k & l.	Spores	675 x

(j, k - dorsal view l - ventral view)

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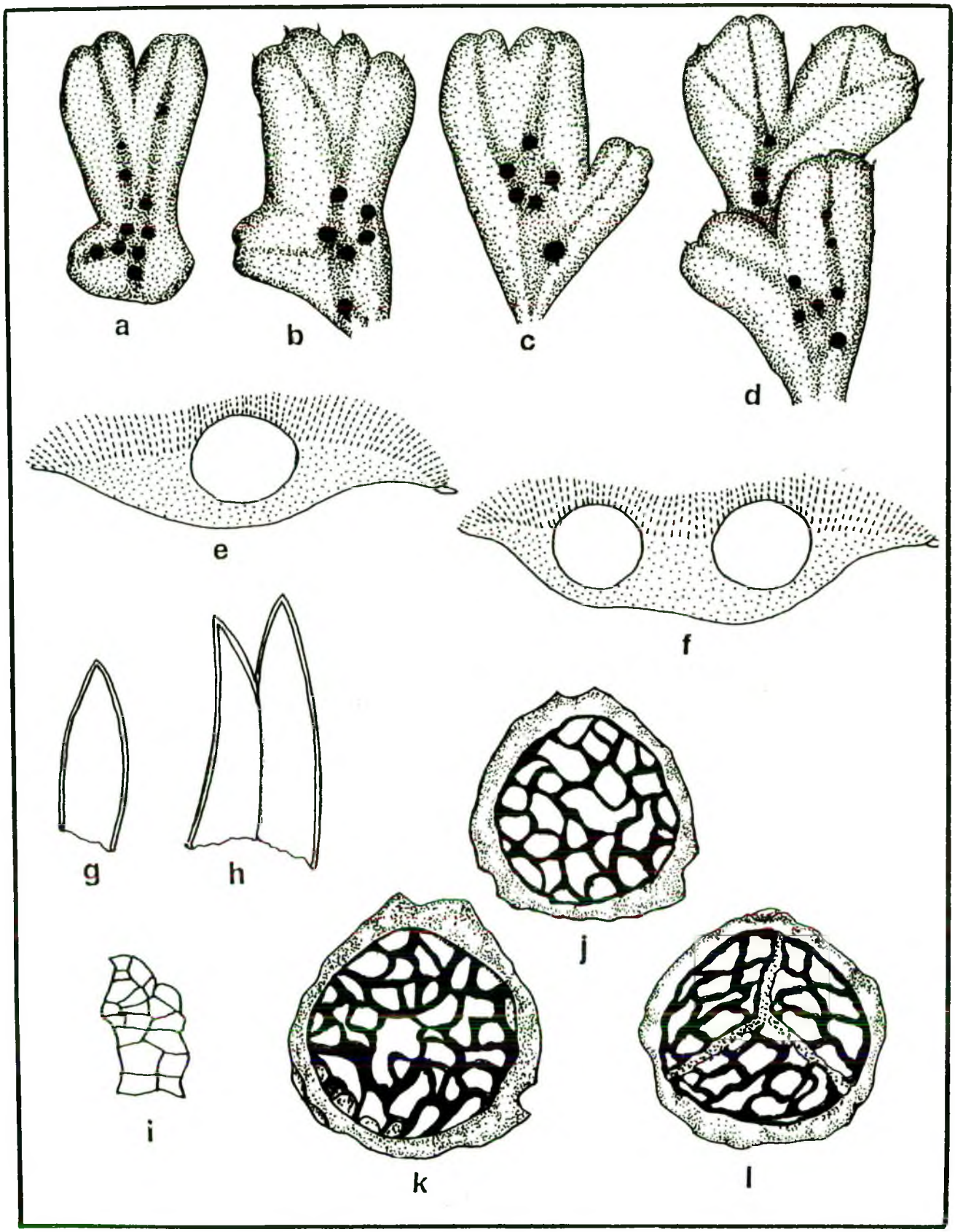
PLATE XIV



Riccia gangulii sp. nov.

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Riccia gopalpurensis sp. nov.

PLATE XV

SEM PLATE **3 D**

Monoica, herba viridis,in colonia rosulata vel superpositas.

Thallus nonramosus vel dichotome ramosus usque diplex, usque 7mm longus et 2mm latus.

Squamae absentes .

Thallus in sectione transversa ± diplex latior quam alia.

Antheridia in 1-3 seriebus dispositus .

Archegonia in 1-3 seriebus dispositus.

Sporangia dorsalia, sporae liberatae per regionem dorsale .

Sporae nigro brunneus, 72-95.5 μ in diam. Paries reticulatus, 9-12 areolae dorsales.

Ala 5-6 μ lata, signa triradiates distincta.

Monoecious, plant green in rosette colony or overlapping.

Thallus unbranched or branched dichotomously upto 2-times, upto 7mm long and 2mm broad.

Scale absent.

T.S. of thallus nearly double as broad as high.

Antheridia 1-3 seriate.

Archegonia 1-3 seriate.

Sporangia dorsal, spores release through dorsal region.

Spores blackish brown, 72-95.5 μ in diameter. Wall reticulate, 9-12 areolae dorsally.

Wing 5-6 μ broad, triradiate marking distinct.

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Specimens examined:

Tangail : On damp soil under direct sunlight on Gopalpur-Bhuapur road, July 1985. 01, Md. Kamruzzaman, Holotype (DUH).

Madhupur : On Madhupur forest floor, July, 1985. 19, Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Thallus branching divergent. Apex broadly truncate, dorsal suture very shallow or sometimes indistinct.

ii) T.S. of thallus mainly plano convex, margin slightly curved ventrally.

iii) Sporangium enormously produced per thallus, both thinly spread or crowded, mostly leaving no space in between.

iv) Spore wall sculpturing differ substantially from dorsal face to ventral face. 9-12 areolae develop dorsally, wing wavy and ruptured. Spores release dorsally.

The species has been named after the locality Gopalpur from which it was collected for the first time.

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PLATE XV

Riccia gopalpurensis sp. nov.

a, b, c & d.	Thalli	10 x
e & f.	T. S. of thalli showing sporangial position	36 x
g, h, i & j.	Spores	300 x

(g & h - ventral view, i & j - dorsal view)

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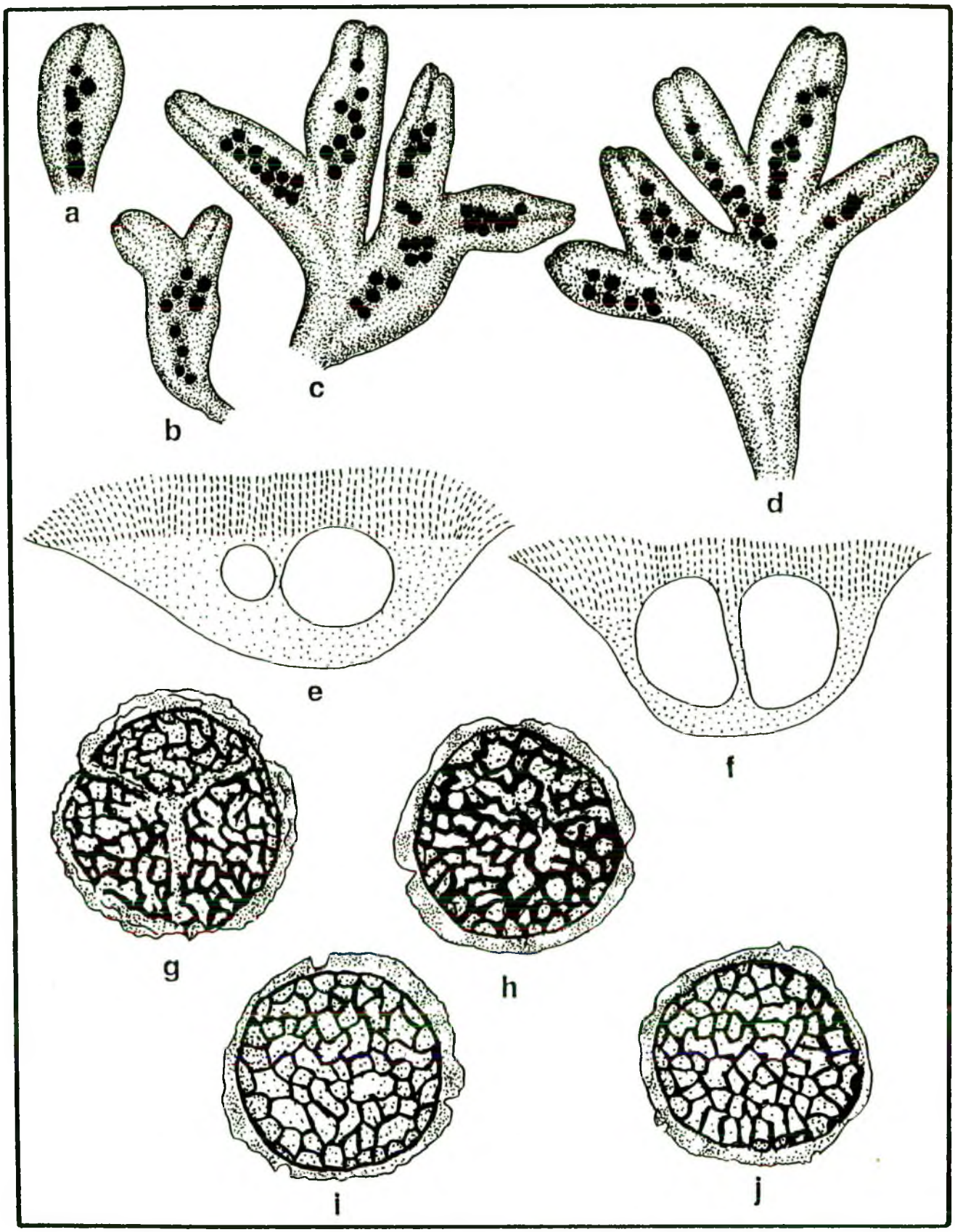
PLATE XV



Riccia gopalpurensis sp. nov.

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Riccia hasnabadii sp. nov.

PLATE XVI

SEM PLATE **4 A**

Dioica herba atroviridis, colonia magna, rosulata et irregularis.
Thallus ± linearis emerginatus ad apicem. Non ramosus vel ramosus, usque duplex, usque 8mm longus et 1-2mm latus. Squamae hyalinae. Thallus in sectione transversa duplex vel triplex latior quam alta, latior convexus ventraliter. Cellulae epidermales ovales et parum papillosae.
Planta mascula nonramosus, cum plantis feminis consociata.
Antheridia in 1-3 seriebus disposita.
Archegonia uniseriebus disposita.
Sporangia dorsalia, sporae magnae, 85-140 μ in diam ovales vel rotundae, atrobrunneae. Paries reticularis, reticulum incrassatum, 7-10 areolae dorsales, Ala absens .

Dioecious, plant deep green colony large, rosette and in irregular patches.
Thallus ± linear, apex emerginate.
Unbranched or branched, up to 2 times, upto 8mm long and 1-2mm broad.
Scale hyaline.
T.s. of thallus 2-3 times as broad as high, broadly convex ventrally.
Epidermal cells oval and slightly papillose.
Male plant mostly unbranched, grows in association with female plants.
Antheridia 1-3 seriate. Archegonia uniseriate.
Sporangia dorsal, spore large, 85-140 μ in diameter, oval or round, dark brown.
Wall reticulate, reticulation thick, 7-10 areolae across dorsally, wing absent.

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Specimens examined:

Dhaka : Hasnabad, in house garden on damp soil, June 1985. 202, Md. Kamruzzaman, Holotype (DUH).

Baldah gardens, on damp shady soil, 1985, June 210. Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Plant dioecious, male plant unbranched, small, female plants large, branched dichotomously upto twice, apical region bear a marked triangular depressed area, dorsal furrow restricted in anterior region.

ii) Assimillatory cells compact and in column, epidermal cells slightly papillose.

iii) Sporangium dorsal, very limited in number per thallus with small number of spores.

iv) Spores large, 85-140 μ in diameter, dark brown or chockolet in colour, oval or round, having 7-9 areolae across the distal surface with shallow cavity.

The species has been named after the place Hasnabad, from where it was collected.

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PLATE XVI

Riccia hasnabadii sp. nov.

a, b & c.	Female thalli	10 x
d & e.	Male thalli	10 x
f.	T. S. of thallus showing sporangial position	36 x
g & h.	Spores	300 x

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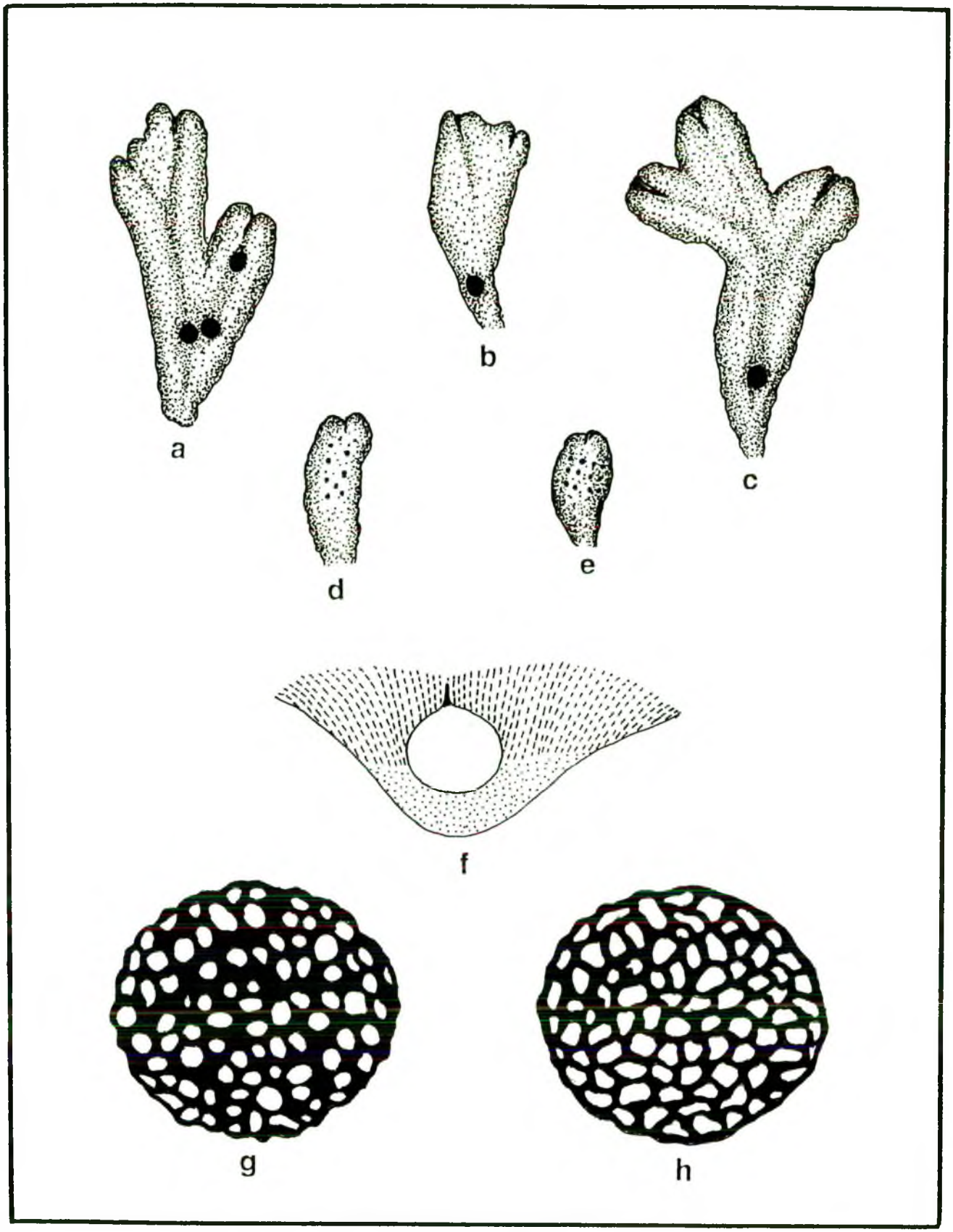
PLATE XVI



Riccia hasnabadii sp. nov.

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Riccia jamalpurensis sp. nov.

PLATE XVII
SEM PLATE **4 B**

Monoica, herba vinosa, in colonia rosulata vel irregulariter superposita.
Thallus linearis, obovatus ad apicem, ramosus dichotome ad triplex, usque 11mm longus et 3mm latus.
Squamae distinctae, brunneae ad nigro-brunneolae
Thallus in sectione transversa navicullaris, 1.5 vel triplex latior quam alta. Epidermis hyalinus, ± globosus.
Antheridia in 2-3 seriebus dispositus.
Archegonia in 1-2 seriebus dispositus.
Sporangia ventrales, ± cernua, sporae brunneae, plusminusve rotundae, 95-110 μ in diam, paries retiformis, 7-12 areolae dorsales, reticulum perfectum dorsaliter, imperfectum ventraliter.
Ala maxime sinuata non perforata, usque 12 μ lata, signa triradiates non conspicua.

Monoecious, plant bluish green, in rosette colony or irregular overlapping patches. Thallus linear, obovate at apex, branched dichotomously upto 3 times, upto 11mm long and 3mm broad.

Scale prominent, brown to blackish brown.

T.S. of thallus ± boat shaped, 1.5 to 3 times as broad as high. Epidermal cells hyaline, ± globose.

Antheridia 2-3 seriate.

Archegonia 1-2 seriate.

Sporangia ventral, ± pendulous, spore brown, roughly round, 95-110 μ in diameter, wall reticulate, 7-12 areolae dorsally, reticulation complete dorsally, incomplete ventrally.

Wing highly wavy, non perforated, upto 12 μ broad, triradiate marking not distinct.

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Specimens examined :

Jamalpur : Sharishabari, on damp garden soil, March, 1988, 452, Md. Kamruzzaman, Holotype (DUH).

Sirajganj : Near Ferry ghat, on sandy soil, March, 1988, 457, Md. Kamruzzaman (DUH).

Distinguishing characters :

1. Thallus long, compact, apex mostly curved dorsally, scale prominent and covering margin also.
2. Sporangia both ventral and ± pendulous.
3. Spore 95-110 μ in diameter, 7-12 areolae across, wing non perforated and upto 12 μ wide.

The species has been namded after the district Jamalpur.

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PLATE XVII

Riccia jamalpurensis sp. nov.

a & b.	Thalli	10 x
c & d.	T. S. of thalli showing sporangial position	36 x
e.	Scale	120 x
f, g & h.	Spores	300 x

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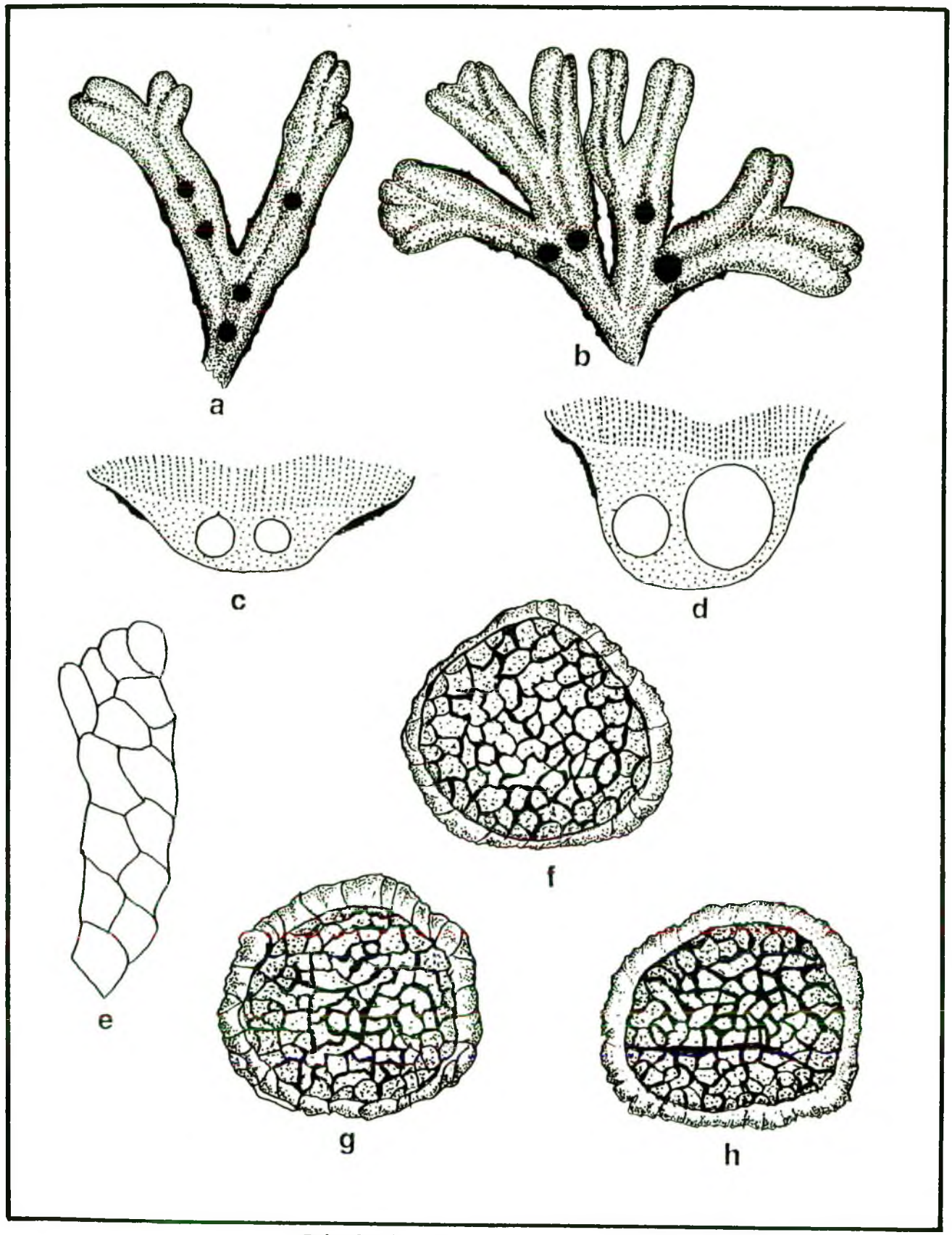
PLATE XVII



Riccia jamalpurensis sp. nov.

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Riccia kagmariensis sp. nov.

PLATE XVIII
SEM PLATE **4C**

Monoica, herba atroviridis, 4-8 herbae in colonia rosulata, nonramosa vel ramosa, dichotoma ad triplex.

Thallus 15-25mm longus et 4-8mm latus,

Squamae absentes.

Thallus in sectione transversa usque quadruplex latior quam alta.

Antheridia in 1-3 seriebus disposita.

Archegonia uniseriates, aliquando compacta.

Sporangia, dorsales, nigrobrunneus, magnus, numerosus, distinctes visibiles a dorsale.

Sporae nigrobrunneae, 52-85 μ in diam, paries reticulatus, 6-8 areolae dorsales. Ala sinuatus, crenatus, perforata, signa triradiates conspicua.

Monoecious, plant deep green, rosette colony of 4-8 plants, unbranched or branched, dichotomy upto 3 times.

Thallus 15-25mm long and 4-8mm broad,

Scale absent.

T.S. of thallus upto 4 times as broad as high.

Antheridia 1-3 seriate.

Archegonia uniseriate, sometimes crowded.

Sporangium dorsal, blackish brown, large, many, distinctly visible from dorsal side. Spores blackish brown, 52-85 μ in diameter, wall reticulate, 6-8 areolae across dorsally. Wing wavy, crenate, perforated, triradiate markings distinct.

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Specimens examined:

Tangail : Kagmari, on the bank of drying ditch on damp soil under a bush, February 1988, 445 Md.Kamruzzaman, Holo type (DUH).

Jamalpur : Near circuit house, on the sandy bank of Brahmaputra river, March 1988, 461, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Plant blackish green posteriorly, forming a ± cup like rosette colony thallus fleshy, margin thick, slightly curved ventrally.

ii) Sporangia dorsal, blackish brown, distinctly visible from dorsal surface.

iii) Spore with 6-8 areolae distally and not forming any regular areolae proximally.

iv) Wing perforated at 1-3 points at least one of which breaks the margin.

The species has been named after the name of the locality Kagmari from which it was first collected.

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PLATE XVIII

Riccia kagmariensis sp. nov.

a, b, c & d.	Thalli	10 x
e.	T. S.of thallus showing sporangial position	36 x
f, g & h.	Spores	300 x

(f & g - ventral view, h - dorsal view)

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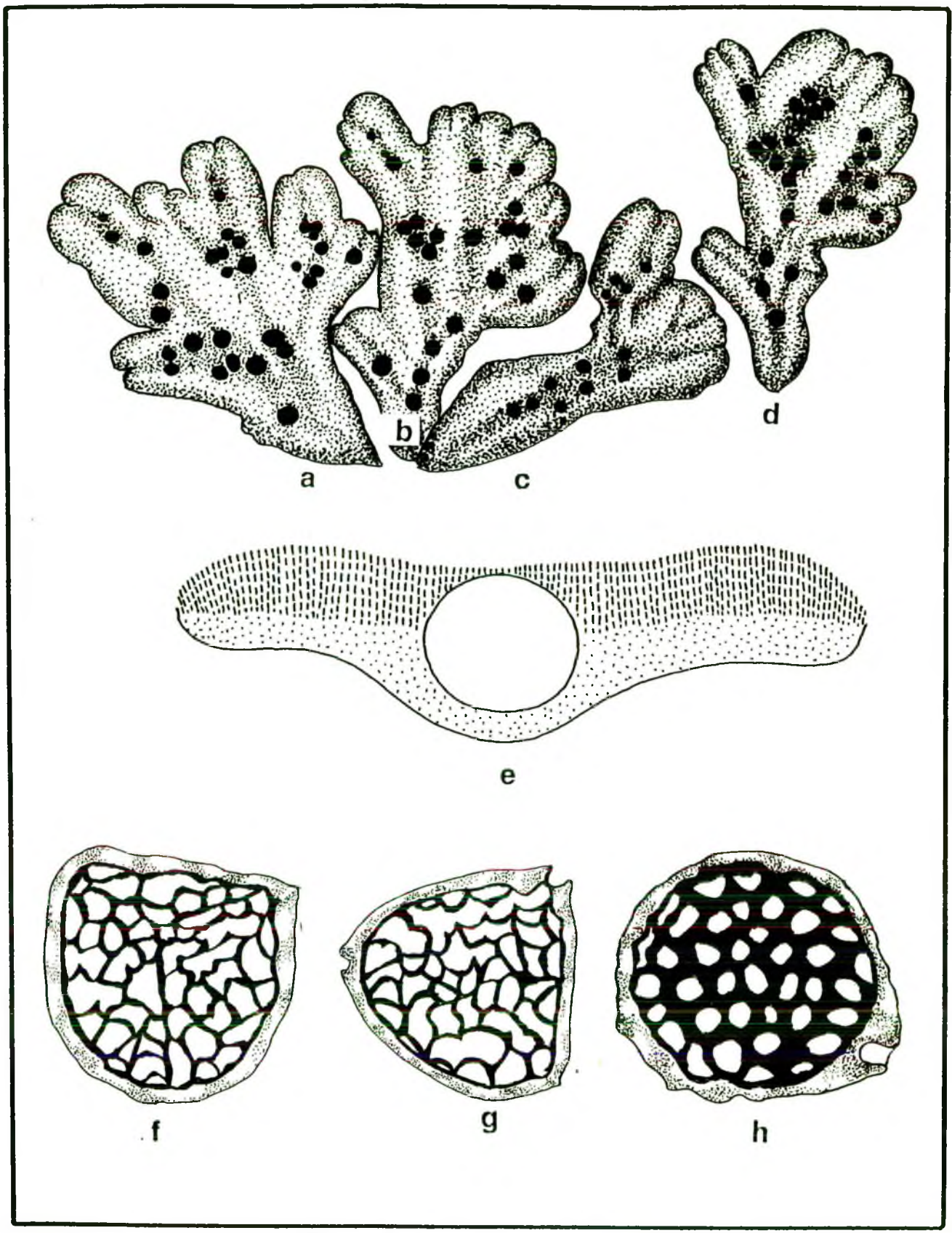
PLATE XVIII



Riccia kagmariensis sp. nov.

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Riccia lithophilii sp. nov.

PLATE XIX

SEM PLATE **4 D**

Monoica, herba viridis, tegetis irregulares formantes, aliquando in colonia rosulata.
Thallus incrassatae, linearis, emarginatus, non-ramosus vel ramosus dichotome ad uni, 5-9mm longus et. 1-2mm latus.
Thallus in sectione transversa quam lata quam alta.
Antheridia in 2-3 seriebus disposita.
Archegonia uniseriebus disposita.
Sporangium ventrale.
Sporae atrobrunneae vel nigrobrunneae, 85-100 μ in diam, paries reticulatus, reticulum perfecte dorsalita, imperfecte ventraliter, 7-9 areolae dorsales.
Ala crenata, usque 9 μ lata.
Signa triradiates conspicua.

Monoecious, plant green, forming mat like irregular overlapping large patches, sometimes in rosette colony.
Thallus thick, linear, emerginate, unbranched or branched dichotomously for once, 5-9mm long and 1-2mm broad.
T.S. of thallus as broad as high.
Antheridia 2-3 seriate.
Archegonia uniseriate.
Sporangium ventral.
Spore dark brown to blackish brown, 85-100 μ in diameter, wall reticulate, reticulation complete dorsally, incomplete ventrally 7-9 areolae across dorsally.
Wing crenate, upto 9 μ broad.
Triradiate markings distinct.

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Specimens examined

Bandarban : Sitamura, at the bank of the river Shankha on rock, October 1985. 85, Md. Kamruzzaman, Holotype (DUH).

Cox's Bazar : Near Heem chhari, on sandy soil, November 1988. 305, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Plants of rocky habitat, on thin layer of soil formed by rotten plant parts and wind carried dust and forming mat like rosette or large irregular patch.

ii) Plant scaly, thallus fleshy in anterior region and thin posteriorly.

iii) Sporangium strictly ventral, spore with complete, thick reticulation on dorsal surface and incomplete and irregular reticulation ventrally, wing finely crenate, upto 9 μ broad. Triradiate marking highly distinct.

The species was named on rocky habitat from which it was collected.

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PLATE XIX

Riccia lithophilii sp. nov.

a, b, c & d.	Thalli	10 x
e & f.	T. S. of thallus showing sporangial position	36 x
g.	Scale	120 x
h & i.	Spores	300 x

(h - dorsal view, i - ventral view)

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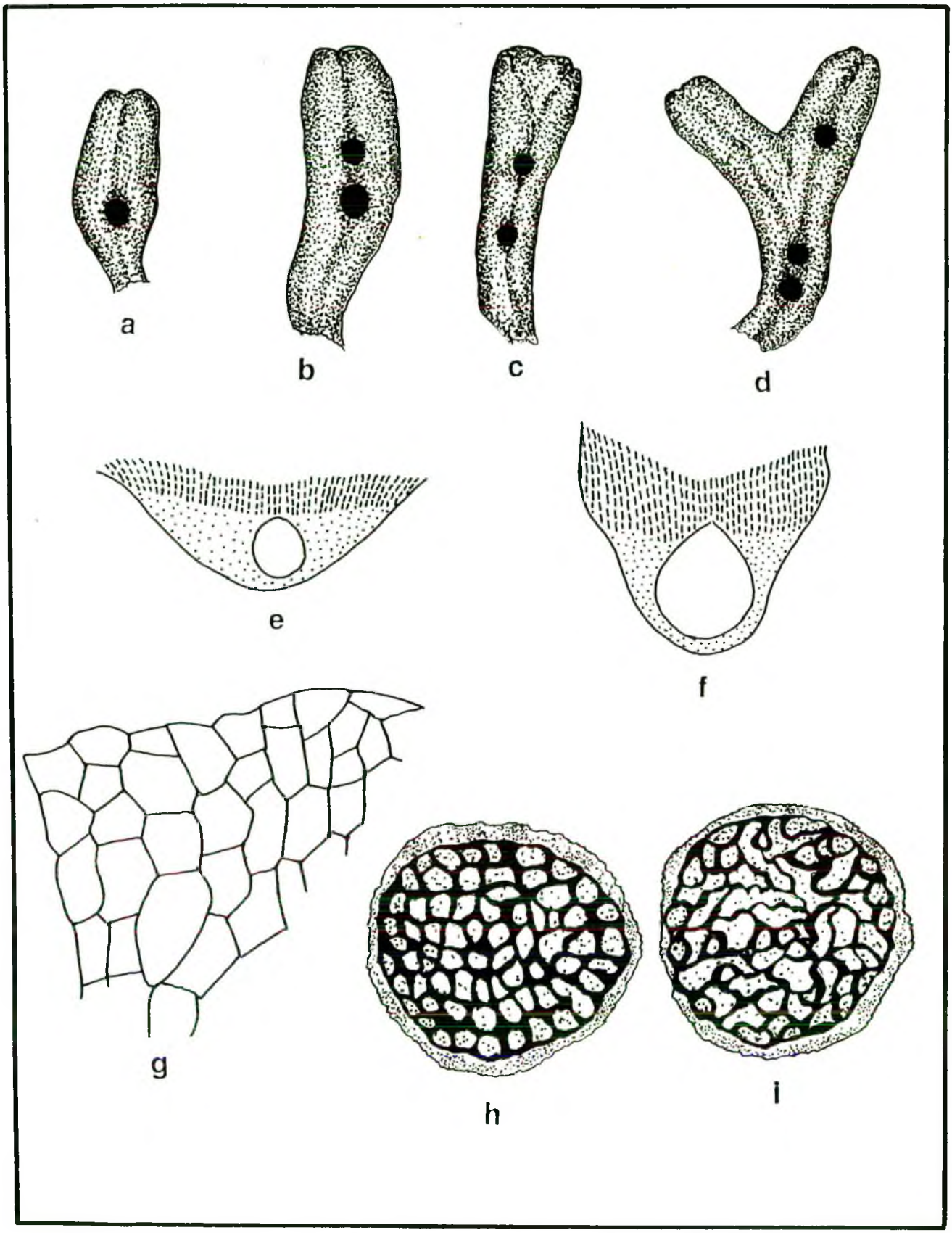
PLATE XIX



Riccia lithophillii **sp. nov.**

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Riccia lunata sp. nov.

PLATE XX

SEM PLATE

Monoica, herba pallide viridis, colonia laxa.

Thallus longus, ± linearis, succulentus, lacuna distincta, 8-11mm longus et 1-2mm latus.

Squamae absentes.

Thallus in sectione transversa lunatus, usque triplex latior quam alta.

Antheridia in 1-3 seriebus disposita.

Archegonia in 1-2 seriebus disposita.

Sporangia ventrales, sporae brunneoflavae, 54-90 μ in diam. Paries reticulatus, reticulum ambo perfectus et imperfectus, 5-8 areolae dorsales. Signa triradiates nonconspicua.

Monoecious, plant light green in loose colony.

Thallus long, ± linear, fleshy, distinctly pitted, 8-11mm long and 1-2mm broad.

Scale absent.

T.S. of thallus crescent shaped, upto 3 times as broad as high.

Antheridia 1-3 seriate.

Anchegonia 1-2 seriate.

Sporangium ventral, spores brownish yellow, 54-90 μ in diameter. Wall reticulate, reticulation both complete and incomplete, 5-8 areolae across dorsally, triradiate marking inconspicuous.

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Specimens examined :

Tangail : Karatia, on the bank of a canal on damp soil under the shadow of trees, April 1988. 432, Md. Kamruzzaman, Holotype (DUH).

Mymensingh : Fulpur, on ditch side damp soil, April 1988. 438, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus pitted, long, divergent, margin thin, dorsal furrow deep and wide. Tuberculate rhizoids are dominant in number.

ii) T.s. of thallus crescent shaped. Assimillatory cells in column, air space wide, epidermis with wide pits.

iii) Spore brownish yellow, ± round, triangular, half circled, wing thin, wavy dentate or crenate and perforated at many points.

The species has been named on its crescent shaped character of thallus in transverse section.

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PLATE XX

Riccia lunata sp. nov.

a.	Thallus	10 x
b & c.	T. S. of thallus showing sporangial position	36 x
d.	Assimillatory cells in column	120 x
e, f, g & h.	Spores	300 x

(g - ventral view, e, f, h - dorsal view)

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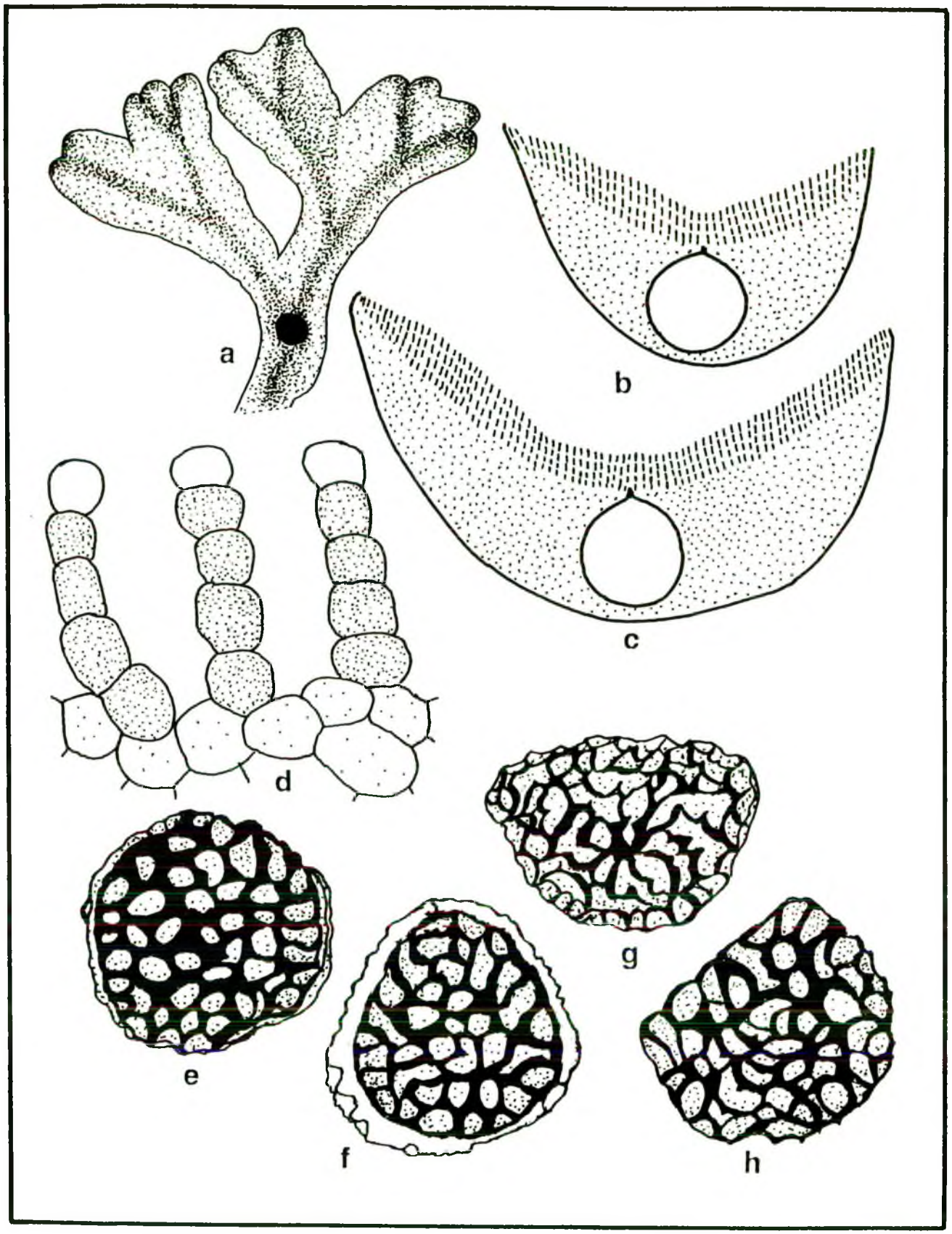
PLATE XX



Riccia lunata sp. nov.

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Riccia madhupurensis sp. nov.

PLATE XXI

SEM PLATE **5 A**

Monoica, herba pallide viridis, in colonia irregulare, compacta.
Thallus gracilis, latus, sulcus dorsalis vadosus, dichotome ramosus duplex vel triplex, usque 8mm longus et 2mm latus.
Thallus in sectione transversa duplex vel triplex latior quam alta.
Squamae absentes.
Antheridia in 2-3 seriebus disposita.
Archegonia 1-2 seriebus disposita.
Sporangia ventralia, nigrobunnea.
Sporae nigro brunneae, plerumque rotundae, 60-80 μ in diam. Paries reticularis, ambo perfecte et imperfecte, 7-9 areolae dorsales.
Ala crenata, usque 8 μ lata.
Signa triradiates conspicua.

Monoecious, plant light green, in crowded irregular patches, compact.
Thallus thin, broad, dorsal furrow shallow, dichotomously branched for 2-3 times, upto 8mm long and 2mm broad.
T.S. of thallus 2-3 times as broad as high.
Scales absent.
Antheridia 2-3 seriate.
Archegonia 1-2 seriate.
Sporangium ventral, blackish brown.
Spore blackish brown, mostly round, 60-80 μ in diameter. Wall reticulate, both complete and incomplete, 7-9 areolae across dorsally.
Wing crenate, upto 8 μ broad.
Triradiate marking conspicuous.

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Specimens examined:

Tangail : Madhupur on damp soil, rich in organic decaying substratums, October, 1985. 142, Md. Kamruzzaman, Holo type (DUH).

Mymensingh : Muktagacha on high way side shady damp soil, Nov. 1985, 156, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus thin, T.S. 2-3 times as broad as high.

ii) Archegonial neck long, projecting, sporangium ventral and with persistent neck.

iii) Spore winged, crenate, wall ornamentation reticulate, thick, ± regular, complete dorsally, forming 7-9 areolae across and thin, irregular, incomplete ventrally, Triradiate marking conspicuous.

The species has been named after the name of the locality (Madhupur) from which it was collected for the first time.

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PLATE XXI

Riccia madhupurensis sp. nov.

a & b.	Thalli	10 x
c.	T. S. of thallus showing sporangial position	36 x
d, e & f.	Spores	300 x

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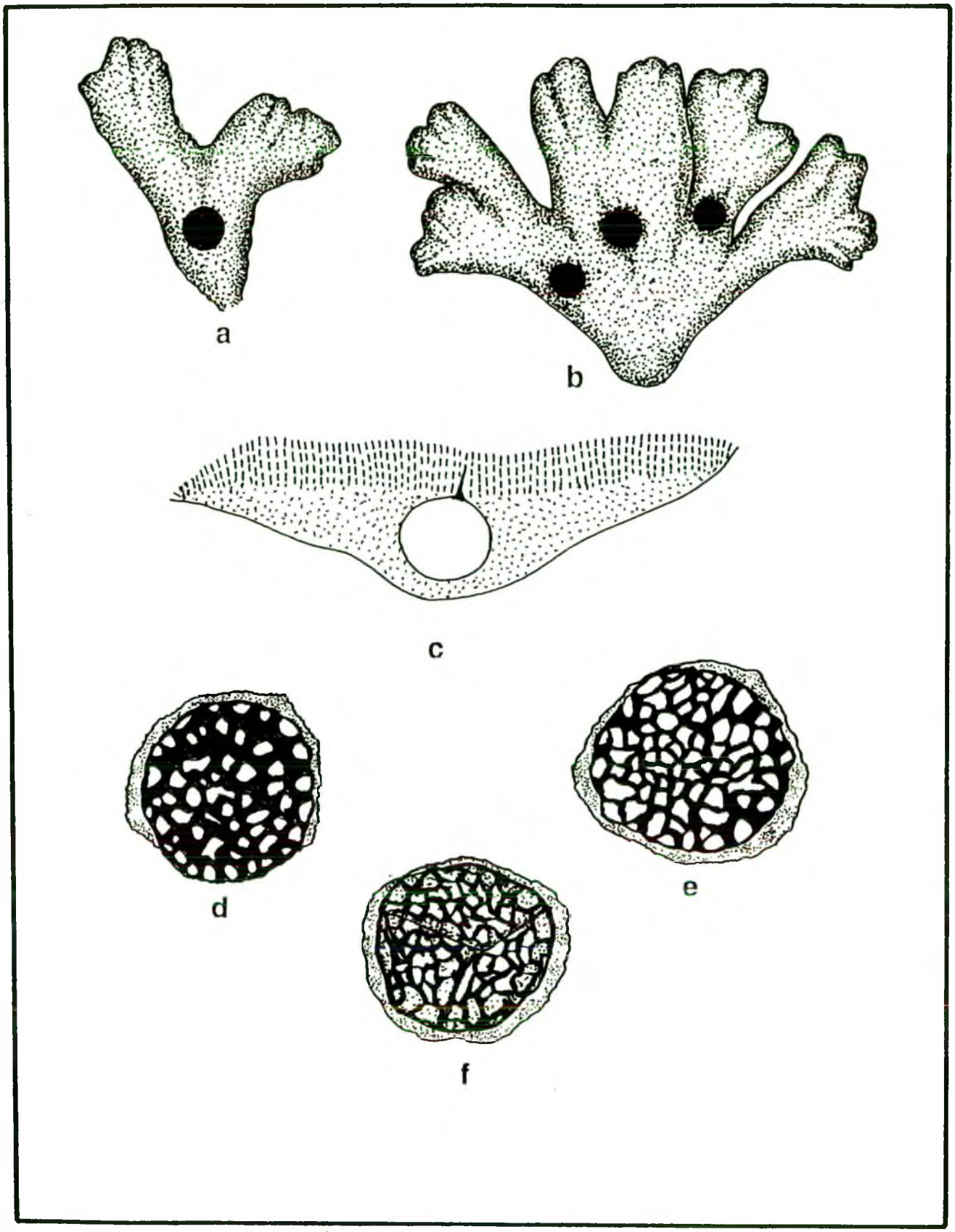
PLATE XXI



Riccia madhupurensis sp. nov.

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Riccia mogransis sp. nov.

PLATE XXII

SEM PLATE **5 B C**

Monoica, herba pallide viridis vel viridis, in colonia rosulata vel superposita.
Thallus ramosus dichotome ad triplex, 5-8mm longus et 2-3 5mm latus.
Squamae hyalinae.
Antheridia in 2-3 seriebus disposita.
Archegonia in 2-3 seriebus disposita.
Sporangia dorsales, compacta vel lineares, sporae aureobrunnae, ± triangulares, 66-95 μ in diam. Paries reticulatus, 6-8 areolae dorsales, reticulum ventrales et dorsales distinctum. Alae presens, uni perforatae in angulis, sinuatae usque 9μ latae, signa triradiates conspicua.

Monoecious, plant light green to green, forming rosette colony or overlapping patches.

Thallus branched dichotomously upto 3 times, 5-8mm long and 2-3 5mm broad. upper epidermal cells hyaline and characteristically crescent shaped.

Scales hyaline.

Antheridia 2-3 seriate.

Archegonia 2-3 seriate.

Sporangia dorsal, crowded or in line, spores golden brown, ± triangular, 66μ to 95 μ in diameter, wall reticulate, 6-8 areolae across dorsally, ventral reticulation differ from dorsal ones. Winged, one perforation at each corner, wavy, upto 9μ broad, triradiate markings distinct.

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Specimens examined

Netrokona : On damp shady brick embankment of the river Mogra, near Baraghat bridge of Netrokona town. March 1986, 231, Md. Kamruzzaman, Holo type (DUH).

Dhaka : Kashimpur, on the bank of the river Turag, April 1986, 243, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus apex rounded or obovate, thick, ± smooth, margin curved ventrally.

ii) Sporangium many per thallus, prominently visible from dorsal surface, ± dispersly develop throughout thallus, dorsal, brown, neck ± persistent.

iii) Spore golden brown, thick walled, reticulation wide dorsally and comparatively narrower ventrally. Wing wavy, not uniform in width having perforation at corners.

The species has been named on the name of the river Mogra from the bank of which it was collected for the first time.

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PLATE XXII

Riccia mogransis sp. nov.

a,b,c,d,e & f.	Thalli	10 x
g & h.	T. S. of thallus showing sporangial position	18 x
i, j & k.	Spores	270 x

(i & k - dorsal view, j - ventral view)

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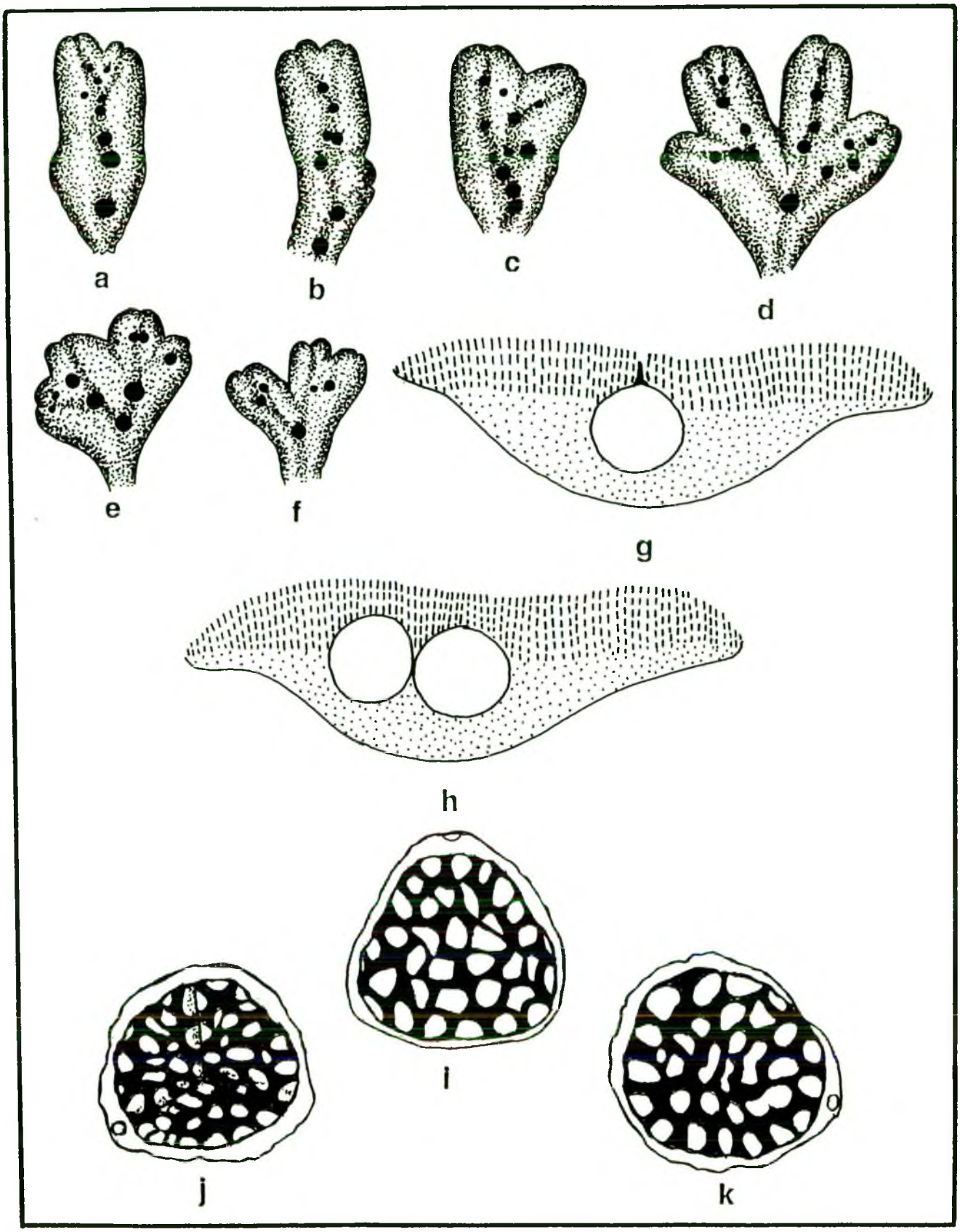
PLATE XXII



Riccia mogransis sp. nov.

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Riccia nathurcharensis sp. nov.

PLATE XXIII
SEM PLATE **5 D**

Monoica, herba pallide viridis, in colonia rosulata.
Thallus dichotome ramosus usque duplex, 9mm longus, 3-5mm latus.
Thallus in sectione transversa plusminusve duplex latior quam alta.
Squamae ambo hyalinae et pallide purpureae.
Antheridia in 1-3 seriebus disposita.
Archegonia in 1-2 seriebus, raro 3 seriebus disposita.
Sporangia ventralia, sporae atrobrunneae, 65-95 μ in diam.
Paries reticularis, irregularis 5-7 areolae dorsales.
Ala sinuata, usque 7 μ lata.

Monoecious, plant light green, in rosette colony.
Thallus branched dichotomously upto 2 times. 9mm long and 3-5mm broad.
T.S. of thallus ± double as broad as high.
Scales both hyaline and light purple.
Antheridia 1-3 seriate.
Archegonia 1-2 seriate, rarely 3 seriate.
Sporangia ventral, spores dark brown, 65-95 μ in diameter
Wall reticulate, irregular, 5-7 areolae across dorsally.
Wing wavy, upto 7 μ broad

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Specimens examined :

Tangail : Tangail, On damp soil under banana plant on Mirzapur-Mohonpur road at village Nathurchar point, July 1985. 02, Md. Kamruzzaman, Holo type (DUH).

Dhaka : Mirpur, low lying area near zoo, on damp soil, June 1987. 369, Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Thallus broad triangular in outline, broadly biconvex in T.S.
ii) Sporangium ventral.
iii) Spore irregularly reticulate on both the surfaces, wing unevenly wide. Triradiate marking and perforation absent.

The species has been named after the village Nathurchar from which it was collected for the first time.

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PLATE XXIII

Riccia nathurcharensis sp. nov.

a,b,c,d & e.	Thalli	10 x
f & g.	T. S. of thallus showing sporangial position	18 x
h,i,j & k.	Spores	300 x

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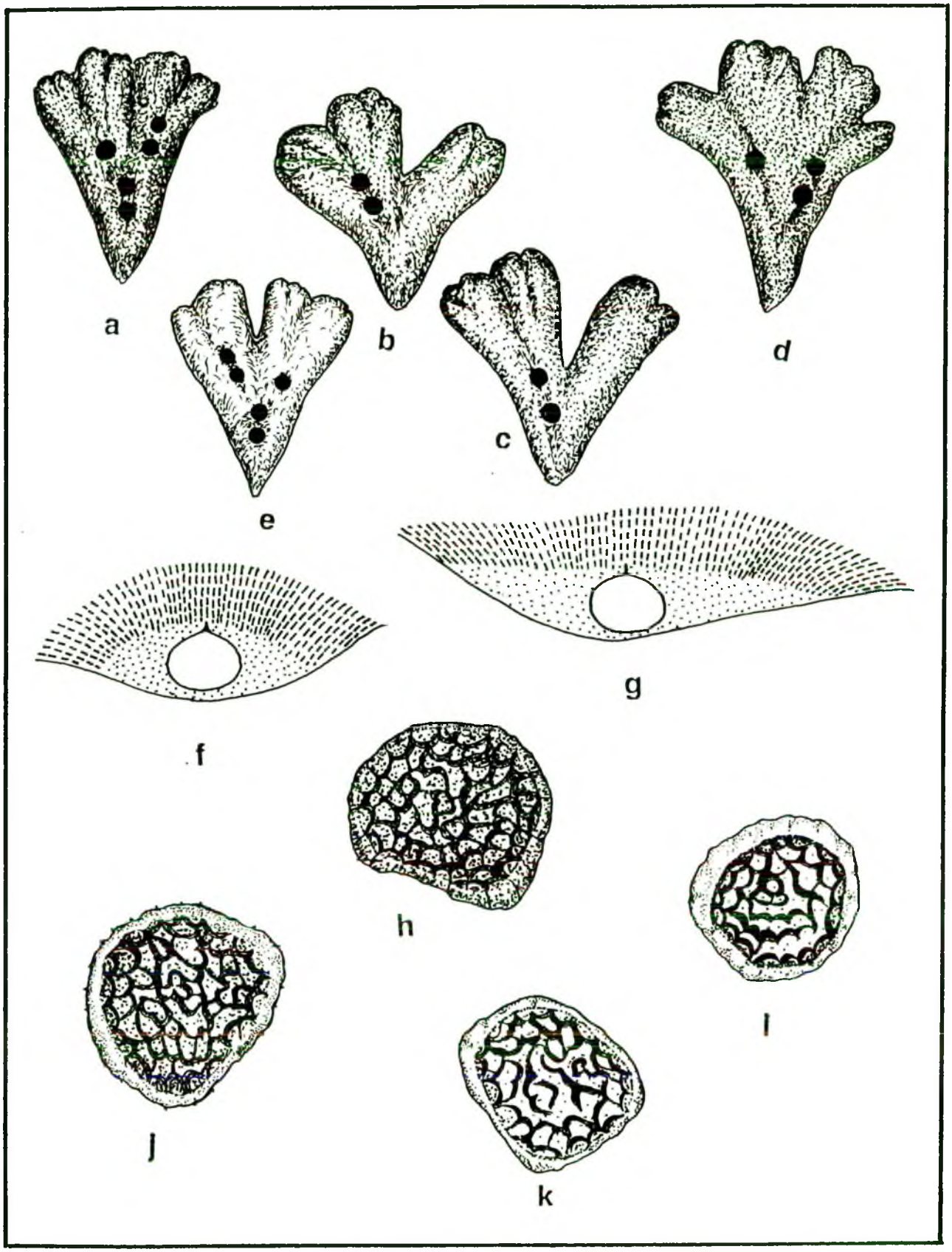
PLATE XXIII



Riccia nathurcharensis sp. nov.

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Riccia parvulii sp. nov.

PLATE XXIV

SEM PLATE **5 E**

Monoica, herba viridis, in colonia vel irregularis, parvula, plerumque superposita.
Thallus parvulus, 1-2mm longus 0.5-1mm latus, lingulatus, taenia formis vel in forma irregularis non ramosus.
Thallus in sectione transversa plusminusve duplex latior quam alta.
Squamie ambo hyalinae et subrosea brunneae.
Antheridia in 1-2 seriebus disposita.
Archegonia uniseriebus disposita.
Sporangia dorsalia, atrobrunnea.
Sporae flavobrunneolae, ± rotundae, 75-100 μ in diam, paucae.
Paries vermiculatus dorsaliter, raticulatus ventraliter. Ala, sinuata, 3-10 μ lata.

Monoecious, plant green, in colony or irregular patches, very small, often overlapping.

Thallus very small, 1-2mm long 0.5-1mm broad, tongue ribbon or irregular in shape, unbranched.

T.S. of thallus nearly double as broad as high.

Scales both hyaline and pinkish brown.

Antheridia 1-2 seriate.

Archegonia uniseriate.

Sporangia dorsal, dark brown.

Spore yellowish brown, ± round, 75-100 μ in diameter, few in number. Wall vermiculate dorsally, reticulate ventrally, 8-10 areolae across dorsally. Wing wavy, 3-10 μ broad.

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Specimens examined:

Tangail : Kagmari, on damp soil in jute field, June 1985. 08, Md. Kamruzzaman, Holo type (DUH).

Gopalpur in house garden, July 1985. 17, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus very small, 1-2mm long and 0.5-1mm broad at its broadest point, always unbranched, mostly curved, inwardly folded and of various shapes.

ii) Sporangia dorsal, large in comparison to the size of the thallus.

iii) Spore wing wavy, broader at the corners, wall ornamentation ± vermiculate on outer face and reticulate in interface. Triradiate marking on proximal face may or may not be conspicuous.

The species has been named on the basis of its very small thallus character.

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PLATE XXIV

Riccia parvulii sp. nov.

a,b,c,d,e,f,g & h.	Thalli	36 x
i.	Thallus lateral view	36 x
j & k.	T. S. of thallus showing sporangial position	45 x
l, m & n.	Spores	300 x

(l, m - ventral view, n - dorsal view)

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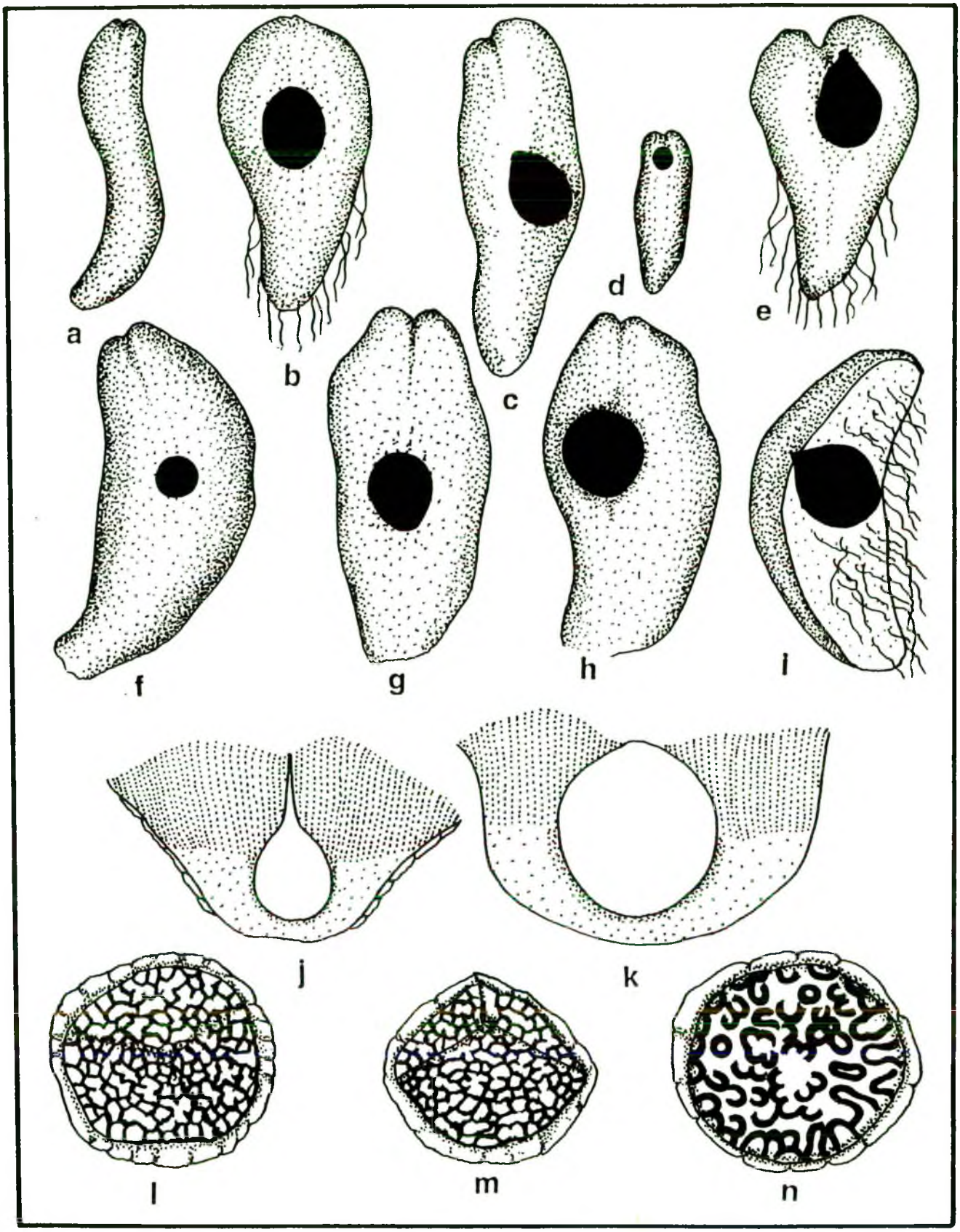
PLATE XXIV



Riccia parvullii sp. nov.

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Riccia rangpurensis sp.nov.

PLATE XXV
SEM PLATE **5 F**

Monoica, herba viridis, in colonia rosulata vel superposita.
Thallus latus ad apicem, valde angustus postice, 4-7mm longus et 2-2.5mm latus.
Dichotome usque duplex.
Squamae absentes.
Thallus in sectione transversa plusminusve duplex latior quam alta, lacunosa prasentes dorsalis.
Antheridia in 2-3 seriebus disposita.
Archegonia 1-2 seriebus disposita. Sporae atrobrunneae, 70-80 μ in diam.
Ala prasens, sinuata et crenata usque 7 μ lata, perforata in angulis, signa triradiates conspicua.

Monoecious, plant green, in rosette colony or overlapping patches.
Thallus broad anteriorly, very narrow posteriorly, 4-9mm long and 2-2 5mm broad.
Dichotomy upto 2 times.
Scales absent.
T.S. of thalli nearly double as broad as high, pits present dorsally.
Antheridium 2-3 seriate.
Archegonia 1-2 seriate. Spores dark brown, 70-80 μ in diameter.
Wing present, wavy and crenate, upto 7 μ broad, perforated in corners. Triradiate markings distinct.

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Specimens examined:

Rangpur : Ghoraghat, on damp soil of a drying ditch, December 1985, 173, Md. Kamruzzaman, Holo type (DUH).

Dinajpur : Tetulia, canal side damp soil, December 1985, 179, Md. Kamruzzaman (DUH).

Panchagarh : Near Sonali Bank, on damp soil, 1985, 178, Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Thallus fleshy, broad anteriorly and narrow posteriorly, large air pores, apical region with broad notch.

ii) T.S. of the thallus broadly oval ventrally, epidermis ruptured, air pore distinct.

iii) Antheridial papilla short and ± hidden in air pores.

iv) Spore dark brown, wall sculpturing ± alike on both faces, wing wavy and crenate. Triradiate marking conspicuous.

The species has been named after the name of district Rangpur from where it was collected for the first time.

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PLATE XXV

Riccia rangpurensis sp. nov.

a, b & c.	Thalli	10 x
d & e.	T. S. of thalli showing sporangial position	18 x
f & g.	Spores	300 x

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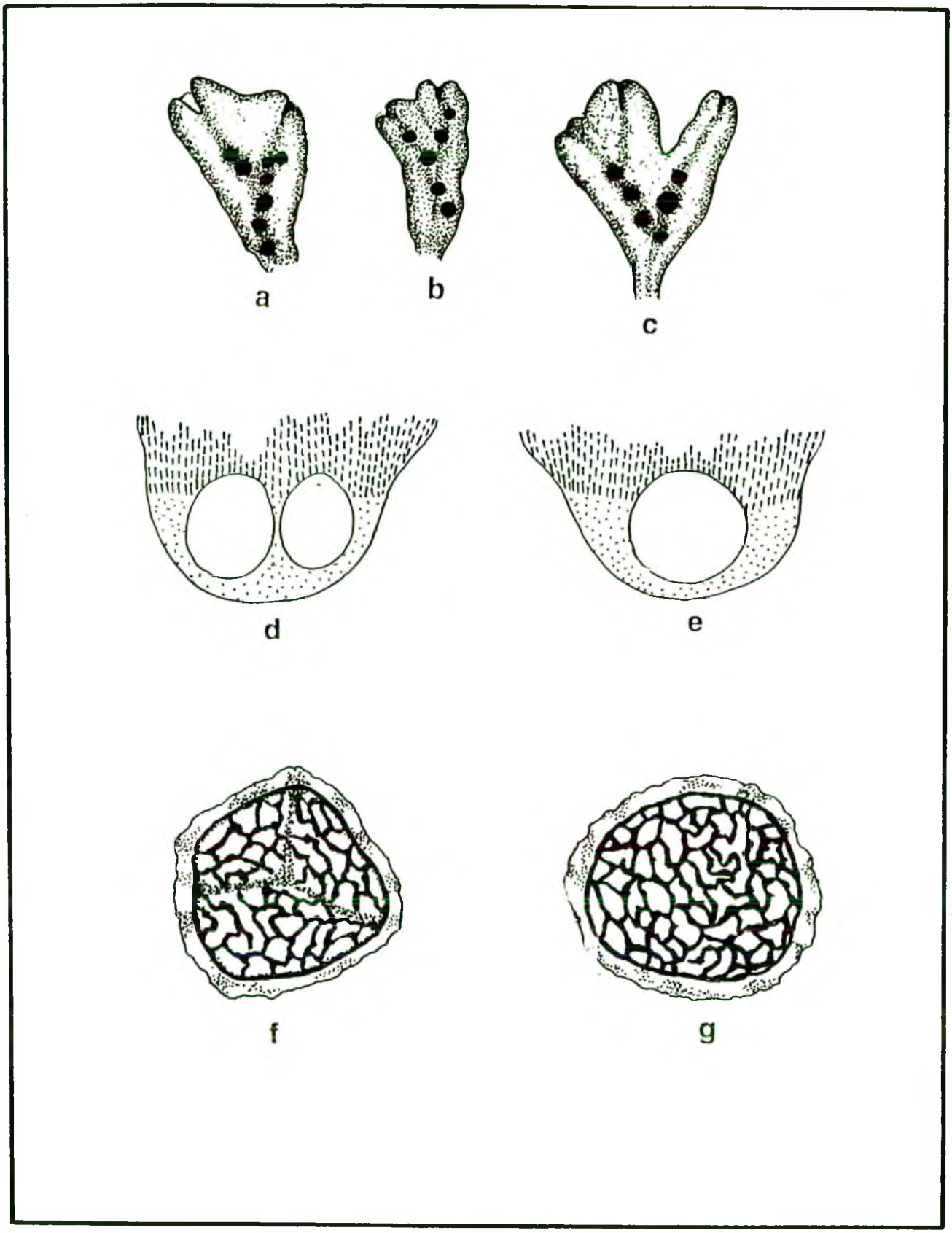
PLATE XXV



Riccia rangpurensis sp. nov.

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PLATE XXVI

SEM PLATE **6 A**

Monoica, herba subrosea viridis, in colonia rosulata, compacta.
Thallus dichotome ramosus usque triplex vel irregularis, usque 8mm longus et 1.4mm latus. Margo purpureae.
Squame perpureae.
Thallus in sectione transversa plusminusve diplex latior quam alta.
Antheridia in 1-2 seriebus dispositus. Archegonia in 1-2 seriebus dispositus.
Sporangia dorsalia, sporae brunneae, 65-80 μ in diam. Paries reticulatus, 7-8 areolae dorsales.
Ala non-uniformiter lata, 3-7 μ lata. Signa triradiates nondistincta.

Monoecious, plant pinkish green, in rosette colony, compact.
Thallus branched dichotomously upto 3-times or irregular, upto 8mm long and 1.4mm broad.Margin purple.
Scales purple.
T.S. of thallus roughly double as broad as high.
Antheridia 1-2 seriate. Archegonia 1-2 seriate.
Sporangia dorsal, spores brown, 65-80 μ in diameter, wall reticulate, 7-8 areolae across dorsally.
Wing not uniform in broadness, 3-7 μ broad. Triradiate marking indistinct.

Specimens examined :

Bandarban : On soft damp drying canal bed soil, near town side Army check post, October 1985. 86, Md. Kamruzzaman, Holo type (DUH).

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Sitamura, on bank of Shankha river, October 1985. 88, Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Thallus pinkish green, broad anteriorly and narrow posteriorly forming ± triangular structures.

ii) Dichotomy irregular, secondary branches develop with forking apically.

iii) T.S. broadly convex, sometimes rounded spore 65 μ to 80 μ in diameter, winged, reticulation ± alike on both faces. Triradiate marking indistinct.

The species was named after the name of the river Shankha.

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PLATE XXVI

Riccia shankhii sp. nov.

a.	A part of the colony	10 x
b.	Thallus	10 x
c & d.	T. S. of thalli showing sporangial position	18 x
e.	Scale	120 x
f & g.	Spores	300 x

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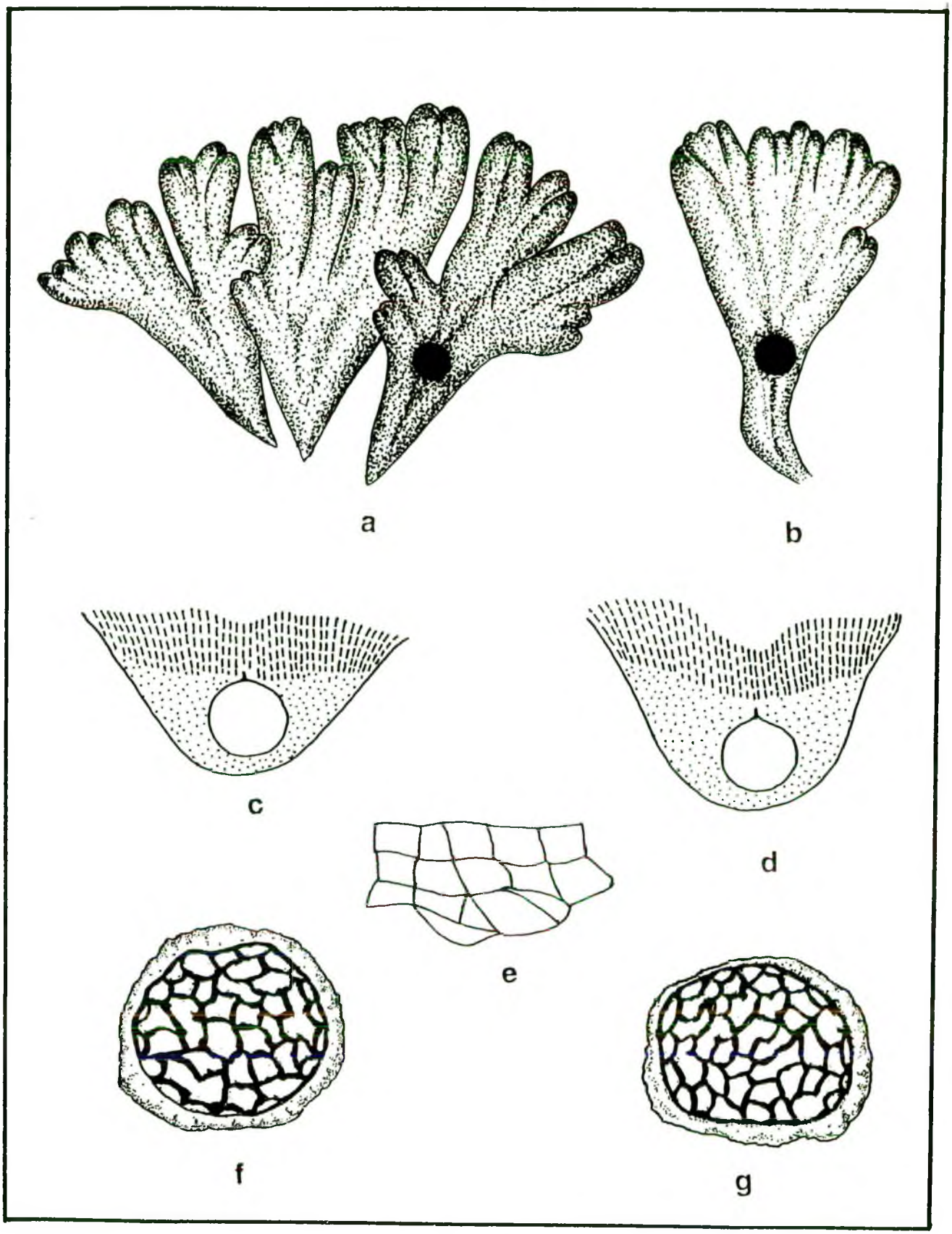
PLATE XXVI



Riccia shankhii sp. nov.

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Riccia sorocarpa Bisch.

PLATE XXVII

SEM PLATE

Riccia sorocarpa Bisch., Nova Acta Leop. Carol. 17: 1053, 1835.

Monoecious. Bluish green plant forming both irregular overlapping patches and rosette colony. Thalli compact, fleshy, upto 1cm long and 1-1.5mm broad both unbranched and branched dichotomously upto three times. Segment oblong, ovate and or sub-acute at the tip. Dorsal groove prominently deep at the anterior region and becomes shallow posteriorly, epidermal cells in two layers and in most cases the upper layer disorganized. Ventral scale hyaline and ill developed. T.S. of the thallus sub-quadrate or somewhat parabolic, 1-2 times as broad as high and sometimes very broadly convex ventrally. Assimillatory cells in column with wide air spaces in between two columns. Antheridia many in anterior region of the thallus, generally in 1-3 rows, ostiole slightly curved, distinct and upto 65 μ long above the thallus surface. Sporangium ventral. Spores mostly liberate through dorsal surface. Spores tetrahedral, 66-86 μ in diameter, dark brown, areolate, 6-10 areolae across, reticulation projecting like ridges, winged, wing upto 6.6 μ broad, wavy along with the granule like growth. Triradiate marking inconspicuous.

Specimens examined :

Sirajganj : On damp soil of the Jamuna river bank & char land, December, 1985. 176, Md. Kamruzzaman (DUH).

Tangail : Shakhipur, on red damp soil, December, 1987. 309, Md. Kamruzzaman (DUH).

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Distinguishing characters :

i) Epidermal cells in two layers and in most places destroyed.

ii) T.S. of the thallus sabquadrate or somewhat parabolic.

iii) Broad air space in between two columns of assimillatory cells.

iv) Antheridia many on both side of the dorsal furrow.

v) Sporangium ventral but spores liberate mainly through dorsal side.

vi) Spore 66-86 μ in diameter, areolae with minute ridges.

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PLATE XXVII

Riccia sorocarpa Bisch.

a, b, c & d.	Thalli	10 x
e, f & g.	T. S. of thalli showing sporangial position	18 x
h, i & j.	Spores	300 x

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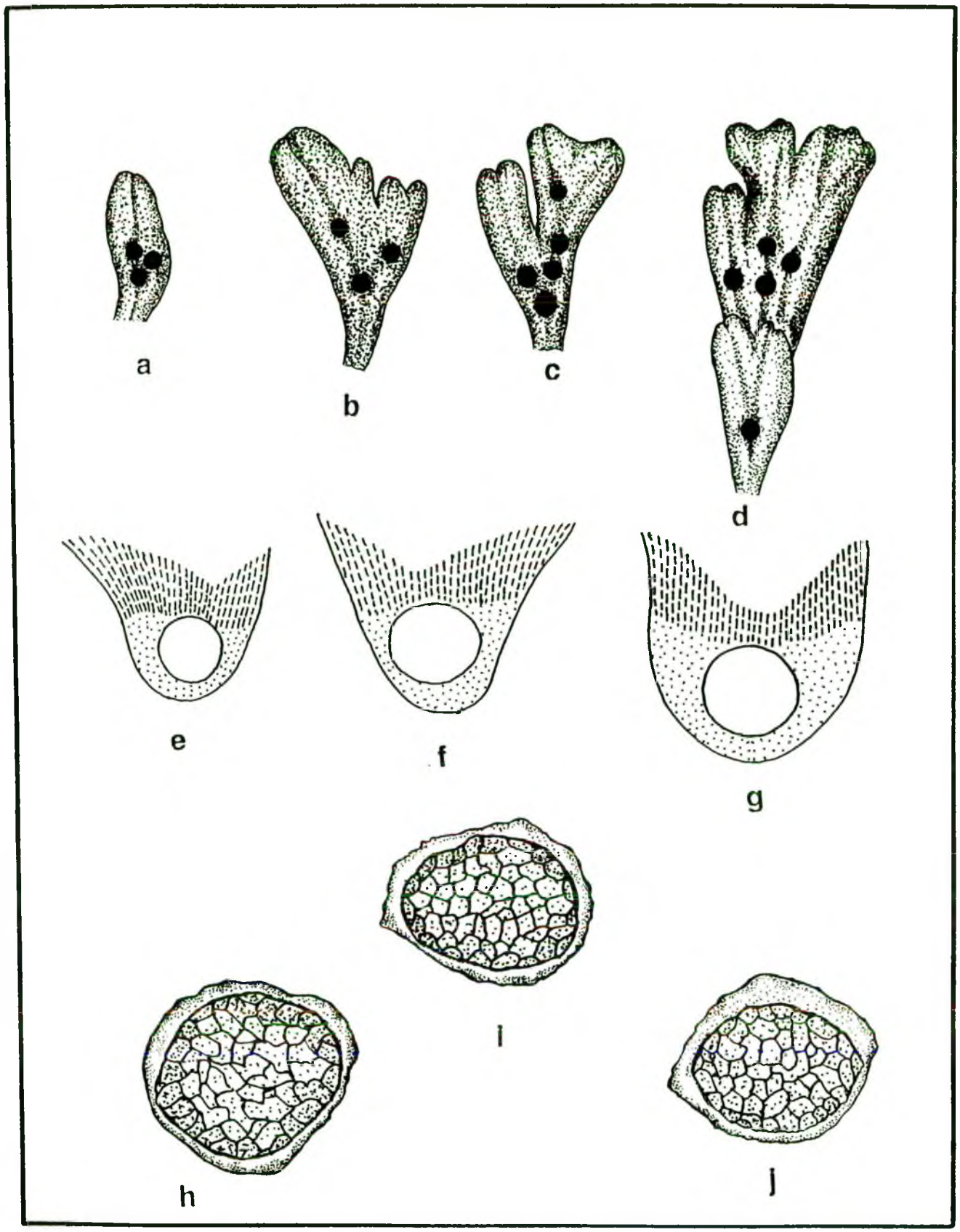
PLATE XXVII



Riccia sorocarpa Bisch.

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Riccia tangailensis sp. nov.

PLATE XXVIII

SEM PLATE **6 B**

Monoica, herba atroviridis, in colonia rosulata et superposita vel aggregata.
Thallus succulentus, sulcus dorsalis distinctus, nonramosus vel dichotome ramosus usque triplex, margo sinuatus, 4-7mm longus et 2-3 mm latus.
Thallus in sectione transversa uni vel diplexlatior quum alta.
Squamae presentes, margo superpositae.
Antheridia in 1-3 seriebus disposita.
Archegonia uniseriebus disposita.
Sporangia ventralia, nigro brunneae.
Sporae flavobrunneae vel brunneae, 70-80 μ in diam, paries reticulatus, reticulum latum, usque 6 areolae dorsale ab ventrale irregulariter et imperfecte reticulatae.
Ala sinuata, crenata, usque 12 μ lata, perforata in angulis. Signa triradiates conspicua.

Monoecious, plant dark green in rosette colony and overlapping or crowded patch.
Thallus fleshy, dorsal furrow distinct, unbranched or branched dichotomously up to 3 times, margin wavy, 4-7mm long and 2-3mm broad.
T.S. of thallus 1-2 times as broad as high.
Scales present, covering the margin.
Antheridia 1-3 seriate.
Archegonia uniseriate.
Sporangia ventral, blackish brown.
Spores yellowish to brown, 70-80 μ in diameter, wall reticulate, reticulation broad, upto 6 areolae across dorsally. Reticulation on ventral side irregular and incomplete. Wing wavy, crenate, upto 12 μ broad, perforated at corners as well as in other places of the wing. Triradiate marking distinct.

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Specimens examined:

Tangail : Registry para, in house garden on damp soil, February 1988. 424, Md. Kamruzzaman Holo type (DUH).

: Gorai Hill side shady damp soil, February 1988. 439, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Thallus green, broad, compact, scaly.
ii) Rhizoid mostly vermiculate and tuberculate, smooth walled types rare.
iii) Spore winged, mostly triangular, 70-80 μ in diameter, wing perforated at corners or on other parts of the wing.

The species has been named after the name of Tangail district from where it was first collected.

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PLATE XXVIII

Riccia tangailensis sp. nov.

a, b & c.	Thalli	10 x
d.	T. S. of thallus showing sporangial position	18 x
e, f & g.	Spores	300 x

(e & g - dorsal view, f - ventral view)

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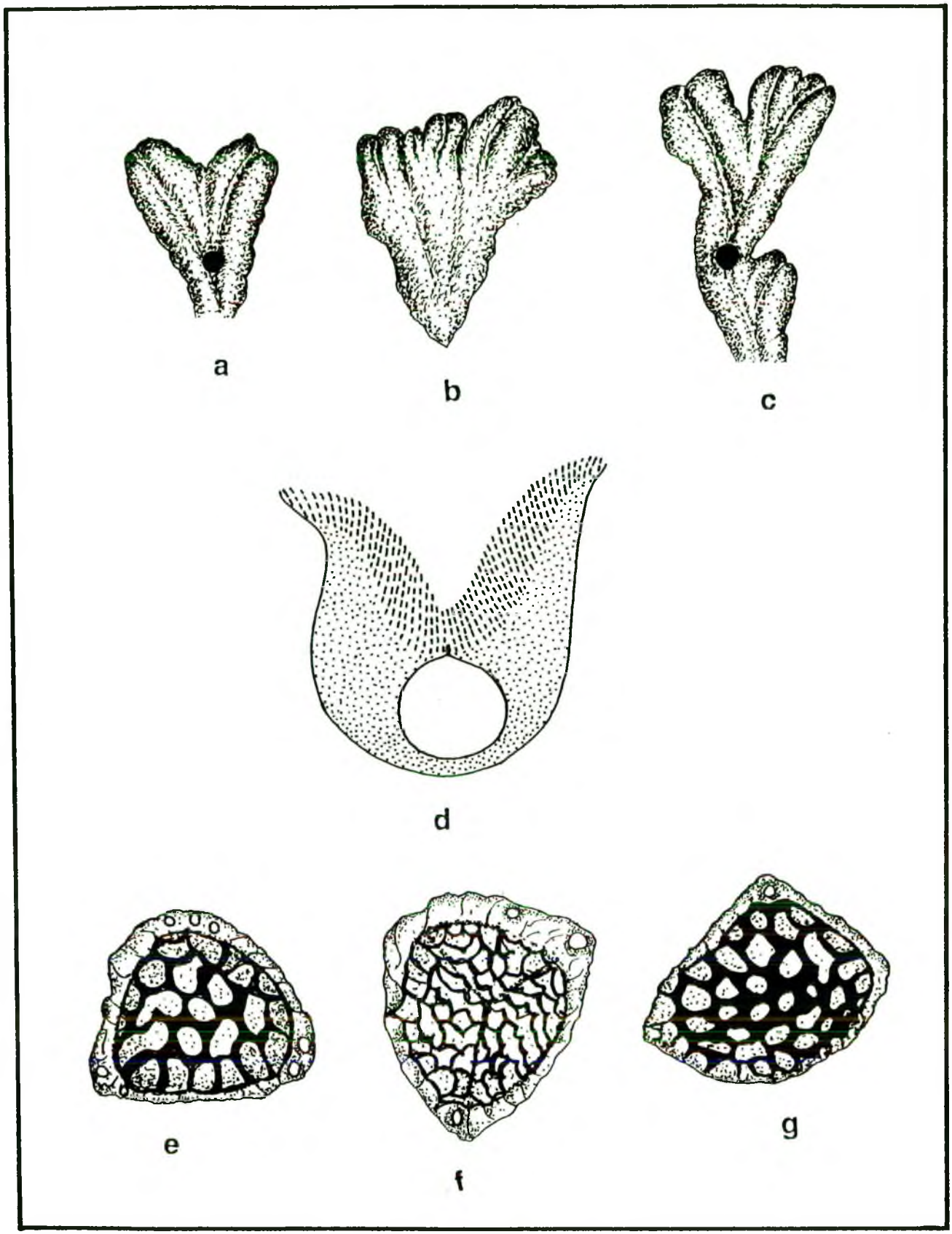
PLATE XXVIII



Riccia tangailensis sp. nov.

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Riccia tubulosa **sp. nov.**

PLATE XXIX

SEM PLATE **6 C**

Dioica, herba olivaca, in colonia rosulata vel irregularis.
Ambo planta mascula et femina parvula, usque 4.5mm longa, 2mm lata, linearis, tubularis, ramosa vel nonramosa, ± complanata, rotunda vel truncata ad apicem.
Squamae absente.
Thallus in sectione transversa plusminusve latior quam alta.
Late convexus ventraliter, plusminusve complanatus dorsaliter.
Regio penaria tenuis.
Planta mascula nonramosa, antheridia 2-4 seriebus disposita.
Archegonia uniseriata, raro biseriata.
Sporangia dorsalia stricte.
Sporae atrobrunneae, 40-60μ in diam, reticulum irregulare.
Signa triradiates conspicua, ala laevis.

Dioecious, plant olive green in rosette or irregular colony.
Both male and female thalli small, up to 4.5mm long, 2mm broad, linear, tubular, branched or urbranched, apex ± flat, round or truncate.
Scales absent.
T.S. of thallus ± broad as high.
Broadly convex ventrally, nearly flat dorsally.
Storage region thin.
Male plant unbranched, antheridia 2-4 seriate.
Archegonia uniseriate, rarely 2-1 seriate.
Sporangia strictly dorsal.
Spores dark brown, 40-60 μ in diameter, reticulation irregualrly branched, triradiate marking distinct, wing smooth.

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Specimens examined:

Tangail : On the damp soil on the bank of the river Dhaleswari near Elashin ghat Nov. 1987. 244, Md. Kamruzzaman Holotype (DUH).

Near Tangail Stadium, on the river side sandy soil, Nov. 1987. 266, Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Plant dioecious, both male and female plants grow in same colony, thallus minute, linear, tubular, very firmly attached with neighbouring thallus of the colony. Storage region thin.

ii) Antheridia crowded. Sporangia dorsal, spore winged, reticulation irregularly branched.

The species has been named on the tube like character of the thallus.

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PLATE XXIX

Riccia tubulosa sp. nov.

a, b & c.	Female thalli	18 x
d & e.	Male thalli	18 x
f.	T. S. of thallus showing sporangial position	36 x
g & h.	Spores	675 x

(g - ventral view, h - dorsal view)

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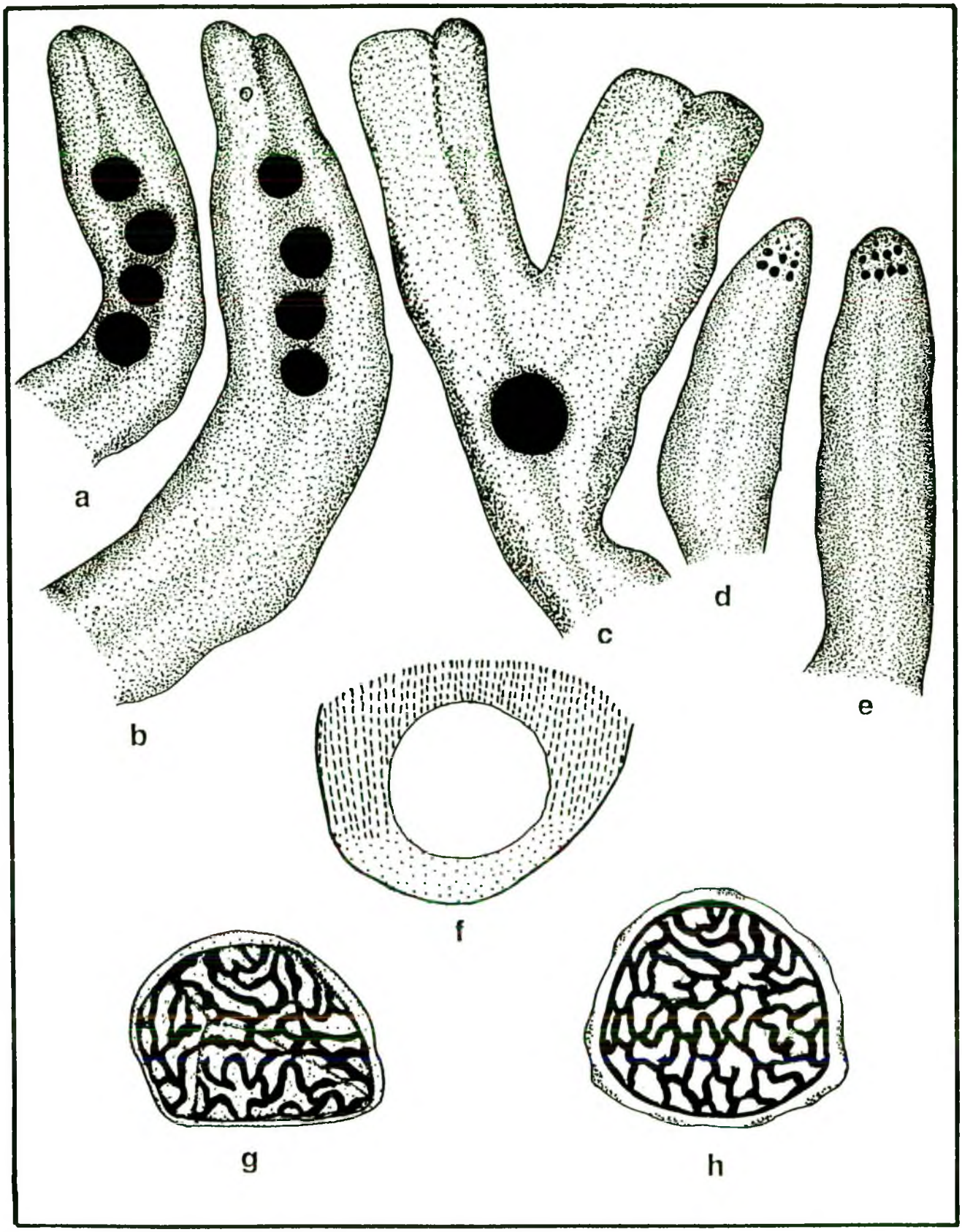
PLATE XXIX



Riccia tubulosa sp. nov.

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SUBGENUS - II:RICCIELLA

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OCCURANCE OF SPECIES UNDER THE SUB-GENUS - II : *RICCIELLA*

SPECIES		DISTRICT CODE
Riccia bakshii	:	15, 16, 41
Riccia cavernosa	:	13, 15
Riccia crystallina	:	13, 15, 26
Riccia dhakensis	:	1, 2, 6
Riccia fluitans	:	15, 60
Riccia Jamunii	:	13, 16, 17, 40
Riccia lingulata	:	1, 15, 41
Riccia marsupiformis	:	15, 26, 50,
Riccia plana	:	13, 15
Riccia sharishabariensis	:	12, 14, 16,
Riccia sultanii	:	1, 15
Riccia vulgaris	:	1, 15, 16, 18

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Genus : *Riccia*

Sub-genus-II *Ricciella*

Key to the species:

1. Thallus wooly, forming small variable pits on the upper surface - 2

   Thallus smooth, pits absent on the upper surface - 5

2. Sporangia ventral, in a long projected sac (marsupial) - *R. marsupiformis*.

   Sporangia ventral, deeply embedded, not marsupial - 3

3. Spore reticulation thin and incomplete on both the surfaces - *R. crystallina*.

   Spore reticulation both thick and thin and both complete and incomplete on both the surfaces - 4

4. Aereole mostly complete, few incomplete, germ pores distinct - *R. cavernosa*.

   Aereole mostly incomplete, few complete germ pores not distinct - *R. bakshii*.

5. Plant sterile, aquatic - *R. fluitans*.

   Plant fertile, terrestrial - 6

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6. Sporangium distinctly pendulous, constricted between thallus and sporangial sac - 7

Sporangium not distinctly pendulous, constriction not distinct - 8

7. Thallus broader, reticulation complete dorsally, mostly incomplete ventrally - *R. sharishabariensis.*

Thallus thin, reticulation both incomplete and complete dorsally and complete ventrally - *R. vulgaris.*

8. Spore reticulation complete both dorsally and ventrally - 9

Spore reticulation complete dorsally incomplete ventrally - *R. sultanii.*

9. Thallus thin, branch tip ± tongue like,without apical notch - *R. lingulata.*

Branch tip not tongue like, apical notch present - 10

10. Dorsal reticulation thick - 11

Dorsal reticulation thin - *R. plana.*

11. Thallus branched and unbranched, spores 65-85μ in diam. - *R. jamunii*

Thallus branched, spores 50-65 μ in diam. - *R. dhakensis.*

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Riccia bakshii sp. nov.

PLATE I

SEM PLATE **6 D**

Monoica, herba viridis ad flavo viridis, spongiosa, in colonia rosulata vel superposita thalli dichotome, ramosus unici, vel raro diplex.

Thallus 3-8mm longus et 1.5-4mm latus, sulcus dorsalis inconspicuus.

Squami absens.

Thallus late ventraliter convexus a pagina dorsalis lacunosa, cavernula aeria magna, multistrata.

Antheridia 2-4 seriebus disposita numerosa cum papillis projectis ad incisuram apicalam proxime.

Archegonia numerosa, 1-4 seriebus disposita.

Sponrangium ventrale.

Sporae atrobrunneae triangulares vel ovales, 65-78μ in diam.

Paries reticulum asymmetrice incrassatum, reticulum asymmetrice projectum.

Ala crenulata vel denticulata, usque 6μ lata, signa triradiates conspicua.

Monoecious, plant green to yellowish green, spongy, colony rosette or in overlapping patches, thalli dichotomously branched once or rarely twice.

Thallus 3-8mm long and 1.5-4mm broad, dorsal furrow indistinct.

Scale absent.

Thallus broadly convex on ventral side, dorsal surface pitted, air chambers large, many layered.

Antheridia in 2-4 seriate, many, with projecting papillae near apical notch.

Archegonia many, 1-4 seriate.

Sporangium ventral.

Spore dark brown, triangular or oval, 65-78μ in diameter.

Wall reticulation irregularly thickened, reticulation irregularly projected.

Wing crenate or dentate, upto 6μ broad, triradiate marking conspicuous.

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Specimens examined:

Tangail : Patulipara on sandy drying canal side damp soil, November, 1985, 182. Md. Kamruzzaman (DUH). Charabari, on damp soil in drying canal, March, 1986, Md. Kamruzzaman, Holo-type (DUH).

Jamalpur : At Sthall, on canal side damp shady soil, May 1990, 839 (DUH).

Sirajganj : On Jamuna char near at Chohali on damp sandy soil, January 1990, 677. Md. Kamruzzaman (DUH).

At Ferry Ghat - On damp soil, March 1991, 1160. Md. Kamruzzaman (DUH).

Distinguishing characters:

(i) Plant thick, spongy light or yellowish green,

(ii) Sporangium ventral,

(iii) Spore of different shapes, sizes, wall ornamentation not uniform in thickness and development. Wing crenate, dentate and upto 6μ broad.

The species has been named after the name of renound Indian plant taxonomist D.N. Guha Bakshi.

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PLATE I

Riccia bakshii sp. nov.

A, b, c	Thalli	10x
d	T. S. of thallus showing sporangial position	18x
e, f, g, h	Spores	270x

(e, f - dorsal view, g, h - ventral view)

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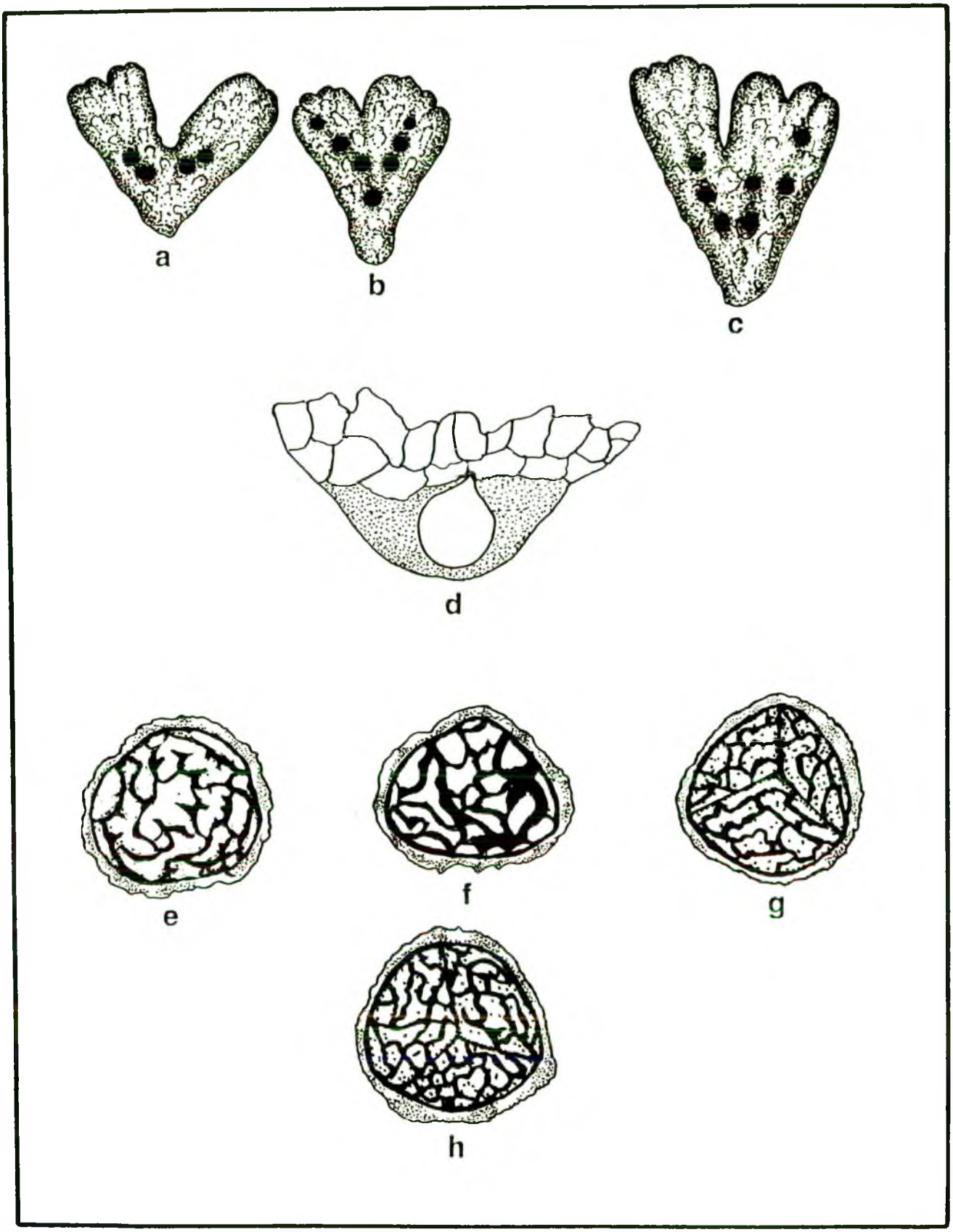
PLATE I



Riccia bakshii **sp. nov.**

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Riccia cavernosa Hoffm.

Riccia cavernosa Hoffm. emend Raddi. Deutchlands Fl., Cryp. 3: 95, 1975. emend. Raddi. Opusc. Scient. Bologna: 353, 1818.

R. multilamellata Steph. Hedwigia. 28: 273, 1889: Sp. Hep. 1: 48, 1900.

PLATE II

SEM PLATE

Monoecious. Plant both deep and light green, colony both rosette and irregular patches, ± wooly, having distinctly visible air pores on dorsal surface, branched dichotomously upto thrice. Individual thallus ± thin but appear fleshy due to woolyness, 4-7mm long, 2-3mm broad, roughly triangular in outline, dorsal furrow shallow, margin both wavy and smoothly running. Rhizoids are vermiculated, having mostly smooth wall type along with a very few tuberculate type. Scale absent. T.S. of the thallus 2-4 times as broad as high, air chamber narrow in between loosely arranged assimillatory cells, and the region is comparatively large above the thin storage region. Antheridium in 2-3 lines, small, globose and pear shaped, ostiole short. Archegonia in 1-2 three lines on mid dorsal region of the thallus or sometimes in cluster. Sporangium strictly ventral, blackish brown, prominently visible at ventral surface, covered in fleshy thallus extending ventrally. Spore tetrahedral shining brown, 68-86 μ in diameter. Mostly triangular, wall ornamentation beautifully articulated. The characteristically developed ± reticulate type of ornamentation both complete and incomplete along with dot like separate outgrowth of variable thickenings are present on dorsal surface.

Specimens examined:

Tangail : Santosh, Patulipara, on road side damp soil, July 1985, 186. Md. Kamruzzaman (DUH).

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Santosh. Islamic University College pond side drying soil May 1990, 817. Md. Kamruzzaman (DUH).

Karatia, canal side shady damp soil, May 1990, 822. Md. Kamruzzaman (DUH).

Netrokona : Dupaura, on canal side shady damp soil, November 1991, 1463. Md. Kamruzzaman (DUH).

Distinguishing characters :

(i) Thallus both light and deep green, ± wooly and thin.

(ii) Sporangium blackish brown and distinctly visible, strictly pendulous.

(iii) Spores shining brown, ± triangular, reticulate ornamentation, both complete & incomplete with dot like thickening dorsally. Triradiate markings conspicuous, wing perforated at corners, 1-2 perforations complete, as well as breaks the wing margin.

PLATE II

Riccia cavernosa Hoffm.

a,b,c & d.	Thalli	10 x
e.	T. S. of thallus showing sporangial position	18 x
f.	T. S. of thallus (a part)	120 x
g, h, & i.	Spores	270 x

(g - ventral view, h & i - dorsal view)

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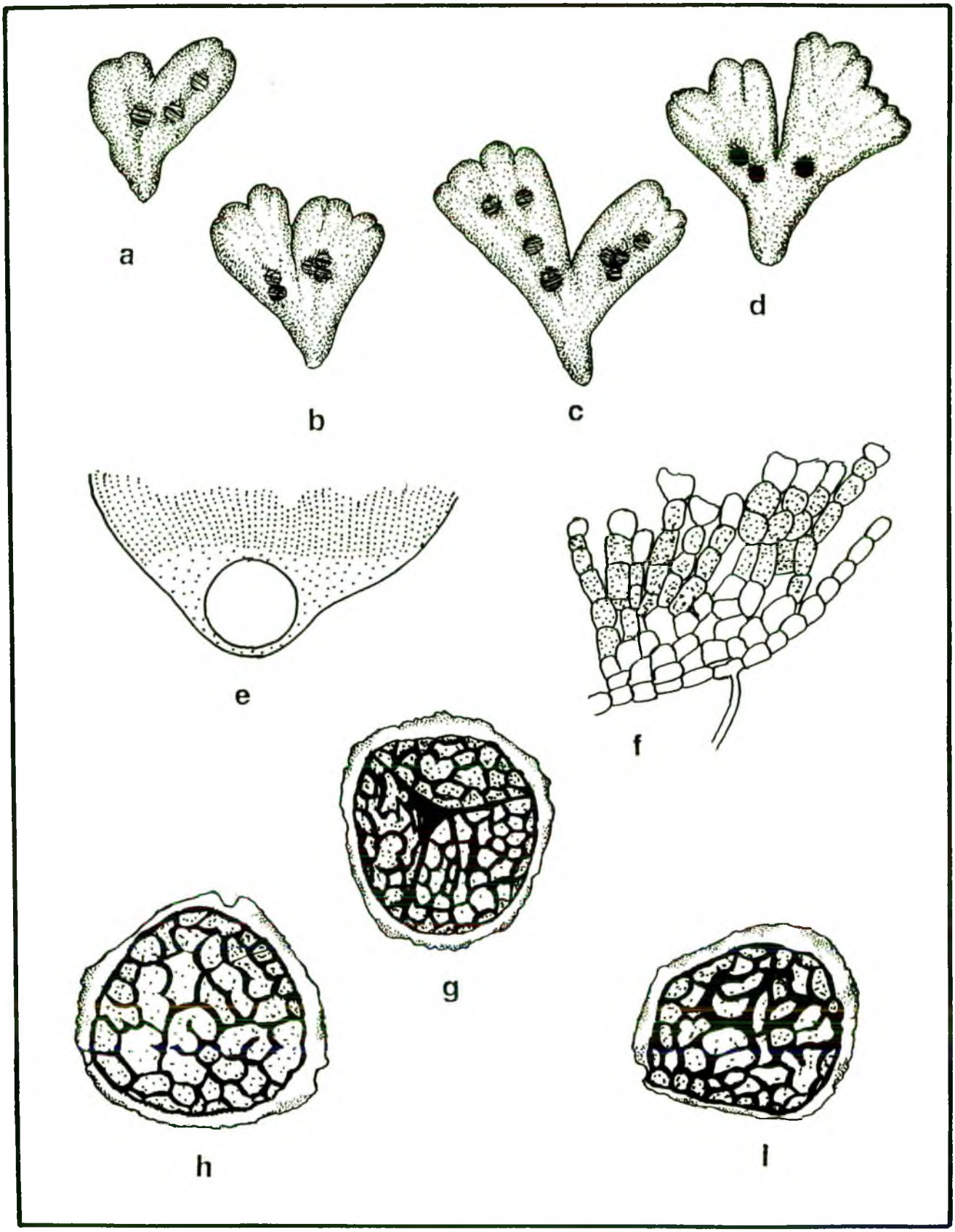
PLATE II



Riccia cavernosa H.

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Riccia crystallina L.

Riccia crystallina L., Sp. Pl.; 1138, 1753.

Riccia catalinae Underw, Bot. Gaz. 19: 275, 1984.

Riccia brandegei Underw, Bot. Gaz. 19: 275, 1984.

Ricciella crystallina Warnst, Krypt. FL. Mark Brendenoug 80: 1902.

Riccia robusta Kash, J. Bomb. Nat. Hist. Soc. 24: 348, 1916.

PLATE III

SEM PLATE **6E**

Plant monoecious, light or yellowish or crystalline green, ± spongy, fleshy, forming rosette or overlapping patches, generally 8mm - 2cm in diameter or more. Thalli branched dichotomously for 1-3 times. Segment 5-10 mm long, 1.5-1.5mm broad, lobes spreading, obcordate to obcuneate, dorsal farrow restricted in the anterior region, margin plane. Epidermal cells disorganise early causing pits, on the dorsal side, and clearly visible without the aid of lens. Scale absent. Rhizoids mainly smooth walled and very few are tuberculate. Cross section of the thallus 2-3 times broader than height, dorsal surface flat and broadly convex ventrally, air chamber large, polyhedral, opening by large pores. Antheridia develop along the median groove in 1-3 rows, near the apical notch, papillae distinct. Archegonia 1-3 seriates long necked and slightly projecting above the thallus surface. Sporangia ventral, numerous, ± spherical and 450-610 μ in diameter. Spore tetrahedral, 76 μ to 90 μ in diameter, brown, light brown when young and opaque brown on maturity, broadly round or triangular, reticulate, reticulation incomplete and irregular, generally 4-5 in number, arrangement more or less similar on both surfaces except the size of reticulation. Triradiate markings conspicuous. Wing ± broad, finely crenate, ± 3.5-5.9 μ wide. Sporangium dehiscence dorsally.

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Specimens examined:

Tangail : Santosh, Patulipara canal side on damp soil, February, 1986, Md. Kamruzzaman. Kagmari canal side on damp soil, March 1987, 231. Md. Kamruzzaman (DUH).

Comilla : Daudkandi Ferryghat, on damp fallow river bank and side of boro paddy field, February 1986, 165. Md. Kamruzzaman (DUH).

Netrokona : Hossainpur, on damp soil at the bank of river Mogra, March 1986, 170. Md. Kamruzzaman (DUH).

Distinguishing characters:

(i) Thallus light crystalline green in colour, obcordate, ± spongy, with broad airpits and large airchambers

(ii) Sporangium ventral

(iii) Sporangium dehiscence through dorsal side, spore with incomplete reticulation.

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Riccia dhakensis sp. nov.

PLATE IV

SEM PLATE **6 F**

Monoica, herba viridis, in colonis rosulata vel superposita.

Thallus ramosus dichotome ad quadruplex, linearis, gracilis, usque 6mm longus et 1mm latus.

Margo ± laevis, apex ± rotundus, sulcus dorsalis distinctus.

Squami absens.

Thallus in sectio transversa duplex vel triplex latior quam alta.

Cavernula aeria parva.

Antheridia in 1-3 seriebus disposita, aliquando aggregata.

Archegonia uniseriata, raro biseriata.

Sporangium ventrale.

Sporae atrobrunneae, ± rotundae, ellipticae vel quadrangulares.

50-66u in diam.

Pariam reticulum incrassatum, et perfecte dorsaliter, gracilis et perfecte ventraliter, 6-8 areolae dorsales.

Ala denticulata, et. crenulata, 3-9μ lata, latior in angula, perforata, signa triradiates inconspicua.

Monoecious, plant green, colony rosette or overlapping.

Thallus dichotomously branched upto 4 times, linear, slender, upto 6mm long and 1mm broad.

Margine ± smooth, apex ± round, dorsal furrow distinct.

Scales absent.

T.s. of the thallus 2-3 times as broad as high.

Air chambers small.

Antheridia 1-3 seriate, sometimes crowded together.

Archegonia uniseriate, rarely in two rows.

Sporanguim ventral.

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Spore dark brown, ± round, elliptical or quadrangular.

50-66μ in diameter.

Wall reticulation thick and complete on dorsal face, thin and complete on ventral face, 6-8 areolae dorsally.

Wing dentate and crenate, 3-9μ broad, broader at corner, perforated, triradiate marking inconspicuous.

Specimens examined:

Dhaka : Mirpur - At Jheel Bank on damp soil, March 1988, 414. Md. Kamruzzaman, Holotype (DUH).

Mirpur, near bus depo on drying soil, March 1988, 417. Md. Kamruzzaman (DUH).

Gazipur : BARI garden soil, February 1990, 701. Md. Kamruzzaman (DUH).

Sreepur : On pond side soil, February 1990, 709. Md. Kamruzzaman (DUH).

Munshigonj : Near Ferryghat, April 1990, 739. Md. Afzal Hossain (DUH).

Near Women's College, April 1990, 740. Md. Afzal Hossain (DUH).

Distinguishing characters:

(i) Plant green, much branched. Dorsal furrow extended throughout the entire length of the thallus,

(ii) Assimillatory celles rounded, loosely arranged, airchambers small,

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(iii) Sporangium ventral, dark or blackish brown, spore dark brown, ± round, elliptical and also quadrangular.

The species has been named after Dhaka from where it was collected for the first time.

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PLATE III

Riccia crystallina L.

a, b, c & d.	Thalli	10 x
e & f.	T. S. of thallus showing sporangial position	36 x
g, h, i & j.	Spores	270 x

(g & i - dorsal view, h & i - ventral view)

PLATE IV

Riccia dhakensis sp. nov.

a.	Thallus	10 x
b.	T. S. of thallus showing sporangial position	36 x
c, d, e & f.	Spores	300 x

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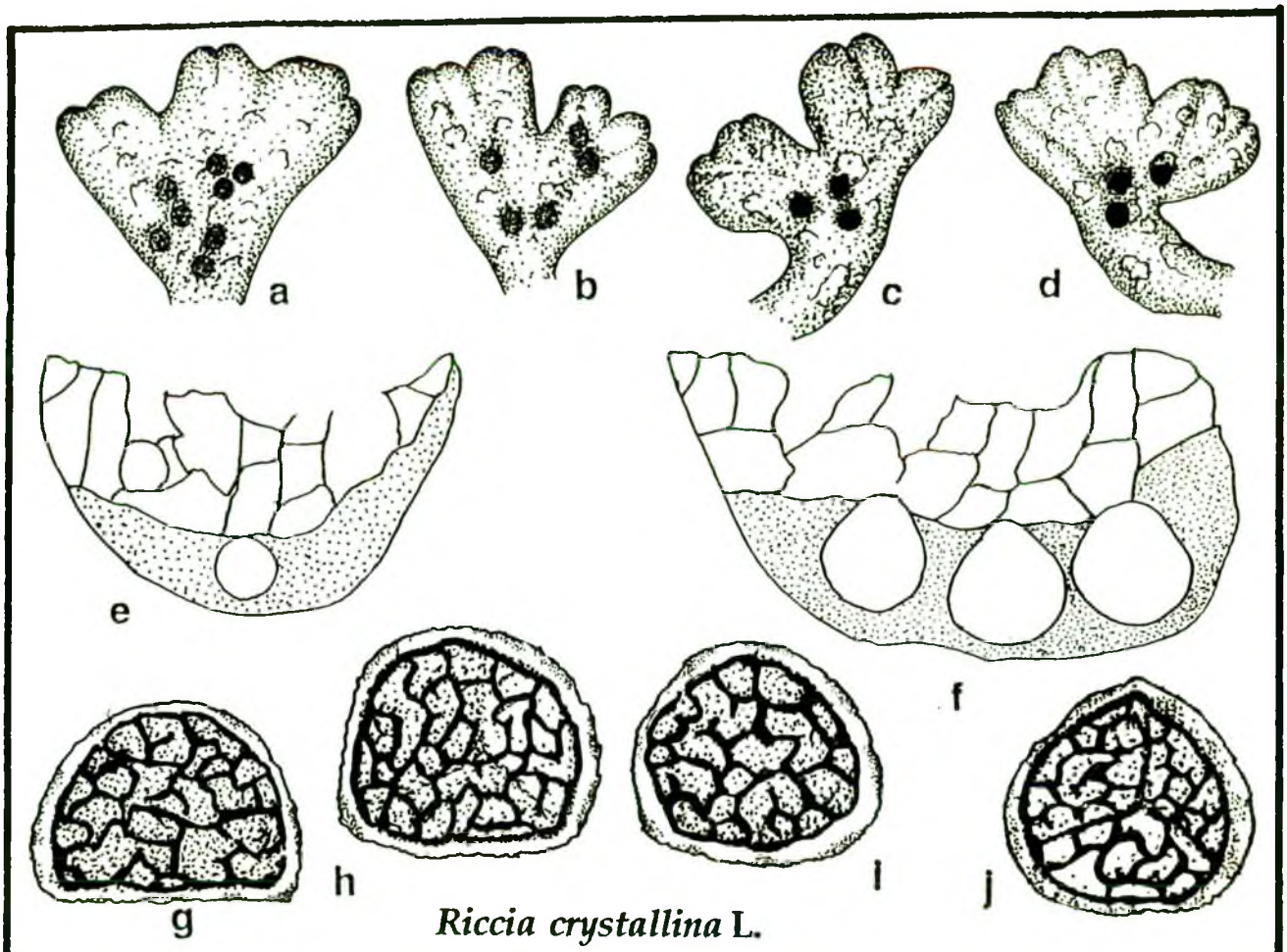
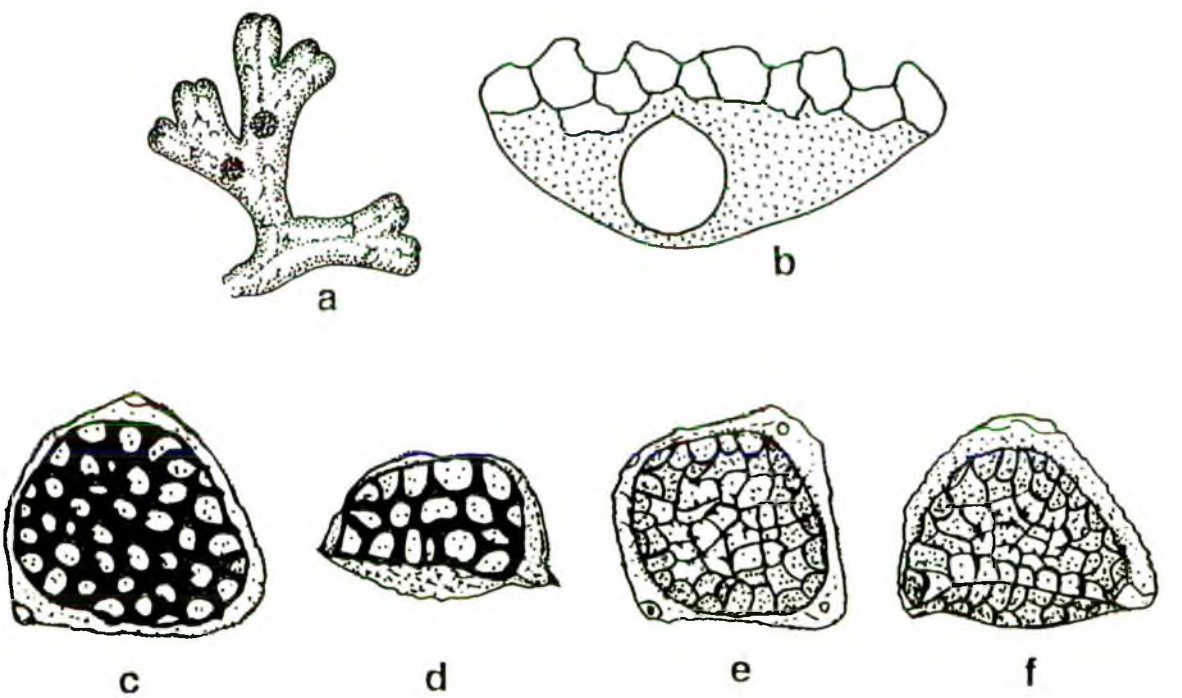
PLATE III



Riccia crystallina L.

PLATE IV



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Riccia fluitans L.

Riccia fluitans Linn. (1753) Spec. Plant: 1130.

PLATE V

Sterile. Plant light green, ± translucent, forming crowded patches or sometimes rounded plant masses where thalli remains interwoven arround the central older ones, floating in fresh water and mainly found to adhere with roots of water-hyacinth or with other weeds, floats on water surface along with algal flora or being adhered with air bubbles. Thalli 5-8 mm long and upto 1 mm broad, thin, ribbon like, several times branched dichotomously, segment divergent, linear, with air bubbles inside it, as net like streak, and minute depression is visible near apex, margin mainly smoothly running, very rarely or shightly wavy. Thin, one cell thick, flattened appendages developes at regular interval ventrally, the terminal one of which covers the apical tissues of the thallus, cells in the appendages are greenish initially and later on become pinkish, rhizoid absent. Cross section flat, 2-3 times as broad as high, cells ± poly-hedral and thin walled. Air chamber large, mostly continuous, and generally 1-3 seriate. Reproduction occur vegetatively by the formation of green rounded sowllen structure at the tip of the thallus and by death and decay of the older parts. The terminal separated portion on progressive growth and bifercation give rise to a new plant.

Specimen examined:

Tangail : Bhabanipur - In Bhahuria beel connecting canal, as floating plant mass and also attached with water-hyacinth root, February, 1987, 363. Md. Kamruzzaman (DUH).

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Santosh in a pond with profusely growing water hyacinth, January 1988, 463, Md. Kamruzzaman (DUH).

Bhabanipur - In canal water, as floating plant, May 1988, 512, Md. Kamruzzaman (DUH).

Patuakhali : Near Patuakhali Govt. College in canal water, November 1987, 261, Mr. Mazibar Rahman Khan (DUH), near Banani Hotel in a pond, December 1988, 545, Md. Kamruzzaman (DUH).

Distingushing characters:

(i) Aquatic planktonic plant,

(ii) Thallus ribbon like, much branched,

(iii) Air chamber with air bubbles distinctly seen,

(iv) Single celled thick flat, ventral leafy appendages develop at regular interval, sexual reproductive structure absent.

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PLATE V

Riccia fluitans L.

a, b, c & d.	Thalli	10 x
e.	Thallus	36 x
f & g.	Appendage	120 x
h.	T. S. of thallus	120 x

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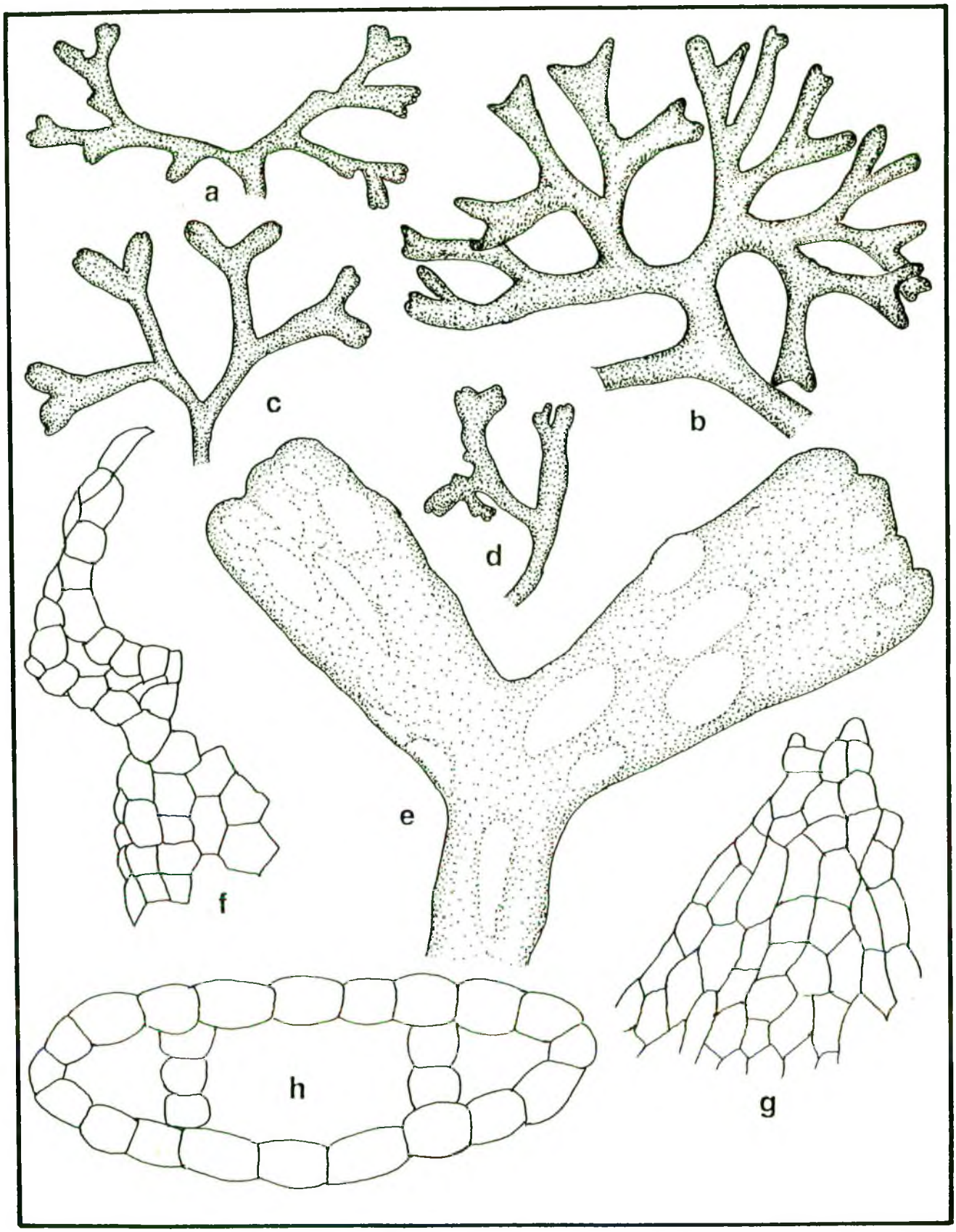
PLATE V



Riccia fluitans L.

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Riccia jamunii sp. nov.

PLATE VI

SEM PLATE 7 A

Monoica, herba flavo-viridis, colonia irregulariter superposita, thalli non-ramosus, vel dichotoma ramosi ad duplex.

Latis, linearis, gracilis, 5-9mm longa, 2-5mm latis, ambo truncatus et rotundatus, margo gracilis plusminusve ventraliter arcuatus, sulcus dorsalis penitus.

Squamae rariores, plerumque hyalinae, pauce violaceae.

Thallus in sectione transversa triplex vel quadruplex latior quam alta.

Cavernula aeria magna in 1-2 seriebus disposita.

Antheridia in 1-2 seriebus disposita.

Archegonia in 1-2 seriebus disposita.

Sporangium ventrales, aliquando plusminusve cernuum, plerumque biseriates.

Sporae nigroe vel nigro-brunneae, late triangularis, 65μ to 85μ in diam.

Paries retiformis, reticulum perfecte in ambo dorsales et ventrales 5-9 areolae dorsales.

Reticulum apice projectum paries latior et crassior dorsaliter, plusminusve gracilis ventraliter.

Ala sinuata, denticulata vel crenulata, 5μ-12μ lata. Perforata, signa triradiates inconspicua.

Monoecious, plant yellowish green, colony irregularly overlapping, thalli unbranched or dichtomously branched upto twice.

Broad, linear, thin, 5-9mm longa 2-5mm broad, apex both truncate and rounded, margin thin, ± curved ventrally, dorsal groove deep.

Scale scanty, mostly hyaline, few violet.

T.s. of thalli 3-4 times as broad as high.

Air chambers large, 1-2 layered.

Antheridia 1-2 seriate, develop anteriorly.

Archegonia 1-2 seriate.

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Sporangium ventral, some times ± pendulous, generally in two lines.

Spore black or blackish brown, broadly triangular, 65μ to 85μ in diameter.

Wall reticulate, reticulation complete on both dorsal and ventral faces,areolae 5-9 across dorsally.

Reticulation tip projected, wall broader and thicker on dorsal face, ± thinner on ventral face.

Wing way, munutely dentate or crenate, 5u-12μ broad, perforated, triradiate marking not distinct.

Specimens examined:

Jamalpur : Sharishabari, on roadside damp soil, November 1986, 274. Md. Kamruzzaman, Holo type (DUH).

Boira - At rail station side on fallow land, 729. Md. Kamruzzaman (DUH).

Pabna : On town side drying sandy soil, April 1991, 1205. Md. Mahfuzur Rahman (DUH).

Netrokona : Shikerpur, on the bank of the river Mogra, October 1991, 1421. Md. Kamruzzaman (DUH).

Sherpur : At Goalpatti, on the bank of a pond, October 1991, 1450. Md. Kamruzzaman (DUH).

Distinguishing characters:

(i) Green plants both unbranched and branched, apex of the thallus both truncate and rounded, and remarkably narrow posteriorly and broad anteriorly.

(ii) Sporangium both ventral and slightly pendulous.

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(iii) Spore wall ornamentation differ substantially in thickness and broadness between the distal and proximal faces.

(iv) Wing not uniform in width and varies from 5-12 μ, bearing 1-4 perforation.

The species has been named after the name of the river Jamuna.

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PLATE VI

Riccia jamunii sp. nov.

a.	Colony	10 x
b, c & d.	Thalli	10 x
e & f.	T. S. of thallus showing sporangial position	18 x
g,h,i & j.	Spores	300 x

(g & h - dorsal view, i & j - ventral view)

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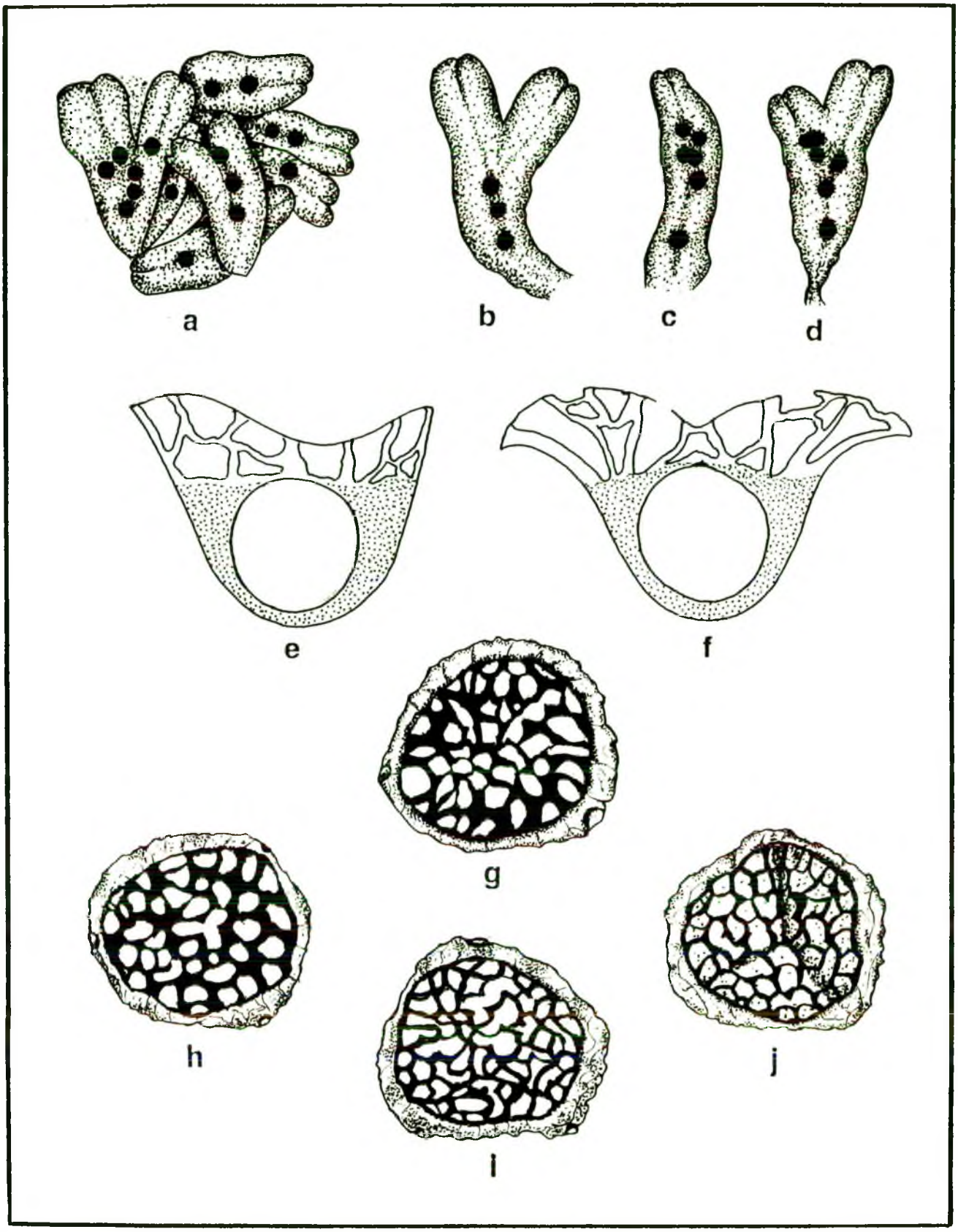
PLATE VI



Riccia jamunii **sp. nov.**

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Riccia lingulata **sp. nov.**

PLATE VII

SEM PLATE **7 B**

Monoica, herba atrovirdis ad flavo-viridis, colonus rosulata vel irregulariter superposita.

Thallus gracilis dichotoma ramosus ad diplex, 0.6-1.4cm longus, linearis, truncatus vel lingulatus ad apicem, sulcus dorsalis latus.

Squamae ambo hyalinae et violaceae.

Thallus in sectione transversa diplex vel quadruplex latior quam alta.

Cavernula aeria magna, numerosa, multistrata.

Antheridia in 1-2 seriebus disposita, plerumque proxime ad epicem.

Archegonia in 1-2 seriebus disposita, collis projectus.

Sporangia cernua, brunnea ad nigro-brunnea.

Sporae flavo-brunneae, plus minusve translucens, rotundae, ovale, vel late triangulares, 60-85μ in diam.

Paries retiformis, reticulum gracile, perfecte ad ambo dorsalis et ventralis, areolae 7-10 dorsalis.

Ala 3-10μ latae, perforata, plus minusve crenulata vel denticulata, signa triradiates inconspicua.

Monoecious, plant dark to light green, colony rosette or irregularly overlapping.

Thallus thin, dichotomously branched upto 2 times, 0.6-1.4cm long, linear, truncate or tongue like at apex, dorsal furrow broad.

Scales both hyaline and violet.

T.s. of the thallus 2-4 times as broad as high.

Air chambers large, many, in several layers.

Antheridia in 1-2 seriate, generally at the anterior region.

Archegonia 1-2 seriate, neck projecting.

Sporangia pendulous, brown to blackish brown.

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Spores yellowish brown ± translucent, round, oval or broadly triangular 60-85μ in diameter.

Wall reticulate, reticulation thin and complete on both dorsal and ventral faces, areolae 7-10 across dorsally.

Wing 3-10μ wide, perforated, crenate or finely dentate, triradiate marking inconspicuous.

Specimens examined:

Tangail : Gopalpur, on sandy partially shady soil, November 1986, 207. Md. Kamruzzaman, Holo type (DUH).

Alamnagar, on garden soil, January 1990, 670. Md. Kamruzzaman (DUH).

Sirajganj : Belkutchi on semi drying soil, January 1990, 689. Sultana Syeed (DUH).

Dhaka : Keraniganj on the bank of the river Buriganga, April 1990, 763. Selina Habib (DUH).

Gandaria, on garden soil, February 1991, 1002, M.R. Chowdhury (DUH).

Gandaria, on pond side shady soil, February 1991, 1075, Md. Kamruzzaman (DUH).

Kashimpur, Nadirpur, on shady damp soil, February 1991, 1078, Mrs. Shireen Akhter (DUH).

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Sirajganj : On damp sandy soil at the bank of the river Jamuna, December 1985, 143. Md. Kamruzzaman (DUH).

Manikganj : On road side damp soil, December 1985, 151. M.A. Mannan (DUH).

Feni : On drying soil in a fallow field, January, 1986, 212. Md. Kamruzzaman (DUH).

Comilla : Daudkandi ferry ghat on damp soil, February 1986, 227. Md. Kamruzzaman (DUH)

Mymensingh : Haluaghat, Pagalpara on damp paddy field, March 1986, 233. Md. Kamruzzaman (DUH). Boraghat on drying river bed, March 1986, 234. Md. Kamruzzaman (DUH).

Netrokona : Village-Nagra on the bank of the river Meghna, March 1986, 230. Md. Kamruzzaman (DUH).

Distinguishing characters:

(i) Plant thin, branched, terrestrial.
(ii) Air chambers large, cells in the assimillatory regions are not in regular column.
(iii) Sporangium strictly pendulous.
(iv) Spores winged, wing crenate or dentate.
(v) Spore with reticulated wall ornamentation.

The species has been named after the truncate character of thallus at apex.

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PLATE VII

Riccia lingulata sp. nov.

a, b, c & d.	Thalli	10 x
e.	T. S. of thallus	120 x
f & g.	T. S. of thallus showing sporangial position	18 x
h, i, j & k.	Spores	300 x

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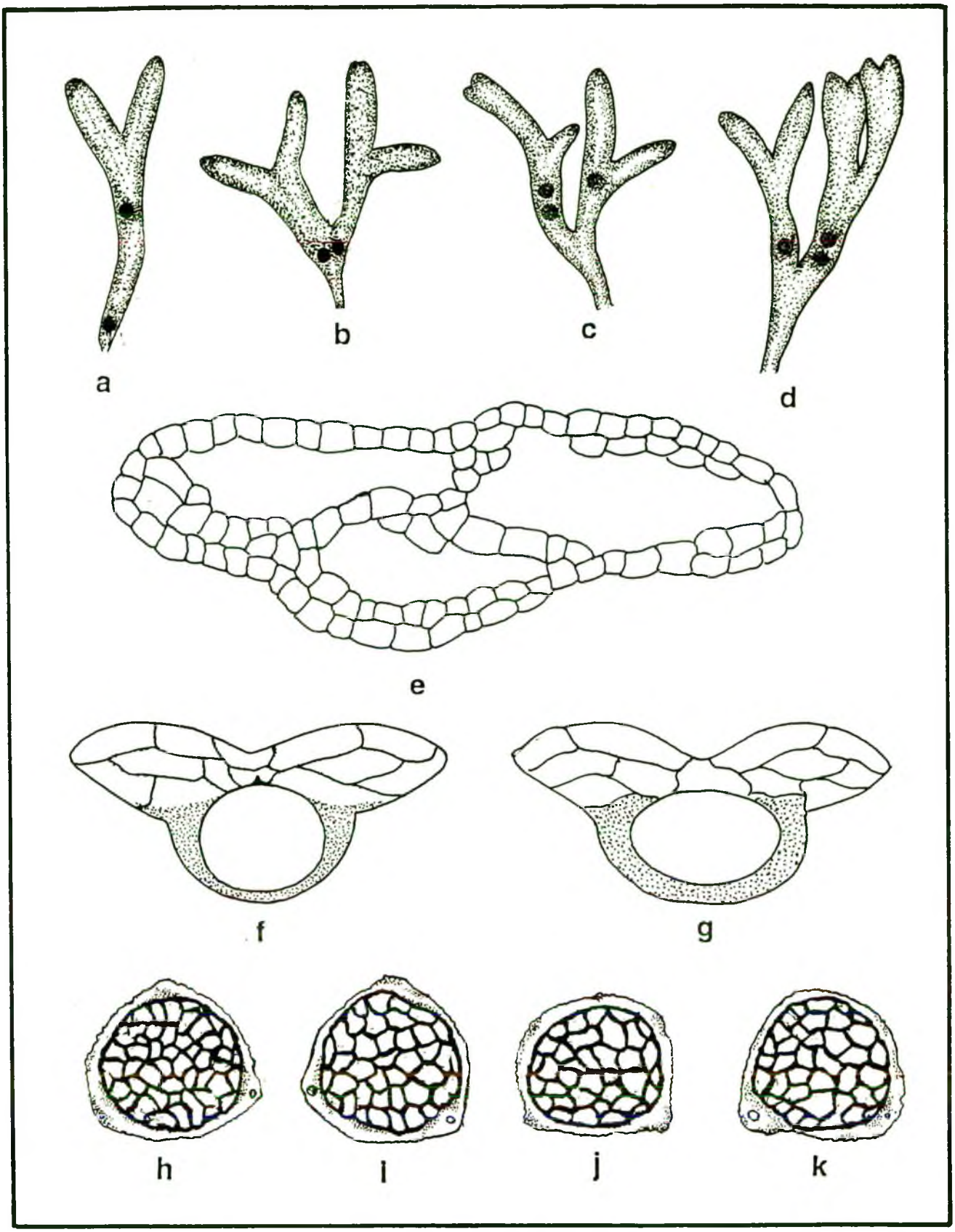
PLATE VII



Riccia lingulata **sp. nov.**

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Riccia marsupiformis sp. nov.

PLATE VIII

SEM PLATE 7 C

Monoica, herba atro-viridis ad flavo-viridis, lanata, in colonia in rosulata, aliquando superposita.

Thalli, 4-10mm longi, 1.5-3mm lati, dichotome ramosi ad triplex.

Pagina dorsalis profuse lacunosa, lacuna grandis, sulcus dorsalis inconspicuus, margo ambo levis et sinuata.

Squamae absente.

Thallus in sectione transversa ± triplex latior quam alta.

Cavernula aeria magna.

Antheridia in 1-3 seriebus disposita, papulae projectae.

Archegonia 1-3 seriebus disposita, collis immersus et nunquam projectus.

Archegonia postice disposita.

Sporangium profunde cernuum (marsupiforme), pyriforme, ovale, vel aliquandum elongatum.

Sporae brunneae ad nigrobrunneae, 60-72 μ in diam.

Parium reticulum gracilentum et ventraliter imperfectum.

Valde incrassatum et dorsaliter perfectum.

Monoecious, plant deep green to light green, wooly, colony rosette sometimes overlapping.

Thalli 4-10mm long, 1.5-3mm broad, branched dichotomously upto 3 times.

Dorsal surface highly pitted, pit large, dorsal groove not distinct, Margin both smooth and wavy.

Scale absent.

T.s. of the thallus ± three times as broad as high.

Air chambers large.

Antheridia 1-3 seriate, papillae projected.

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Archegonia 1-3 seriate, neck sunken and never projecting.
Archegonia develop posteriorly.
Sporanginum deeply pendulous (Pouched). pearshaped, oval or somewhat elongated.
Spore brown to blackish brown, 60-72 μ diameter.
Wall reticulation thin, incomplete on ventral surface.
Distinctly thick and complete on dorsal face.

Specimens examined :

Tangail : On the bank of Patulipara canal (on damp soil), January 1985. 185. Md. Kamruzzaman, Holotype (DUH).

Comilla : On the bank of the Gomti river, near Comilla town, January 1986. 169. Md. Kamruzzaman (DUH).

Satkhira : On the bank of the river Bhairab, near a bridge, April 1988. 417. Md. Kamruzzaman (DUH).

Distinguishing characters :

(i) Thallus wooly, colony both as rosette or overlapping patch.
(ii) Antheridial papillae short, ± obscure due to extending pit walls.
(iii) Archegonial neck sunken, not visible directly from dorsal surface due to its extreme ventral position.
(iv) Sporangium highly pendulous, for which it is tough to place a thallus vertically on a slide, oval, pear shapped or elongated.
(v) Spore brown to blakish brown, 60-72 μ in diameter, wing narrow & dentate. Spore wall reticulations markedly differ from dorsal to ventral surface in the context of thickening and also completeness. Triradiate marking distinct.

The species has been named after the marsupiform sporangium character.

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PLATE VIII

Riccia marsupiformis sp. nov.

a, b, c, d.	Thalli	10 x
e.	Thallus	36 x
f.	T. S. of thallus showing sporangial position	36 x
g,h,i,j & k.	Spores	300 x

(g & h - ventral view, i, j & k - dorsal view)

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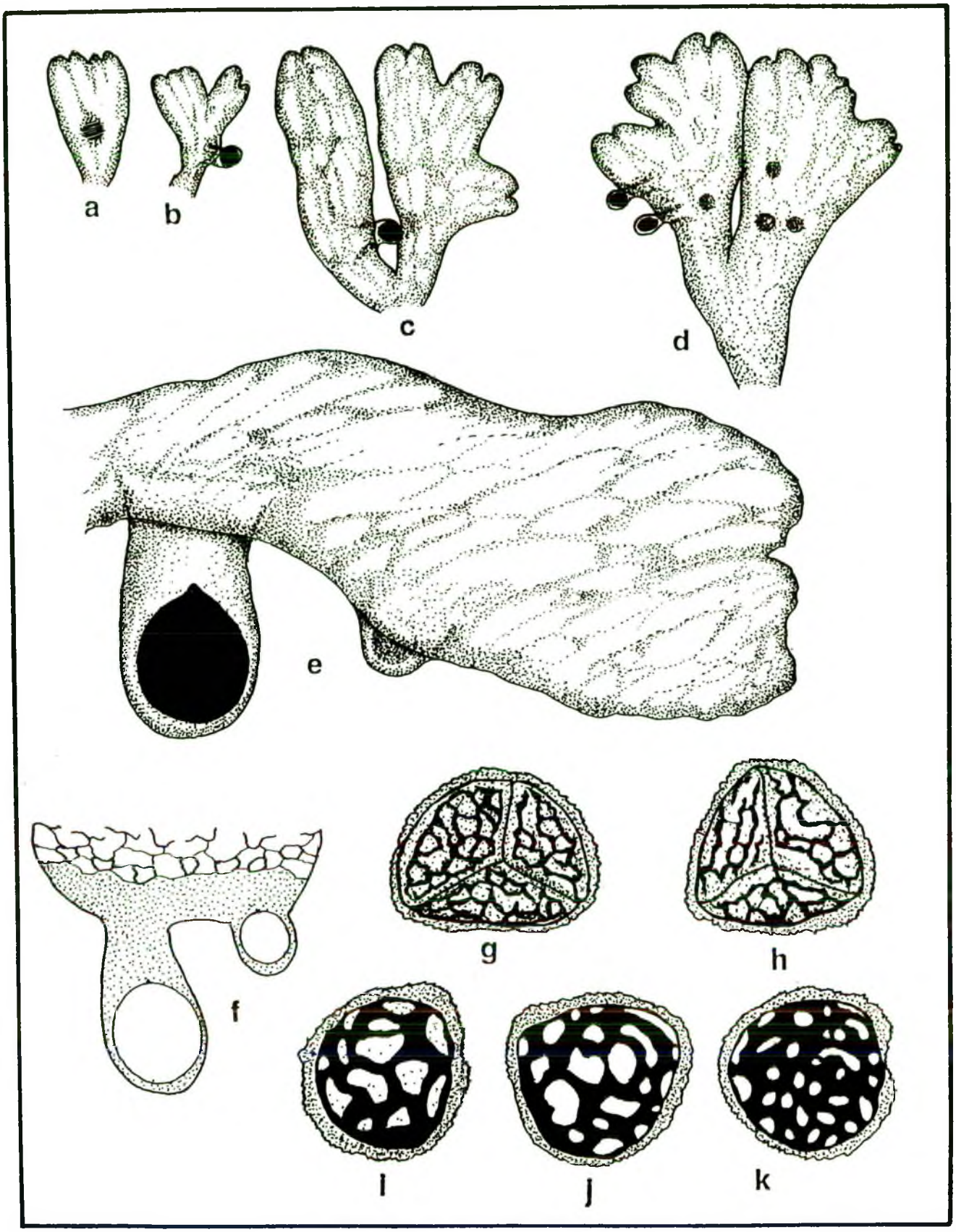
PLATE VIII



Riccia marsupiformis **sp. nov.**

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Riccia plana Taylor

Riccia plana Tay. 1846. J. Bot. London: 414.

Riccia manglorica Ahmad. 1942. Curr. Sci. 11: 433.

PLATE IX

SEM PLATE

Monoecious, plant light green, forming dense overlapping patches, branched, dishotomously and repeatedly upto four times. Budding common, develop both from the margin and apical region forming irregular branching. Thalli thin, linear, oblong, ovate, apex rotunded, upto 9 mm long and 1-1.5 mm broad, dorsal groove narrow, deep anteriorly and shallow posteriorly. Ventral scales both hyaline and purplish. T.S. of the thalli 2-3 times as broad as high, epidermal cell thin walled, globose; airchamber large, 1-3 layered. Antheridia 1-3 seriate and in apical region on both side of the dorsal farrow, antheridial papillae hyaline, distinctly projected above the thallus surface. Archegonia very small in number per thallus, generally 1-2 per segment and in single row. Sporangia brown, ventral, sometimes slightly pendulous. Spore tetrahedral, yellowish brown to golden brown, mostly traingular, roughly round or of other shapes; 60-75 μ in diameter, wall ornamentation reticulate, reticulation both complete and incomplete types, end of which both pointed or blunt and projected, 6-10 areolae across dorsally and 6-9 ventrally. Winged, wing thin, margin crenate, broader at corners, upto 7 μ broad. With one distinct performation at each corner. Triradiate marking conspicuous ventrally.

Specimens examined:

Tangail : Patulipara - on road side damp sandy soil, November 1987, 297, Md. Kamruzzaman, Holotype (DUH).

Netrokona : On the bank of river Mogra, November 1987, 299, M.R. Khan (DUH).

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Distinguishing characters:

(i) Plant forming overlapping, crowded, light green colony,

(ii) Thalli thin, linear, much branched, frequently bud forming,

(iii) Antheridia with markedly projecting osteole,

(iv) Sporangial number per thallus is very low, sporangium ventral or slightly pendullous,

(v) Spore 60-75 μ broad, wing thin, crenate, wavy and perforated at corners.

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Riccia sharishabariensis sp. nov.

PLATE X

SEM PLATE **7 D**

Monoica, herba atroviridis, thallus irregulariter, dichotome ad triplex, colonia irregulariter superposita.

Thallus linearis, crassus, margine plus minusve levis, incisura apicalis distincta, sulcuta dorsallis penitus.

Thallus usque 7mm longus, plerumque 0.5mm latus, raro usque 1mm latus.

Squamae hyalinae.

Thallus in sectione transversa ± diplex latior quam alta.

Cavernulaeria numerosa et multistrata.

Antheridia in 1-3 seriebus disposita.

Papula conspicua.

Archegonia uniseriebus disposita.

Sporangium cernuum.

Sporae atrobrunneae, triangulares, raro ± quadrangulares, 60-66μ in diam.

Ala leviter sinuata et profuse crenulata.

Paries retiformis, reticulum perfectum et dorsale incrassatum areolae 5-6 dorsales, reticulum ad apicem projectum.

Reticulum ventraliter imperfecte et gracilis.

Signa triradiates conspicua.

Monoceious, plant dark green, thallus irregularly dichotomous upto three times, colony irregularly overlapping.

Thallus linear, thick, margin ± smooth, apical notch distinct, dorsal furrow deep.

Thallus upto 7mm long, mostly 0.5mm broad, rarely upto 1mm broad.

Scale hyaline.

T.s. of thallus about double as broad as high.

Airchambers many and multilayered.

Antheridia 1-3 seriate.

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Papillae conspicuous.

Archegonia uniseriate.

Sporangium pendulous.

Spore dark brown, triangular, rarely ± quadrangular, 60-66μ in diameter.

Wing slightly wavy and highly crenate.

Wall reticulate, reticulation complete and thick on drosal face, areolae 5-6 across dorsally, reticulation tip projected.

Reticulation incomplete and thin on ventral face.

Triradiate marking conspicuous.

Specimens examined:

Jamalpur : Sharishabari, on canal side damp soil, October, 1985, 55. Md. Kamruzzaman, Holo type (DUH).

Baoshi, on road side damp soil, May 1990, 805. Md. Shirajuddaula (DUH).

Jagannath Gonj Ghat on the Bank of Jamuna March 1991, 1112. Md. Kamruzzaman (DUH).

Mymensingh : Fulbaria, on fellow lands, March 1991, 1167. Muzaffar Hossain (DUH).

Kishoregonj : Pakundia, on road side soil, March 1991, 1172. Eng. Abdul Jalil Dhalee (DUH).

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Distinguishing characters:

(i) Thallus branched both irregularly and dichotomously, thick, linear, with marked anteriorly situated dorsal groove , air chamber large.

(ii) Archegonia in single line, sporangia large and pendulous.

(iii) Spore wall ornamentation reticulate, reticulation large, projecting dorsal and thin, small ventrally.

The specimen has been named after the locality Sharishabari from which it was collected for the first time.

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PLATE IX

Riccia plana Taylor

a, b, c & d.	Thalli	10 x
e.	T. S. of the thallus	45 x
f, g, h & i.	Spores	300 x

(f. g - dorsal view. h, i - ventral view)

PLATE X

Riccia sharishabariensis sp. nov.

a, b, c & d.	Thalli	10 x
e.	T. S. of thallus showing sporangial position	36 x
f, g, h & i.	Spores	300 x

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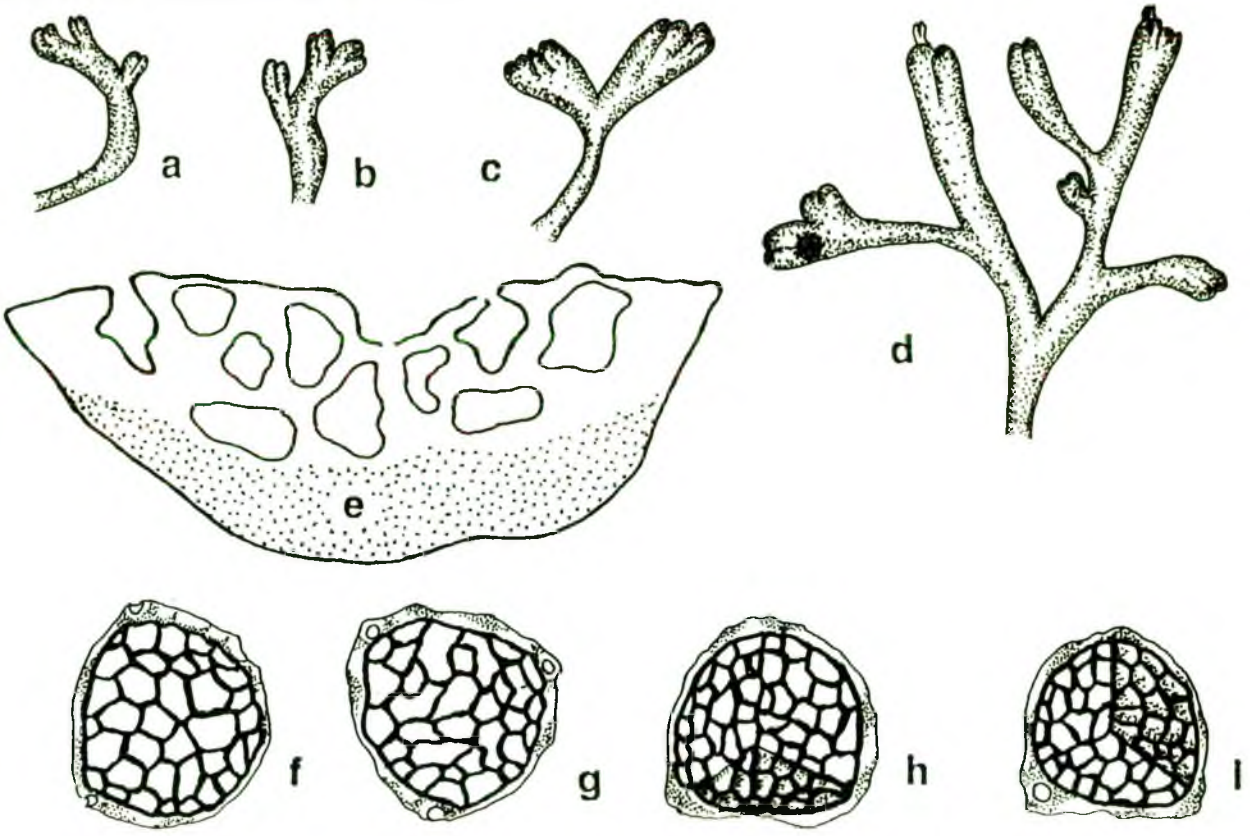
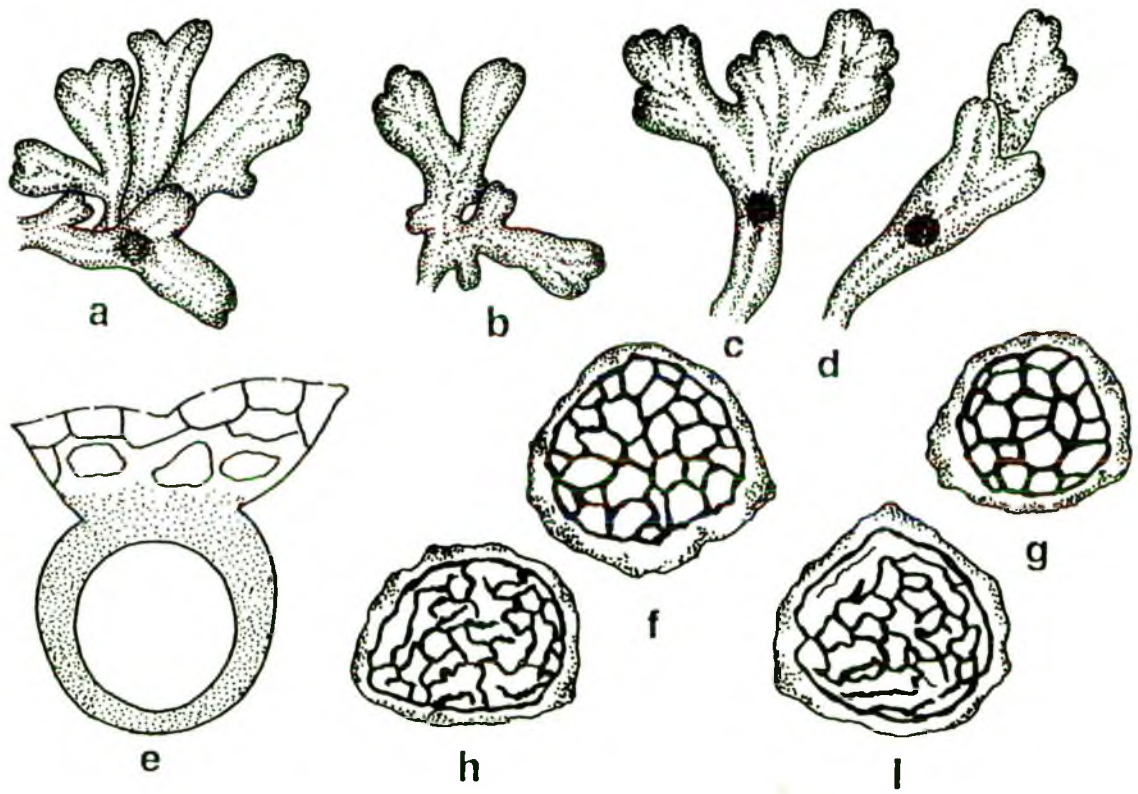
PLATE IX



Riccia plana Tayl.

PLATE X



Riccia sharishabariensis sp. nov.

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Riccia sultanii sp. nov.

PLATE XI

SEM PLATE

Monoica, herba atro-viridis, colonia in rosulata,dichotome, ramosa usque triplex

Thalli 4-6mm longus,1-1.5mm latus.

Squamae plerumque hyalinae, paucae leviter violaceae.

Rhizoides vermiculares.

Thallus in sectione transversa diplex ad triplex latior quam alta, ± plano convexa.

Cavernula aeria lata, cellulae rotundae, cum spatius distinctis intercellularibus.

Antheridia 2-3 seriebus disposita, fronte disposita, papila hyalina (maxima projecta) in thallus supra thalli pagina in maxima.

Archegonia 1-2 seriebus disposita.

Sporangia ventrale aliquando cernua.

Sporae flavidae ad auerobrunneae, forma variabilis.

48u to 75μ in diam, paries retiformis, 5-7 areolae dorsales.

Reticulum ad apicem projecerum. Paries latus crassus, dorsale perfectum, angustum et ventraliter imperfectum.

Ala crenata, dentata et sinuata, latior in angulis.

Usque ad 9μ lata, perforata, signa, triradiates conspicua.

Monoceious, plant deep green, colony rosette, branched dishotomously upto three times. Thalli 4-6mm long, 1-1.5mm broad.

Scales mostly hyaline, few slightly violet.

Rhizoids vermiculate.

T.S. of the thallus 2-3 times as broad as high, ± plano-convex.

Air chambers broad, cells round with distinct intercellular space.

Antheridia 2-3 seriate, develop anteriorly, papillae hyaline, highly projecting above the thallus surface.

Archegonia 1-2 seriate.

Sporangia ventral, sometimes pendulous.

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Spores yellowish to golden brown, variable in shape.

48μ to 75μ in diameter, wall reticulate, 5-7 areolae across dorsally.

Reticulation tip projected, wall broad and thicker, complete on dorsal face, narrower and incomplete on ventral face.

Wing crenate, dentate wavy, broader at corner.

Upto 9μ broad, perforated, triradiate marking conspicuous.

Specimens examined:

Tangail : On damp garden soil, March, 1988, 412, Kamruzzaman, Holo type (DUH).

College pond side, on sandy soil, March 1988, 415 Kamruzzaman (DUH).

Dhaka : On garden soil, Baldah gardens, April, 1988, 417, Kamruzzaman (DUH)

Tongi - On road side damp soil, April, 1988, 421, Md. Kamruzzaman (DUH).

Distinguishing characters:

(i) Green thallus broadly traingular in appearance. T.S. ± plano-convex.

(ii) Spore variable in shapes.

(iii) Spore well ornamentation reticulate, end projected, reticulation broader, complete, 6-7 areolae across at distal face and narrowar, mainly incomplete on proximal face.

(iv) Wing crenate, wavy and dantate upto 9 μ broad and perforated at corner.

The species has been named after the name of the renound bryologist Sultan Ahmed Khan.

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Riccia vulgaris sp. nov.

PLATE XII

SEM PLATE

Monoica, herba atro-viridis ad flavo-viridis, in colonus rosulata vel irregulariter superposita.

Thallus dichotome ramosus ad triplex, linearis, gracilis, anguste taenuiformis, margine laevis et sinuatus.

Usque ad 8mm longus, squamae rudimentales, hyalinae.

Thallus in sectione transversa diplex latior quam alta.

Cavernula aeria magna, plerumque in 1-2 seriebus disposita, cellulae epidermicae plerumque elongatae.

Antheridia in 1-2 seriebus disposita.

Archegonia uniseriebus, raro biseriebus disposita.

Sporangia profounde cernua, intrasubstrato evolutus evolvens.

Sporae nigro brunneae, plusminusve traiangulae, 50 μ - 75 μ in diam.

Paries retiformis, reticulum ad apicem projectum, ambo perfectum et imperfectum dorsaliter,

ventraliter imperfectum.

Ala sinuata, usque 10 μ lata, perforata in angulis, signa triradiates inconspicua.

Monoecious, plant deep green to light green, colony rosette or irregularly overlapping.

Thallus branched dichotomously upto three times, linear, thin, narrow ribbon like, margin smooth and wavy.

Upto 8mm long, scale rudimentary, hyaline.

T.s. of the thallus ± double as broad as high.

Air chambers large, generally in 1-2 rows, epidermal cells mostly elongated.

Antheridia 1-2 seriate, develop anteriorly.

Archegonia uniseriate, rarely biseriate.

Sporangia highly pendulous, develop within substratum.

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Spore blackish brown, roughly triangular, 50 μ to 75 μ in diameter.

Wall reticulate, reticulation tip projected, both complete and incomplete on dorsal face, incomplete on ventral face.

Wing wavy upto 10 μ broad, perforated at corner, triradiate marking inconspicuous.

Specimens examined:

Tangail : Registry para - On house garden, January, 1988, 407, Md. Kamruzzaman, Holo type (DUH).

At Nathurchar, Gopalpur, on house side and earthen plinth of dwelling houses. February 1984, 7. Md. Kamruzzaman (DUH). Pakutia, Ghatail, on road side damp soil, April August, September 1985, 19. Md. Kamruzzaman (DUH). Elashin, Deldowar, on the bank of the river Dhaleswari, August 1985, 17. Md. Kamruzzaman (DUH). Dubail, Ghatail, on garden soil, September 1985, 20. Md. Kamruzzaman (DUH). Madhupur, Syed Ahmadia Orphanage farm on damp soil, March 1986, 148. Jalchatra, Garodouse, on damp soil, March 1986, 153. Md. Kamruzzaman (DUH). Rasulpur, Forest Bid Office campus on red damp soil, April 1986, 205. Md. Kamruzzaman (DUH). Dhigulia, on the bank of the river Lohajang, February 1990, 725. Md. Kamruzzaman (DUH).

Jamalpur : Sharishabari, on canal side damp sandy soil, February, 1985, 14. Md. Kamruzzaman (DUH). Jamalpur town, on drying soil, February 1985, 15. Md. Kamruzzaman (DUH). Farm garden, Golapbag and on the bank of river Brahmaputra, November 1986, 229. Md. Kamruzzaman (DUH).

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Dhaka : Zinzira, on drying fallow field, January 1984, 6, Md. Kamruzzaman (DUH). Kashimpur, on the embankment of the river Turag. January 1985, 9. Md. Kamruzzaman (DUH). Kaliakoir, on drying fallow field, October 1985, 43. Zahid Hossain (DUH). Islampur, on hill side damp soil, October 1985, 44. Md. Kamruzzaman (DUH).

Chittagong : Faizlake, on damp soil, October 1985, 46. Prof. Syed Hadiuzzaman (DUH). Pahartali, hill base damp soil, November 1985, 49. Md. Kamruzzaman (DUH).

Distinguishing characters:

(i) Plant both light and deep green, thallus much branched regularly thin, narrow, long; dorsal farrow short, shallow and apical.

(ii) T.S. of the thallus $\pm$ double as broad as high but highly extended at sporangial region to cover it.

(iii) Sporangium highly pendulous, very large in comparison to thallus thickness.

(iv) Spore wall both regularly and irregularly raticulate abaxially and only regularly adaxially.

The species is very common and as such it has been named accordingly.

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PLATE XI

Riccia sultanii sp. nov.

a & b.	Thalli	10 x
c.	T. S. of thallus showing sporangial position	18 x
d.	T. S. of thallus(a part in detail)	120 x
e.	Scales	90 x
f,g	Spores	300 x

f- dorsal view , g- ventral view .

PLATE XII

Riccia vulgaris sp. nov.

a & b.	Thalli	10 x
c.	T. S. of thallus showing sporangial position	36 x
d & e.	Spores	300 x

(d - dorsal & e - ventral view)

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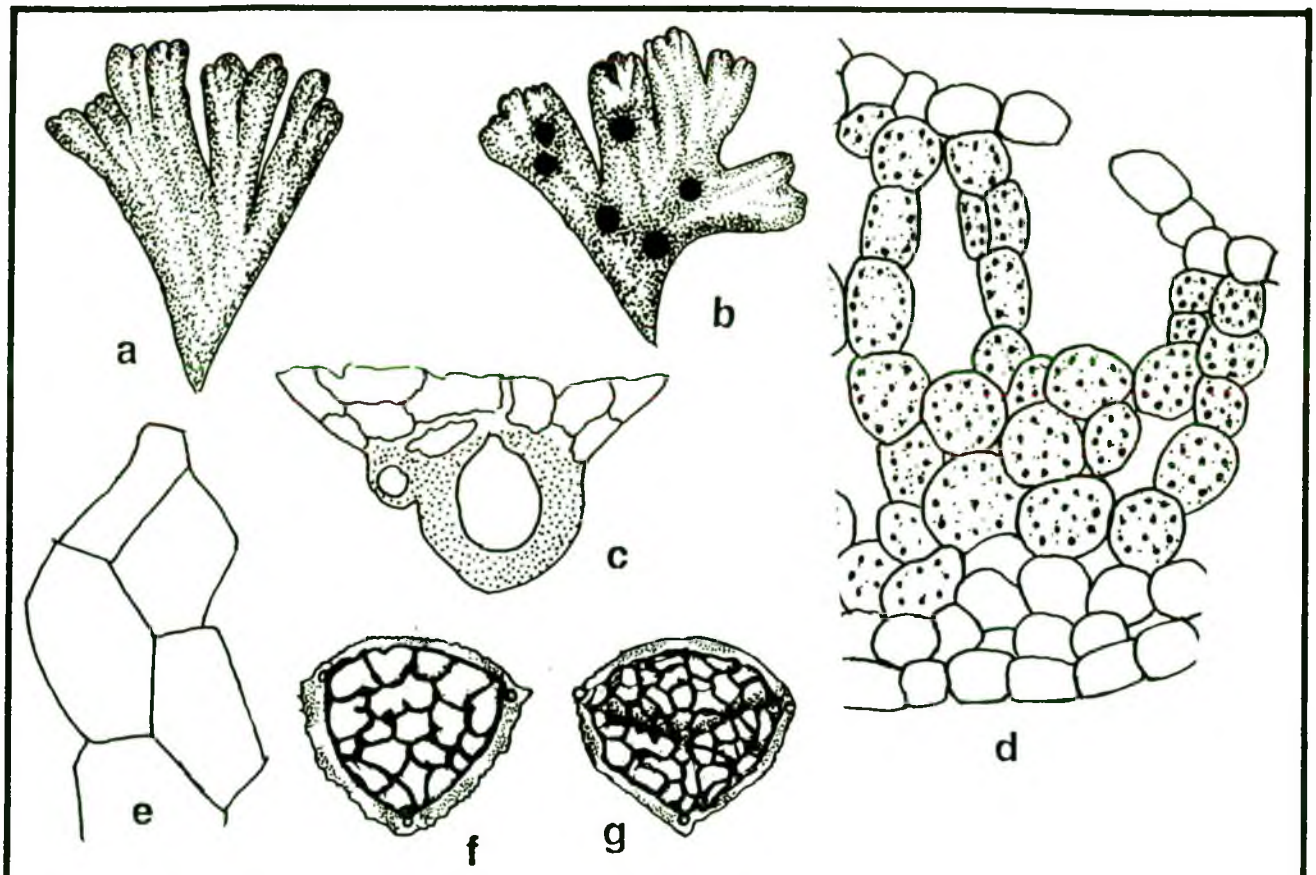
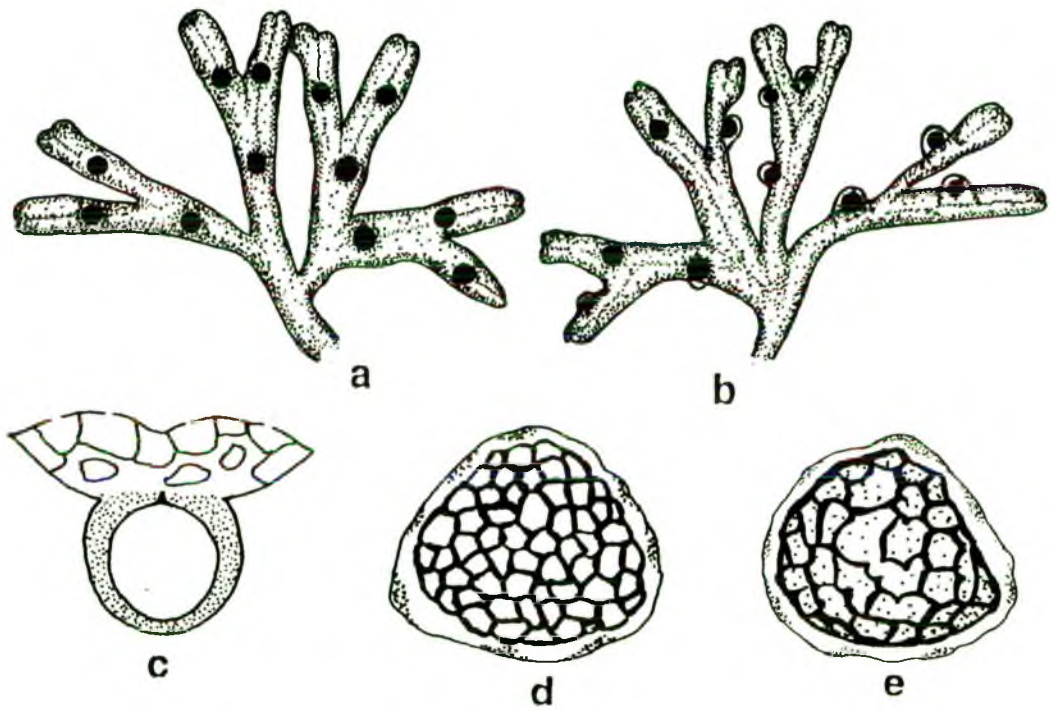


Riccia sultanii sp. nov.

PLATE XII



Riccia vulgaris sp. nov.

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SUBGENUS - III:RICCIOMAMILLOSA

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OCCURANCE OF SPECIES UNDER THE SUB-GENUS - III : *RICCIOMAMILLOSA*

SPECIES		DISTRICT CODE
Riccia arnellii	:	1, 12, 29
Riccia centroporii	:	12, 15, 17
Riccia perssonii	:	1, 12, 13, 14, 15, 26, 29, 37, 59
Riccia varientes	:	12, 15, 16

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Genus: *Riccia*

Sub-genus III: *Ricciomamillosa*

Key to the species:

1. Sporangium ventral, spore tetrad isobilateral - *R. perssonii.*

   Sporangium ventral, spore tetrad otherwise - 2

2. Distinct pore present at the centre of spore tetrad, spines long, multiheaded - *R. centroporii.*

Central pore absent, spines blunt or pointed - 3

3. Spore tetrad rhomboidal and tetrahedral, spines short, mainly blunt - *R. arnellii.*

Spore tetrad variable (tetrahedral, isobilateral and rhomboidal), spines ± long, both blunt and pointed - *R. variantes.*

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Riccia arnellii Khan

PLATE I

SEM PLATE **8 A**

Riccia arnellii Khan. The Bryologist 60: 23-30. 1957.

Dioecious, Female plant green or light green and becomes yellowish green when mature. Rosette colony 5-16 mm in diameter.Plants also occur as crowded and over-lapping patches. Thallus ± wooly, generally forked one or twice dichotomously, thin anteriorly and fleshy posteriorly, or thin althrough, 3-7 mm long, 2-4mm broad, lobes oblong, margin crenulate and sometimes undulating. Dorsal surface with large number of air pores forming pits and are easily visible with naked eyes. T.S. of the thallus 3-6 times as broad as high. Male plants are small, yellowish green, comparatively less chlorophyllous in the basal portion. Male plants are mostly associated with female plants in a colony or form separate small colony. Individual thallus is thin, linear, semi-oval or with broad anterior part. Thallus 2-7mm long, 1-2mm broad, apex obovate, dichotomously branched for 1-2 times. Antheridia 2-5 seriates, also develop in cluster in the upper two-third portion of the thallus, oval or rounded in shape with prominent and projecting distinct ostiole. Archegonia develop throughout the female thallus and in most cases occur prominently in mid dorsal line in one or more lines. Sporangia blackish brown, oval or spherical with persistent and long neck. Sporangia ventral in fleshy thallus and ± pendulous in thin thallus. The size of the sporangia varies on its spore content. Spore blackish brown, permanently attached in tetrad, in tetrahedral and rhomboidal plans in the same sporangium, 75-85 μ in diameter. Spores spiny, spines short and blunt, 4-8 μ long.

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Ghatail - Khilgati Syed Ahmdia Yatimkhana - on road side damp soil. September 1985, 27, Md. Kamruzzaman (DUH).

Bhuapur - on damp in fallow rice field, December 1985, 28, MdKamruzzaman (DUH).

Sylhet : Fenchuganj - village Judhisther-near hill side fallow rice field, on damp soil, February 1986, 206, Md. Kamruzzaman (DUH). Village Gilachara - on damp soil in fallow rice field by the side of bamboo bush, February 1986, 209, Md. Kamruzzaman (DUH). At the bank of the river Kushiara at the point of Thana Head Quarter, February 1986, 210 Md. Kamruzzaman(DUH).

Dhaka : Kamrangirchar, January 1988, 399, Md. Kamruzzaman (DUH).

Mymensingh : On the bank of the river Brahmaputra near ferry ghat, February 1988, 409, Md. Kamruzzaman (DUH).

Distinguishing characters:

i) Dioecious, colony with small thin male plant and comparatively large female thallus,

ii) Dorsal cavities distinct.

iii) Sporangium mainly ventral, sometimes slightly pendulous in case of thinner thallus.

iv) Spores blackish brown, papillate, pupillae short and broad based. The tetrads are always both tetrahedral and rhomboidal in arrangement.

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PLATE I

Riccia arnellii Khan

a, b & c.	Female plants	10 x
d, e, f & g.	Male plants	10 x
h.	T.s. of female plant showing sporangial position	18 x
i & j.	Spiny spores in tetrads	300 x

(i- tetrahedral plan, j - rhomboidal plan)

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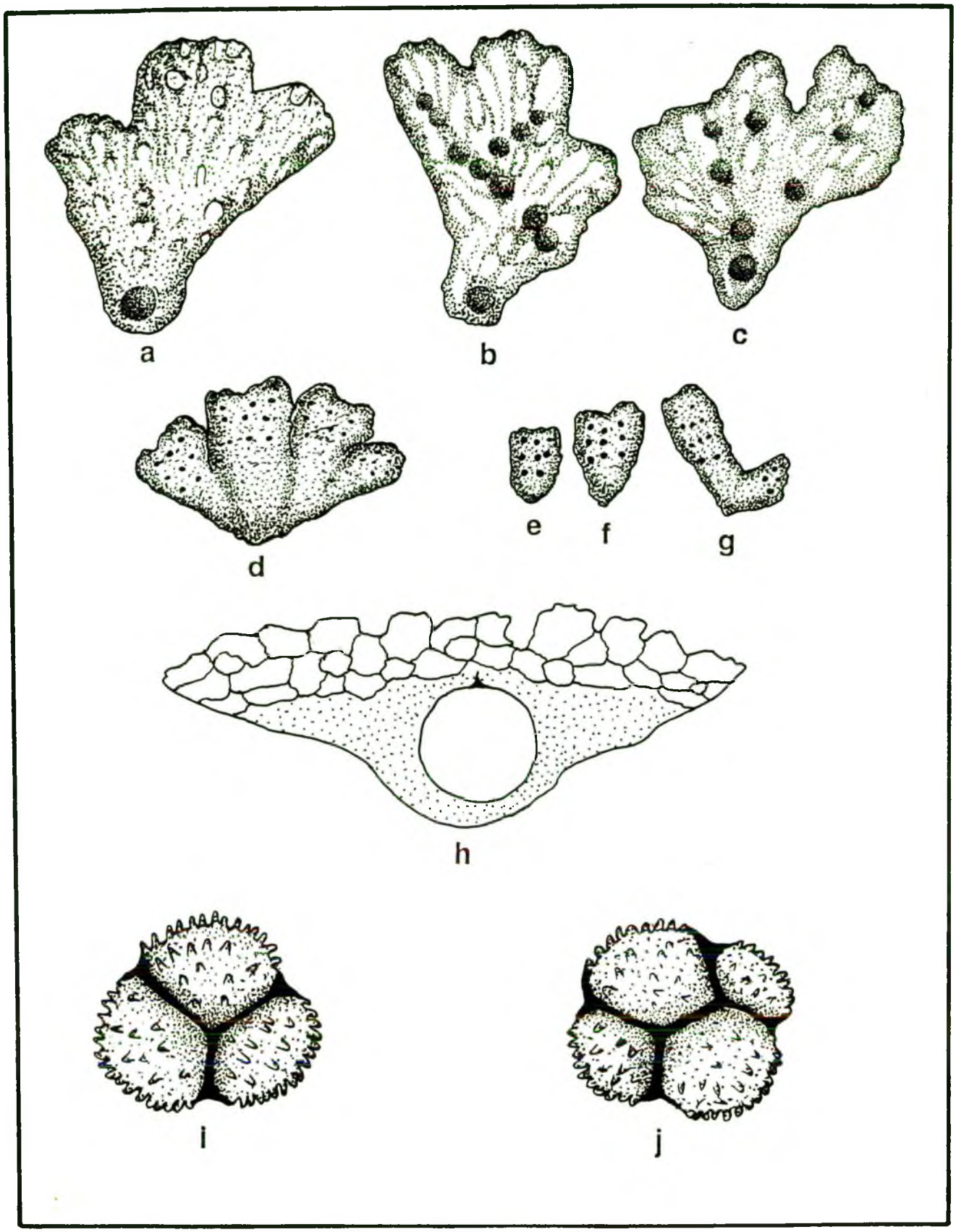
PLATE I



Riccia arnellii Khan

Dhaka University Institutional Repository

Riccia centroporii sp. nov.

PLATE II

SEM PLATE **8 B**

Dioica, herba viridis in colonia compacta, rosulata in coloniae medio rubra vivido vel atroflavea.

Thallus non-ramosus vel dichotome ramosus ad di et triplex.

Thallus crassus, succulentus, ± lanatus, usque 7mm longus, 2mm latus.

Margio tenuis et sinuatus, pagina lacunosa, squamae absentes.

Planta mascula crescens cum planta femina, non-ramousus, succulentus, 3-4mm longus, 1-1.5mm latus.

Thallus in sectione transversa ± duplex latior quam alta. Cavernularum aeriarum magna.

Antheridia in 2-3 seriebus disposita. Archegonia in 1-2 seriebus disposita.

Sporangia ventralia pauca, plerumque 1-2 per thallus.

Sporae atrobrunneae ad aureobrunneae. Tetradum affixum permanente.

Sporarum tetradia isobilateralia rhombica et tetrahedralia, 90μ-120μ in diam.

Porus distinctus in isobilateralis et rhombica tetradium centro.

Spinae plerumque complanatae ad apicem, aliquot arcuatae et acutae, ± uniformites latae 5 μ - 7 μ longae.

Dioecious, plant green, colony compact, rosette, brick red or deep yellow colour at the center of the colony.

Thallus unbranched or branched dichotomously 2-3 times.

Thallus thick, fleshy, ± wooly, upto 7mm long, 2mm broad.

Margin thin and wavy, surface pitted, scale absent.

Male thallus grow together with female plant, unbranched, fleshy, 3-4mm long, 1-1.5mm broad.

T.S. of thallus ± double as broad as high.

Antheridia 2-3 seriates, Archegonia 1-2 seriates.

Sporangia ventral, few in number, generally 1-2 per thallus.

Spore dark brown to golden brown, Tetrad permanently attached.

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Spore tetrad isobilateral, rhomboidal and tetrahedral, 90 μ - 120 μ in diameter.
Distinct pore present at the center of isobilateral and rhomboidal tetrad.
Spines mostly flat at tip, few curved and pointed, $\pm$ uniformly broad, 5-7μ long.

Specimens examined:

Tangail : Santosh - on the bank of a drying pond on sandy soil under direct sunlight, April 1988, 450, Md. Kamruzzaman Holotype (DUH).

Nathurchar - on sandy bank of a ditch, April, 1989, 462, Md. Kamruzzaman (DUH).

Elasin - on the bank of the Dhaleswari river on drying sandy soil, April, 1988, 458, Md. Kamruzzaman (DUH).

Mymensingh : On the bank of Brahmaputra, April, 1989 Syed Hadiuzzaman (DUH).

Kewat khali -on sandy soil of a drying ditch, May, 1989, 463, Md. Kamruzzaman (DUH).

Sherpur : Near BDR camp on drying canal, October, 1991, 743. Md. Kamruzzaman, (DUH).

Distinguishing characters:

i) Dioecious, plants form compact rosette colony, central zone of the colony is brick red and the posterior region of the thallus is blackish green.

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ii) Dichotomy ± restricted in the anterior region of the thalli.

iii) T.S. of thallus broadly round or highly convex ventrally and ± flat dorsally.

iv) Spiny spores in tetrad remain permanently attached. The tetrads are isobilateral, rhomboidal and tetrahedral in arrangement in the same sporangium.

v) Single distinct pore is present at the central position of the isobilateral and rhomboidal type of spore tetrads.

The species has been named after the pore character which is distinctly present at the centre spore tetrads.

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PLATE II

Riccia centroporii sp. nov.

a, b & c.	Female plants	10 x
d.	Male plant	10 x
e.	T. S. of female thallus showing sporangial position	18 x
f,g,h & i.	Spiny spore tetrads	270 x

(f & g - spores tetrads in isobileteral plans with central pore,

h - spore tetrad in rhomboidal plan and

i - spore tetrad in tetrahedral plan)

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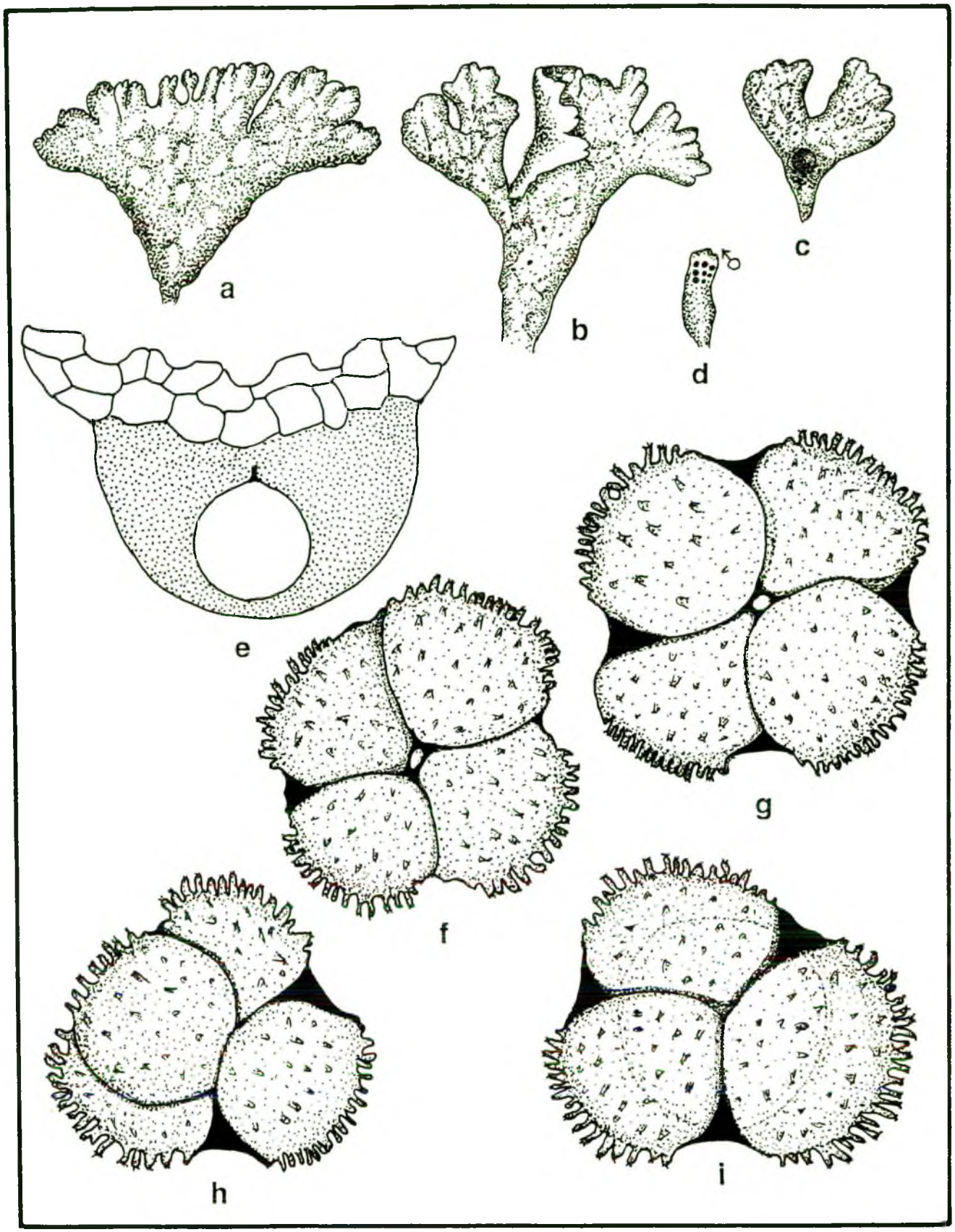
PLATE II



Riccia centroporii sp. nov.

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Riccia perssonii Khan

PLATE III

SEM PLATE 8 C

Riccia perssonii Khan Sv. Bot Tidskr. 49: 433 436. 1955.

Dioecious. Plant wooly, occur as circular patches, both male and female plants are grouped together where the male plants may grow centrally or at the side of the female thallus in a rosette colony of 4-10mm in diameter. Segment upto 8mm long. The male thalli are always smaller than that of their female associates. Male plants are lighter green in colour whereas females are bright green. In context of wooliness female thalli are more wooly in texture than that of the male. Thallus bears distinctly visible airpores, ridge like thickenings, dorsal median groove present in anterior region alongwith prominent apical notch like area with broadly rounded or oblong lobes. Most of the female thalli are branched dichotomously for once or twice but male thalli are mostly unforked. Male plants are also less fleshy than that of the female plants, Margin of the thallus is undulated. In context of reproductive structure archegonia develops throughout the thallus in female plant and antheridium develop only at the anterior half of the male thallus. Scales absent. T.S. of the thallus is more or less flat dorsally ,convex ventrally and 4-5 times as broad as high. The spongy plant has large number of distinct air chambers in two or more lines, enlarging greatly in the older parts of the thallus. The air pores are small behind the growing apex but rapidly enlarging with the enlargement of the airchambers due to the separation and contraction of cells bordering the pores. The air chambers are bordered by cholorophyllous cells. Ventral region of the thallus consists of parenchymatous cells having no intercellular spaces in between them. Antheridia are born at the anterior half of the male thallus, generally in 3-4 lines. Archegonia are generally in two lines along the mid dorsal line of the thallus. Sporangium ventral, dark brown in colour. Spore brown to shining golden brown. Spore permanently adhere in an isobilateral tetrad, 70 μ to 95 μ in diameter. Wingless spores bears spines all over its surface except in the juncture regions. The spines are blunt, pointed and some are with bifercated tips. Spines 8-16 μ long.

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Kishoreganj : Gurudayal College - in damp soil of a fallow fields border line. February 1987, 301 Md. Abul Hassan (DUH).

Netrokona : Baraghat Bridge-near the bridge, on damp soil in Boro seedling bed, March 1986, 304, Md. Kamruzzaman (DUH). Village Hossainpur - on the bank of the river Mogra, on shady damp soil under herbaceous plants. March 1986, 168, Md. Kamruzzaman (DUH).

Barishal : Kashinathpur village - on damp and drying paddy field. December 1986, 143, Md. Kamruzzaman (DUH). Shikarpur village under sadar thana, on damp soil under a culvert. December 1986, 239, Md. Kamruzzaman (DUH).

Mymensingh : Haluaghat - village Pagalpara - on damp and fallow rice field, March 1986, 232, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Dioecious, plant wooly, colony with smaller, light green pinkish wooly male plants and bright green wooly and fleshy female plants. Male plants almost always mixed with female plants in the colony.

ii) Dorsal cavities distinct, through which sporangia are clearly visible with naked eyes.

iii) Golden brown or blackish golden brown spores adhere permanently in tetrad. The tetrad are always iso-bilateral in arrangement.

iv) Spores mamillate with blunt, pointed or with forked tip.

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Specimens examined

Tangail : Mohanpur - canal bank on damp shady soil, April 1985, 71, Md. Kamruzzaman (DUH). Adalat para fallow and shady garden soil, April 1985, 73, Md. Kamruzzaman, (DUH). Madhupur Garo house near an unused well, October, 1984, 10. Md. Kamruzzaman. Pakutia in damp rice field, November, 1985, 89. Md. Kamruzzaman. Santosh near IRRI field and road side, February, 1986, 203. Md. Kamruzzaman. Katuli on the side of a drying ditch, March, 1986, 219, Md. Kamruzzaman, (DUH).

Dinajpur : Raniganj - the Mahila river side, on damp soil, December 1985, 96, Md. Kamruzzaman (DUH). Ghora ghat - on fallow damp rice field, December, 1985, 88, Md. Kamruzzaman (DUH).

Dhaka : Demra Zinzira and Sonargaon on fallow damp soil and rice fields. January 1986, 204, Md. Kamruzzaman (DUH).

Sylhet : Fenchuganj - in the village-Judhisthir near hill side damp soil in a fallow rice field. February, 1986, 211, Md. Kamruzzaman, (DUH). Fenchuganj village - Gila chara - on damp soil of a fallow rice field under the shade of bamboo jungle, February 1986, 212, Md. Kamruzzaman (DUH).

Comilla : Daudkandi ferry ghat on drying soil of the bank of the Meghna river at the side of a boro field and fallow land. February 1986, 213, Md. Kamruzzaman (DUH).

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PLATE III

Riccia perssonii Khan

a & b.	Female plants	18 x
c & d.	Male plants	18 x
e.	T. S. of female plant showing sporangial position	18 x
f & g.	Spiny spores in tetrads cemented together in isobileteral plan	270 x

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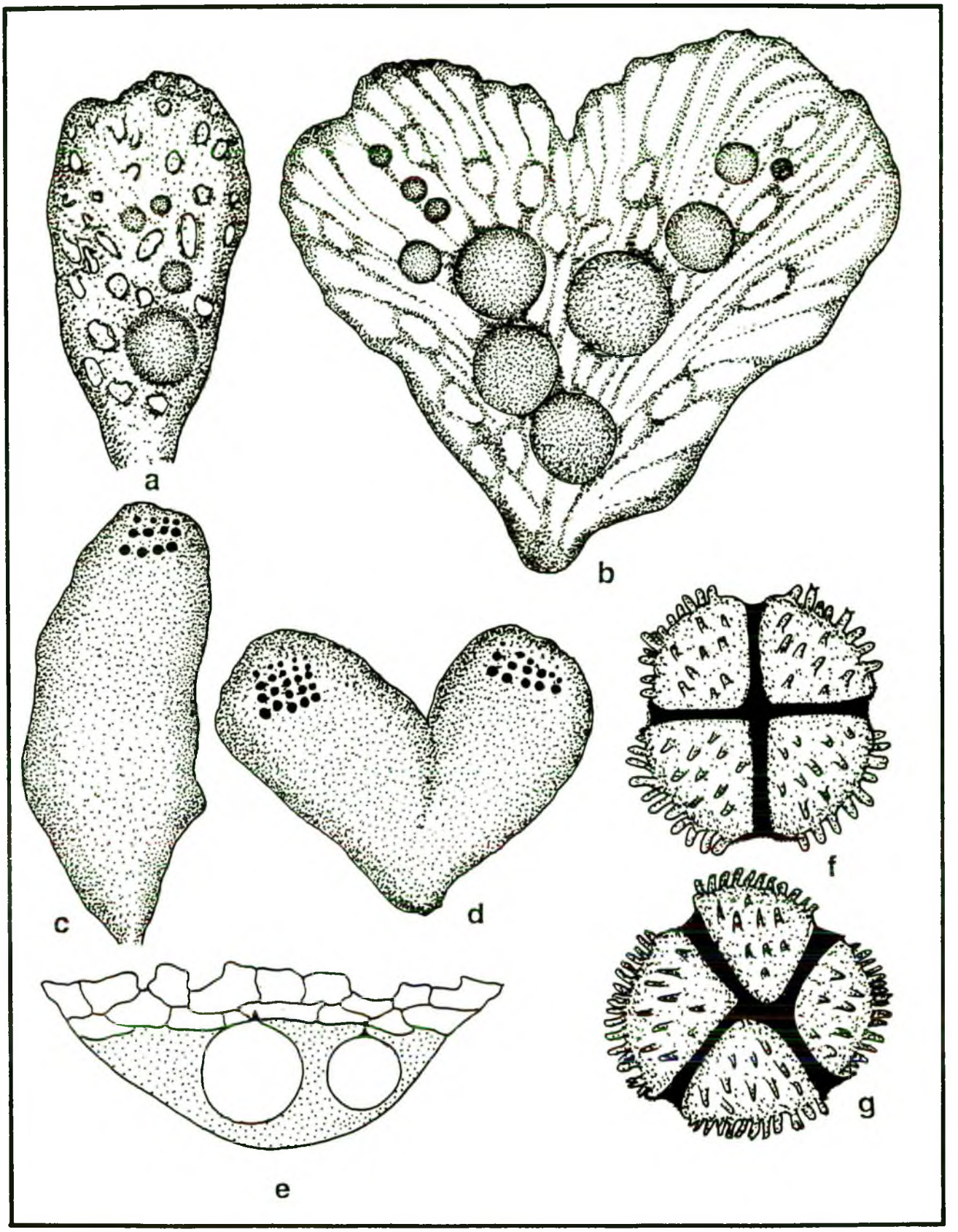
PLATE III



Riccia perssonii Khan

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Riccia variantes sp. nov.

PLATE IV

SEM PLATE 8D

Dioica, herba ravido viridis ad flavovirens, in colonia rosulata vel irregularis. Thallus non-ramosus vel dichotome ramosus ad uni et duplex, succulentus, 4-9mm longus, 3-5mm latus, margo gracilis. Thallus in sectione transversa duplex latior quam alta.

Planta mascula 2-4mm longa, 1-2mm lata, tenuis, taeniaformis. Antheridium in 2-3 seriebus disposita. Archegonium in 2-3 seriebus disposita.

Sporangium ventralia, numerosa, nigra vel nigrobrunnea, late rotunda.

Sporae nigrobrunneae ad flavobrunneae, tetradum afixum permanente.

Sporarum tetradum rhomboidale, tetrahedrale et isobilaterale, 100μ-115μ in diam.

Spinae latae ad basim, attenuatae ad apicem, ambo obtusatae et acutae ad apicem, 10-12μ longa.

Dioecious, plant greyish green to yellowish green, colony rosette or in irregular large patches.

Thallus unbranched or branched dichotomously for 1-2 times, fleshy, 4-9mm long, 3-5mm broad, margin thin. T.S. of thallus double as broad as high.

Male plant 2-4mm long, 1-2mm broad, thin, ribbonlike. Antheridia 2-3 seriates. Archegonia 2-3 seriates.

Sporanguim ventral, many, black or blackish brown, broadly round, clearly visible from both dorsal and ventral side of the thallus.

Spore blackish brown to yellowish brown, tetrad permanently attached.

Spore tetrad rhomboidal, tetrahedral and isobilateral, 100μ - 115μ in diameter.

Spines broader at base, narrower at apex, both blunt and pointed at tip, 10-12μ long.

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Specimens examined:

Tangail : Bhabanipur - on fallow land as densely growing colonies, February 1988, 426, Md. Kamruzzaman Holotype (DUH).

Elanga, on drying fallow field. February 1988, 432, Md. Kamruzzaman (DUH).

Mymensingh : On the bank of the river Brahmaputra near Circuit House point, February 1989, 438, Prof. Syed Hadiuzzaman (DUH).

Jamalpur : On the bank of the river Brahmaputra near Ferry ghat, March 1989, 447, Md. Kamruzzaman (DUH).

Distinguishing characters :

i) Dioecious; plant greyish or yellowish green in colour, forming mat like rosette colony or in large irregular patches.

ii) Sporangium ventral and many per thallus.

iii) Spiny spores in tetrad are cemented together in all tetrahedral, rhomboidal and isobilateral plans and are found in same sporangium.

iv) Spines broader at base and narrower anteriorly both blunt and pointed at the tip, 10-12 μ long.

The species has been named after the spore tetrad arrangement in various plans in the same sporangium.

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PLATE IV

Riccia variantes sp. nov.

a.	Colony	10 x
b, c & d.	Female plant	10 x
e & f.	Male plants	10 x
g.	T. S. of thallus showing sporangial position	18 x
h, i & j.	Spiny spore tetrads at three different plans	270 x

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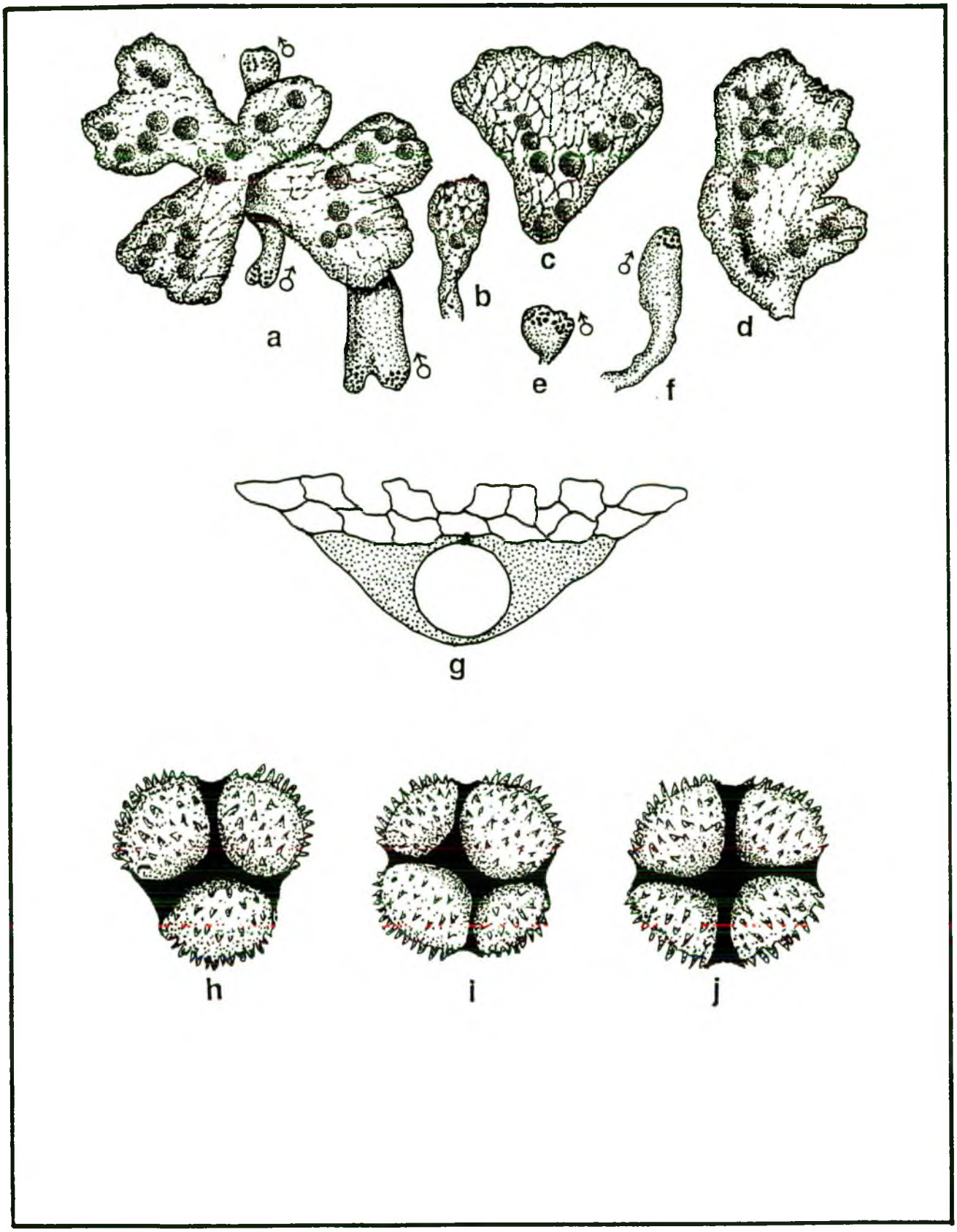
PLATE IV



Riccia varientes **sp. nov.**

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SCANNING ELECTRON MICROGRAPHS (SEM)

AND

PHOTOMICROGRAPH

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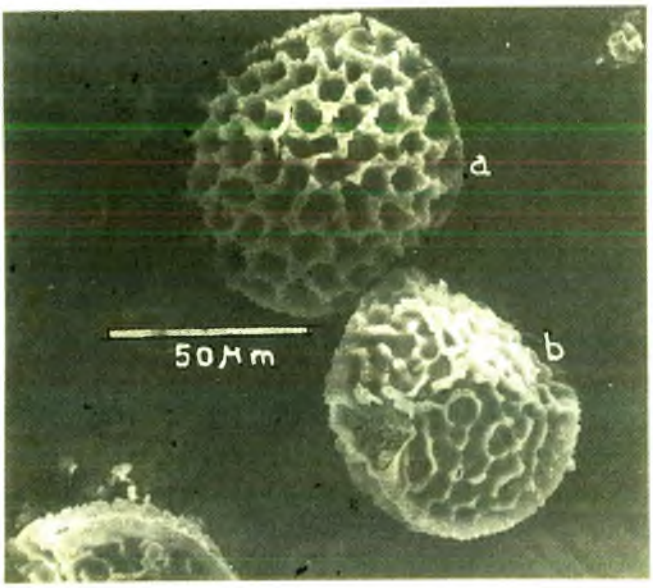
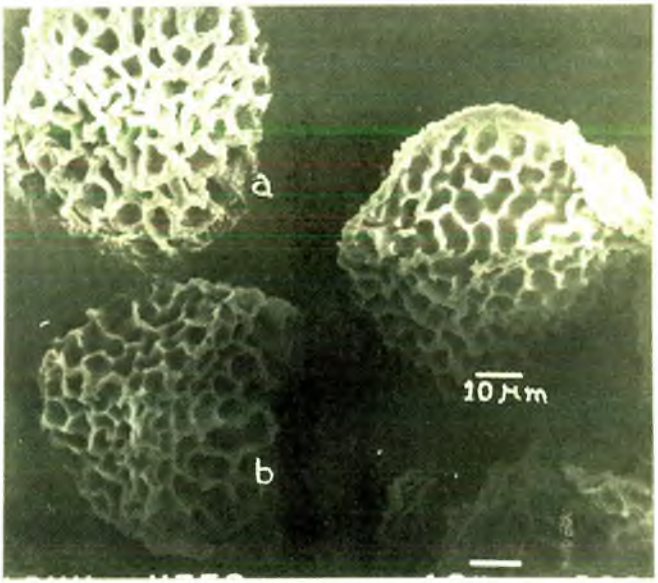
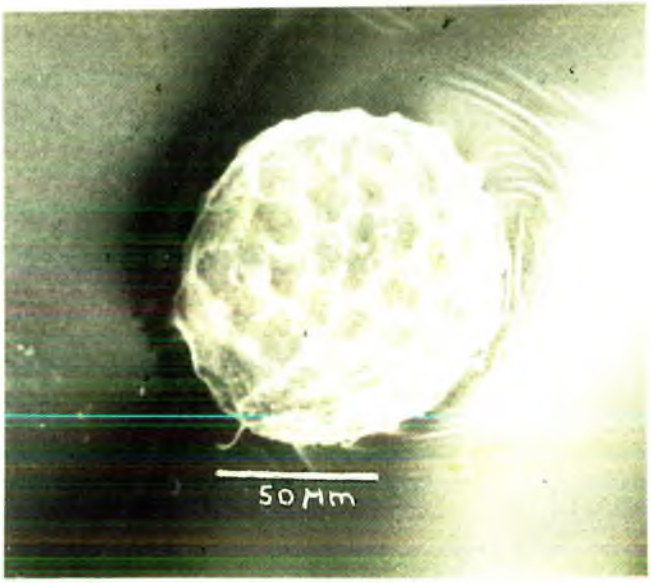
PLATE - 1
(SEM of spores)



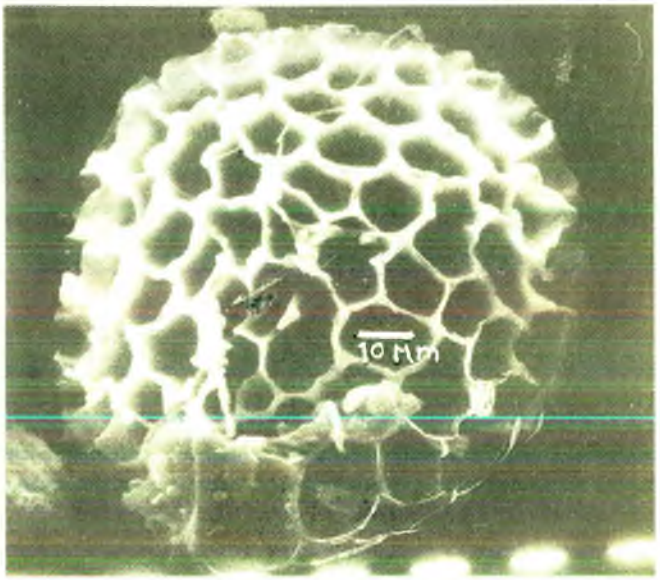
A *Riccia bandarbanensis* sp. nov.
a - dorsal view
b - ventral view



B *Riccia barabaidensis* sp. nov.
a - dorsal view
b - ventral view



C *Riccia bengalensis* Khan
ventral view



D *Riccia billardieri* M et. N.
dorsal view

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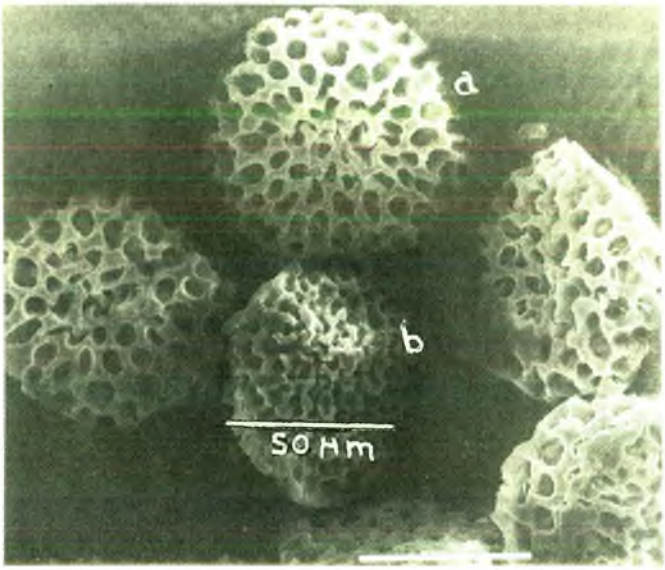
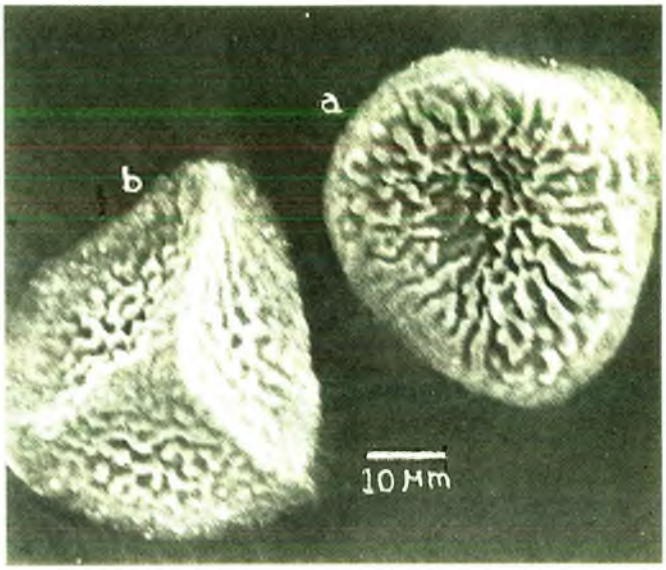
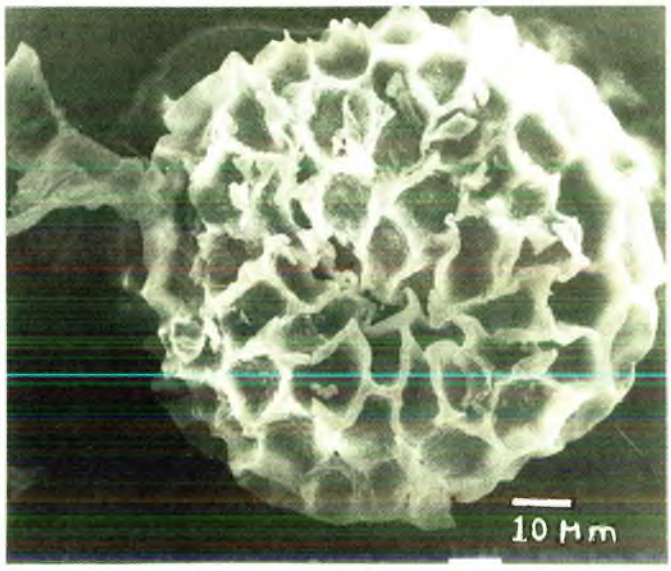
PLATE - 2
(SEM of spores)



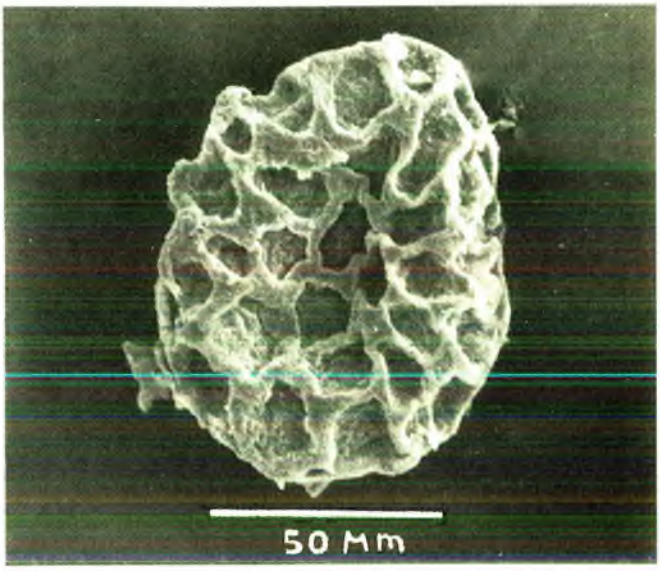
A *Riccia bogransis* sp. nov.
a - dorsal view
b - ventral view



B *Riccia compaginata* sp. nov.
a - dorsal view
b - ventral view



C *Riccia crundwellii* sp. nov.
dorsal view



D *Riccia discolor* L.
dorsal view

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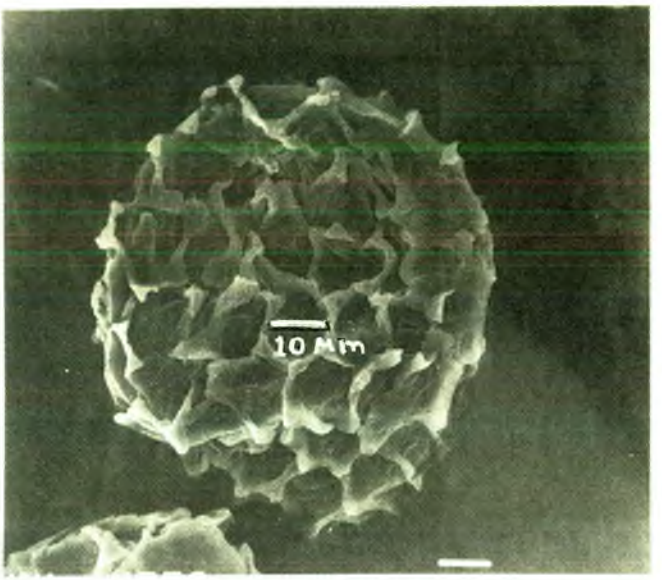
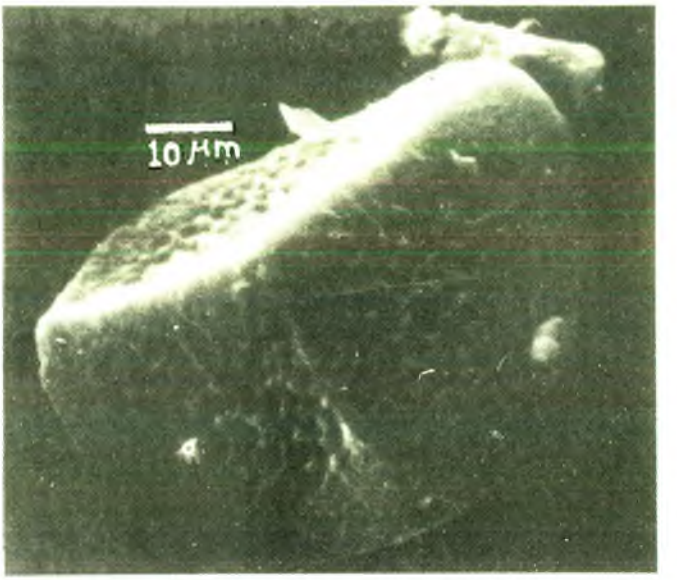
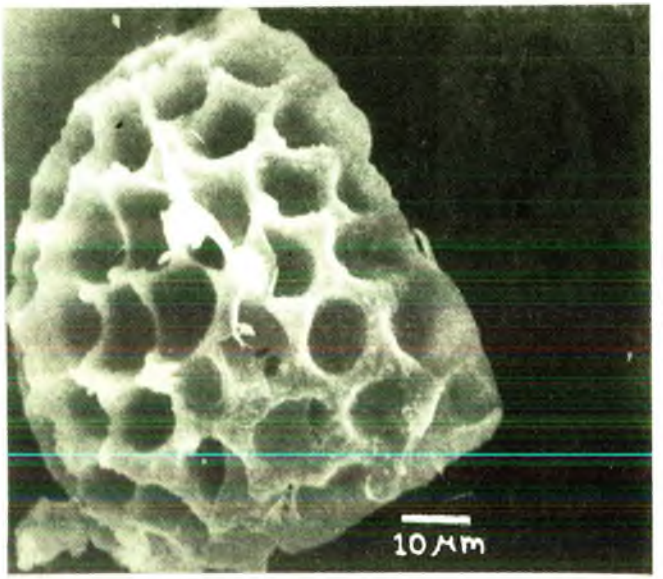
PLATE -3
(SEM of spores)



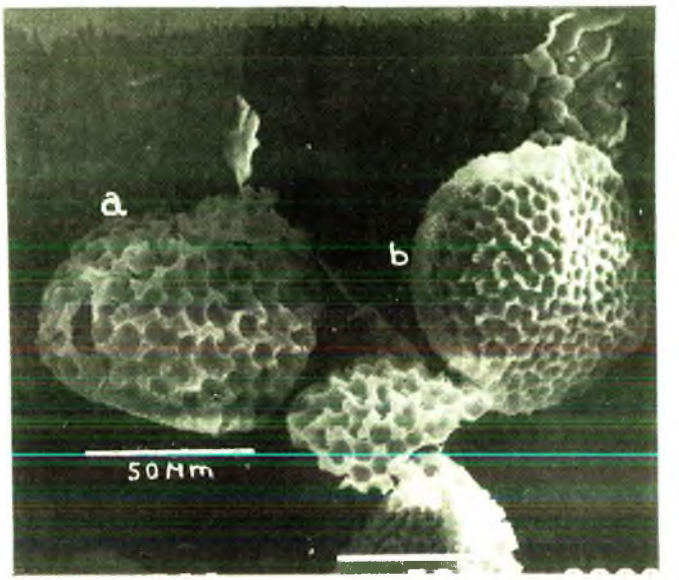
A *Riccia elliptica* sp. nov.
dorsal view



B *Riccia frostii* Aust.
ventral view



C *Riccia gangulii* sp. nov.
dorsal view



D *Riccia gopalpurensis* sp. nov.
a - dorsal view
b - ventral view

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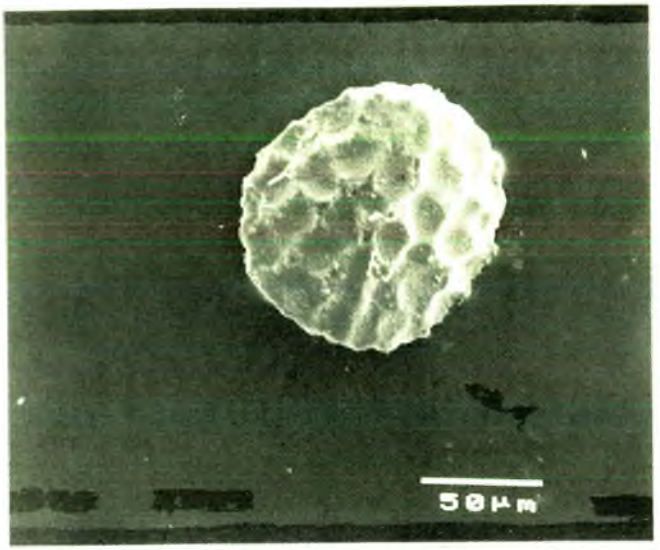
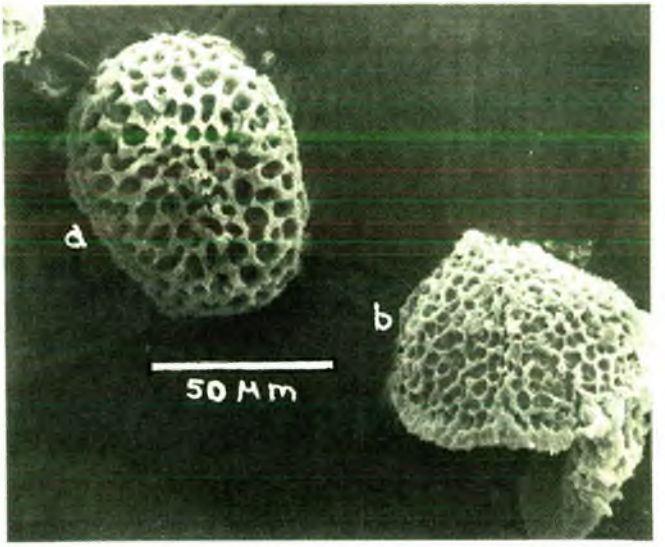
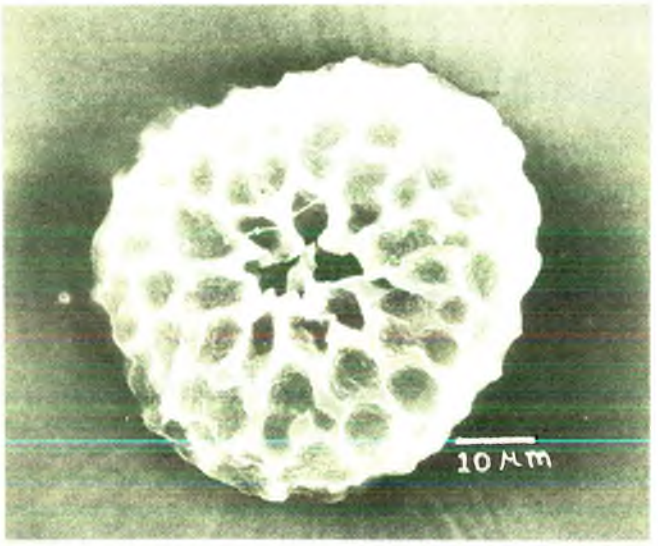
PLATE - 4
(SEM of spores)



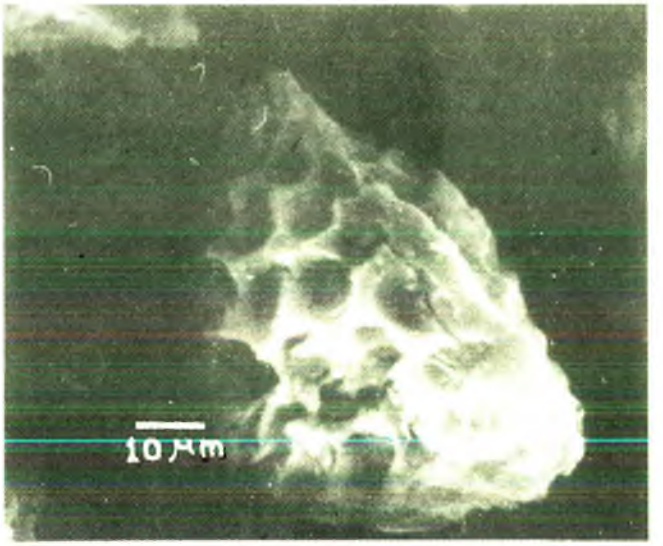
A *Riccia hasnabadii* sp. nov.
dorsal view



B *Riccia jamalpurensis* sp. nov.
a - dorsal view
b - ventral view



C *Riccia kagmariensis* sp. nov.
dorsal view



D *Riccia lithophillii* sp. nov.
dorsal view

PLATE - 5

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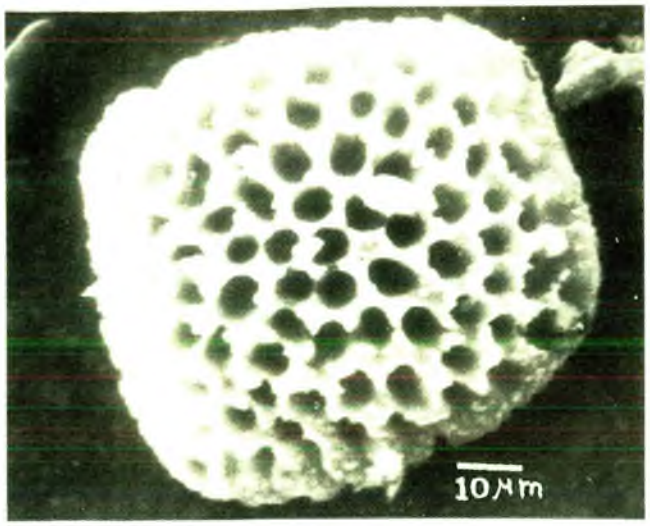
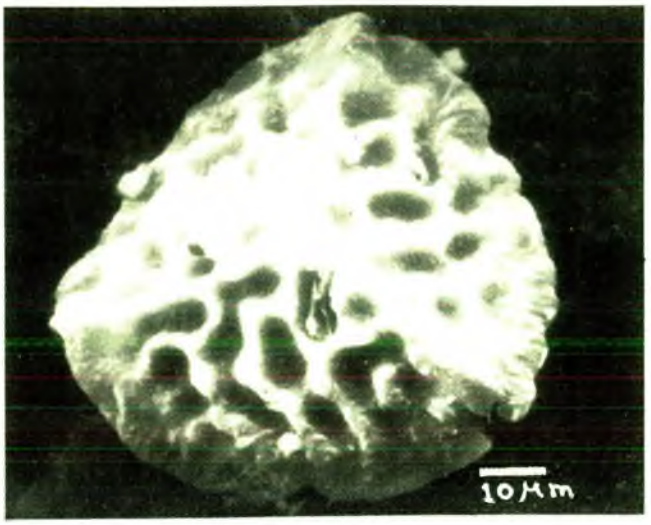
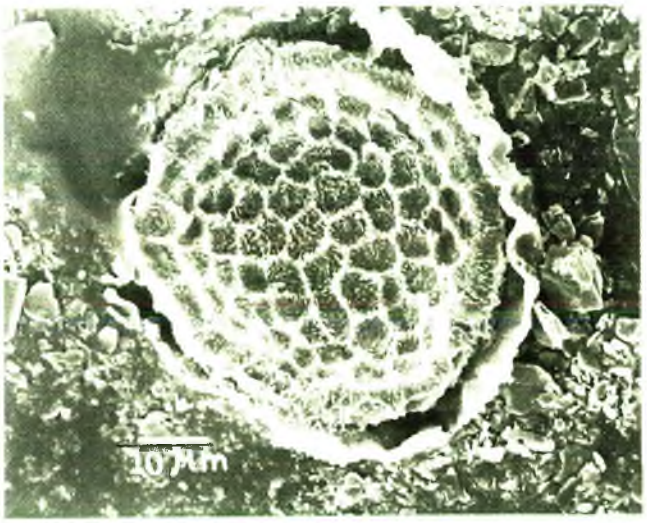
(SEM of spores)



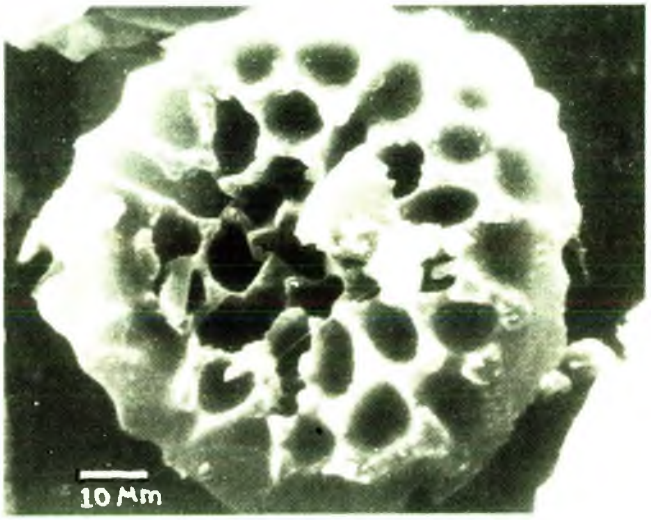
A *Riccia madhupurensis* sp. nov.
dorsal view



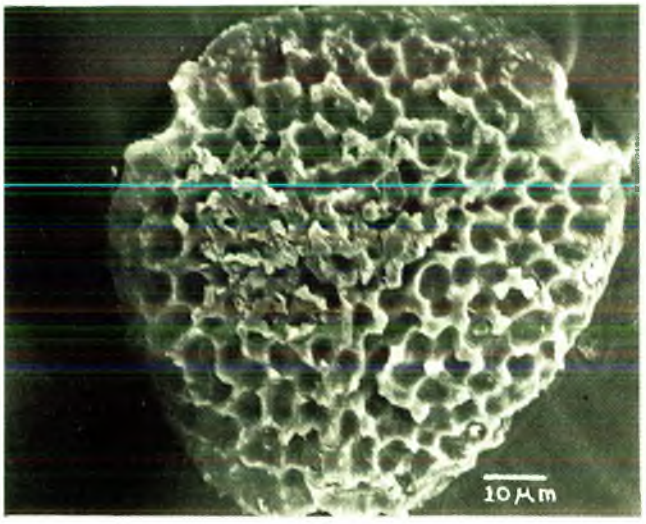
B *Riccia mogransis* sp. nov.
ventral view



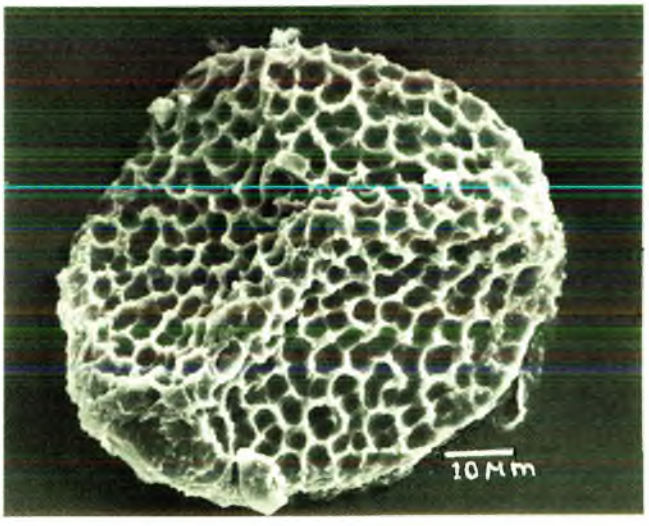
C *Riccia mogransis* sp. nov.
dorsal view



D *Riccia nathurcharensis* sp. nov.
dorsal view



E *Riccia parvullii* sp. nov.
ventral view



F *Riccia rangpurensis* sp. nov.
ventral view

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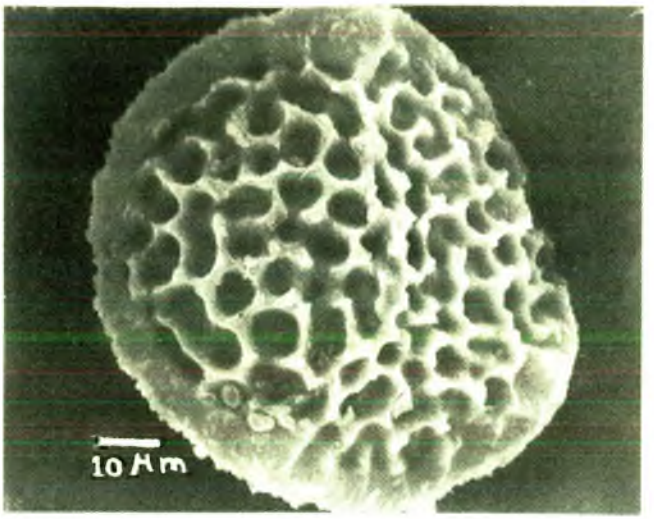
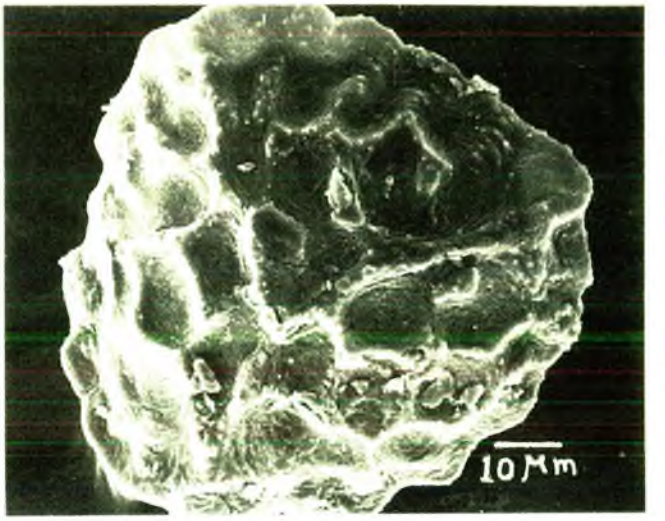
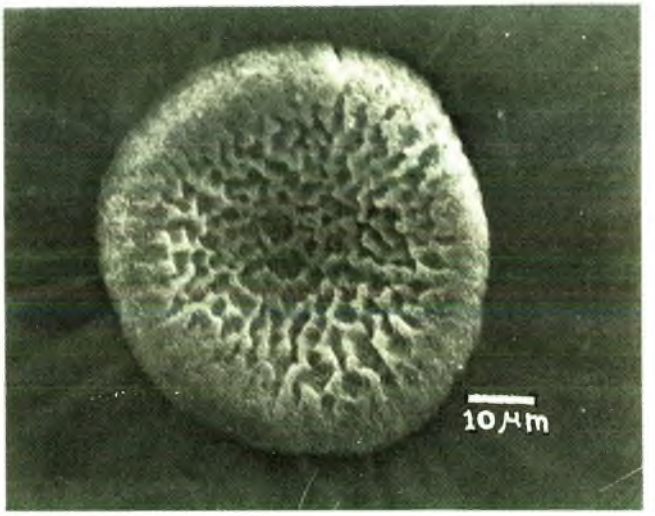
PLATE - 6
(SEM of spores)



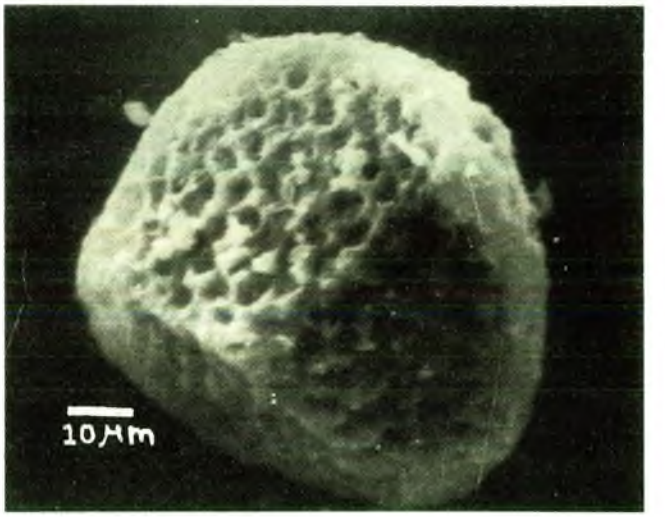
A *Riccia shankhii* sp. nov.
ventral view



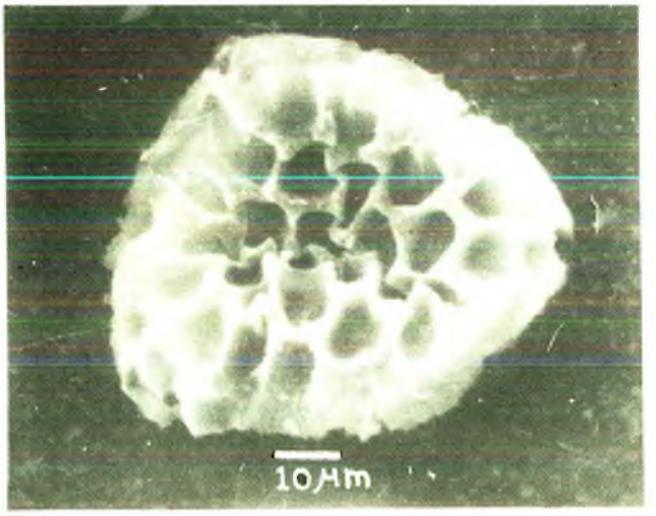
B *Riccia tangailensis* sp. nov.
ventral view



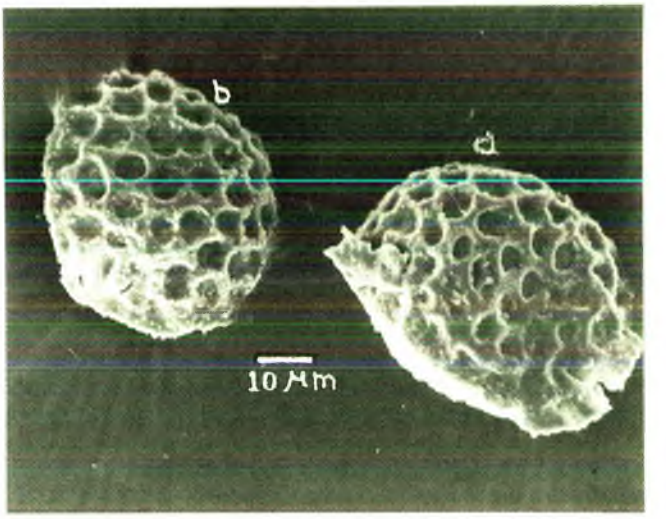
C *Riccia tubulosa* sp. nov.
dorsal view



D *Riccia bakshii* sp. nov.
ventral view



E *Riccia crystallina* L.
ventral view



F *Riccia dhakensis* sp. nov.
a - dorsal view
b - ventral view

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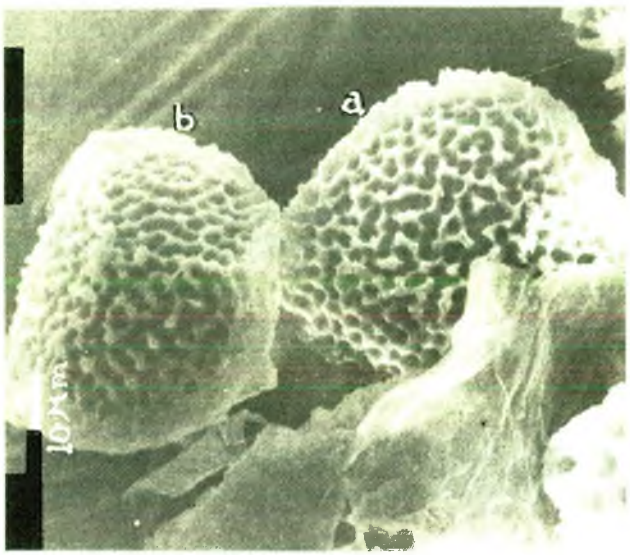
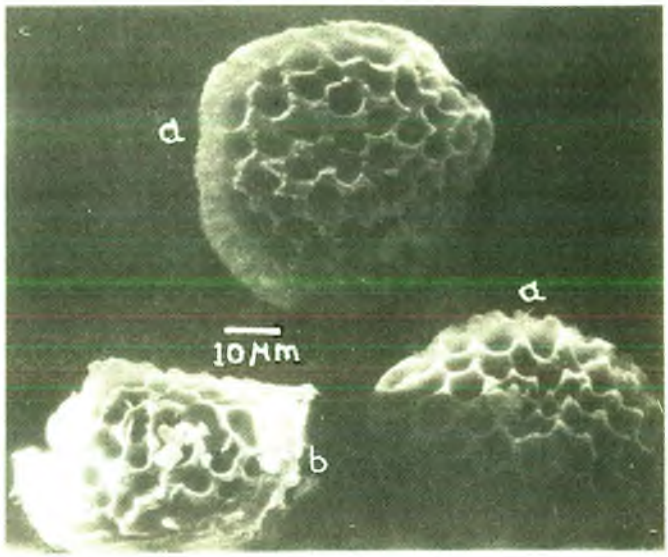
PLATE - 7

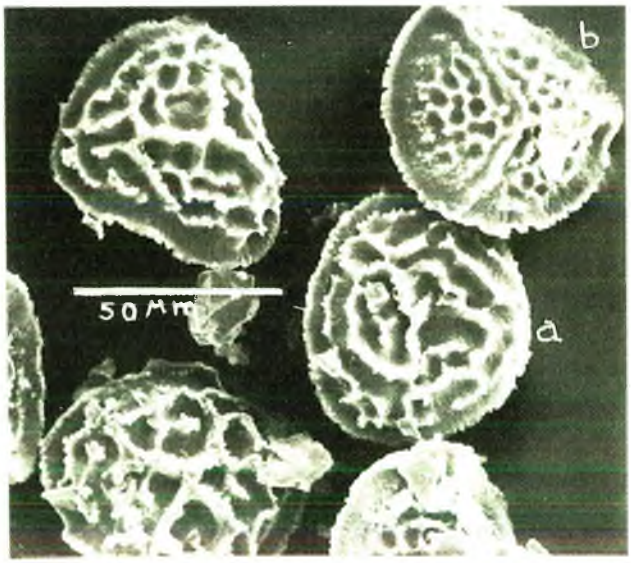
(SEM and photomicrographs of spores)



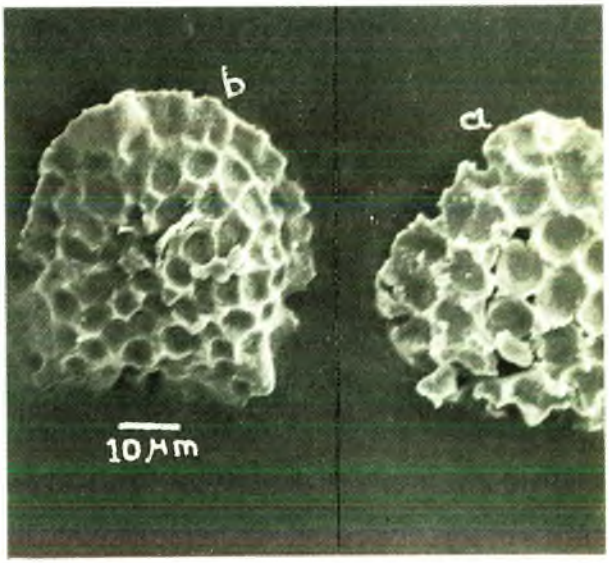
A *Riccia jamunii* sp. nov.
a - dorsal view b - ventral view



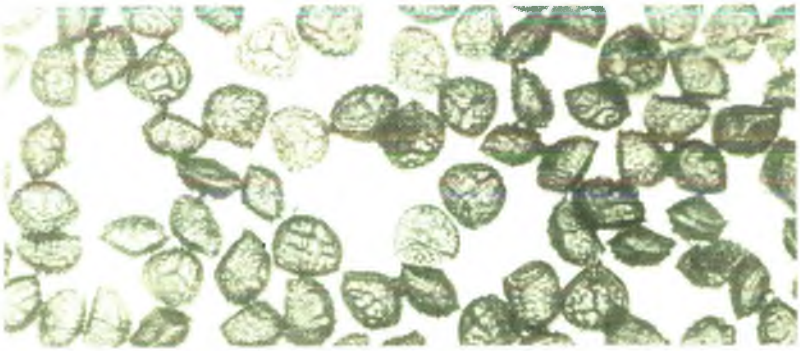
B *Riccia lingulata* sp. nov.
a - dorsal view b - ventral view



C *Riccia marsupiformis* sp. nov.
a - dorsal view b - ventral view



D *Riccia sharishabariensis* sp. nov.
a - dorsal view b - ventral view



E. *Riccia marsupiformis* **sp. nov.**
Photomicrograph of spores

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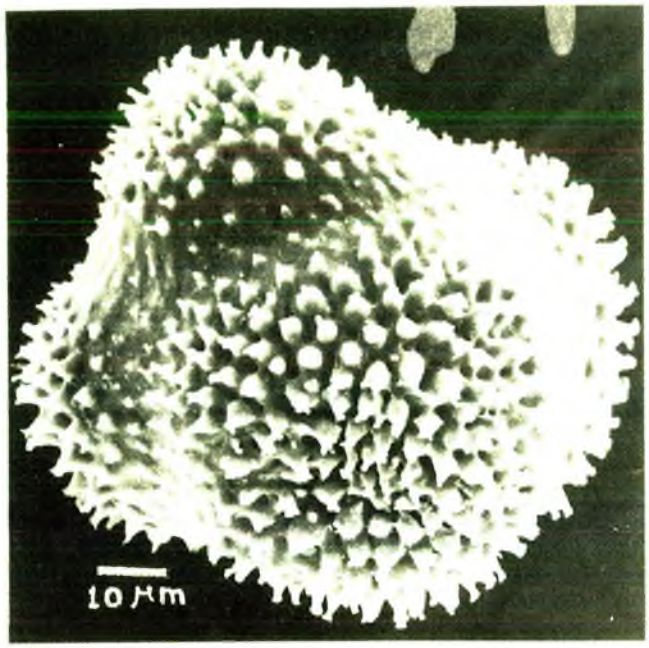
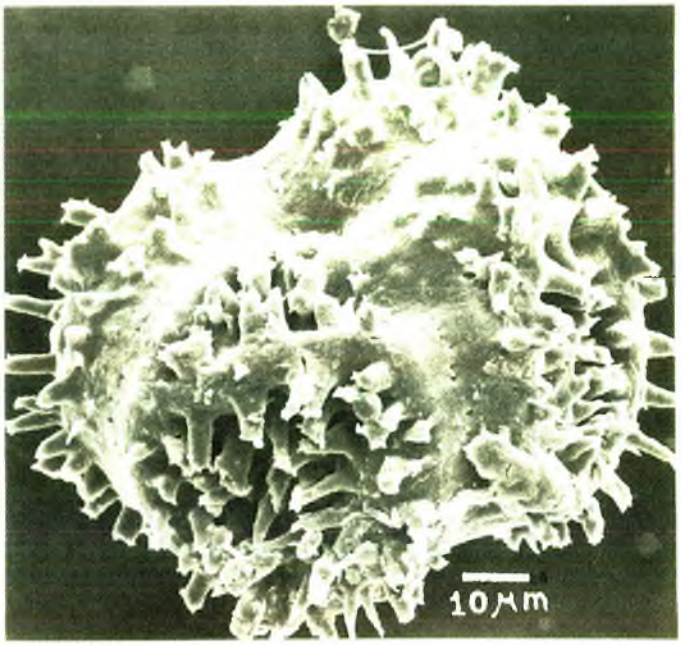
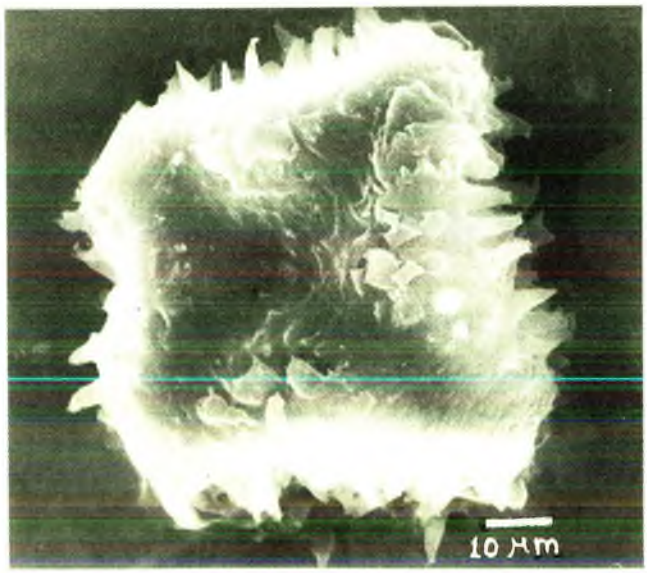
PLATE - 8
(SEM of spores)



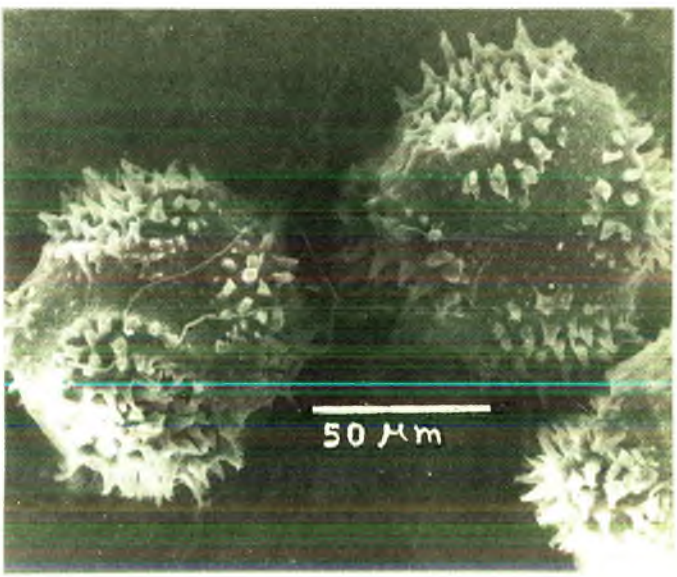
A *Riccia arnellii* Khan



B *Riccia centroporii* sp. nov.



C *Riccia perssonii* Khan



D *Riccia varientes* sp. nov.

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