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Reinterpretation of an extinct taxon *Sporangioceros nipanica* Sharma *et al.* from the Rajmahal Hills, India

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ABSTRACT

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Morphology of an elongated, cylindrical, oval or ovate, coenocytic plant fossil resembling sporogonium of *Notothylas* is reinterpreted and correlated now with an extant fresh water green alga *Characiosiphon* Iyengar. In extinct material the wall layer is present but non-cellular and is covered over by a thick mucilaginous sheath. The protoplast is divided into discrete units each with a chloroplast and the nucleus. Zoospores ? and zoogametes ? liberated through an apical pore. Aplanospores are also identified. A new name *Characiosiphonites nipanica* has been suggested for *Sporangioceros nipanica* and a reconstruction of the fossil plant is attempted.

Key-words—Mesozoic, Coenocytic, Discrete protoplasts, Green alga.

भारत की राजमहल पर्वतश्रेणियों से प्राप्त सुस्पष्ट वर्गक *स्पोरैंजियोसिरॉस निपानिका* का पुनर्निर्वचन

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सारांश

नोटोथाइलस के स्पोरोगोनियम प्रदर्शित करने वाले एक प्रलम्बित, बेलनाकार, अण्डाकार संकोशिकी पादपाश्म के संरचना विज्ञान का पुनर्निर्वचन किया गया तथा अब इसे एक विद्यमान ताजे जलीय हरित शैवाल *चैरासिओसाइफ़ॉन* आयंगर से सहसम्बन्धित किया गया है। सुस्पष्ट पदार्थ में भित्ति पर्त्त उपस्थित है, किन्तु यह अकोशिकीय है तथा एक स्थूल श्लेष्मीय आच्छद द्वारा आच्छादित है। प्रोटोप्लास्ट को एक-एक क्लोरोप्लास्ट (पर्णहरिम) तथा नाभिक द्वारा प्रत्येक विविक्त इकाई में वर्गीकृत किया गया हैं। अलैंगिक चलबीजाणु? तथा चलयुग्मकों? को एक शिखाग्र रन्ध्र द्वारा विलग किया गया है। अचल बीजाणु भी निर्धारित किए गए हैं। *स्पोरैंजियोसिरॉस निपानिका* हेतु एक नया नाम *चैरासियोसाइफ़ोनाइटीज़ निपानिका* प्रस्तावित किया गया है तथा अश्मित पादप के पुनर्सृजन का प्रयास किया गया है।

संकेत शब्द—मीसोज़ोइक, सीनोसाइटिक, विविक्त प्रोटोप्लास्ट, हरित शैवाल.

INTRODUCTION

RAO (1943) while working on the chert from Nipania in the Rajmahal Hills, Bihar (now Jharkhand) observed isolated sporangia in thin sections and identified as sporangium 1, sporangium 2 and a doubtful (?) sporangium (Rao, 1943; Figs 38-44). The latter two types are similar to the presented here material. Mittre (1958) could also see a number of isolated sporangia in Nipania chert and in 1969 he figured spore mother cells and dividing chromosomes in them. Sharma *et al.* (1984) on the basis of study of a number of sporangia like specimens in thin sections prepared through the Nipania chert, established a new taxon *Sporangioceros nipanica*. It also included 'Sporangium 2' and '(?) Sporangium' of Rao (1943) and similar fertile structures. Sharma and Suthar (1986) figured some more and better preserved specimens of *S. nipanica* and correlated it with *Notothylas* of Anthocerotales (Bryophyta). Since then many more specimens showing different stages of development and sizes are observed in thin sections prepared through the Nipania chert and on this basis the relationship has now been suggested with the fresh water green alga *Characiosiphon rivularis* Iyengar (1936). It grows in groups in shallow water on stones and pebbles. The alga is unicellular with discretely scattered, condensed protoplast units in the thallus. Each protoplast has a large chloroplast (circular or angular), a small nucleus, a pyrenoid body and 2-5 contractile vacuoles. Comparison has also been made with other similar green algae e.g., *Characiochloris, Protosiphon, Codiolum*, etc. (Fritsch, 1935; Bold *et al.*, 1987). In the present paper a new name has been suggested *Characiosiphonites nipanica* for *Sporangioceros nipanica* Sharma *et al.* (1984).

The type slide of *Sporangioceros nipanica* Sharma *et al.* (1984) was deposited at the depository of Birbal Sahni Institute of Palaeobotany, Lucknow (India). The newly prepared slides of this material used in the present paper shall also be deposited at the BSIP, Lucknow.

MATERIAL AND METHODS

Pieces of chert collected from the well known fossiliferous locality Nipania in the Rajmahal Hills, Jharkhand (Srivastava, 1945; Sahni, 1948; Mittre, 1953; Sharma, 1975) were cut into thin slices with the help of a diamond edge wheel and processed for slide preparation by the usual technique of grinding and polishing methods (Darrah, 1960; Sharma, 1996) and mounted in dilute canada balsam. Some of the slides kept unmounted and examined in a water film because in many silicified cherts the fossiliferous material in thin sections becomes transparent by mounting in canada balsam and details disappear. Staining thin sections with aquous safranin increases the contrast between the fossiliferous material and the matrix of the chert (Sharma *et al.*, 1984).

OBSERVATION AND DISCUSSIONS

The earlier descriptions of *Sporangioceros nipanica* were based on the study of only longisections including the Type Specimen No. BDN 500/Raj (Sharma *et al.*, 1984; Sharma & Suthar, 1986). For the present study a large number of specimens of different sizes, shapes and developmental stages, cut in cross, oblique and longisections have been examined. The specimens range 500-2500 x 200-500 mm in size. These are cylindrical (Pl. 1·2; Fig. 1·2), oval or ovate with round to obtuse apices (Figs 1·7, 8). In some of the specimens the apices are seen either ruptured (Fig. 1·3) or have an apical pore (Fig. 1·5) probably for the release of zoospores and zoogametes which are globose bodies. In extant *Characiosiphon* zoospores and zoogametes are biflagellate structures liberated through apical pores. In present material flagellae are not preserved.

Narrow, cylindrical structures (Pl. 1·1) or thalli with small enations (Fig. 1·1) are generally seen associated with the above mentioned ovate, oblong or cylindrical thalli. It has faintly marked discrete but closely placed protoplasts, each bearing a small dark coloured body representing probably the colligated chloroplast and the nucleus (Fig. 1·1). It is believed that these are the horizontal thalli of the extinct plant (alga). The oblong, cylindrical or oval structures (Pl. 1·2-5; Fig 1·2-5) are probably the vertical thalli produced on the horizontal ones. The vertical thalli have distinct walls covered over by a thick mucilaginous sheath ; but the wall is a non-cellular layer (Pl. 1·4, 5). Earlier (Sharma & Suthar, 1986) it was believed to be a 3-4 cells thick layer - which is wrong. The vertical thalli may be stalked or sessile. The stalk is made up of only mucilage layers (Pl. 1·3-5). The protoplast is divided into discrete units. In each a dark coloured circular to a little irregular central body is visible representing probably the colligated chloroplast, pyrenoid and the nucleus (Pl. 1·6, 7; Fig 1·2, 3, 5, 9). In a

PLATE 1 →

Characiosiphonites nipanica Sharma *et al.*

1 Narrow cylindrical thallus with blunt enations. Poorly differentiated discrete protoplasts. x 60.

2. Cylindrical thallus covered over by a mucilage sheath. Protoplasts hexagonal each with a dark central body (chloroplast). x 120.

3. Oblong thallus with an apical aperture and covered by mucilage sheath. x 80.

4. Same. Fig. 3. enlarged to show discrete protoplasts. x 240.

5 Oblong thalli (young and old) with mucilaginous stalks. Wall distinct but non-cellular. x 240.

6, 7. Enlargement of hexagonal protoplasts from Fig. 2. Dark coloured central chloroplasts are distinctly visible. x 240 (Figs 2-5 from Sharma & Suthar 1986).

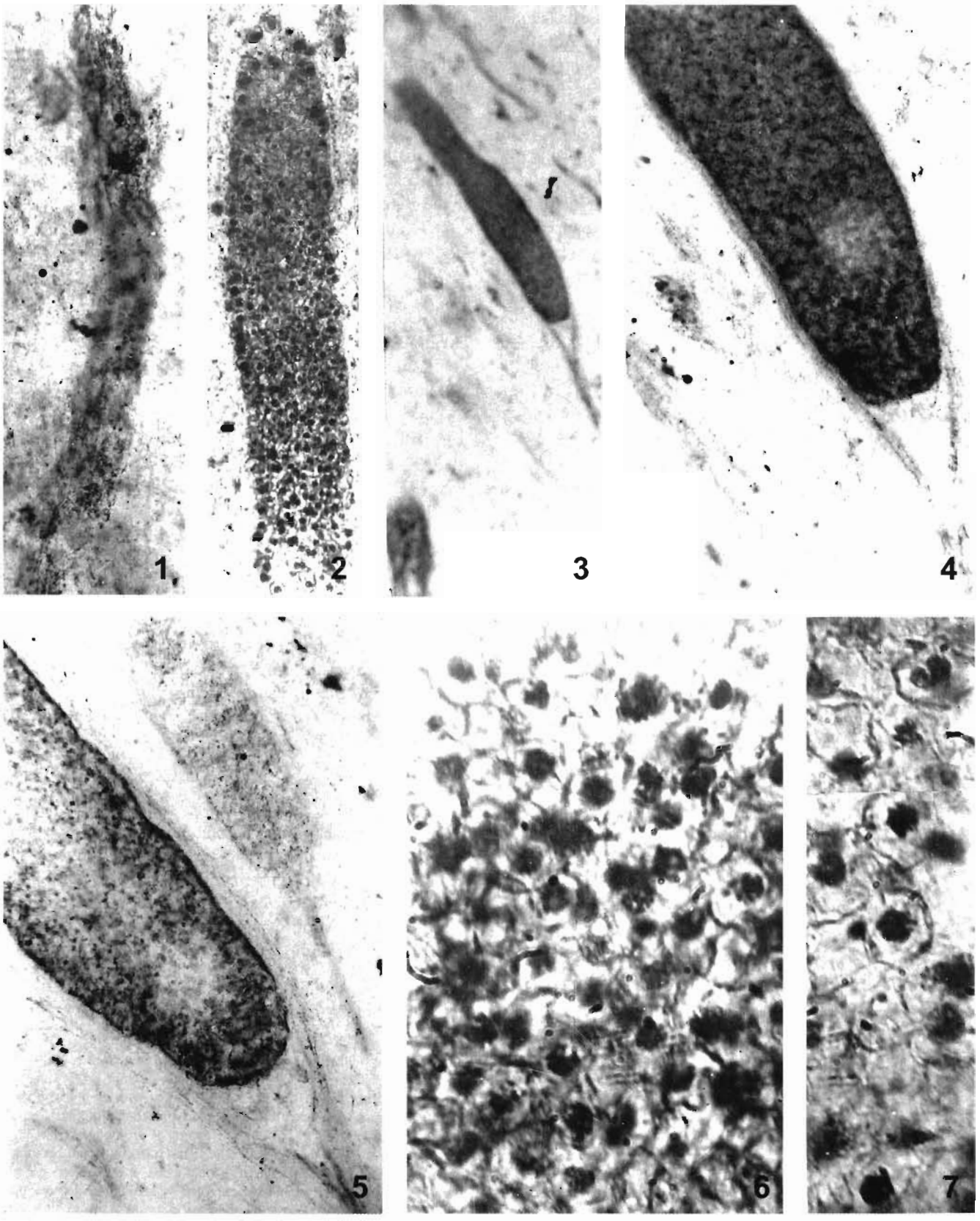


PLATE 1

cylindrical thallus the discrete protoplasts are close hexagonal units each with a dark coloured central body (Fig 1·2, 9 10). A condition quite similar to that of *Characiosiphon* (Iyengar 1936, Fig. 3). The protoplasts become circular when are loose (Fig. 1·14) and may develop protoplasmic connections (Fig 1·6, 11) identical to those seen in the green alga (Iyengar, 1936; Fig. 4).

In some of the specimens with round to obtuse intact apices (Fig 1·7, 8) the discrete protoplasts become distinct and a little or irregular in out line giving a spore like appearance (Fig. 1·12) and resemble Iyengar's description (Iyengar, 1936; Pl. 23; Fig 3 4). These distinct units of protoplasts range 25 to 36 µm in diameter and unlike spores they do not possess any clear exine, there is no distinct pattern of ornamentation on surfaces of these protoplasts. There are seen 1-3 or more cavities per protoplast representing either the contractile vacuoles or mere an artifact of preservation (Fig. 1·12). These dark coloured bodies are considered here as aplanospores or the resting spores which help in survival during adverse conditions.

In archegoniate plants sporogonia (Bryophytes) as well as sporangia (Pteridophytes and Gymnosperms) are characterised by the presence of a distinct sterile cellular walls around spores which may be one cell (*Riccia* leptosporangiate ferns) to several cells in thickness (Anthocerotales, fernallies, eusporangiate ferns and all gymnosperms). Whereas, in majority of thallophyta the wall of sporangium as well as that of the gametangium is non-cellular i.e., there is no sterile cellular wall which surrounds spores, zoospores and zoogametes (Bold *et al.*, 1987). Rao (1943) and Mittre (1958, 1969) considered the structures seen in thin sections prepared through the Nipania chert and which were similar to the present material as an isolated pteridophytic sporangia because of their occurrence in association with leptosporangiate, annuli and spores. While, Sharma *et al.* (1984), and Sharma and Suthar (1986) recognised the material as Bryophyta close to *Notothylas* of Anthocerotales, on the basis of horn-shaped cylindrical oval or ovate morphology of the vertical thalli and because of the presence of a single chloroplast (dark central body) per cell. Sharma and Suthar (1986) in an earlier description considered the narrow horizontal (present view) thalli as gametophytic portions of *Notothylas* like plants. In the present description also it is treated as a vegetative thallus on which probably grew the vertical thalli. The vertical thalli (present view) were earlier thought to be sporogonia bearing spores. It was believed that the body had a wall 2-4 cells thick surrounding many spores, which is incorrect and the wall is non-cellular covered by a thick layer of mucilage. The spores of earlier description are actually descrete condensed protoplasts. In some of the thalli these have distinct shapes and colour and are designated in the paper as aplanospores or resting spores.

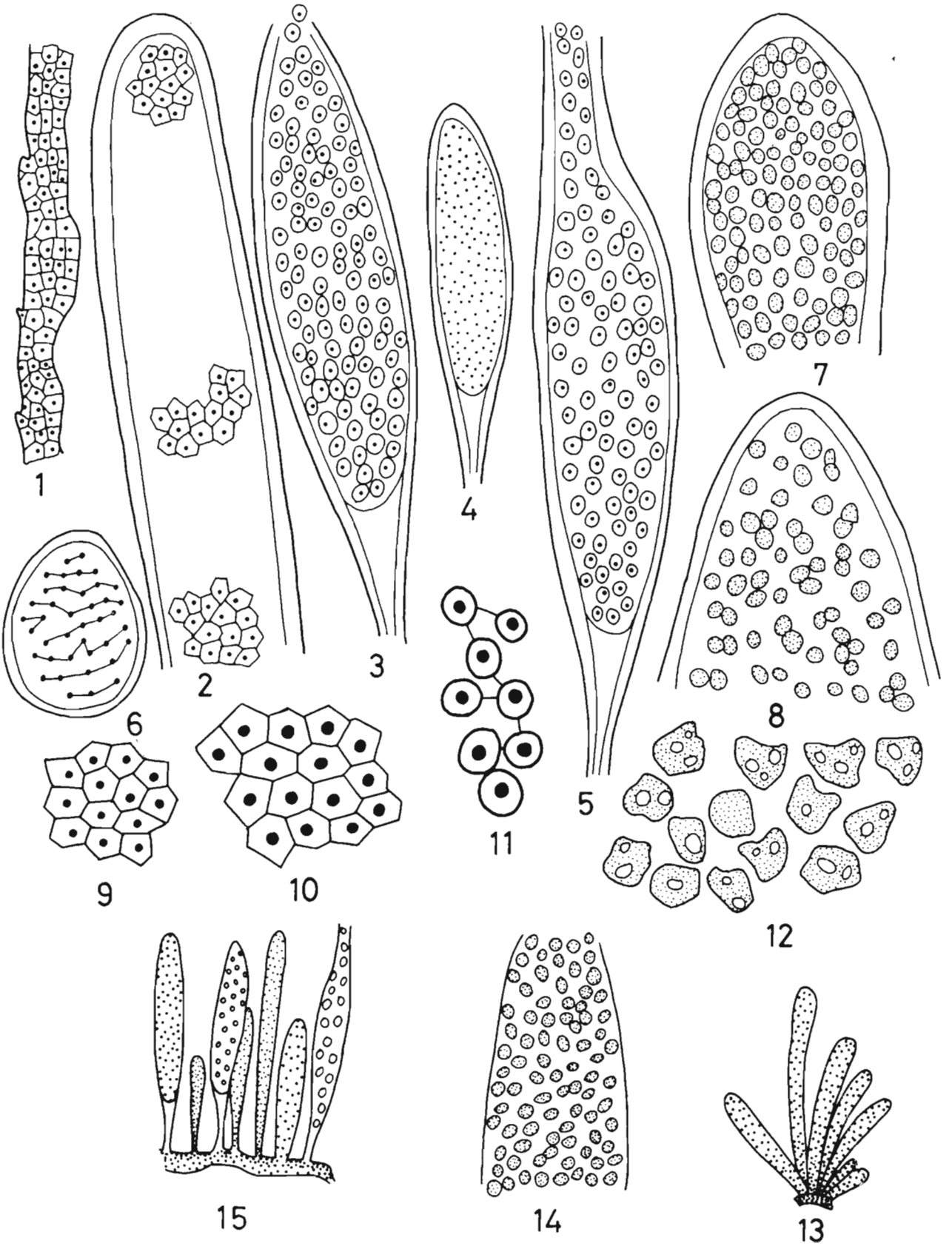
The morphology of the material described here resembles *Characiosiphon rivularis*. The vertical thalli having discrete protoplasts, each containing a single chloroplast and an apical liberation of contents (Fig. 1·13) (Iyengar, 1936). In the extinct material similar to the extant one, each protoplast has a large chloroplast (compare fig 1·9, 10) and may develop protoplasmic connections at a later stage of growth (compare fig 1·6, 11). In a mature plant the protoplasts separate out and may become distinct, each giving a spore like appearance (compare fig 1·7, 14). But they do not have the characters of spore of archegoniate plants i.e., neither are regular in size and shape nor have a distinct exine with a definite pattern of ornamentation.

Comparison may also be made with other similar unicellular green algae e.g., *Protosiphon, Characiochloris, Codiolum,* etc. in gross morphology of the plant. But the present material differs in characters like discrete protoplasts each with a single large chloroplast and the nucleus. Apical liberation of contents (may be zoospores and zoogametes) in the present material resemble the unique character of the green alga *Characiosiphon rivularis* Iyengar.

On the basis of the present investigation a new name has been suggested *Characiosiphonites nipanica* Sharma *et al.* for *Sporangioceros nipanica* Sharma *et al.* (1984) with the following diagnosis :-

Thalli narrow, cylindrical with small enations or wide elongated, oval or ovate with a non-cellular wall covered by a thick mucilage sheath; coenocytic, protoplast discrete, close or loose each with a large central colligated chloroplast, pyrenoid body and a nucleus. Protoplasmic connections may be visible; liberation of contents (may be zoospores and zoogametes) through an apical pore. Thalli with no apical

Fig. **1—1-15.**—*Characiosiphonites nipanica* Sharma *et al.* **1**. Narrow cylindrical thallus with blunt enations. Poorly differentiated protoplasts. x 60. **2**. Cylindrical thallus with hexagonal protoplasts, each with a chloroplast. x 240. **3**. Oblong thallus with circular protoplasts (may be zoospores or zoogametes) and an apical rupturing. x 240. **4**. A young coenocytic thallus. x 240. **5**. Thallus with an apical pore for liberation of contents. Mucilagenous stalk is distinctly visible. x 240. **6**. Cross section thallus with interconnected protoplasts. x 240. **7, 8**. Thalli with intect obtuse apices and containing dark protoplasts i.e., aplanospores. x 400. **9**. Hexagonal protoplasts from Fig. 2 enlarged. x 400. **10**. Hexagonal protoplasts of the green alga *Characiosiphon rivularis* Iyengar. x 640. **11**. Interconnected protoplasts in *C. rivularis*. x 640. **12**. Aplanospores enlarged from Fig. 8. Irregular in shape, size and without distinct exine. x 600. **13**. A group of plants of the green alga *C. rivularis* showing habit. x 15. **14**. A portion of thallus of green alga enlarged to show discrete protoplasts (comparable to fig. 7 of the present extinct material). x 300. **15**. Reconstruction of *Characiosiphonites nipanica*. Groups of vertical thalli grow on a horizontal thallus. x 15 (Figs 1-5, 8, 12 from Sharma & Suthar, 1986; Fig. 7 from Sharma *et al.* 1984; Figs. 10, 11, 13, 14 from Iyengar, 1936).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rupturings or pores; have aplanospores, which are irregular in shape and size and without exine.

RECONSTRUCTION

It is presumed that the plant had a horizontal portion made up of a narrow cylindrical thallus with small blunt enations (points of attachment of vertical thalli). Discrete protoplasts were poorly differentiated in it. The vertical thalli were cylindrical, oval or ovate; stalked or sessile, with or without apical rupturings or pores. Wall was distinct but non-cellular and covered over by a thick mucilage sheath. Protoplasts condensed, discrete, close or loose, circular or hexa-angular each with a large central colligated chloroplast, pyrenoid body and the nucleus. Thalli without apical pores i.e., in which apices were intact, obtuse or round, generally had distinct dark coloured discrete condensed protoplasts or aplanospores. They were variable in shape and size and did not have distinct exine of definite ornamentation. The plant had many vertical thalli at a time and of different developmental stages which probably originated from the horizontal thallus more or less in a crowded manner (Fig. 1·15).

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