On an indian form of *Protosiphon botryoides* Klebs [1].

By

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(With one figure in the text).

Protosiphon botryoides grows commonly in Madras during the North East monsoon (October to December) on the moist silt of rain water pools, as they dry up. It prefers the pools which contain a certain amount of animal droppings or decaying organic matter. Its growth is gregarious, so that it forms a green layer on the soil visible from some distance.

Protosiphon consists of a green vesicular aerial portion and a colourless underground rhizoid, the whole forming a large coenocyte with a lining layer of cytoplasm enclosing a continuous vacuole. A large bell-shaped reticulate chloroplast with numerous embedded pyrenoids occupies the periphery of the cytoplasm in the overground vesicle, while many small nuclei are found scattered in the lining cytoplasm. The long thin rhizoid is usually unbranched, though it occasionally branches once or twice. The wall is thin, but near the apex of the vesicular portion, in the preserved material, it appears slightly thicker and somewhat lamellated. The lamellation was not noticeable lower down.

The budding of the green aerial portion, which Klebs [2]) recorded for the European specimens, was never observed in the Indian alga, although hundreds of specimens were examined. Nor was such budding ever seen in the variety growing on walls described below.

[1]) From the Department of Botany, East London College, University of London.

[2]) Klebs, Die Bedingungen d. Fortpflanzung bei einigen Algen u. Pilzen, Jena, 1896, p. 169.

As the soil begins to dry up, the contents slightly recede from the wall at the apex and move downwards leaving the upper part of the vesicle empty (Fig. 1, A, B). They then proceed to divide into a number of round bodies which after a time become surrounded by a wall and constitute resting "cysts" (Fig. 1, J). The contents of these cysts, as recorded by KLEBS, are at first green, but soon change to a bright red colour, while their wall becomes very thick and appears lamellated.

The vesicular portion is 80—160 μ broad and 125—200 μ long, while the rhizoid is 600—1050 μ long. The cysts measure 12—26 μ in diameter.

Protosiphon botryoides KLEBS **forma *parieticola* f. nov.**
(Fig. 1, C, D, F—I, K—Z).

This form is of interest because it always grows on walls of houses and compounds (white-washed with lime) in Madras for a very brief period during the height of the North East monsoon (October to December), when the weather is wet and cloudy. The growth only lasts for about 10 to 25 days, its duration depending on the length of the spell of wet, cloudy weather. *Protosiphon* has not yet been recorded from such a habitat. The alga appears only on those portions of the walls which provide some organic nutriment. The droppings of birds on the wall are washed down by the rain and the alga grows along such stretches. The growth of the alga is richest in those areas near the ground, where dogs urinate on the wall.

This form differs from the type in having a shorter and somewhat broader rhizoid-portion. Very often the long rhizoid is altogether absent and the alga consists merely of an oblanceolate or obovate vesicle (Fig. 1, H, R, T). In the preserved material the wall is lamellated, somewhat mucilaginous, and thicker than that of the normal type (Fig. 1, L). The wall is very transparent and difficult to see in the preserved material, but readily stains with methylene blue or congo red. This mucilaginous wall may by retaining moisture constitute a protection against the ever-present danger of rapid desiccation, living as the alga does in a subaerial situation in the Tropics.

Enough time may thus be allowed for the protoplasts to form cysts. The habitat of course affords less moisture than the wet clayey soil on which the type was found, and its exposed position renders it much more liable to rapid desiccation.

The distribution of moisture on the walls is not uniform since it tends to gravitate downwards, so that there is more moisture in

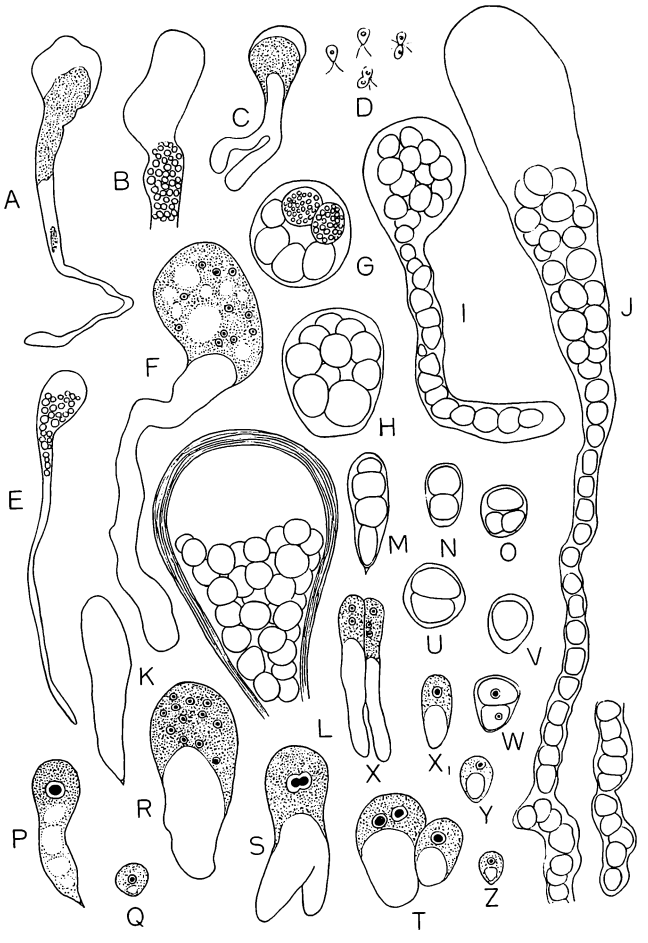

Fig. 1. A, B, E, J, *Protosiphon botryoides* Klebs f. *typica;* B, E, J, showing formation of cysts. C, D, F—I, K—Z, *P. botryoides* Klebs f. *parieticola* f. nov. C, S, specimens with branched rhozoids; D, gametes and conjugation; F, P—T, X—Z, plants in various stages of development; G, H, plants, without any rhizoidal portions, forming cysts; L, showing lamellated wall; in G, two cysts are dividing to form gametes; M—O, U—W, very small plants growing higher up the wall forming cysts. A—C, E $\times$215; I, J, L, N, O $\times$650; the rest $\times$740.

the lower than in the upper portions. Moreover, a certain amount of moisture may rise from the wet soil by means of capillarity, whilst the upper parts of the wall as a result of greater exposure

to wind and sunshine are apt to be still drier. For all these reasons the parts of the wall near the ground are more moist than those further up.

The *Protosiphon*-plants near the ground are larger than those higher up, the largest being found nearest the soil. These plants resemble the type in general habit, but have a broader and shorter rhizoid (Fig. 1, F, I). As one passes up the wall, the plants gradually become smaller and smaller. Moreover, plants on the higher portions of the walls become broadly pear-shaped with the narrow end, which does duty as a rhizoid, downwards; there is no definite rhizoid. Many of these plants show a small solid tip at their base which is very characteristic (Fig. 1, K, M, P). Still higher up the plants become more rounded, some of the smallest being not unlike a broadly obovate *Chlorococcum*-individual (Fig. 1, M—O, U—W). But for the series of transitional stages from the base of the wall upwards, it would be impossible to recognize them as *Protosiphon*-plants. The series of stages is of interest as lending some support to the suggestion that *Protosiphon* may have evolved from a form like *Chlorococcum*.

When the substratum begins to dry up, the contents of the larger plants form numerous cysts as in the type species; not uncommonly, however, they round off to form one huge cyst. The small plants near the top of the wall form only a few cysts, sometimes only two or even only one (Fig. 1, N, O, U, V). The cysts quite resemble those of the type in the colour of their contents and the nature of their wall. During this period the white-washed wall shows green and red patches; later completely red patches are visible from a distance.

The young plants have a single large pyrenoid which later divides into two (Fig. 1, P, S, T). The upper vesicular part measures 55—85 μ in breadth and 50—100 μ in length; the rhizoid is 60—200 μ long and 13—42 μ broad; the cysts measure 18—30 μ in diameter.

When the living specimens are immersed in water for some time the contents of the coenocytes or of the cysts (Fig. 7, G), if cysts are already formed, break up into numerous gametes. The pear-shaped gametes have a bell-shaped chloroplast with a single pyrenoid and two equal cilia, about as long as the body or slightly longer; they are 8—10 μ long and 5—8 μ broad. These were observed to swarm very actively for a time and to conjugate in pairs (Fig. 7, D). One of the conjugating gametes is often larger than

the other. Their further fate after conjugation was not traced. Many of the gametes failed to conjugate; these came to rest and assumed a rounded form, but their further development could not be followed. It is probable that they may act as parthenospores, as Klebs [1]) observed in European material. The red contents of a cyst were seen dividing into gametes and some of those swimming in the water were reddish in colour.

This form thus differs from the type in the reduced development of the rhizoid and the somewhat thicker lamellated wall. It is, however, connected with the type by numerous transitional forms.

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[1]) loco. cit.