

OBSERVATIONS ON THE GENUS *COLEOCHAETE* DE BREBISSON*

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ABSTRACT

Two new varieties belonging to two species of *Coleochaete*, viz. *C. pulvinata* var. *indica* var. nov. and *C. scutata* var. *pinguis* var. nov. have been described. In the third species, *C. nitellarum*, in which only terminal antheridia were known so far, intercalary antheridia as well have been reported. Possible evolutionary significance of this and certain other morphological features among the species of *Coleochaete* is briefly discussed.

INTRODUCTION

The present paper deals with three species of *Coleochaete* found locally. Significant differences have been observed in two of these and, therefore, two new varieties have been erected to accommodate these plants. Interesting forms of antheridial development have been observed in the third species, *C. nitellarum*. These have been briefly described and some comments have been made on the possible evolutionary significance of this and certain other features.

DESCRIPTION

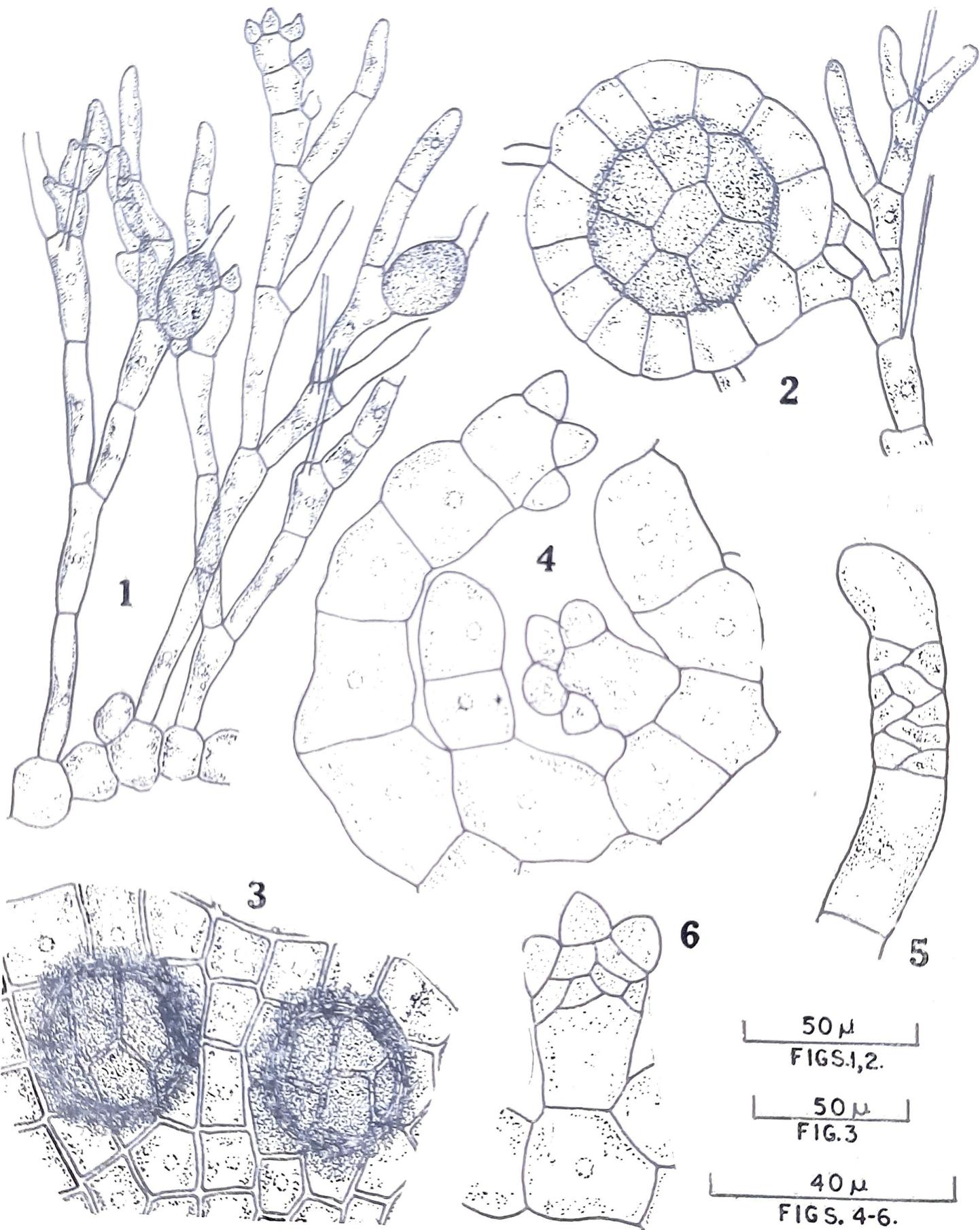
***Coleochaete pulvinata* var. *indica* var. nov.**

The plants were collected from a small fresh-water pond - - about eight km from Lucknow city, in October, 1975. The alga occurred as bright green mucilaginous specs, barely visible to the naked eye, attached to leaves of aquatic angiosperms.

The thallus of the alga is differentiated into a prostrate and an erect portion (Text-fig. 1). The erect filaments arise from cells of the prostrate system and are composed of elongate cells disposed radially, which collectively form a small pin-cushion like pulvinate thallus about 0.5 mm in diameter. Its growth appears to be terminal. The cells of the erect filaments measure 7-10 μ m in diameter and are 3-6 times longer than broad. They possess a single nucleus and a parietal laminate chloroplast containing two or three pyrenoids. The prostrate system of the alga is made up of small branched filaments, the cells of which are 12-20 μ m in width and are nearly as long as broad. They also contain a single parietal chloroplast with two or three pyrenoids. Many cells of the prostrate as well as erect filaments possess a single, long, delicate cytoplasmic bristle sheathed at the base by short tubular outgrowth from the cell. The entire thallus is enclosed in a common soft mucilaginous envelope.

The plants are homothallic. Antheridia are formed in groups of 3-6 on cells which are smaller than the vegetative cells (Pl. 1, Fig. 2). These cells are usually found in groups of two or three, arranged one after the other at the terminal ends of the filaments; such cells may occur in intercalary positions as well. Antheridia develop as blunt projec-

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Text-figs. 1-2. *Coleochaete pulvinata* var. *indica* var. nov., 1. A portion of thallus showing antheridia and oogonia, 2. The spermatocarp., Text-fig. 3. The spermatocarp of *Coleochaete scutata* var. *punguis* var. nov., Text-figs. 4-6. *Coleochaete nitellarum* Jost, 4. Terminal antheridia, 5. Intercalary antheridia, 6. Antheridia formed in succession.

tions which grow and are ultimately cut off from the mother cell by the formation of septa. Each antheridium is a small cone-shaped structure 4-5 μm in diameter and 6-7.5 μm in length (Pl. 1, Figs. 2, 3; Text-fig. 1.).

The oogonia develop terminally but are subsequently shifted to a lateral position by the growth from the sub-terminal (sub-oogonial) cell of the filament on one side. They are small, flask-shaped, oval or slightly elongate structures measuring 15-20 μm in diameter (Text-fig. 1). The neck or trichogyne is prominent and measures 12-20 μm in length. The basal rounded portion of the oogonium possesses dense green contents while the neck is hyaline.

The fertilized oogonium develops sterile cortications around itself and, in mature stage, the spermocarp measures 90-100 μm in diameter (with cortications). The corticating cells around the oospore are equidimensional and are generally twice as broad as the normal vegetative cells. The oospore (without cortications) measures 40-45 μm only.

The present alga agrees with the description of *C. pulvinata* A. Braun (1849) in gross morphology but differs from the latter in the following characters : 1. the vegetative cells of the erect filaments are greatly elongate and are nearly half as wide as in *C. pulvinata*, 2. the cells bearing antheridia are distinguishable from the ordinary vegetative cells due to their smaller size, 3. the cells of the sterile cortications around the fertilized oogonium are almost double in width than the ordinary vegetative cells, while in *C. pulvinata* they are of the same size.

On the basis of the above-mentioned differences, the present plant is considered as a new variety of *Coleochaete pulvinata* A. Braun and is named as *C. pulvinata* var. *indica* with the following diagnosis :

Coleochaete pulvinata var. *indica* var. nov.

A typo differt cellulae elongatae, 7-10 μm latae, 3-6 plo longiores quam latae; cellulae antheriiae minores, 7-10 μm \times 7-14 μm ; oosporae superne corticatae 90-100 μm in diam., cellulae corticae unilamellatae 18-20 μm latae.

The type material is deposited in the Algological Collection of Botany Department, Lucknow University, Lucknow, India. No. Chaeto/101.

***Coleochaete scutata* var. *pinguis* var. nov.**

The present plant is one of the most common species of *Coleochaete* found in various ponds and puddles in the vicinity of Lucknow. The thallus of the alga is made up of a sub-circular, oval or irregularly lobed monostromatic pseudo-parenchymatous disc formed by branched filaments which laterally coalesce together and appear radiating from a common centre, a feature which may not be evident in older thalli. Many cells bear long delicate bristles which are enclosed at the base by short tubular outgrowths from the cells. The cells of the thallus measure 12-20 μm in breadth and are 1-1.5 times longer than broad. They contain a single nucleus and a parietal laminate chloroplast with a single pyrenoid.

The plants are heterothallic. Antheridia are developed on male plants by division of ordinary vegetative intercalary cells forming groups of small cubical cells, each of which produces an antherozoid. The oogonia are developed on the female plants from the marginal cells of the disc and become subsequently displaced to the interior of the thallus due to further growth of the disc on its margins. The oogonia after fertilization develop sterile cortications on the upper side only and no corticating cells are formed on the lower side. The corticated spermocarp measures 50-55 μm in diameter and the thick walled oospore (without cortications) measures 40-45 μm in diameter (Pl. 1, Fig. 14; Text-fig. 3.).

The present plant resembles *C. scutata* De Brebisson (1844) in vegetative morphology and dimensions, antheridia and oogonia but differs from it in the possession of spermocarps which are much smaller in diameter and are only one-third the size of spermocarp of *C. scutata*. Since this is an important diagnostic character, it is proposed to regard the present alga as a new variety of *C. scutata* and name it as *Coleochaete scutata* var. *pinguis* with the following diagnosis :

Coleochaete scutata var. *pinguis* var. nov.

A typo differt oosporae breviores, superne corticatae 50-55 μm in diam.

The type material is deposited in the Algological Collection of Botany Department, Lucknow University, Lucknow, India. No. Chaeto/102.

Coelochaete nitellarum Jost, 1895

Coleochaete nitellarum, a species found epiphytic on plants of *Chara* and *Nitella* was repeatedly collected for many years. The species was reported for the first time from India by PRASAD AND SRIVASTAVA (1965). Only terminal antheridia are recorded in the species by earlier authors, but we observed the antheridia in subterminal and intercalary positions as well. Thus, the plant shows interesting sequential stages of transition from the terminal to intercalary position of the antheridia.

The typical terminal antheridia are developed as small protuberances from the antheridial mother cells which are subsequently cut off from the parent cells and appear as small conical outgrowths about 5-8 μm in width and 8-13 μm in length (Text-fig. 4). In certain cases, after the formation of the typical terminal antheridia, small lens-shaped cells may be successively cut off at the base of the previously formed terminal antheridia (Pl. 1, Fig. 6; Text-fig. 6). In this way a group of 6-10 antheridia may be formed in a sequence near the apical tip of the filament. Intercalary antheridia are also developed by successive partition of the vegetative cells into 6-8 small cells in lower positions of the filament (Pl. 1, Fig. 5; Text-fig. 5).

DISCUSSION

On comparison of the antheridia of taxa just described, some interesting conclusions can be drawn. Only four species of the genus *Coleochaete* are pulvinate; all the rest of them possess only prostrate filaments, without any erect branches (PRINTZ, 1964). All the heterotrichous species possess only terminal or lateral specialized antheridia while in all the discoid prostrate species the antheridia are intercalary (cf. Table 1). *Coleochaete nitellarum* and *C. pseudosoluta* are the only species which show both terminal as well as intercalary antheridia (cf. Table 1). The third type of antheridium formation described above, in which below the terminal antheridia, secondary antheridia may be successively cut off, is an intermediate condition between the terminal and intercalary positions of the male gametangia. It clearly indicates how in the course of evolution, a shift may have occurred from a terminal to an intercalary position of the antheridia or vice versa.

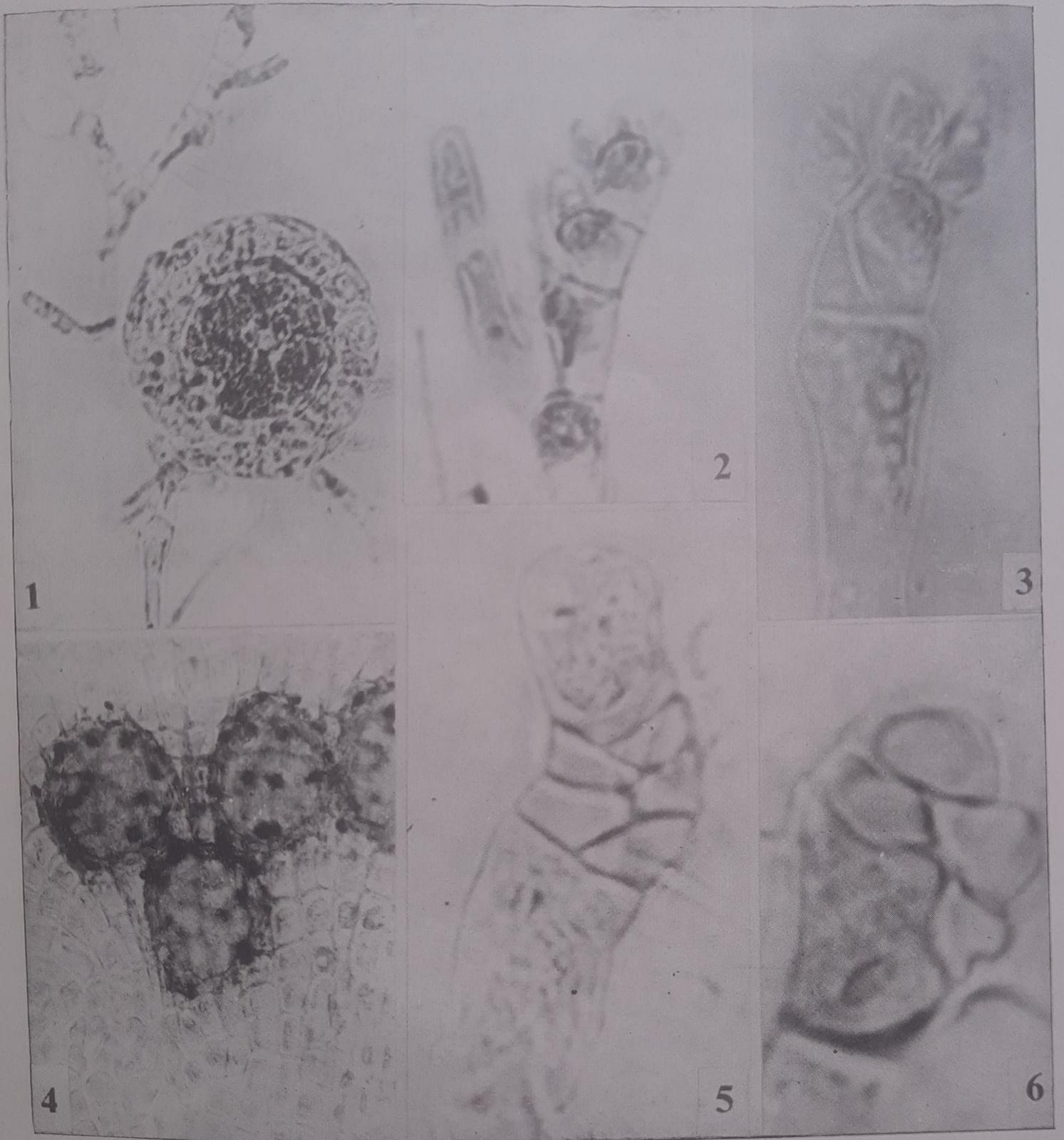
Besides the position at which the antheridia are formed in different species, it can be noted that basically there are two distinct modes of their formation. The terminal antheridia initially arise as small protuberance on the outer side of the cell and are cut off externally as small specialized cells (OLTMANN, 1898; PRINGSHEIM, 1860) while the intercalary antheridia arise by internal divisions within the existing intercalary vegetative cells which become compartmentalised into several small antheridia (WESLEY, 1930). The former type may thus be termed "external antheridia" while the latter may be called "internal antheridia".

It is interesting that all pulvinate species and those prostrate species which do not form a compact discoid thallus, except *C. nitellarum*, possess only the former type of antheridium while truly discoid species possess internal antheridia only (cf. Table 1). In *C. pseudosoluta*, internal antheridia may arise from the terminal cell as well (GAUTHIER-LIEVRE, 1956) and *C. nitellarum* shows a transition between the two types described earlier. These two species, therefore, occupy an intermediate position and this may be so from the evolutionary point of view as well.

Table 1—A comparative table of some important features in the genus *Coleochaete*

| Species | Habit | Antheridia | Spermocarp cortications | References |
|---------------------------|--|---|-------------------------|---|
| 1. <i>C. pulvinata</i> | Heterotrichous | Terminal or lateral external antheridia | All round the oospore | Pringsheim, 1860; Oltmanns, 1898 |
| 2. <i>C. divergens</i> | " | " | " | Pringsheim, 1860; Printz, 1964 |
| 3. <i>C. sampsonii</i> | " | " | " | Transeau, 1943; Printz, 1964 |
| 4. <i>C. disjuncta</i> | " | " | " | Tiffany, 1936; Printz, 1964 |
| 5. <i>C. conchata</i> | Loosely preading lax, prostrate thalli | " | " | Printz, 1964 |
| 6. <i>C. soluta</i> | " | " | " | Pringsheim, 1860; also authors' own observations |
| 7. <i>C. irregularis</i> | " | " | Only on upper side | Pringsheim, 1860; also authors' own observations |
| 8. <i>C. nitellarum</i> | " | Terminal or lateral external as well as internal antheridia | All round the oospore | Jost, 1895; also authors' own observations |
| 9. <i>C. pseudosoluta</i> | Compact discoid thalli | Intercalary or terminal internal antheridia | Only on upper side | Gauthier-Lievre, 1956; also authors' own observations |
| 10. <i>C. orbicularis</i> | " | Intercalary, internal only | " | Pringsheim, 1860; Gauthier-Lievre, 1956; also authors' own observations |
| 11. <i>C. scutata</i> | " | " | " | Pringsheim, 1860; Wesley, 1930; also authors' own observations |

Side by side with the variation in antheridial position, the oogonium in pulvinate species possesses a prominent trichogyne but in the prostrate forms it is represented at best by a short papilla-like growth or protuberance (FRITSCH, 1935). It is interesting to note that the phenomenon of formation of fruit-body or spermocarp also displays differences in development. In *C. pulvinata* and other heterotrichous species, the corticating investment is formed all round the oospore, while in *C. scutata* and other discoid species the sterile protective cortication is formed only on the upper and exposed side and it is not formed on the lower side at all (cf. Table 1). In this feature also, *C. nitellarum* shows an intermediate position in being a prostrate species wherein cortications are formed all round the oospore as in pulvinate species. Thus, *C. nitellarum* occupies an intermediate position between the two types of highly



specialized species of *Coleochaete*, the pulvinate and the discoid and it represents an evolutionary status through which evolution progressed in one direction or the other depending on the advanced or primitive position of the pulvinate species in relation to the discoid forms.

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EXPLANATION OF PLATE 1

Coleochaete pulvinata var. *indica* var. nov.

1. The spermocarp showing thick corticating cells, $\times 400$.
2. Cells bearing antheridia, $\times 1000$.
3. Antheridia, $\times 1600$.

Coleochaete scutata var. *pinguis* var. nov.

4. The spermocarp, $\times 360$.

Coleochaete nitellarum Jost

5. Intercalary antheridia, $\times 1000$.
6. Antheridia being formed in succession, $\times 1250$.