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Some bog denizens

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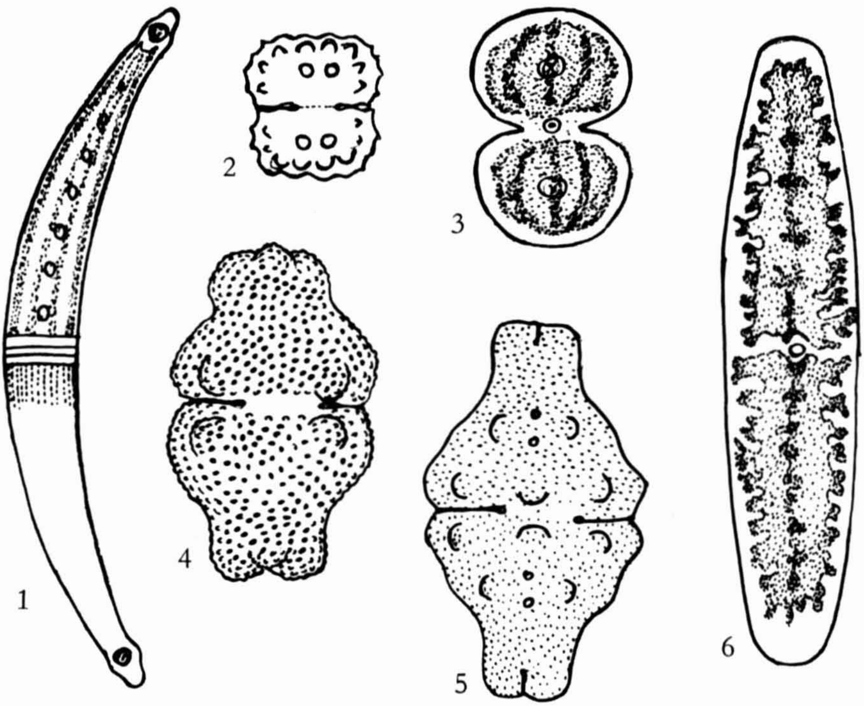
SOME BOG DENIZENS

Tucked away in the bogs and swamps of Wisconsin, and in similar habitats throughout the world, thrive a myriad of unicellular plants known as Desmids. They are among the most aesthetic of all microorganisms and vie with the glassy-walled Diatoms as "Jewel Plants." If it were not for the inquisitive biologist and the students of the microscopic cosmos, Desmids well might exist unnoticed. For although they have highly intriguing biological features they play no role in water spoilage problems, nor are they important in the food cycle of aquatic animals. Hence they do not attract attention nor invite the condemnations that are directed toward some other groups of algae such as the blue-greens.

As microscopists know, there are two classes of Desmids. One group, known as the Saccoderm (Fig. 6) has a simple, plain cell wall in one piece, with no median incision or sinus. There are nine genera and a relatively few number of species of saccoderms. The other 'true' Desmids or Placoderm, about 30 genera (Fig. 1, 10, 11, e.g.) have a cell wall that is composed of two sections which adjoin in the midregion where there is an incision or sinus, resulting in the cell being composed of two 'semicells', the halves being mirror images of one another. (*Closterium,* Fig. 1 an exception). In a few genera cells remain adjoined after division so that filaments are formed. In fact, the word Desmid implies a band or chain, whereas the name might also refer to the linkage of the two cell halves. The cell wall in the Placoderm is not plain but is furnished with all manner of ornamentations–striations, granules, knobs, spines, verrucae, areolae, punctations, and there are often complex mucilage pores. In a few curious tropical genera there is a peculiar dichotypical morphology, especially in respect to the polar lobe (Fig. 9, *Allorgeia,* e.g.)

Both groups of Desmids reproduce sexually by conjugation which gives them a place in the Order Conjugales, along with the Zygnemataceae (*Spirogyra, Zygnema, Mougeotia*). In vegetative reproduction, the Saccoderm cell elongates and divides by simple division, whereas in the Placoderm the two semicells separate and each half constructs a replication. Thus each Desmid cell is comprised of one young and one older semicell—a semicell which may be very old indeed, and no one knows how old because it persists generation after generation of cell division. In the situation mentioned above in which the apical lobe of one semicell differs from the other it is obvious that the axes of morphogenesis are somehow or in some way at variance. The statistics involved in the genetical inheritance of this phenomenon have not been determined, but an interesting study awaits the phycologist.



Representative Desmids, most of which occur in Wisconsin

Fig. 1. *Closterium*, 2. *Cosmarium*, 3. *Cosmarium*, 4. *Euastridium*, 5. *Euastrum*, 6. *Netrium*, 7. *Staurastrum*, 8. *Cosmarium*, 9. *Allorgeia*, 10. *Euastrum*, 11. *Staurastrum*, 12. *Staurastrum* (end view), 13. *Micrasterias*

Aside from the attractiveness of their endless variety of geometric forms and ornate wall designs, Desmids have been the subject of wonderment and investigation since the early days of microscopy. This is because they possess so many unique features and unexplainable behaviors—presenting more mysteries perhaps than does any living cell which is enigmatic enough. In the first place, their cytology and the cytoplasmic behaviors that are responsible for the complex cell wall are highly intriguing. Here we have a group of one-celled organisms in which evolution has progressed far indeed from the primitive, ancestral globular cell. (The phylogenetic history of Desmids offers considerable interesting specu-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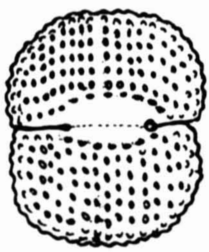
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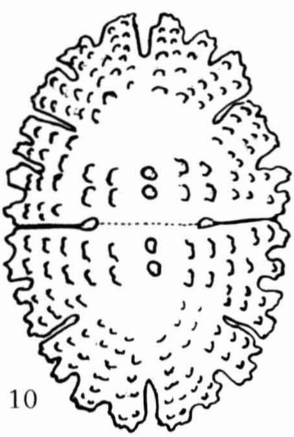
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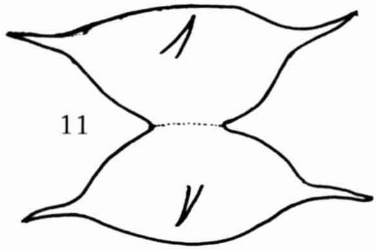
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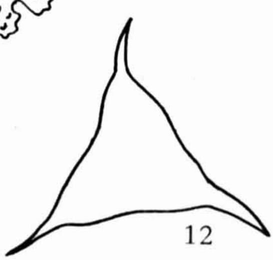
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lation for they have no known ancestors and they appear to have no evolutionary progeny—hence they exist in an 'island' position, as does the Characeae, for example.)

The cytologist and the electron microscopist have contributed greatly toward a hoped-for understanding of the chemico-physical 'storms' which must be involved in cell morphogenesis. As yet, we do not know 'how'—but there appears to be inheritable axes in the cytoplasm along which energy transfers are made that lead to the architectural complexities. It seems highly possible that DNA in the cytoplasm, only remotely controlled by the nucleus, regulates the construction of lobes, arms and other projections.

Another cytoplasmic characteristic of the Desmids which invites study is the chloroplast—the most ornate and complex in the plant kingdom. The electron microscopists have only just begun to analyze the structural features of the chloroplast and its included pyrenoids which are the largest known. The chloroplast may be axial or stellate with longitudinal radiating bands or plates, (Fig. 6, *Netrium*) or parietal in the form of plates or spiral ribbons. In a number of genera there occur terminal vacuoles containing granules of gypsum (*Closterium*, Fig. 1), supposedly waste material. And then there are other granules which exhibit peculiar movements during cell division and which may in some way enter into the construction of new membranes or wall material.

One of the paradoxes exhibited by the Desmids is in reference to their speciation. Although they are amazingly conservative in the precise manner in which they construct specific complex walls, generation following generation for millions of years, some genera especially have a most unsettled complement of genes and DNA organization. This has resulted in a wild display of variables and in the genus *Cosmarium* (Figs. 2,3,8) for example there are about 3500 recognizable taxa whereas in *Staurastrum* (Figs. 7, 11), a most highly evolved genus, there are about 2000 species. Probably in no other groups of plants on earth has there been so much speciation (at least judging from living representatives). Although bacteria are more numerous in numbers of individuals, and although Diatoms have prodigious populations, they do not equal the Desmids in number of living species and varieties.

Involved in and complicating the speciation for the taxonomist is converging evolution. Such a genus as *Staurastrum,* for example, includes 'species' which apparently have been derived along different evolutionary lines from various, distantly related ancestors. Species in *Arthrodesmus,* in *Cosmarium* and possibly in *Micrasterias* (Fig. 13) have undergone modifications in their axes of morphogenesis and their semicells have become radiate and extended in more than one plane (as is true for *Staurastrum*). Hence that genus is artificial and among its two thousand taxa are species from different ancestors which have come to appear as *Staurastrum*-like.

Desmids show an as yet not well-understood habitat selectivity. For although some forms adjust to a wide range of water chemistry and nutrients, most are to be found in soft water or acid habitats. Thus they may be used by the limnologist to evaluate relative hardness or softness of aquatic habitats. Characteristically Desmids occur in profusion in waters which have pH ranging from 4.8 to 6.8 (or 7.0). Accordingly the *Sphagnum* bog, or lakes receiving drainage from igneous (non-calcareous) rock, and aquatic habitats in which organic acids have been formed by bacterial action, are suitable for Desmids. Southern Wisconsin, for example, is an area in which there are limestone outcrops and most ponds, lakes and swamps contain hard water. Cedarburg Bog has relatively hard water and is not suitable for but very few Desmids. Northward, however, in the upper tier of Wisconsin counties (Oneida, Vilas, Langlade, Forest, Iron, e.g.) the basic rock is crystalline and glaciation has left a mantle of sandy soil in many sections. Hence the waters are soft and the topography is strewn with bogs and swamps populated with tamarack, leather leaf and others such as cranberry, pitcher plants, sun dews and cotton grass. Here Desmids abound in prodigious numbers. Northcentral United States and on through Canada to the Arctic there are veritable garden spots for Desmids. Other areas in the United States where Desmids abound are the igneous rock and sandy areas of New England, and the sandy soils of southeast United States, especially Florida. Oddly enough, although Desmids are prevalent in arctic habitats they are practically non-existent in Antarctica. Not a few species of Desmids exhibit an adjustment to a wide range of pH and to calcium and to nutrient-content, and are often found in relatively hard-water situations, especially as plankters. Perhaps the majority of Desmid species are world-wide in their distribution, invoking speculation as to the means by which this has been achieved. Very clearly there has been sufficient geological time and opportunity for a uniform dispersal (as there has been for many aquatic organisms), and the reason why all species are not found equally distributed can be explained by first, the specific selectivity of ecological factors and second, the pure chance factor. A check list of world-wide distribution of species shows that the region where there are more endemic species than any other is in the East Indies-Burma-Ceylon sector. This invites speculation that this area may be the center of Desmid evolution and dispersal, but it is necessary to remember that since Desmids had their birth in geologic time the climate, land masses and water chemistry in different sections of the world have undergone drastic and repeated changes.

Hence when Desmids are collected in Wisconsin (or in any part of the world) one does not know whether the species represent a persistent flora dating from ancient times, or whether they are relatively recent immigrants from some remote evolutionary birthplace. In any event this group of the algae offers ample research opportunities for the taxonomist, the cytologist and the ecologist.

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