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VARIABILITY OF SCENEDESMUS ECORNIS (RALFS) CHOD. IN THE DEAD-ARM OF THE RIVER TISZA AT KÖRTVÉLYES

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Abstract

In the "soil blooming" along the riverside of the Tisza dead-arm at Körtvélyes and in the biocoenosis of its psammon, *Scenedesmus ecornis* was a mass producer. The considerable morphological variability observed among them is illustrated in Figs.1—20,Plate *1.* The polycellular coenobium developed only in the surface "soil blooming", in the psammon, however, the monodesmoid cells predominated. The isolates prepared of site matter continued growing in clone-cultures. From the isolates, two coenobia and their derivates are shown in Figs.21/a—f and 22/a—f. The variability of these was smaller. From the monodesmoid cells those in chlorelloid state are most considerable because in the future it will possibly be (possible), as well, to use them for investigating the differential gene activity in algal cultures.

Introduction

I have studied for some years the algal flora and algal vegetation of the Tisza dead-arms at Mártély and Körtvélyes, lying north of Szeged, at the left bank of the river, by means of samples taken from time to time. The water of the dead-arm at Mártély is more and more eutrophicalized, and its algal world, in respect of species- and individual numbers, is richer than the water of the dead-arm at Körtvélyes which is eutrophicalized less, for the time being. The dead-arm at Körtvélyes is polluted rather but by the desintegrating organic matters of plants, leaves and waste-crops being present or in the environment. Here, the sandy-silty sands of the bank are partly covered with moulding vegetable remains what gave occasion for the *Cyanophyta, Chlorophyta,* and *Bacillariophyceae* species to appear in larger masses, as well.

On this occasion, I am exposing the considerable variability observed within the form cycle of *Scenedesmus ecornis* (RALFS) CHOD., manifesting itself in the algal samples collected from the dead-arm at Körtvélyes and in the laboratory cultures isolated from these. Our primary aim was, to be able to interpret the large variability in form observed by us, too, in case of this organism (KISS 1962), also on the basis of bringing about some clones of pure culture.

Materials and Methods

The material investigated was taken on November 23, 1973, on the sands of the eastern bank of the dead-arm at Körtvélyes, from the small green spots of 1—2 sq.cm extension. This colouration manifested itself at the surface and in the 0,5—1 mm soil-layer below that, that is to say, it formed the "soil blooming" and the biocoenosis of the psammon. These coloured spots and the 3—4 mm soil-layer below them were collected into Petri—dishes.

In the algal substance of the soil-spots *Scenedesmus ecornis* (RALFS) CHOD. grew in large masses, together with *Oscillatoria angustissima* W.& G. S.WEST, *Lyngbya bipunctata* LEMM., *Lyngbya circumcreta* G.S. WEST and some *Bacillariophyceae* species.

From the material kept in a glass case, in a cool place for a few days, with repeated washings and decantations, a culture was made, rich in *Scenedesmus* and poor in blue-green algae. We continued enriching these in Knop's solutions of different concentration. This culture enriched was already suitable for being "purified" from a 1,5—2 per cent agar plate, similarly with Knop's solution, by means of repeated transfers. With the strongly diluted suspension of the nutritive solution obtained in this way, agar-plate cultures were set of which the coenobia of *Scenedesmus ecornis* could be isolated.

Discussion of results

At the surface of the soil samples of the habitat, and in the water filling in the gaps of grains of the sand, the substance of *Scenedesmus ecornis* was found partly in the form of coenobia, partly in that of monodesmoid cells. At the surface, the majority of cells were forming coenobia, in the thin water-layer between the grains of sand, on the other hand, the cells were overwhelmingly in monodesmoid or 2-cell state.

The size of the cells of varied shapes fluctuated within broad limits, according to the conditions of growing, the life of age, and the state of development. The length of the cells appearing to be well-developed changed between 7 and 18, their breadth between 5 and 15 μm.

In the following, we are offerring a brief survey of the changes observed in the substance of *Scenedesmus ecornis* of the material collected and in the cultures isolated from that, according to the figures in Plate I, as grouped into main types.

Coenobium-types and cell-forms of the natural substance

Figs. 1 to 20 are made about the organisms of the natural substance or about the material of that during "purification". The denomination of main types and the description of the conditions of their occurrence are as follows:

(1) Linear coenobium consisting of comparatively broad cells. The breadth of cells is not completely equal. They mostly occurred in the surface "soil blooming" (Fig. 1).

(2) Linear coenobium consisting of more slender cells. The external wall of the lateral cells is mostly bulging. They proved to be of dominant role in the *Scenedesmus*-substance of the surface "soil blooming" (Fig. 2). Further on, the serial number of the single types is meaning the serial number of figures, as well.

(3) Linear coenobium with smaller and bulging lateral cells. The cells are medium sized. They appeared sporadically at the surface of "soil blooming", occupying intermediate positions joined with the former types.

(4) One end of the cells of the linear coenobium is grown narrow. They occurred sporadically both in the surface "soil blooming" and in the material of psammon. The size of cells is comparatively small.

(5) Multicellular arched coenobium. The medium-sized cells are elliptical, one of their ends is sometimes a little narrower. They only occurred in the surface "soil blooming", forming sometimes tissued coenobium-masses. The cells are medium-sized or smaller.

(6) Linear coenobium, with cells standing somewhat alternated. The localization of cells at two levels alternately may immediately be attributed to that one end of the adjacent cells develops growing narrow in alternating sequence, whereby they may move off from each other on their sides. This alternated arrangement may be induced by the division of cells with slanted walls, as well. They occur in the surface "soil blooming" and the psammon substance equally sporadically.

(7) Linear or a little arched polycellular coenobium, with strikingly smaller interposed cells. The few cells at the beginning and end of the coenobium are medium-sized, at about the middle, however, some cells are very short and narrow. In the surface "soil blooming" they occurred but rarely.

(8) Coenobium of heteromorphic structure. The coenobium consists in one half of large cells aligned in a row but in the other half of smaller cells, localized disorderly. The latter ones may be aligned in two rows, as well, and the last cells sometimes join one another dactylococcoid-like, that is with their ends. They occurred in "soil blooming" in a few cases.

(9) A somewhat "disciformoid"-like coenobium. In the medium part of the coenobium, there are two cells over each other. It is not impossible that this is a primitive manifestation of the development in the direction of *Scenedesmus ecornis* var. *disciformis* CHOD. It could not be observed but on two occasions in the surface "soil blooming".

(10) A more definitely "disciformoid"-like coenobium. Two or more cells cover one another, the coenobium is, however, closed at both ends with a cell each. They mainly occurred in the psammon substance, forming frequently smaller or larger heaplike groups.

(11) Didesmoid coenobium. The two cells of the same shape and size are localized at one level adjacently, as linear "fundaments". In the psammon they occurred frequently, but in the surface "soil blooming" only rarely.

(12) Two-celled coenobium, with cells of unequal sizes and located not at the same level. The shapes of the two cells are not fully equal, either. One of them is elongated elliptical, one of the ends of the other cell may even be narrower. In the surface "soil blooming" they occurred but rarely but in the psammon often. They are to be regarded as a result of an unequal cell-division.

(13) Monodesmoid cell, with unequal poles. One of the poles is rounded, the other is growing narrow or ending in a point. In the psammon they appeared frequently.

(14) A slinghtly arched monodesmoid cell, with regularly rounded termination. It may have been the lateral cell of a regular coenobium. It occurred both in the psammon and in "soil blooming".

(15) A stocky monodesmoid cell, one of its ends being broadly rounded. It was frequent both in the psammon and in the surface "soil blooming".

(16) A slender monodesmoid cell, at one end being archedly narrow. It appeared in the psammon frequently, in the surface "soil blooming" rarely.

(17) A monodesmoid cell, one of its ends being broadly rounded, the other growing archedly strongly narrow. It is characteristic of the psammon substance, in the surface "soil blooming" it could be seen but rarely.

(18) A spatula-like triangular monodesmoid cell, with a haftlike elongated protrusion. It could be observed rarely, in the psammon.

(19) A monodesmoid cell with a rounded peak, a concavely arched footing. It is an extreme monodesmoid form of the polymorphism of *Scenedesmus ecornis*. It appeared only on two occasions, in the psammon.

(20) A monodesmoid cell, round at one of the ends and concavely flattened at the other one. It is one case of the chlorelloid stage. In the psammon it appeared often, in the surface "soil blooming" rarely.

Development-morphological conditions of isolated cultures

We are trying to approach the problem of the considerable variability of *Scenedesmus ecornis* by investigating the culture of a few isolated coenobia further on. We have more than once succeeded in doing this, starting from the agar-plate surface of the strongly diluted suspension of the nutritive material. We took the coenobia, cell-free and apparently characteristic even in their broad environment, into Knop's solution, investigating the increasing substance of these partly by liquid culturing, partly on Knop's agar.

From the varied material of isolations, in Figs. 21 and 22 of Plate 1, only the derivatives of the two coenobia are demonstrated which could mostly be interpreted, resp. the interpretation of which seemed to be mostly necessary. Both coenobia are 4-celled, the forebears of both originated in the last resort from the originally collected "soil blooming". The mainly characteristic derivatives of these are denoted in ABC-sequence with small letters under the figures.

Fig. 21. A 4-celled coenobium, with considerably bulging lateral cells. This corresponds to main type 3 of the natural substance already discussed above. Its sub-types are, with the percentile denotation of their frequency, the following: a=a regular, somewhat arched monodesmoid cell (circ. 10 per cent), b=a monodesmoid cell, at one end peaked or narrowing (circ. 20 p.c.), c=a regular monodesmoid cell (circ. 40 p.c.), d=a 2-celled coenobium, mostly with not quite equal cells (circ. 5 p.c.), e=a 4-celled coenobium, frequently with not equal cells (circ. 20 to 25 p.c.), f=a spherical or irregularly polyhedric, sometimes disk-like flattened, so-called chlorelloid cell (circ. 0—1—2—5 p.c.). Their diameter was sometimes only 4—5, but sometimes 10—12 μm.

Fig. 22. A regular 4-celled coenobium. This corresponds to main type 2 of the natural substance. Its sub-types are, with the denotation of their percentage, the following: a=a spherical or irregularly roundish, sometimes polyhedric or disk-like, so-called chlorelloid cell (circ. 0—1—2—5 per cent). Its diameter fluctuated between 4—12 μm, b—c=a regular monodesmoid cell, sometimes with a diagonal division or forming 4-celled successor coenobia (circ. 40 p.c.), d=a monodesmoid cell, at one end rounded, at the other end peaking or narrowing (circ. 30 to 35 p.c.), e—f=a 4-celled coenobium, mostly with not equal cells (circ. 25 p.c.). Sub-type e occurred only on a single occasion.

Discussion of results. Conclusions

The considerable variability of algae, the so-called polymorphism is a considerable problem in respect of establishing the taxonomical place of a species. The concept was first used by Agardh, in 1820, to denote that an organism was imitating the shape of a relative or not relative species. To give a still more exact denotation, CHODAT introduced the concept of the so-called preponderant stadium, for designating the prevaling, resp. most frequent, longest developmental state in the ontogenesis of green algae, primarily of *Scenedesmus*. In the polymorphism of *Scenedesmus*, he also distinguished the monodesmoid, chlorelloid, coelastroid, tetradesmoid, and dactylococcus-like stages. The variability among green algae is even increased by the occurrence of irregularities what is to be attributed to their being a phylogenetically younger category (HORTOBÁGYI 1956). This may particularly be referred to the *Chlorococcales* order, seeming to be phylogenetically the youngest one (UHERKOVICH 1961).

Above we have followed with our own investigations the variability in form of *Scenedesmus ecornis*, originating from the dead-arm at Körtvélyes, on the basis both of the site-material and the clone-cultures. Corresponding to the essential conditions, the habitat-material was much richer in form than the cultures of clones. In case of *Scenedesmus*, the preponderant 4-celled and poly-celled coenobium manifested itself mainly in the surface "soil blooming". The narrower field of the biocoenosis of psammon enabled only the development of monodesmoid forms.

The extremes of the polymorphism of the habitat mass-production are irregular cell-formations, to be attributed to extreme circumstances, particularly to the narrower field relations of the psammon. Such is, *e.g.*, the spatula-like trianglular cell-form the point of which continued in a haftlike formation (Fig. 18). There were to be seen manifold transitions between the straight or arched monodesmoid cells, too, being narrower or bulging at one end and rounded at the other one. The immediate descendents of forms, arrested in development owing to some mechanical influences, seem to have borne the traces of the change in form of their forebear even in agar-cultures providing for more favourable field-conditions. The regular, a little arched monodesmoid cell (Fig. 14) is supposedly a derivative of the lateral cells of coenobia limited by the arched cells (Figs. 3, 21). In our culture it could often be observed that the monodesmoid cells divided by more or less slanting walls (Fig. 21-b). From a division like this may have originated the 2-celled coenobium and one of its cells has considerably shifted from the adjacent other cell (Fig. 12). In this way may have come about also the polycelled coenobia consisting of more or less alternating cells (Fig. 6).

In the polymorphism of *Scenedesmus ecornis* the chlorelloid form is most remarkable which manifested itself in the habitat material and cultures with a frequency of 1 to 2 per cent. This state was observed, already before Chodat, by BEIJERINCK in the phylogeny of *Ankistrodesmus,* describing this under the name of *Chlorella*-cycle in 1890. The *Chlorella*-cycle can be observed in the phylogeny of *Kirchneriella,* as well (KISS 1956, 1962). The more intensive study of *Ankistrodesmus* resulted in a further revealing of the nature of the chlorelloid cells (MCMILLAN 1967, KISS 1961, 1966). We have observed, for instance, in the cultures of *Ankistrodesmus braunii* that only about the half of the chlorelloid autospores had developed into elongated vegetative cells, the others, continuing to multiply bipartition, had brought about recent chlorelloid cells. "In case of the autospores that remained, further on, in the *Chlorella* cycle seems the factor of longitudinal growing to have missed or to have been fully stunted" (KISS 1961). The phenomena of developmental stunt are attributed by the phylogenetical physiology to the processes of the differentiated gene activity. A study of the chlorelloid states seems to be possibly useful in the domain of phylogenetics because by the help of these the events of repression and depression may be followed with algal cultures, as well.

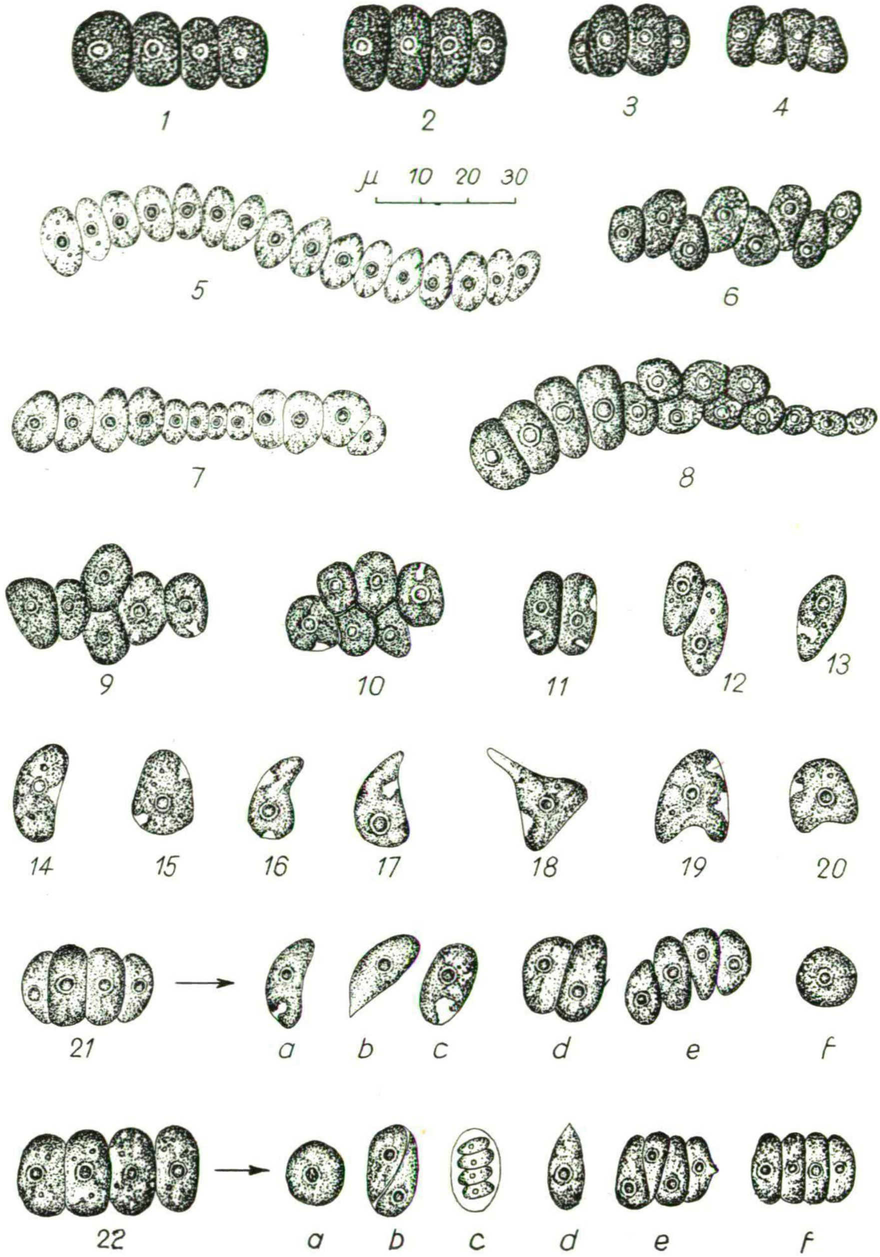
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Fig. 1—22

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