Tiscia (Szeged) Vol. XII, pp. 37–47 (1977)

INVESTIGATION OF THE WATER BLOOMS OF EUDORINA ELEGANS IN THE DEAD-ARM OF THE RIVER TISZA AT THE COMMUNITY MÁRTÉLY

I. KISS

(Received September 15, 1976)

Abstract

Eudorina elegans is a vegetable micro-organism occurring in Hungary often and sometimes in large masses. I could study its algal blooms intensively in the Tisza dead-arm at Mártély, recently in the Summers of 1968 and 1973. The quick colouration of the water surface was in both cases induced by the rise to the surface of a phytoseston-mass already multiplied in the depth. The green water surface discoloured in spots more than once for the morning because of the organisms retiring into the depth but for the afternoon a full greening out followed again. In this, apart from the active movement, the change in specific gravity had also a part.

I have observed the mass productions of *Eudorina elegans* in strongly polluted salt- and alkaline waters, as well. It was shown by our physiological experiments, as well, organized for the opportunity of the algal bloom at Mártély that the damaging effect of the large salt-concentration and of the strong alkalinity is to some extent reduced by the dung-water containing decomposing organic matters.

PASCHER's earlier supposition that there may exist some "races" differentiated within the species-category physiologically, as well, is supported by our earlier and present-day, partly experimental investigations, too. It may be supposed, in my opinion, as well, that *Eudorina elegans* is, both in morphological and in physiological respects, a "collective species" that may conceal in itself more than one biotype. This can be supposed in case of several other algal species, as well. With this can be connected the "unpleasant" hydrobiological fact, too, that the value of an algal species as a saprobiological indicator may change not only according to authors but also according to countries, regions, and even biotopes. It is probable that the reality of the biological water-qualification will be strongly augmented by the exploration of biotypes.

The *Eudorina* algal blooms at Mártély are pointing out that the water may here be eutrophicalized, possibly to a dangerous extent, too.

Introduction

With the more and more increasing eutrophicalization of some dead-arms of the river Tisza the mass-production phenomena of algae also become more and more frequent. In the water of the dead-arm at the community Mártély lying north of Hódmezővásárhely, I have found already more algal mass-production induced by the representatives of the *Euglenophyta* phylum, mainly by *Euglenida*.

On this occasion I am speaking of the water "bloom"-like mass productios induced in the dead-arm at Mártély by *Eudorina elegans* EHR. almost alone. I try to compare these with the *Eudorina* algal blooms observed by me earlier.

Eudorina elegans EHR. is an organism occurring in Hungary frequently. It occurs in minor standing waters sometimes in large individual numbers. I could investigate one of its algal bloom mass productions in the environment of the community Pusztaföldvár in County Békés in details for a month in the Summer of 1936 and analysed the development and changes in the mass production from meteorobiological point of view, as well. The sudden appearance of the algal bloom was a phenomenon similar to the apparition of "weather-sensitivity" (KISS 1942). I have found this alga even in surface waters of comparably large salt-concentration and sodification, in so-called "alkaline" waters. It occurred on the confines of the town Orosháza, for instance in the "natron" lake "Kis-Szék" or in the stagnant pools of saline-alkaline waters of an area named "Szikhát", often in large individual numbers and sometimes inducing algal bloom (KISS 1939, 1961). In the dead-arm named "Nagyfa" of the Tisza, close to Szeged, it was also observed by *Hortobágyi* (HORTOBÁGYI 1939). Later on, it was also found by UHERKOVICH in the water of the stretches of the Tisza in Hungary and in some of its tributaries (UHERKOVICH 1971).

The above observations are showing that *Eudorina elegans* may also be found in the territory of Hungary under very much varied environmental conditions. Earlier it was already pointed out by PASCHER that, there may exist some physiologically differentiated races within the species-category *Eudorina elegans,* suitable for the various environmental conditions (PASCHER 1927). In order to approach this problem, we have performed physiological experiments with the phytoseston collected in the dead-arm at Mártély.

Method of the investigation

The investigation of both algal blooms were carried out on living material as there are induced distortions in the colonies even by a careful fixing. The bioseston-samples were taken by dipping, possibly on more occasions a day. The pH-value of water was measured on any opportunity, fluctuating between 7,2 and 7,5. It was necessary to take profile-samples, as well, because phytoseston accumulated in the deeper layers of water, too. Profile-samples were taken in the area of algal bloom or in its vicinity in the places without colouration, as well, because we already observed in the Summer of 1936 that *Eudorina elegans* was strongly inclined to retire into the deeper layers of water from time to time.

We tried to set the physiological experiments for investigating the development of colonies, as well as to follow with more intensive attention their toleration against the total salts and alkalizing salts, halo-tolerance and natro-tolerance. For these experiments partly natural saline-sodic waters, partly salt solutions made in the laboratory and sometimes a little dung water (thin manure) were used. The latter one was applied to investigate the effect of pollution by organic matters.

Analysis of the water blooms of Eudorina elegans

I investigated the algal flora of the dead-arm at Mártély from 1953 till 1954, from 1966 till 1968, and from 1972 till 1975. *Eudorina elegans* appeared in the phytoseston on three occasions: in 1968, in 1972, and in 1973. Two occurrences, in the Summers of 1968 and 1973, were mass-productions in from of water blooms. Both water blooms took place in the southern part of the dead-arm, in the section bending towards West. Close to the riverside, there are some deeper places here, as well.

Water bloom in the Summer of 1968

I observed first water blooms of *Eudorina elegans* on July 21, 1968. The surface was coloured grass-green by the phytoseston in a length of about 9 to 10 m in about 4 to 5 m breadth inwardly from the riverside. The water had some greenish hue almost everywhere till a depth of 8 to 10 cm. On the somewhat paler spots some greenish turbidity could be observed even in a depth of 20 to 25 cm depth. Till July 22, the phytoseston colouration continued expanding, mostly in smaller or largyer spots: at about 11 o'clock the water surface was green 14 to 15 m long and 6 to 7 m broad. The surface bioseston was sporadically foamy, induced in smaller part by the photosynthesis, in larger part by the gas bubbles going up from the depth and enclosed in the phytoseston mass at the surface. The rising gas bubbles considerably contributed to the expansion of the green colouration at the surface, bringing with themselves not only dark or blackish silt but also green phytoseston masses surrounding ring-like the black, silty spot which was flowing to the surface. The gas was partly H_2S, partly it may have originated from the methanic fermentation of cellulose. H_2S could be smelt faintly on the foamy mass and the black silt flowing to the surface together with the gas bubbles, was also pointing at a considerable quantity of H_2S.

The water surface became mostly coloured by the organisms "swarming" upwards from the depth. The uprise to the surface in "cloudlike swarms" was also shown, anyway, by that the colouration of the water surface was variegated with lighter and darker green spots.

In the morning of July 23, the water surface became paler or almost colourless here and there, because in these places the colonies of *Eudorina* retired into the deeper layers of the water. The colonies settled in the 10 to 20 cm deep riverside water on the substratum, and farther from the riverside they mostly accumulated in a depth of 25 to 40 cm. Some greenish turbidity could be observed in some places even in a depth of 50 to 60 cm. In the morning, however, the colonies began swarming up again, and for the afternoon, the water surface was turning green again.

The movement in cloudlike swarms was particularly striking in case of *Eudorina elegans*. It is questionable, to what extent were the comparatively quick retiring into the depth and the repeated rising up to the surface a consequence of the active motion. I could establish by investigating the phytoseston on a depression slide that the colonies, in 8—10 sec, could swim down not more than 1,5 mm deep, or migrate up the same distance. Thus, the comparatively rapid change in level was partly caused by the decrease in specific gravity, as well.

For July 24, the surface again became paler in some spots because of the partial retreat of colonies into the depth. This was already of small degree. For the hours of the late afternoon the surface of water again turned thoroughly green, and later on there followed no paleness-inducing migration into the depth any more. On July 25, the water bloom still was of thoroughly planktogenic character, on July 26, however, the surface bioseston became closed in a thin membrane, *i. e.,* the process of neuston-formation began. In the following days the neuston-coat became thicker because from the bioseston below it newer and newer organism-masses joined it. Some days later, the neuston began losing colour, broke more and more to pieces, and in the first days of August the water bloom disappeared, without leaving a trace behind.

This enormous mass production of water bloom was brought about by *Eudorina elegans* nearly alone. In very small individual numbers the following species were also present: *Spirulina subtilissima* KÜTZ., *Phacus alata* KLEBS, *Trachelomonas volvonica* EHR., *Trachelomonas volvocina* EHR. far. *derephora* CONRAD, *Trachelomonas oblonga* LEMM. var. *truncata* LEMM., *Trachelomonas Mangini* DEFL., *Pediastrum constrictum* HASSALL., *Tetraedron caudatum* (CORDA) HANSG., *Scenedesmus obliquus*

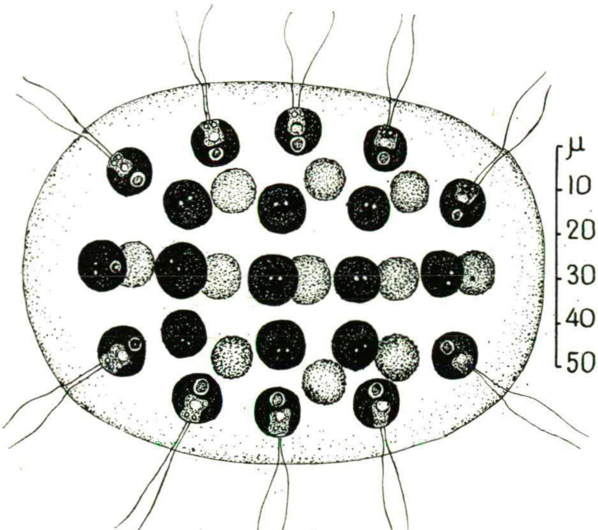
(TURP.) KÜTZ., *Scenedesmus acutus* (MEYEN) CHOD., *Scenedesmus ellipsoideus* CHOD., *Ankistrodesmus setigerus* (SCHROED.) G. S. WEST.

The colonies of *Eudorina elegans* EHR. are elliptical or bluntly egg-shaped, 80—150 μ long and 45—90 μ broad. Colonies of almost spherical form occur rarely, as well, with a diameter of 78—80 μ. The elliptical colonies are rounded at both ends nearly equally (Plate 1, picture 1). In this case, there can only be established from their end in the direction of motion that the anterior pole is represented by that. A smaller proportion of colonies is morphologically definitely bipolar, and in this case, the rounded end is to be regarded as a posterior pole (Plate 1, picture 2). The colonies mostly move vaguely, unsteadily. The bipolar ones did the same and if these started definitely in some direction, their rounded end was always ahead. It is proved by this that the rounded end is the posterior pole. It is questionable if the bipolar colonies occurring in the population represent a "race" fixed genetically, as well. I have often observed that the posterior pole of older organisms or of those living under unfavourable conditions begins becoming rounded off, and sometimes it is definitely blunted. Picture 2 of Plate 1 was made of an individual living in a considerably aggregated bioseston, and picture 3 of Plate I is showing an individual taken from an airless, age-worn vegetation. In case of this, the posterior pole is already squashed and rounded off. It is to be seen in picture 2 that the colonies with a rounded off posterior pole bulge out in some places on their sides as well. This may probably be attributed to some osmotic damagement.

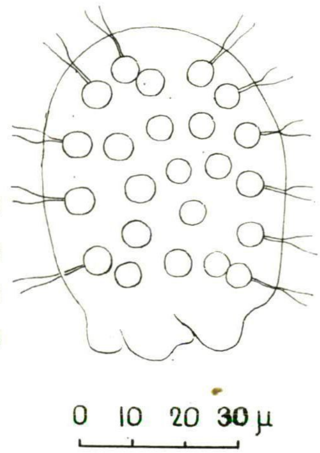
The cells of colonies take place in the external one-third or one-fourth part of the whole envelope, and are embedded in a still comparatively broad envelope. In a fully developed individual the colony contains 22 cells. I have found these cells taking place only rarely regularly in five "ropes" (Plate 1, 1). In this case, the ropes at the poles are 4-celled, and the internal ropes are 8-celled each. The less regular arrangement of cells is frequent, particularly at bipolar individuals (Plate 1, 2). In cases like this, the number of cells may also be considerably smaller (Plate 1, 4). The cells of colonies take place in about the same distance from one another, distributed proportionately. In the colonies of perishing individuals considerable disorder may prevail.

I have found some cells of the colonies in water bloom having mostly almost a spherical form with a diameter of 14—15 μ. Sometimes they are smaller, in extreme cases with a diameter of 9—10 μ. The chromatophore is always smooth and without striation. I have found in every cell but a single pyrenoid. I have often observed that the activity of flagella is not synchronous. It may be attributed to this that the movement of colonies is sometimes turning round *in situ* or vacillating undecided. In the course of the ageing process of colonies all this is increassing, and the developed colony-masses either sink down to the bottom or turn up to the surface.

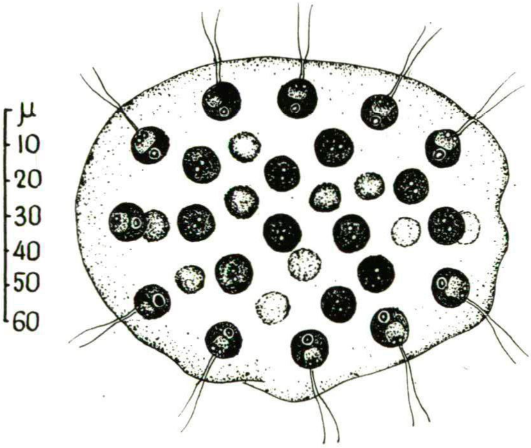
At taking the bioseston-samples, I have always followed with attention the form of multiplication, as well. Within the colonies, the transformation of the single cells into daughter-colonies could only be observed in few cases; on the other hand, I found the propagation by zoospores to be frequent. The germinated zoospores multiplied by bipartition many times in a few hours, bringing about new colony-fundaments. The cells of these fundaments still take place closely side by side, mostly pressed to be square (Plate 1, 4).



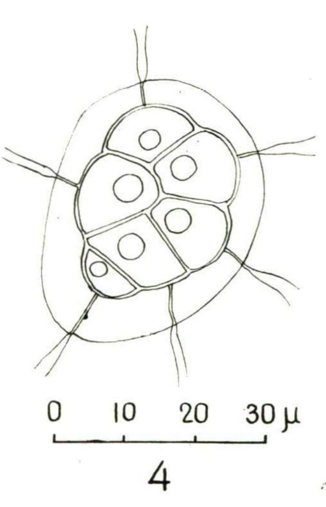
1



3



2



4

Plate legend

1. The bluntly egg-shaped colony of *Eudorina elegans*, with cells localized in five "ropes".
2. Bipolar colony, with a wavely bulched-out side (from the accumulated bioseston).
3. Bipolar colony with squashedly blunted posterior pole (from a senescent vegetation).
4. A colony-fundament developed from zoospores, with cells pressed to be cornered.

Water bloom in the Summer of 1973

I observed the second *Eudrina* water bloom in the dead-arm at Mártély first on July 15, 1973, similarly in the section bending towards West of the southern part, by and large in the area of the first water bloom. This was of somewhat smaller expansion and of weaker development. Further on, it did not dilated farther. It was shown by this that the development of mass-production had begun at least 4—5 days earlier. On July 17, the earlier homogeneous green surface was paler in spots, a part of the organisms retiring deeper at night. The colonies of *Eudorina* were similar to those found at the water bloom observed in the Summer of 1968, and the propagation took place in this case, too, mainly by zoospores. On July 18, the water bloom became everywhere of neuston character, beginning to lose colour and disintegrate. Next day, the bark-like neuston broken into pieces, united in small groups, got under the surface and on July 19, the water bloom disappeared almost without any trace.

In the water bloom, in addition to *Eudorina elegans,* in small individual number, the following organisms also occurred: *Trachelomonas conica* PLAYF., *Trachelomonas angustata* DFEL., *Tetraëdron caudatum* (CORDA) HANSG., *Scenedesmus costulatus* CHOD., *Scenedesmus nanus* CHOD., *Scenedesmus falcatus* CHOD., *Cosmarium subtumidum* NORDST.

With bioseston-samples taken on July 15, I have begun physiological experiments to investigate the salt- and alkalinity-tolerance and the effect of dung water rich in decomposing organic matters. A series of bioseston-samples got into a nutrient solution of 12 000 mg l total salt-content, made of Crone's culture fluid, by adding to each litre of that the following sodium-salt doses, too: 6000 mg $NaHCO_3$, 3000 mg Na_2SO_4, and 500 mg NaCl. The dilution of this in one-in-two, one-in four ratios was also applied. For investigating the alkalinity-tolerance, another series of bioseston-samples was used. As a nutrient solution of this the water of a natron-sodic lake, known as one of the most alkaline waters, was applied (Lake Szappanszék-tó, in the Danube—Tisza interstream region), showing 10 pH value in June of 1973.

Our experimental observations may be summed up in the following:

(a) The overwhelming majority of the colonies of *Eudorina* were quickly damaged by the concentrated salt solution. Their active motion ceased already on the first day, the colonies became mostly deformed and later on, even the envelopes of some of them burst. Cells contracted, too, their localization became irregular, their colour grew pale, they got disorganized in one to two days. The effect of the solutions diluted was similar, as well. Damage appeared but very rarely to be not so quick and considerable. Motion ceased in case of these, too, but the other signs of destruction became only visible rather in the third week.

(b) The dammaging effect of the water of the strongly alkaline sodic-natron lake could only be observed slower than the above-mentioned effects. Some of the colonies were moving weakly and unsteadily even in the third day, and their cells only began to be destroyed in the third week. Among the latter it became frequent that the sides of their envelope bulged out or got wavy.

(c) The concomitant species, occurring but rarely in the *Eudorina* water booms *(Trachelomonas, Tetraedron, Scenedesmus, Cosmarium)* visibly sufferred damage in the concentrated salt-solution but they only began perishing some weeks after. They suffered similarly on account of the strongly alkaline, sodic water but some percentage of them seemed to be capable of living even some weeks after.

(d) Crone's solution was of differentiated effect. *Eudorina* began perishing in the third or fourth week. From among the concomitant species, *Cosmarium* was ailing, too, but the others got over the change in environment well. Some of the *Scenedesmus* species were even multiplying.

(e) The bioseston sustained in the natural water of the Tisza dead-arm at Mártély remained without suffering damage during the ensuing weeks, as well.

(f) From the 10 millilitre amount of dung water, rich in decomposing organic matters, added to 1 litre alkaline-salty lakewater, we have obtained a "nutrient solution" in which the colonies of *Eudorina elegans* became more or less deformed but their cells did not perish and their settling on the bottom, too, followed but later. In an environment like this, the individual number of *Trachelomonas conica* and *Scenedesmus nanus* even increased somewhat. The damaging effect of the concentrated salt solution was — by the dung water, administered in a similar quantity — also moderated to a lesser extent.

Discussion of results Conclusions

The mass-productions of the green algae *Chlorococcales (Chlorella, Chlorococcum, Oocystis, Scenedesmus)* develop comparatively slowly, with a multiplication through some weeks. The water blooms of the *Euglenophyta* and *Volvocales* species are, on the other hand, mostly of rapid appearance. To interpret this phenomenon correctly, we emphasize anyway that this rapid appearance cannot be attributed to a too rapid multiplication (say in 1—2 hours) of these organisms. In respect of their production it is more important that the bioseston-mass lying hidden in the deeper layers, *i. e.* the already existing kryptogenic mass-production, are rising invasion-like to the surface. Earlier I denoted the form settled down to the bottom of the kryptogenic mass-production like this with the expression "pseudobenthos" (Kiss 1974). The appearance of the rapid water blooms is, therefore, less a phenomenon of propagation than that of the physiology of stimuli.

The water bloom of *Eudorina elegans*, taking place in the dead-arm at Mártély in the months of July in 1968 and 1973, had also a similar course. This was proved by profile-sampling and further observations, as well. The kryptogenic and pseudobenthos-like form of mass-production developed in the observation period even repeatedly, always followed by an invasion-like "swarming" up to the surface. The retiring into depth at night may have been induced by the strong falls in temperature. In the following, in connection with the mass-production of *Eudorina elegans*, we have to investigate the problem, raised already by Pascher, whether there may exist "race"-categories within the limits of species, corresponding to the various environmental conditions. According to our experiences, they may. But less in morphological than rather in physiological direction. This problem is of general character. It is practical, therefore, to extend the discussion to other algal species with mass-production, as well, investigating it together with the environmental conditions of the development of mass-productions.

The environmental causes of the development of mass-productions may be mainly of edaphicous (nutritional) and atmospherical (meteorological) nature. It is well-known that the nutrient substratum becomes favourable, enriching in nutritive matters, in the form of the eutrophicalization of waters, leading to the mass-multiplication of organisms. In the multiplication, according to our investigations, there take place also meteorological situations of favourable prefrontal character. In the waters polluted with dung materials or faecal matters (faeces), several representatives of some *Volvocales*, like *e.g.*, *Eudorina elegans* and more *Chlamydomonas* species, as well as of the *Euglenophyta* phylum, may develop their water blooms in 1—2 hours, in the time of the prefrontal meteorological situations of the atmosphere. This explosion- or invasion-like development takes place by "swarming" upwards of the organisms being present in masses in the depth. The swarming upwards of the bioseston is not cleared up completely, for the time being. The algal organisms may be forced by a negative chemotactic stimulus to move upwards. In this case, the motion upwards may be regarded as a reaction of escape, as well. A role may be played by the depth anoxia, resp. some less clarified factors of the atmospherical situation. H_2S and NH_3, known as plasma poisons, come about just in the anoxic space, mostly at the surface of the silt, owing to the anaerobic activity of bacteria. It is a wide-spread opinion that the activity of the bacterium *Desulfovibrio desulfuricans* which develops H_2S gas in anaerobic way, is released from the side of atmosphere by the increasing warmth. This may play a part, as well. But it is not to be explained with a simplified warm-effect that at the bottom of shallow waters hydrogen sulphide formation can be observed sometimes in Winter, as well. And in these cases, the "swarming" upwards of the organisms in water cannot be impeded by the ice- and snow-layers either, because the bioseston-mass multiplying and moving upwards colours even the surface of these (Kiss 1951, 1952). And what is more: in the high mountains and the Arctic and Antarctic regions, the surface of snow and ice may also be coloured by the mass-productions of the facultative kryobiontic algae (Kol 1968). I had mentioned already earlier the increase in ionization as an atmospherical factor promoting the development of algal mass-productions. Today this is already proved by experiments, not only in respect of micro-organisms but of higher plants, as well. The life-functions both of animals and of the man are under the influence of ionization! The importance of the research works like this will increase in the long-range.

Returning to the problem of the factors of nutrient media, promoting the development of mass-productions, it is to be noted as a starting-point for our later comments, that also the presence of some adequate algae is necessary which are suitable for the given nutrient substratum. It was mentioned above that *Eudorina elegans* was a mass-producing organism in the salt-sodic waters of the biotopes named "Kis-Szék" and "Szikhát" on the confines of Orosháza (Kiss 1939, 1961), and produced a lasting water bloom in a neither salty nor sodic but strongly polluted water on the confines of Pusztaföldvár (Kiss 1942). Thus we may say in an ecological approach that *Eudorina elegans* equally occurs in salty and sodic, resp. not salty and not sodic waters. It is a so-called euryhaline-euryionic-limnic organism of broad valency. But the same can be said of several algal organims in our salty-alkaline ("sodic") lakes, as well. But this considerable halo-tolerance and soda-tolerance manifests itself only if the water is polluted with decomposing organic matters or definitely also with dung matters or faecal traces, too. In the salty-alkaline water of "Kis-Szék" at Orosháza, in the Summer of 1943, *Lepocinclis fusiformis*, with its strongly variable forms, brought about an enormous mass-production (Kiss 1961), because a considerable amount of sewage-water, sometimes containing faecalia as well, had got into the water of the lake.

The mass-production of algae in our salty-alkaline waters and soils is a very frequent phenomenon, and we supposed that the decomposing organic matters might carry out opposite to the large salt concentration and alkalinity even certain "protective function" for growth-stimmulation (Kiss 1970a, 1970b). I already observed the mass-production of *Euglena viridis* in a salty-alkaline water and at the surface of soil polluted with dung matters (Kiss 1965). *Euglena viridis* is therefore capable in an environment like this, of a facultative kryobiontism, as well. Vaelikangas Finnish researcher observed as early as in the Winter of 1921—1922 that the ice of the Gulf of Finnland and the brackish water in the vicinity of Helsinki were coloured green by the enormous mass-production of *Euglena viridis*. The sewage-disposing main cloaca of the Finnish capital discharges here into the Gulf. This also explains the surprisingly considerable halotolerant and, at the same time, facultative kryobiontic mass-production of *Euglena viridis*. In the kryobioseston of the polluted brackish water there occurred even *Cryptomonas erosa var. reflexa* (VAELIKANGAS 1921—1922).

Eudorina elegans may occur similarly under varied enough conditions. Is the water polluted by organic matters, then it may grow not only in neutral but also in salty-alkaline water. In the polluted and salty-alkaline water of the lake "Kis-Szék" at Orosháza, it was not only present in Summer but in Winter, as well. In the special literature, it is mostly regarded as ß-mesosaprobic (PASCHER 1927) but, according to a considerable opinion, it also appears as an oligosaprobic organism (HUBER-PESTALOZZI 1961). I found in the Summer of 1936, on the confines of Pusztaföldvár, its above-mentioned enormous mass-production in a pool considerably polluted with dung matters, in which pigs had bathed many times a day. Not only the smell of water but also its substratum of black mud referred to the presence of plenty of H_2S, that is to say, to the polysaprobic character of the biotope. I had already then the opinion that the swarming upwards of *Eudorina* is mostly a chemotactic "escape" from the poisonous decomposition products (KISS 1942).

It is pointed out more and more by the enumerated few data and the similar data of the special literature that the various algae endure the extremities of the circumstances of life by bringing about adequate biotypes within the species-categories. According to these, the species determined mostly by reason of morphological features, are in fact "collective species", concealing several physiologically differentiated biotypes. These must probably be mostly point-mutations that, owing to their recessive character, only manifest themselves, are "developed", as a result of a selecting effect, in the adverse circumstances convenient to them.

In case of a considerable change in the environment, the individuals of a species-population are "severely tried". In case of success, however, adaptation may less be interpreted by means of the "classical" concept of modification. It may be supposed, namely, that in the population the adaptive benefit of selection is only enjoyed by the individuals in whose progenitors, in the course of generations, small mutations (point-mutations) came about or accumulated, respectively which have double or multiple allelic reserves. In this case, the period of the physiological "retuning" of the starting new vegetation, the so-called "lag-phase" also means that the suitable individuals of adequate peculiarities, more and more multiplied, outnumber the non-adequate individuals and bring about an adaptive new population.

On the basis of the above explications, we may explain reasonably the disagreeable hydrobiological fact that in the saprobiological catalogues the saprobiological indicator-value of the single algal species is established in a different way, and thus we have to correct that on the basis of our own experiences (FELFÖLDY 1974). It is obvious that the point in question here is not the "errors" of the research workers of the different countries. The explanation is that within the category of species there are several biotypes that have accumulated in the course of the phylogeny, and are accumulating in our days, too, adapted to the different circumstances and genetically fixed. The indicator-value of an algal species can, therefore, change not only according to lands or countries but also to biotopes, corresponding to the essential environmental conditions releasing the directions of adaptation. It is, therefore, very wrong to condemn the saprobiological qualification which applies indicator-species. Even, ther is demanded considerable effort for selecting well the indicator-species and revealing the biotypes within the race. To search for biotypes is today, rather, but a question of distance, as yet, demanding not only a plant-physiological but a genetic research work, as well. It is sure that after introducing the physiological and genetic research works, the biological water qualification will be more exact, too.

The fact that *Eudorina elegans* brought about water bloom mass-production in the water of the dead-arm at Mártély in the Summers of 1968 and 1973 under ß-mesosaprobic conditions, and on the confines of Pusztaföldvár in 1936 under polysaprobic conditions, is referring to that *Eudorina elegans* is also a so-called collective species, containing biotypes of different demands. It may obviously be attributed to this, as well, that I have found this species in the salty-sodic water of the lakes "Kis-Szék" and "Szikhát", too. The supposition concerning the existence of biotypes is supported by our physiological experiments, as well. But a concrete certainty could only be obtained as a result of researches grounded also genetically.

From coenological point of view it is to be mentioned, as well, that the outlined water blooms of the dead-armat Mártély were brought about, in fact, by *Eudorina elegans* alone, because the few enumerated other species were only present but in small individual number. This is in accord with THIENEMANN's second biocoenotical law, according to which after the environment becoming one-sided the number of algal species decreases and the individual number of the remaining one or more species suddenly increases (THIENEMANN 1939). In the present case, the one-sidedness which has a favourable effect, seems to be brought about by the nutrient and stimulating matters contained in the pollution of water. At the same time it is probable that in the environment of sodic-salty water only a biotype or the biotypes adapted here may be stimulated to a multiplication incorporated in water blooms.

In the formation of the coenological combination of water blooms the physiological factors must also have a part. The various species may influence one another mutually, with their metabolic products discharged into the water, may exert a favourable or unfavourable effect on one another. I have observed, for instance in the lake "Kis-Szék" at Orosháza that the development of *Eudorina elegans* is definitely impeded by the rapid multiplication of the *Euglenophyta* species and the *Aphanizomenon flos aquae* (KISS 1939).

On the occasion of our physiological experiments described, the colonies of *Eudorina elegans* did not respond in the same way to the prevailing conditions. From this, the conclusion can be drawn that in the population of the dead-arm at Mártély more biotypes, resp. more derivative rows grew beside one another which equally found there their essential conditions. In the sodic-salty water of the lakes "Kis-Szék" and "Szikhát" at Orosháza, however, there could probably grow in the *Eudorina*-populations observed there pnly adequate biotypes or ecotypes. But in that time, we did not perform any experimental investigations.

If we evaluate the ecological and physiological phenomena concerning the mentioned and described water blooms of *Eudorina elegans* from the point of view of the protection of environment, as well, we have to establish that the water of the dead-arm at Mártély becomes more and more eutrophic, resp. the water of the recreation area becomes polluted in a dangerous degree. In the course of our investigations, this was referred to by two data, as well: one of these was the more and more frequent occurrence of the species of the *Euglenophyta phylum*, the other was the mass-production of the water bloom of *Eudorina elegans* discussed now.

References

FELFÖLDY, L. (1974): A biológiai vízminősítés. (The biological water qualification). Vízügyi hidrobiológia, *3*, 1—242.

HORTOBÁGYI, T. (1939): A Tisza "Nagyfa"-holtágának phytoplanktonja qualitatív vizsgálata. (Qualitative Untersuchungen des Phytoplanktons des Toten Armes "Nagyfa" der Tisza). — Folia Cryptogamica *3*, 151—208.

HUBER—PESTALOZZI, G. (1961): Chlorophyceae (Grünalgen). Ordnung: Volvocales. — Das Phytoplankton des Süßwassers. Stuttgart.

KISS, I. (1939): Békés vármegye szikes vizeinek mikrovegetációja I. Orosháza és környéke (Die Mikrovegetation der Natrongewässer des Comit. Békés, I. Orosháza und dessen Umgebung). — Folia Cryptomagica *4*, 217—266.

KISS, I. (1942): Bioklimatolóigai megfigyelések az Eudorina elegans vízvirágzásában (Bioklimatologische Beobachtungen bei der Wasserblüte von Eudorina elegans). — Acta Botanica (Szeged) *1*, 81—94.

KISS, I. (1951): Meteorobiológiai vizsgálatok a mikroszervezetek víz- és hóvirágzásában (Meteoro--biological investigations of the water- and snow bloom of micro-organisms). — A M. T. A. Biol. és Agrártud. Oszt. Közl. *1*, 53—100.

KISS, I. (1952): Meteorobiologicheskoe Issledovanie Mikroorganizmov, Vyzyvayushchikh Tsvetenie Body i sznega (Meteoro-biologische Untersuchungen von der Wasser- und Schneeblüte der Mikroorganismen). Acta Biol. Acad. Sci. Hung. 3, 159—220.

KISS, I. (1961): A synoptic meteorobiological analysis on plant micro-organisms with special reference to the form variations of *Lepocinclis fusiformis*. - Acta Bot. Acad. Sci. Hung. *7*, 81—92.

KISS, I. (1965): Az algák fakultatív kryobiontizmusának vizsgálata. Fakultativ kryobiontikus tömegprodukciók Szegeden (Untersuchung des fakultativen Kryobiontismus der Algen. Fakultative kryobiontische Massenproduktion in Szeged). — A Szegedi Tanárképző Főisk. Tud. Közl. 3—24.

KISS, I. (1970 a): Újabb adatok a Kardoskút-pusztaközponti Fehértó algavegetációjához (Neuere Beiträge zur Algenvegetation des Fehértó — Weißen See bei Kardoskút-Pusztaközpont). A Szegedi Tanárképző Főisk. Tud. Közleményei, 1970, 9—43.

KISS, I. (1970b): A kakasszéki szikes tó mikrovegetációja (Die Mikrovegetation des Natronsees bei Kakasszék). — A Szegedi Tanárképző Főisk. Tud. Közl. 55—94.

KISS, I. (1974): Három Bugac-környéki szikes tó mikroflórájának összehasonlító vizsgálata (Vergleichende Untersuchung der Mikroflora und Mikrovegetation dreier Natronseen in der Umgebung von Bugac). — A Juhász Gyula Tanárképző Főiskola Tud. Közl. 3—38.

KOL, E. (1968): Kryobiologie. Biologie und Limnologie des Schnees und Eises I. Kryovegetation. — Die Binnengewässer *24*, 1—216.

PASCHER, A. (1927): Volvocales-Phytomonadinae. — Die Süßwasserflora Deutschlands, Österreichs und der Schweiz *4*, 20—498.

THIENEMANN, A. (1939): Grundzüge einer allgemeinen Ökologie. — Arch. Hydrobiol. *35*, 267—285.

UHERKOVICH, G. (1966): Die *Scenedesmus* Arten Ungarns. — Budapest.

UHERKOVICH, G. (1971): A Tisza lebegő paránynövényei. A Tisza fitoszesztonja (Floating microplants of the Tisza. Phytoseston der Tisza.) — Szolnok megyei múzeumi adattár, *20—22*. 1—282.

VAELIKANGAS, I. (1921—1922): Eine von *Euglena viridis* EHRENB. hervorgerufene Vegetationsfärbung des Eises im Hafengebiet von Helsigfors. Översikt av Finska Vetenskaps-Societetens Förhandligan *64*, 1—22.