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PHYTOPLANKTON OF KARAMIK LAKE (AFYON), TURKEY

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ABSTRACT

Phytoplankton of Karamık Lake consists of 175 species which belong to *Bacillariophyta, Chlorophyta, Chrysophyta, Cryptophyta, Cyanophyta, Dinophyta* and *Euglenophyta* divisions. The fact that a great part of the lake is covered with rushes has increased the number of the species of epipelic and epiphytic origin. In phytoplankton, *Chlorococcales* and *Desmidiales* members have been recorded as widespread and abundant but *Cyanophyta* members have been of secondrate importance.

Most of the existing species are characteristics of eutrophic lakes. The compound indices value that has been found out also indicates that the lake is eutrophic.

INTRODUCTION

Today, pollution is one of the main problems becoming more and more important. In spite of its positive effects, development of civilization, especially the technological achievements, cause increase in environmental pollution. Increasing population, developing industry and pollutions that threaten human health, have made the environmental problems one of the crucial issues of humanity in the 20 th century.

River, lake, puddle, dam lake which cannot be made use of directly by those who live around due to the addition of different sorts of various materials that spoil the quality, are considered to be polluted. Anything that prevents water usage or that causes unfavourable conditions in water is called "pollutant".

Karamık Lake which is 20 km southwest of Afyon-Çay province is exposed to the same kind of pollution. Filthy waste water of the SEKA paper producing factory is sent out to the lake after a partial

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treatment. This effects Karamık Lake unfavourably which is already eutrophic (Beak Consultant Ltd., 1977; Gündüz, 1981 1984). It is also worth mentioning that the lake has a connection with Hoyran Lake where fishing of cray-fish and freshwater perch is of great importance. Because any pollution that might occur in Karamık Lake is likely to effect Hoyran Lake unfavourably (Gündüz, 1984).

Regular and constant biological researches must be made to expose the environmental changes caused by the polluted flow of the factory in Karamık and Hoyran Lakes. Only in this way the effect of the pollution can be found out before any irreversible spoilage occur.

SEKA made an agreement with Beak Consultant Limited to investigate the chemical and biological conditions of Karamık and Hoyran Lakes before the factory began to run and the said compan ychose 18 stations to obtain samples between 26.8.1976 – 7.9.1976. In these stations they investigated the distribution of deep macroinvertebrates, free swimmer macroinvertebrates, fish, zooplankton, phytoplankton communities and researches of physical and chemical analysis of the lake's water and deep mud were made (Beak Consultant Ltd., 1977).

After the factory had started production, the effect of Karamık Lake on the zooplankton community and consequently the effect of the pollution, as weel as the physicochemical conditions, were investigated in detail (Gündüz, 1981 1984). In addition to this, the biology of crane fish living in the lake were also investigated (Aksun, 1984).

Phytoplankton community in Karamık Lake which is of economical importance with its fishes, reeds and canes for the local people, has not been investigated in detail so far.

However algae which are considered to be the sources of food for fish and other animals living in water constitue the first step of food chain in aquatic system, also play a significant role in the researche of the level of water pollution as signifying organisms. For this reason, the composition of algae, their density, seasonal changes and their ecology must be known in detail. Some investigations have been made on water samples collected from the sampling stations in the lake studied to determine the existing phytoplankton community.

BRIEF DESCRIPTION OF THE RESEARCH SITE

Karamık Lake is 20 km southwest of Çay town of Afyon Karakum mountain lies in the south of the lake. The lake's altitude is 1060 m

and it covers an area of 38 km^2. Most of the lake is covered with aquatic plants and its open water area is approximately 20 km^2. It's deepest point is 3,5 m and the average depth is 2,5 m.

Karamık Lake has an underground connection with Hoyran Lake. The lake is fed by underground water sources in the west. In addition to these sources, the dried streams that get full in the spring feed the lake as well (Gündüz, 1981). The lake is rich in plant sliving in and at the surface of water (Gündüz, 1984).

MATERIAL AND METHOD

In order to study the phytoplankton have been chosen 3 sampling stations in the lake (Figure: 1). The water samples taken with plankton net at these stations, have been fixed with 4 % formaldehyde in jars and after having been examined under Lietz SM Lux microscope they have been identified. Moreover, the frequency rate of the algae in one drop of sample water, examined on a microscope slide, can be classified as rare, scarce, abundant and plentiful according to our observations.

In the determination of the algae, the works of Husted (1930), Cleve-Euler (1968), Bourrelly (1966; 1968; 1970), Pestalozzi (1968; 1976; 1972), Prescott (1973), Tiffany and Britton (1971), Geitler (1925) and Patrick-Reimer (1966;r1305) are used and they classified according to system of Round (1953). The structure of some algae are drawn under Lietz Dialux microscope and these are given at the end of the article in Figure: 2 – 12.

RESULTS

The phytoplankton of Karamık Lake consisted of 175 species belong to seven groups of *Bacillariophyta, Chlorophyta, Chrysophyta, Cryptophyta, Cyanophyta, Dinophyta* and *Euglenophyta.* The list of recorded species are given below:

Divisio : BACILLARIOPHYTA

Classis : CENTROBACILLARIOPHYCEAE

Ordo : Centrales

Cyclotella kützingiana Thwaites; *C. meneghiniana* Kütz.; *C. ocellata* Pant.

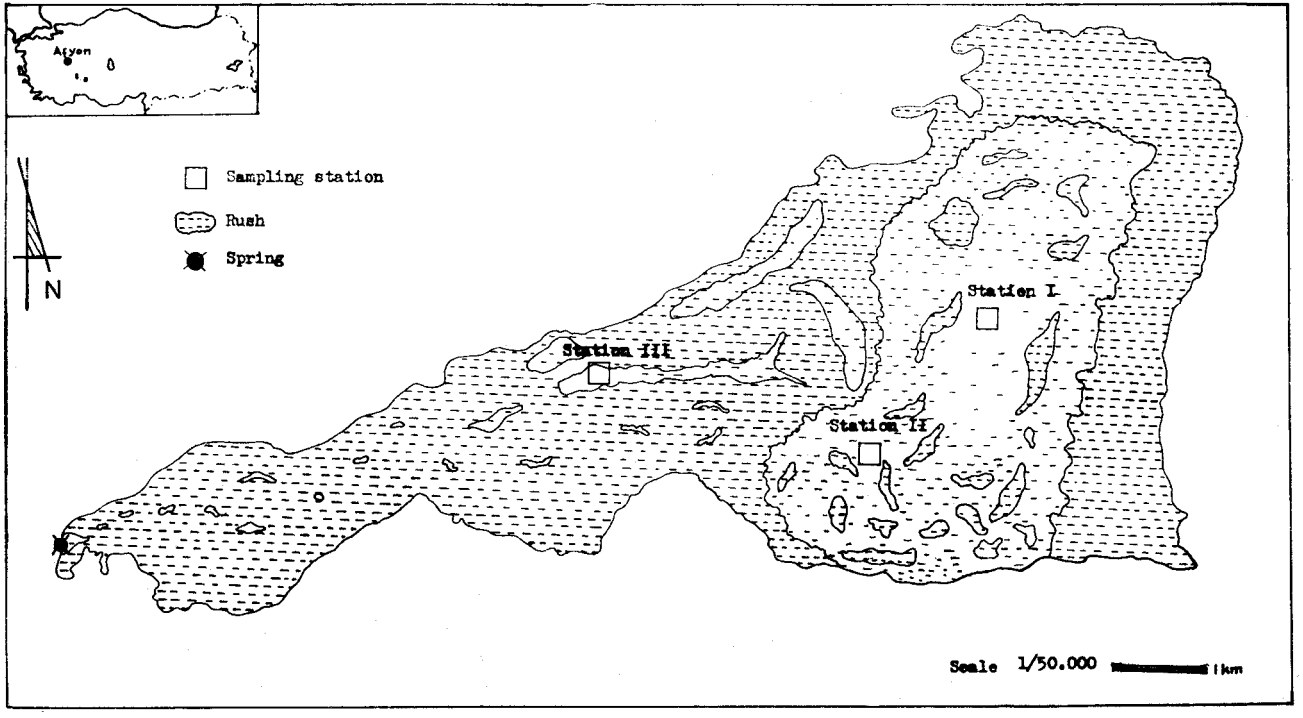

Figure 1. Karamık Lake and sampling stations

Classis : PENNATIBACILLARIOPHYCEAE

Ordo : Pennales

Achnanthes minutissima Kütz.; *A. minutissima* var. *cryptocephala* Grun.; *A. microcephala* Kütz.; *Amphora ovalis* Kütz.; *A. veneta* Kütz.; *Anomoeoneis sphaerophora* (Kütz.) Pfitz.; *Caloneis silicula* (Ehr.) Cleve var. *genuina* Cleve; *Cocconeis placentula* (Ehr.) Cleve var. *euglypta* (Ehr.) Cleve; *Cymatopleura solea* (Breb.) W. Smith; *C. solea* var. *apiculata* (W. Smith) Ralfs; *Cymbella cistula* Hempr.; *C. cymbiformis* (Agarh?, Kütz.) Van Heurck; *C. cymbiformis* var. *longa* n.v.; *C. helvetica* Kütz.; *C. lanceolata* (Ehr.) Van Heurck; *C. microcephala* Grun.; *C. turgida* (Greg.) Cleve; *C. ventricosa* Krnner; *Diatoma elongatum* (Lyngb.) Agardh; *D. vulgare* Agardh; *Epithemia adnata* (Kütz.) Breb.; *E. smithii* Carrut-Desm. var. *mesolepta* (Rabh.) Heib.; *F. intermedia* Grun.; *Gomphonema intricatum* Küt.; *G. lanceolatum* Ehr.; *G. lanceolatum* var. *affine* (Kütz.) Cleve; *G. olivaceum* (Lyngb.) Kütz.; *G. parvulum* Kütz.; *G. parvulum* var. *micropus* (Kütz.) Cleve; *G. truncatum* Ehr. var. *capitatum* (Ehr.) Patr.; *Gyrosigma acuminatum* (Kütz.) Rabh.; *Hantzschia amphioxys* (Ehr.) Grun.; *Mastogloia danseii* Thwaites; *M. danseii* var. *elliptica* A. Boyer; *M. danseii* var. *streptoraphe* (A. Berg.) Cleve; *M. smithii* Thwaites; M. *smithii* var. *lacustris* Grun.; *M. smithii* var. *lanceolata* Grun.; *Navicula cryptocephala* Kütz. var. *veneta* Grun.; *N. cuspidata* (Kütz.) Kütz. var. *major* Meist.; *N. directa* W. Smith; *N. gothlandica* Grun. *N. halophila* (Grun.) Cleve; *N. hungarica* Grun. var. *capitata* (Ehr.) Cleve; *N. pupula* Kütz. var. *rectangularis* (Greg.) Grun.; *N. radiosa* Kütz.; *Neidium dubium* (Ehr.) Cleve; *Nitzschia acicularis* W. Smith; *N. acuta* Hust.; *N. amphibia* Grun.; *N. circumsuta* (Bail.) Grun.; *N. clausii* Hantzs.; *N. dissipata* (Kütz.) Grun.; *N. fonticola* Grun.; *N. palea* (Kütz.) W. Smith; *N. pseudoamphioxys* Hust.; *N. punctata* Per.; *N. recta* Hantzs.; *Pinnularia brevicostata* Cleve; *P. microstauron* (Ehr.) Cleve; *Rhoicosphenia curvata* (Kütz.) Grun.; *Rhopalodia gibba* (Ehr.) O. Müll. *R. gibba* var. *ventricosa* (Kütz.) O. Müll.; *Stauroneis anceps* Ehr.; *Surirella ovalis* Breb.; *Synedra acus* Kütz.; *S. capitata* Ehr.; *S. rumpens* Kütz. var. *fragilarioides* Grun.; *S. ulna* (Nitzs.) Ehr.

Divisio : CHLOROPHYTA

Classis : CHLOROPHYCEAE

Ordo : Chaetophorales

Stigeoclonium farctum Berthold

Ordo : Chlorococcales

Ankistrodesmus falcatus (Corda) Ralfs; *Botryococcus braunii* Kuetz.; *Coelastrum microporum* Naegeli; *Crucigenia rectangularis* (A. Braun) Gay.; *Dictyosphaerium pulchellum* Wood; *Gloeotaenium loitlesbergerianium* Hansg.; *Kirchneriella obesa* (W. West) Schmidle; *Nephrocytium agardhianum* Naegeli; *Oocystis borgei* S ow; *O. gigas* Archer; *O. solitaria* Wittr.; *O. solitaria* var. *major* Wille; *O. solitaria* var. *pachyderma* Printz.; *Pediastrum boryanum* (Turp.) Meneg.; *P. duplex* Meyen; *Scenedesmus arcuatus* Lemm.; *S. circumfusus* Hortob.; *S. ecornis* (Ralfs) Chod.; *S. ecornis* var. *disciformis* Chod.; *S. ovaternus* Chod.; *S. quadricauda* (Turp.) Breb.; *Spherocystis schroeteri* Chod.; *Tetraedron minimum* (A. Braun) Hansg.; *T. muticum* (A. Braun) Hangsg.; *T. regular* Kuetz.; *T. trigonum* (Naegeli) Hansg.

Ordo : Tetrasporales

Gleocystis gigas (Kuetz.) Lagerheim

Ordo : Volvocales

Carteria sp.; *Chlamydomonas globosa* Snow; *Gonium pectorale* Mueller; *Pandorina morum* (Muell.) Bory; *Phacotus lenticularis* (Ehr.) Stein

Classis : CONJUGATOPHYCEAE (= Zygnemaphyceae)

Ordo : Desmidiales

Cosmarium bioculatum (Breb.) ex Ralfs var. *depressum* (Schaarschm.) Schmidle; *C. botrytis* Menegh. ex Ralfs; *C. depressum* (Naeg.) Lund var. *planctonicum* Reverd; *C. formosulum* Hoff.; *C. granatum* Breb. ex Ralfs; *C. humile* (Gay.) Nordst.; *C. impressulum* Elfv.; *C. leave* Rabenh.; *C. meneghinii* Breb.; *C. punctulatum* Breb.; *C. regnellii* Wille; *C. regnellii* var. *minimum* Eichl. and Gutw.; *C. reniforme* (Ralfs) Archer; *C. subimpressulum* Borge; *C. trilobulatum* Reinsch.; *C. wittrockii* Lund; *Cosmarium* sp.; *Closterium dianea* Ehr. ex Rafls; *C. aciculare* T. West; *Euastrum insulare* (Wittr.) Roy; *Staurastrum gracile* Ralfs; *S. hexacerum* (Ehr.) Wittr.; *S. margarithaceum* (Ehr.) Wittr.; *S. punctulatum* Breb.

Ordo : Zygnemales

Mougeotia sp.; *Mougeotia* sp.; *Spirogyra weberii* Kuetz.; *Spirogyra* sp.; *Zygnema pectinatum* (Vauch.) C.A. Agardh

Classis : BRYOPSIDOPHYCEAE

Ordo : Cladophorales

Cladophora crispata (Roth) Kuetz.

Classis : OEDOGONIOPHYCEAE

Ordo : Oedogoniales

Bulbochaeta sp.; *Oedogonium* sp.; *Oedogonium* sp.

Divisio : CHRYSOPHYTA

Classis : CHRYSOPHYCEAE

Ordo : Chrysomonadales

Dinobryon sertularia Ehr.

Divisio : CRYPTOPHYTA

Classis : CRYPTOPHYCEAE

Ordo : Cryptomonadales

Cryptomonas erosa Ehr.

Divisio : CYANOPHYTA

Classis : CYANOPHYCEAE

Ordo : Chroococcales

Aphanocapsa sp.; *Chroococcus dispersus* (Keissl) Lemm.; *C. limneticus* Lemm.; *C. limneticus* var. *subsalsus* Lemm.; *C. turgidus* (Kuetz.) Naegeli; *Gomphosphaeria aponina* Kuetz.; *G. lacustris* Chod.; *Gleocapsa* sp.; *Merismopedia glauca* (Ehr.) Naegeli; *M. punctata* Meyen; *Microcystis aeruginosa* Kuetz.; *M. incerta* Lemm.

Ordo : Hormogonales

Anabaenopsis cunningtonii R. Taylor ;*Cylindrospermum minumum* G.S. West; *Gloeotrichia pisum* (C.A. -gardh) Thuret; *Lyngbya hieronymusii* Lemm.; *Oscillatoria amphibia* C.A. Agardh; *O. brevis* (Kuetz.) Gomont; *O. chalybea* Mertens; *O. iwanoffiana* (Nygaard) Geitler; *O. tenuis* C.A. Agardh; *O. tenuis* var. *tergerstina* Rabh.; *Spirulina jenerii* (Stizenb.) Geitler; *S. major* Kuetz.

Divisio : DINOPHYTA

Classis : DINOPHYCEAE

Ordo : Peridiniales

Ceratium hirundinella (Muell.) Schrank; *Peridinium cinctum* (Muell.) Ehr.; *P. cinctum* var. *regulatum* Lindem

Divisio : EUGLENOPHYTA

Classis : EUGLENOPHYCEAE

Ordo : Euglenales

Euglena gracilis Klebs; *Phacus chloroplastes* Prescott; *Trachelomonas hispida* (Perty) Stein; *Trachelomonas* sp.

In terms of species, *Bacillariophyta* division is considered to be the richest group with its 76 species. However, most of species in the lake are of epipelic and epiphytic origin. The *Centrales* members containing the actual species of plankton haven't been considered important species of *Cyclotella kützingiana*, *C. meneghiniana* and *C. ocellata* of this order have been observed rarely in spring and autumn. Members of *Pennales* are not actual species of plankton. They have integreted to planktons on plants and sediments and have become the permenantly existing organisms in phytoplanktons. Species of *Achnanthes*, *Cymbella*, *Epithemia*, *Navicula* as well as *Rhopalodia gibba* have been the most common ones.

In Karamık Lake phytoplankton, especially members of *Chlorococcales* and *Desmidiales* organisms that belong to division of *Chrorophyta* have been found as the most abundant one in each of the 3 stations. In spite of being represented by the greatest members of species, *Oocystis* and *Scenedesmus* genera haven't been found out in great numbers. Species of *Cosmarium* of *Desmidiales* order in phytoplankton are the organisms found in every sample water obtained from each of the three stations. But in june and july they reached the maximum number. *Spirogyra*, *Mougeotia*, *Zygnema* fibrous algae of *Zygnemales* order have been found abundantly in the sample water obtained from the lake basin. The same algae have not been observed in the sample water taken from the surface of the lake. *Volvocales* order members have been remarkable in respect of neither species members nor quantity. *Tetrasporales* order has been represented by species of *Gleocystis gigas* which is found in small numbers.

Once, most of the phytoplankton consisted of species of *Ceratium hirundinella* which belong to *Dinophyta* division. But species of *Peridinium* had been observed very rarely.

Species of *Merismopedia* and *Gomphosphaeria* that belong to *Chroococcales* of *Cyanophyta* division have been found denser and in great numbers within the phytoplankton. Especially species of *Merismopedia glauca* has been observed mostly. *Hormogonales* members have been found in groups among the branches of aquatic plants.

Dinobryon sertularia of *Chrysophyta* and *Cryptomonas erosa* of *Cryptophyta* represented by only a single species have been seen rarely.

Euglenophyta members haven't been remarkable in respect of species numbers and abundance of individuals in phytoplankton.

Species of *Trachelomonas hispida* when compared with other members of the division, has been relatively found in great quantity.

DISCUSSION

In phytoplankton of Karamık Lake, the species which belong to *Bacillariophyta*, *Chlorophyta* and *Cyanophyta* divisions have been found dominating. Phytoplankton may generally be considered rich in respect of species numbers and density of the species.

The existing organism living in the lake have been in great accordance with the algae found out by the Beak Consultant Limited at the end of their researches in the lake before the SEKA paper producing factory began to run. In spite of the fact that *Cyanophyta* has been mentioned as the dominating group (Beak Consultant Ltd. 1977). In this study our research proved that the dominating groups in the lake are *Chlorococcales* and *Desmidiales* orders of *Chlorophyta* and *Bacillariophyta* division. In the same study, the organisms in the lake have been found out at the level of genus and as unidentified organisms are existing, it is very difficult to determine whether it has affected the phytoplankton groups in the lake unfavourably or not after the factory started production.

Karamık Lake belongs to the lake groups identified as eutrophic in literatüre. The lake has a flat base. The lake is shallow (3,5 m) and has a wide bank. The great part of the lake is covered by rushes.

The lake is quite interesting in respect of phytoplankton type. In literature the plankton type which *Chlorococcales* dominate are widespread in eutrophic lakes, but *Oocystis* species of this order have been mentioned to be oligotrophic (Hutchinson 1967). Within the period of the research, this sort of genus found frequently in the lake and in great numbers has been abundantly observed in eutrophic Mogan, the Puddle Beytepe (Ünal 1984), mesotrophic Çubuk-I and Kurboğazı Dam Lakes in Central Anatolia (Aykulu, Obalı and Gönülol 1983). Although Bayındır Dam Lake (Gönülol 1984) and Altınapa Dam Lake (Yıldız 1982) are also mesotrophic, the same genus has not been found so abundantly as in the others. But the same genus has not been observed at all in oligotrophic Tortum Lake (Altuner 1984). In Marmara Lake (Cirik-Altındağ 1980) located in Western Anatolia region, all existing *Oocystis* genus has been found abundantly.

Although species of *Oocystis* has been mentioned as oligotrophic in literature, the result of the present researches have proved that they are more widespread in the eutrophic waters. Hutchinson (1967), according to the result of the researches made by Jarnefeld in some lakes in Finnland, recorded that species of *Oocystis* were widespread in the eutrophic lakes.

Other existing *Chlorococcales* members in the Karamık Lake are the species observed abundantly in eutrophic lakes.

Desmidiales members which are the other dominant group in the lake are the benthic littoral originated organisms of little lakes covered with plants. Typical planktonic species are rare. A kind of plankton type which *Desmidiales* members dominate in eutrophic lakes have not been observed as frequently as in oligotrophic lakes and generally mentioned among the algae community in oligotrophic lakes. But some *Desmidiales* members, such as *Cosmarium* and *Staruastrum*, have been mentioned as oligotrophic (Hutchinson 1967). In Karamık Lake, existing *Desmid* plankton consists mostly of species of *Cosmarium* but *Staurastrum* in small numbers. *Desmid* members haven't been observed frequently in eutrophic and mesotrophic lakes in Central Anatolia. On the other hand, existing species of *Desmid* has been found out intensively in mesotrophic Çubuk-I Dam Lake (Aykulu, Obalı and Gönülol, 1983) but in small numbers in eutrophic Beytepe Puddle (Ünal, 1984).

From our point of view, representation of *Desmid* and *Bacillariophyta* members with more than reasonable amount of species in the Karamık plankton and determination of the existing species in the obtained sample water may be related with the state of shallowness of the lake and of its being covered with rushes.

Many researches have put forward the idea that the ratio of species numbers of algae groups in the phytoplankton will indicate the fertility of the lake (Pearsal, 1921; Thunmark, 1945; Nygaard, 1949; Hutchinson, 1967). Compound indice, which Nygaard put forward, is the most valid one among the others which has been proposed so far. He identified the ones which are less than 1 as oligotrophic, and the ones which are more than 3 as eutrophic lakes. The values between (1–2,5) indicate less, (3–5) indicate moderate, (5–20) indicate excessive and (20–43) indicate high degree for eutrophic water.

Compound indice value (Cyanophyceae + Chlorococcales + Centrales + Euglenales/Desmidiales) in Karamık Lake has been found 2,3. according to this criterion, Karamık Lake is in the group of less eutrophic lakes. In fact, the lake is regarded as considerably polluted in biological system according to the zooplankton genus variety index criterion (Gündüz, 1984). It is insufficent to make any comments about the eutrophication of the lake only by considering its indices.

The results of physical and chemical analysis that were obtained from Karamık Lake, its morphometry and the existing plankton type indicate a moderate degree of eutrophy. The low compound index value results from the abundance of the number of the species belong to *Desmidiales* which is considered to be oligotrophic. But, as mentioned before, the lake's being shallow, being covered with rushes, and the species being taken with plankton net, have increased the number of the species of *Desmid*. Because, species of *Desmid* are bigger than the *Chlorococcales* members which can escape from the plankton net holes; therefore in the samples taken by means of a net, *Desmid* members can be seen more frequenly than those of *Chlorococcales* and *Centric Diatoms*, species number.

All researchers have claimed that phytoplankton indices should be used with great care. In our opinion it will be misleading to determine the eutrophy degree by using only phytoplankton indices in water which contains a great deal of benthic originated algae in phytoplankton community.

The results obtained from the lake indicate that the lake is eutrophic in respect of edaphic and morphometric factors (Beak Consultant Ltd. 1977; Gündüz, 1981; 1984). For the time being, the waste water has neither affected the plant organisms, as to threaten their presence nor has increased the nutrients density which causes extreme reproduction of some groups which are frequently and abundantly found in over polluted water, such as *Cyanophyceae* and *Euglenales*. But it is supposed that in the course of the time the waste water will enrich the lake even more than before which has already been eutrophic. In this case, it is necessary to examine the lake water and the creatures living in it by the samples taken regularly and consultantly. In case of any negative changes urgent precautions should be taken.

REFERENCES

AKSUN, F.Y. 1984. Karamık Gölünde Yaşayan Turna Balıklarının *(Esox lucius L.* 1958) Biyolojisi Üzerinde Araştırmalar. H.Ü. Fen. Fak. *(Ph. D. Thesis Unpublished)*, 104 p.

ALTUNER,Z. 1984. Tortum gölünden bir istasyondan alınan fitoplanktonun kalitatif ve kantitatif olarak incelenmesi. *Doğa Bilim Dergisi*, Seri A2, Cilt 8, (2): 162–182

AYKULU G., O. OBALI, A. GÖNÜLOL. 1983. Ankara çevresindeki bazı göllerde fitoplanktonun yayılışı, *Doğa Bilim Dergisi*, Temel Bilim., Cilt 7, 277–288

BEAK CONSULTANT LTD., 1977. Karamık ve Hoyran göllerinin biyolojik ve Kimyasal yönlerinden incelenmesi, işletme öncesi çevre etüdü. *Vancouver, B.C., Kanada*, Dosya No: K. 4207. C

BOURRELLY, P. 1966. Les Algues D'eau Douce Tome I, Les Algues Vertes, Ed. N. Bou *bee*, Paris, 572 p.

BOURRELLY, P. 1968. Les Algues D'eau Douce Tome II, Les Algues Jounes et Brunes, Ed. N. Bou *bee*, Paris, 438 p.

BOURRELLY, P. 1970. Les Algues D'eau Douce Tome III, Les Algues Bleunes et Rouges, Ed. N. Bou *bee, Paris*, 512 p.

CİRİK-ALTINDAĞ, S. 1980. Manisa-Marmara Gölü Fitoplanktonu Üzerinde Bir Araştırma, E.Ü. Fen Fak. *(Ph D. Thesis, Unpublished)*.

CLEVE-EULER, A. 1968. Die Diatomen Von Scheweden Und Finnland Stockholm. Bibliothece phycologia, herausgegeben von J. Cramer, Band 5, *Almqvist and Wiksells Baktryckeri A. B., Stockholm*

GEİTLER, L. 1925. Cyanophyceae, Heft 12 in Pascher Die Susswasser Flora Mitteleuropas, *Gustav Fıscher Pub. Jena, Germany*, 481 p.

GÖNÜLOL, A. 1984. Bayındır Barajında Fitoplankton ve Bentik Alg Biyoması (Biyolojik Kütle) ve Besin Tuzlarının Alg Çoğalmalarını Sınırlayıcı Etkileri Üzerinde Araştırmalar, A.Ü. Fen Fak. (Ph D. Thesis Unpublished) 105 p.

GÜNDÜZ, E. 1981. Karamık Gölünün Fiziko-Kimyasal Durumu ve Zooplanktonları, MESEF *(M. Sc. Thesis Unpublıshed)*, 48 p.

GÜNDÜZ, E. 1984. Karamık ve Hoyran Göllerinde Zooplanktonların Türlerinin Tespiti ve Kirlenmenin Zooplankton Üzerine Etkisi H.Ü. Fen Fak. *(Ph D. Thesis Unpublished)*.

HUSTED, F. 1930. Bacillariophyta (Diatome) Heft: 10 in a Pascher Die Susswasser Flora Mitteleuropas, *Gustav Fischer Pub. Jena, Germany*, 466 p.

HUTCHINSON, G.E., 1967. A treatise on limnology Vol. II Introduction to lake biology and the limnoplankton, *John Wiley and Sons, Inc. Newyork-London-Sydney*, 1115 p.

NYGAARD, G., 1949. Hydrobiological studies in some ponds and lakes, Part II: The quotient hypothesis and some new or little known phytoplankton organisms, Kgl. Danske – *Vidensk, Setsk., Biol. Skrifter*, 7 (1): 1–293

PATRİCK, R., C.W. REİMER. 1966. The Diatoms of United States. *The Academy of Natural Sciences of Philedilphia*, USA, 688 p.

PATRİCK, R., C.W. REİMER. 1975. The Diatoms of United States Volume 2, Part I, *Academy of Natural Sciences of Philedelphia, USA.* 213 p.

PEARSAL, W.H. 1921. The development of vegetation in the English Lakes, considered in relation to the general evolution in glacial lakes and rock basins. *Proc. R. Soc.*, 92 B: 259–284

PESTALOZZI, H.G. 1968. Das Phytoplankton des Susswasser Teil, I, *E. Schweizerbart'sche Verlagsbuchhandlung* (Nagele U. Obermiller), Stuttgart, 342 p.

PESTALOZZİ, H.G. 1976. Das Phytoplankton des Susswasser Teil III., *E. Schweizebart'sche Verlagsbuchhandlung* (Nagele U. Obermiller), Stuttgart, 310 p.

PESTALOZZİ, H.G. 1982. Das Phytoplankton des Susswasser Teil VIII. *E. Schweizerbart'sche Verlagsbuchhandlung* (Nagele U. Obermiller), Stutgart, 543 p.

PRESCOTT, G.W. 1973. Algae of The Western Great Lake Area. (5th Edition) *WM. C. Brown Comp. Pub. Dubuque, Iowa*, 977 p.

ROUND, F.E. 1973. The Biology of the Algae. *Edward Arnold, London*, 278 p.

THUNMARK, S. 1945. Zur soziologie des susswasser planktons eine methodologish, Ökologische Studie Fol. *Limnol. Scand.*, 3 p., 66, 377–379, 389–390

TİFFANY, L.H., M.E., BRİTTON. 1971. The Algae of Illinois. *Hafner Pub. co., Newyork*, 407 p.

ÜNAL, Ş. 1984. Beytepe ve Alap göletlerinde fitoplanktonun mevsimsel değişimi. *Doğa Bilim Dergisi*, Seri A2, cilt 8, (1): 121–137

YILDIZ, K. 1982. Altınapa Baraj Gölü Algleri Üzerinde Araştırmalar, S.Ü. Fen-Ed. Fak. *(Ph D. Thesis Unpublished)*

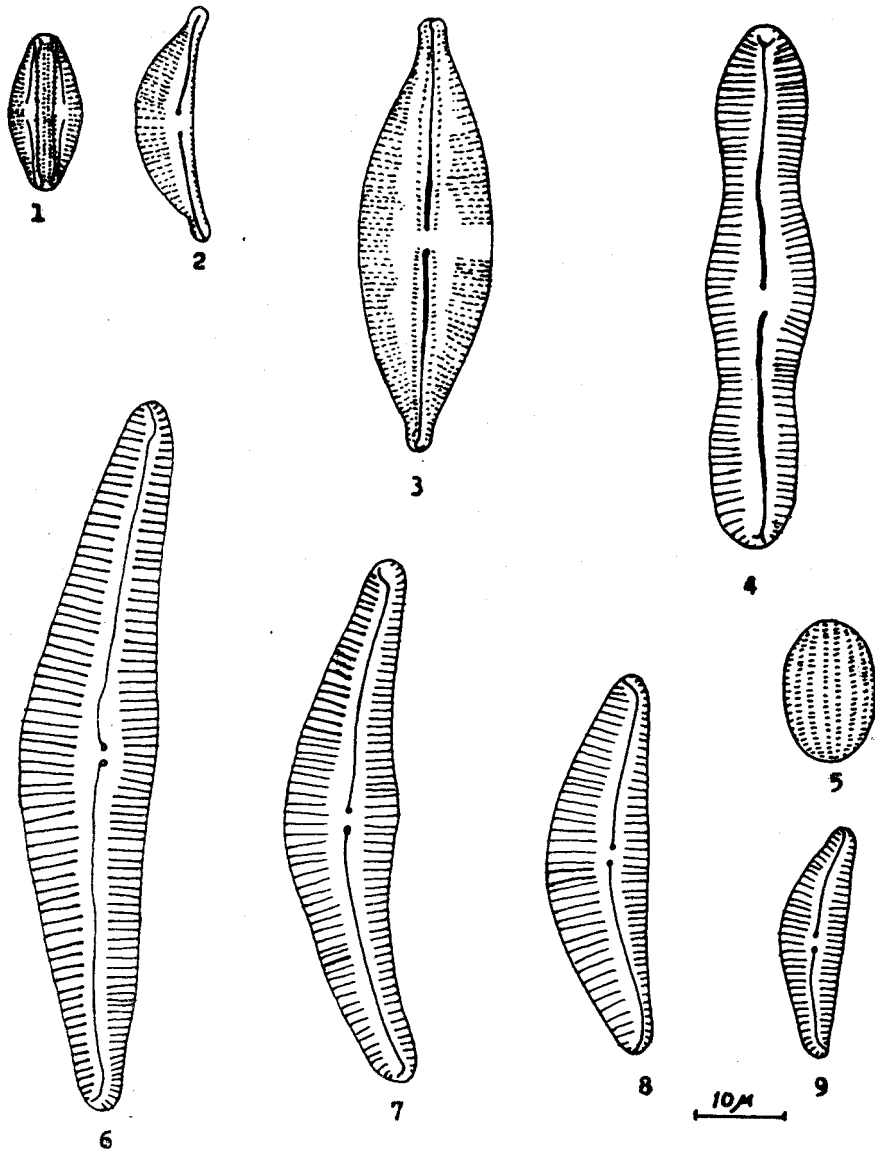

Figure 2. 1, 2. Amphora veneta Kütz., 3. Anomoenoneis sphaerophora (Kütz.) Pfitz., 4. Caloneis silicula (Ehr.) Cleve var. genuina Cleve, 5. Cocconeis placentula (Ehr.) Cleve var. euglypta (Ehr.) Cleve, 6. Cymbella cymbiformis (Agardh, Kütz.) Van Huerck, 7. Cymbella cistula Hempr., 8. Cymbella turgida (Greg.) Cleve, 9. Cymbella ventricosa Krenner.

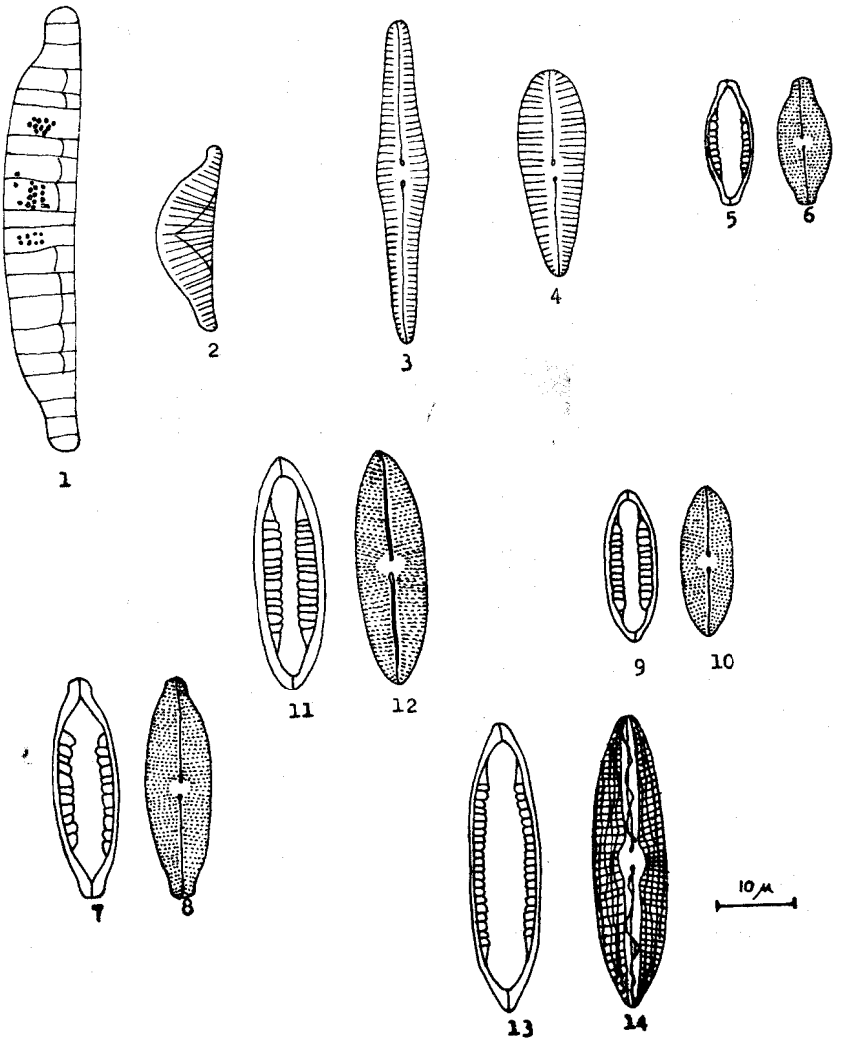

Figure 3. 1. Epithemia turgida (Ehr.) Kütz., 2. Epithemia sorex Kütz., 3. Gomphonema intricatum Kütz., 4. Gomphonema olivaceum (Lyngb.) Kütz., 5–6. Mastogloia smithii Thwaites, 7–8. Mastogloia smithii var. lacustris Grun., 9–10. Mastogloia danseii Thwaites, 11–12. Mastogloia danseii var. elliptica A. Boyer, 13–14. Mastogloia danseii var. streptoraphe (A. Berg.) Cleve.

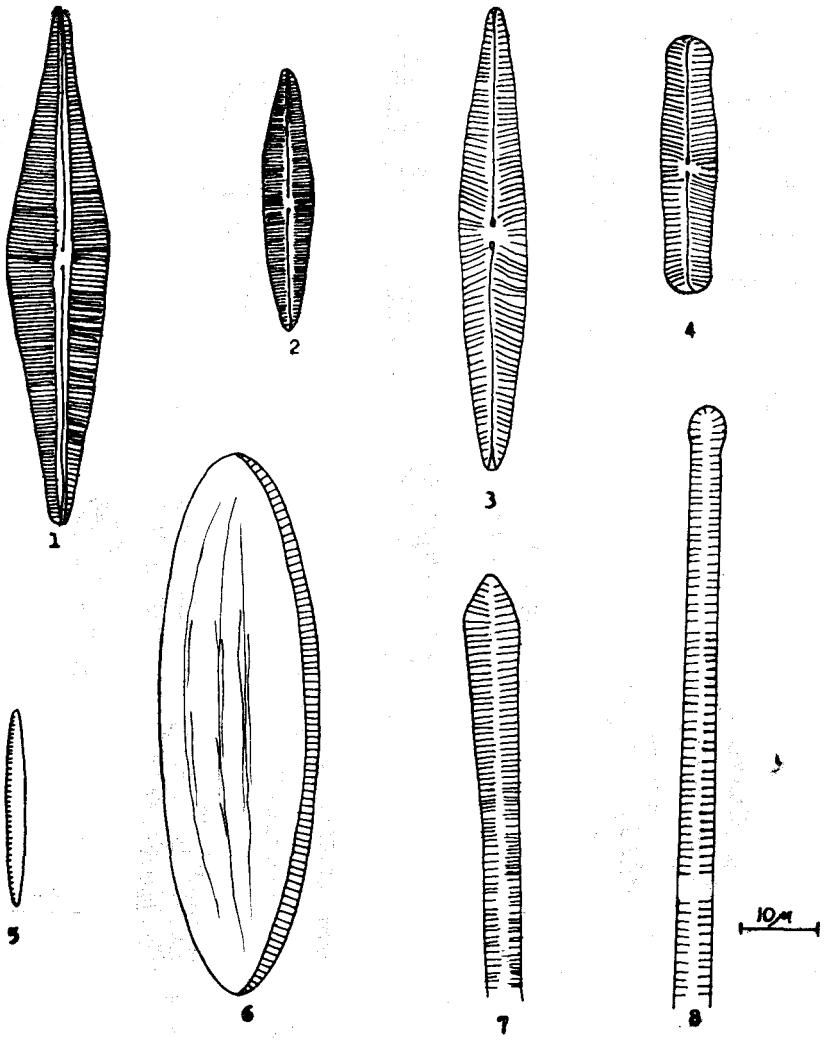

Figure 4. 1. Navicula directa W. Smith, 2. Navicula halophila (Grun.) Cleve, 3. Navicula radiosa Kütz., 4. Navicula pupula Kütz. var. rectangularis (Greg.) Grun., 5. Nitzschia palea (Kütz.) W. Smith, 6. Nitzschia circumsuta (Bail.) Grun. 7. Synedra capitata Ehr., 8. Synedra ulna (Nitzsch) Ehr.

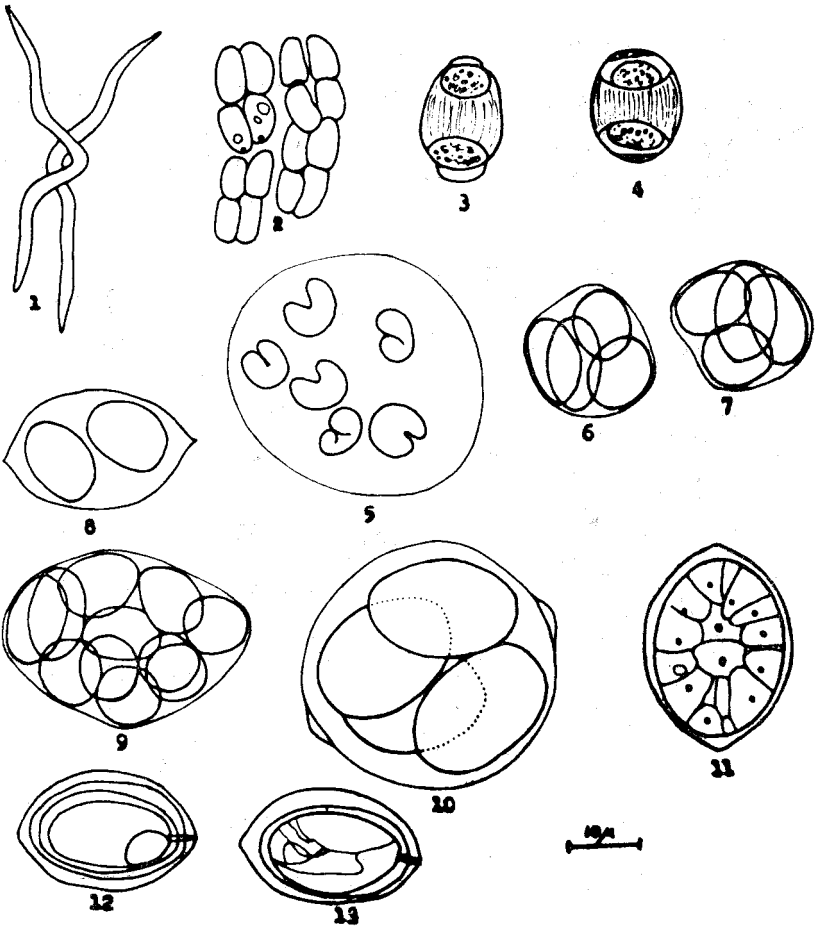

Figure 5. 1. Ankistrodesmus falcatus (Corda) Ralfs, 2. Crucigenia rectangularis (A. Braun) Gay., 3–4. Gloeotaenium loitlesbergerianum Hansg., 5. Kirchneriella obesa (W. West) Schmid., 6–7. Oocystis borgei Snow., 8–10. Oocystis solitaria Witt., 11. Oocystis solitaira var. major Wille, 12–13. Oocystis solitaria var. pachyderma Printz.

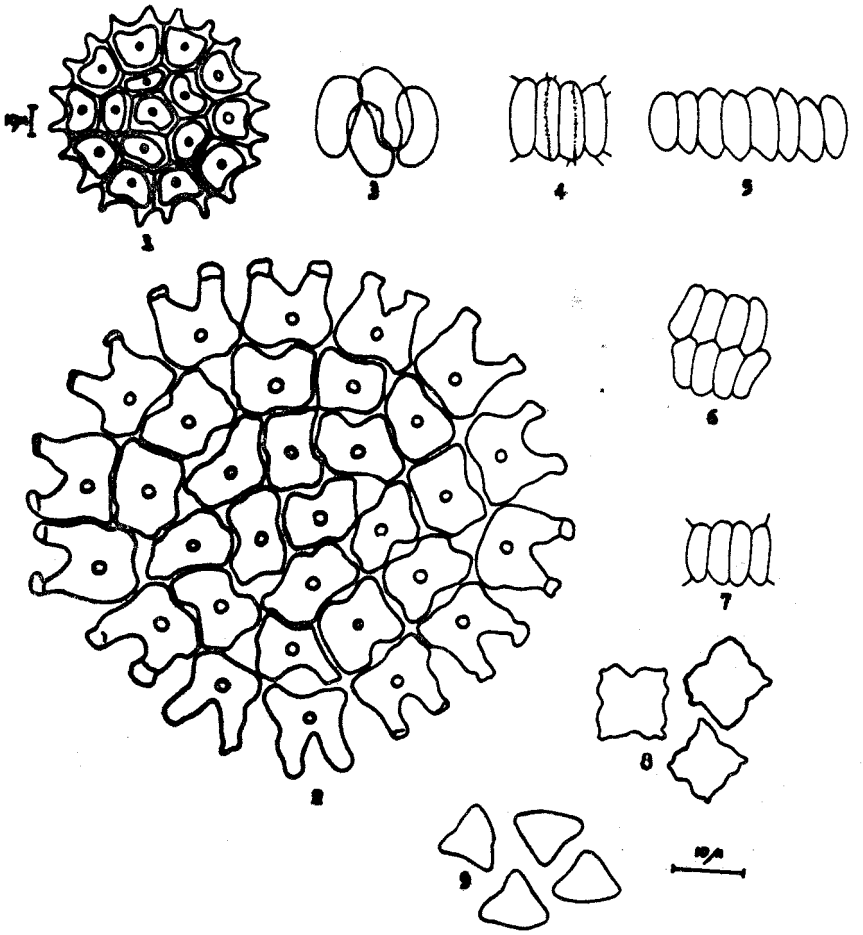

Figure 6. 1. Pediastrum boryanum (Turp.) Menegh., 2. Pediastrum duplex Meyen, 3. Scenedesmus arcuatus Lemm., 4. Scenedesmus circumfusus Hortob., 5. Scenedesmus ecornis (Ralfs) Chod., 6. Scenedesmus ecornis var. disciformis Chod., 7. Scenedesmus quadricauda (Turp.) Breb., 8. Tetraedron minimum (A. Braun) Hansgirg, 9. Tetraedron muticum (A. Braun) Hansgirg.

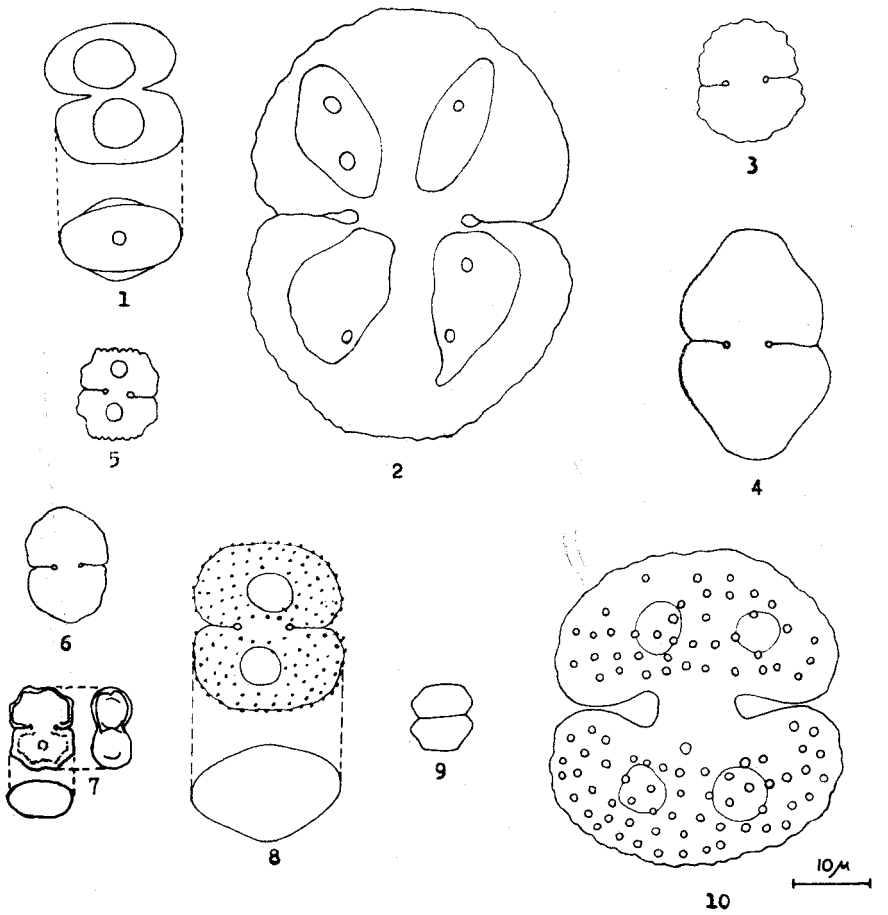

Figure 7. 1. Cosmarium bioculatum (Breb.) ex Ralfs var. depressum (Schaarschm.) Schmidle, 2. Cosmarium botrytis Menegh. ex Ralfs, 3. Cosmarium formosulum Hoff,. 4. Cosmarium granatum Breb. ex Ralfs, 5. Cosmarium humile (Gay.) Nordst., 6. Cosmarium leave Rabanh., 7. Cosmarium meneghinii Breb., 8. Cosmarium punctulatum Breb., 9. Cosmarium regnellii Wille var. minimum Eichl. ex Gutw., 10. Cosmarium reniforme (Ralfs) Archer.

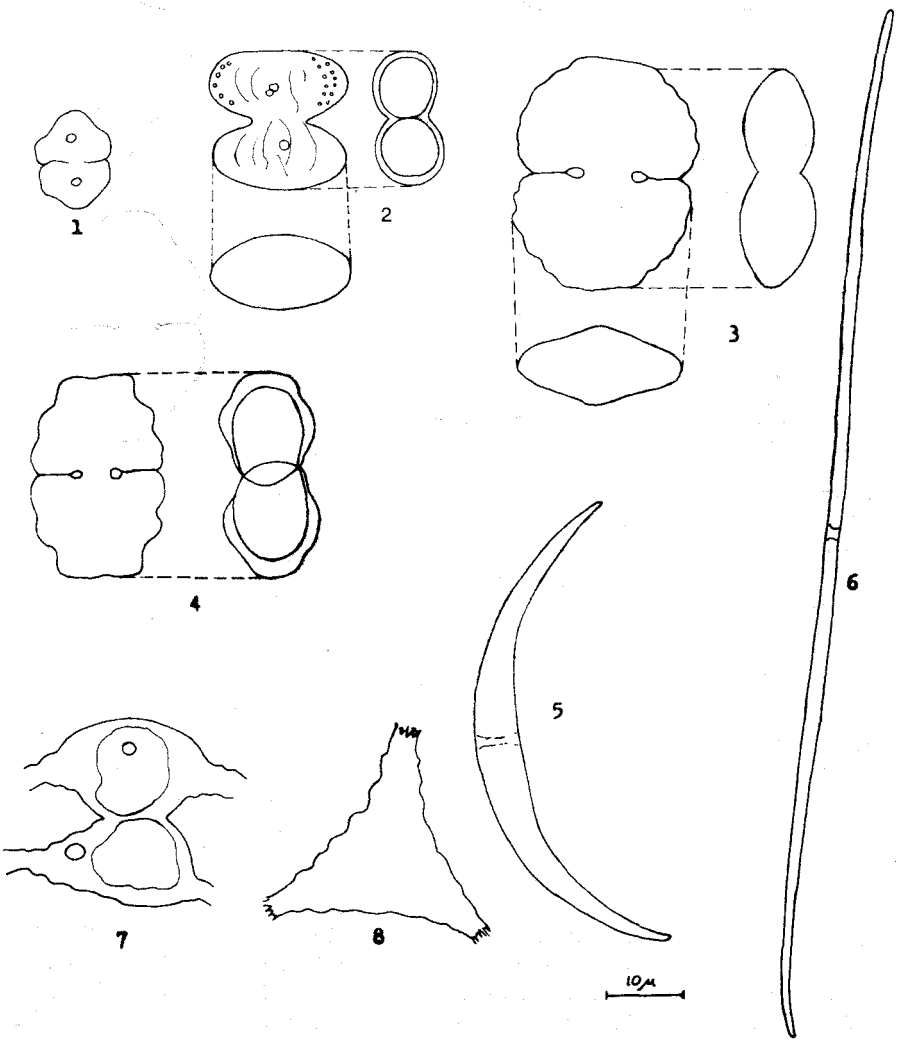

Figure 8. 1. Cosmarium trilobulatum Reinsch., 2. Cosmarium witrocçkii Lund., 3. Cosmarium sp., 4. Euastrum insulare (Wittr.) Roy, 5. Closterium dianea Ehr. ex Ralfs, 6. Closterium aciculare T. West, 7. Staurastrum hexacerium (Ehr.) Wittr., 8. Staurastrum margarithaceum (Ehr.) Menegh.

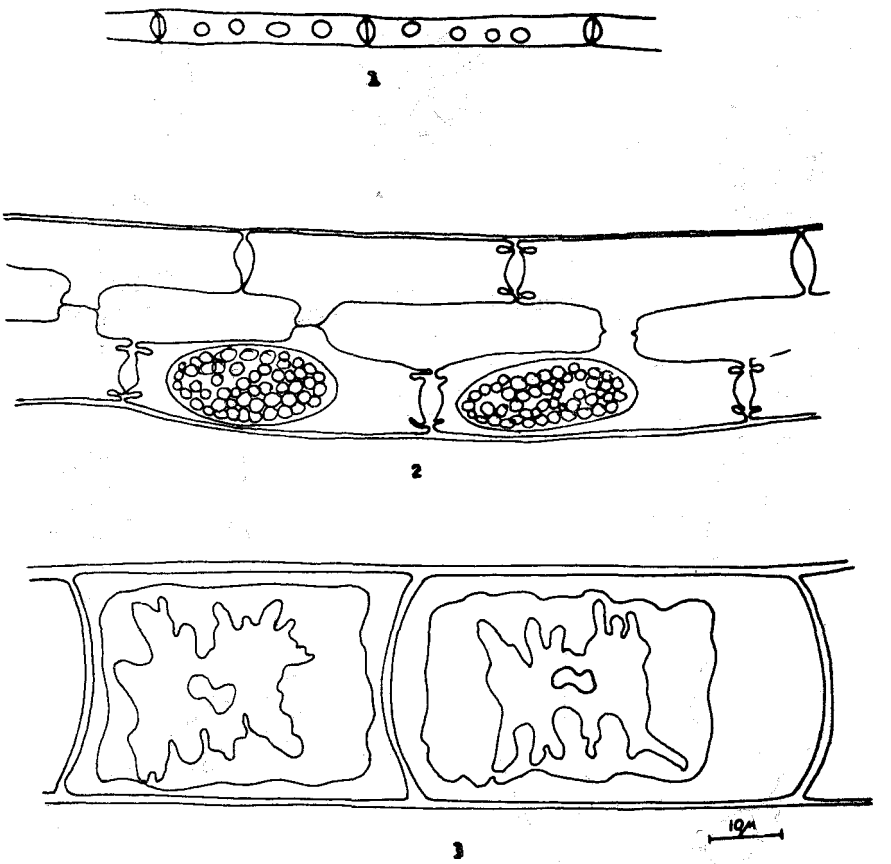

Figure 9. 1. Mougeotia sp., 2. Spirogyra weberii Kuetzing, 3. Zygnema pectinatum (Vauch.) C.A. Agardh.

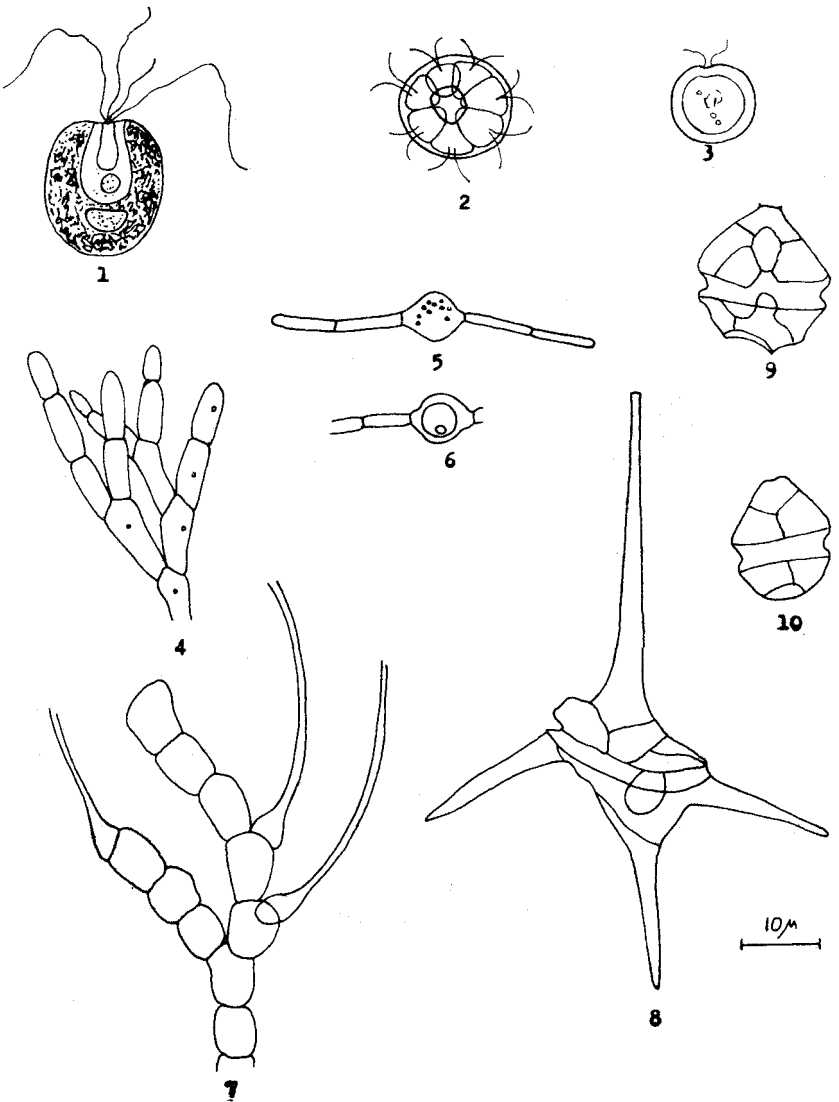

Figure 10. 1. Carteria sp., 2. Pandorina morum (Muell.) Bory, 3. Phacotus lenticularis (Ehr.) Stein, 4. Stigeoclonium farctum Berthold, 5–6. Oedogonium sp., 7. Bulbochaeta sp., 8. Ceratium hirundinella (Muell.) Schrank, 9. Peridinium cinctum (Muell.) Ehr., 10. Peridinium cinctum var. regulatum Lindem.

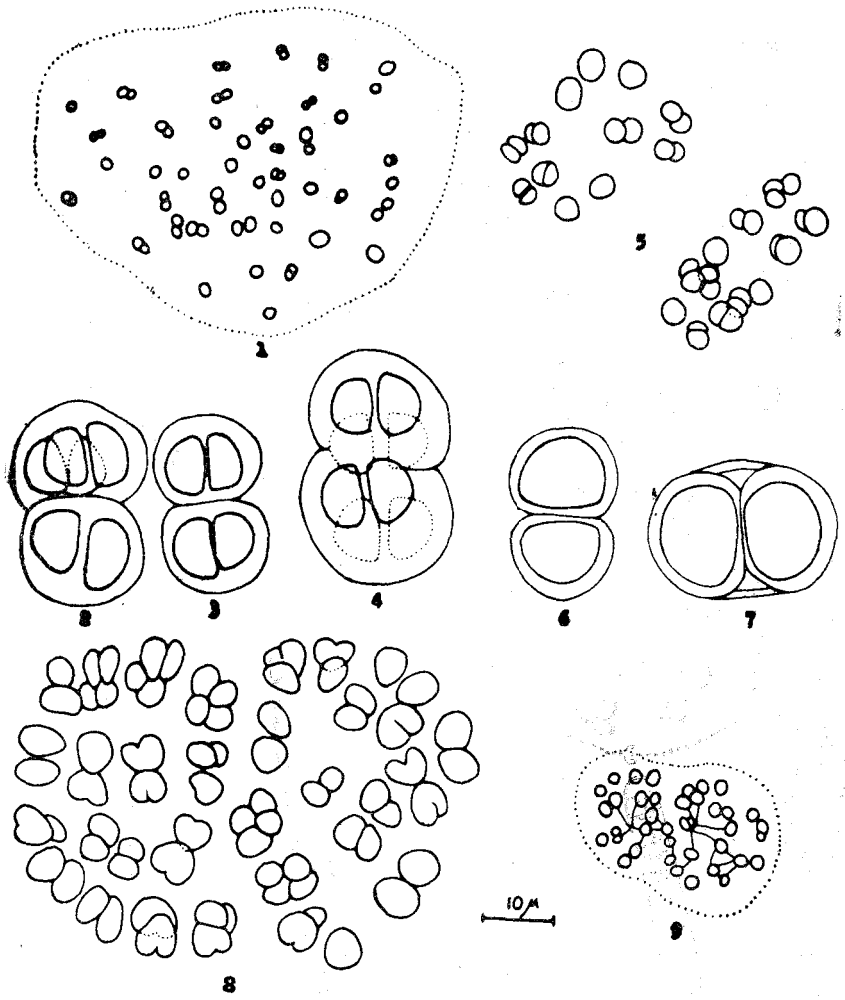

Figure 11. 1. Aphanocapsa sp., 2–4. Chroococcus limneticus Lemm., 5. Chroococcus limneticus var. subsalsus Lemm., 6–7. Chrooccocus turgidus (Kuetz.) Naegeli, 8. Gomphosphaeria aponina Kuetzing, 9. Gomphosphaeria lacustris Chod.

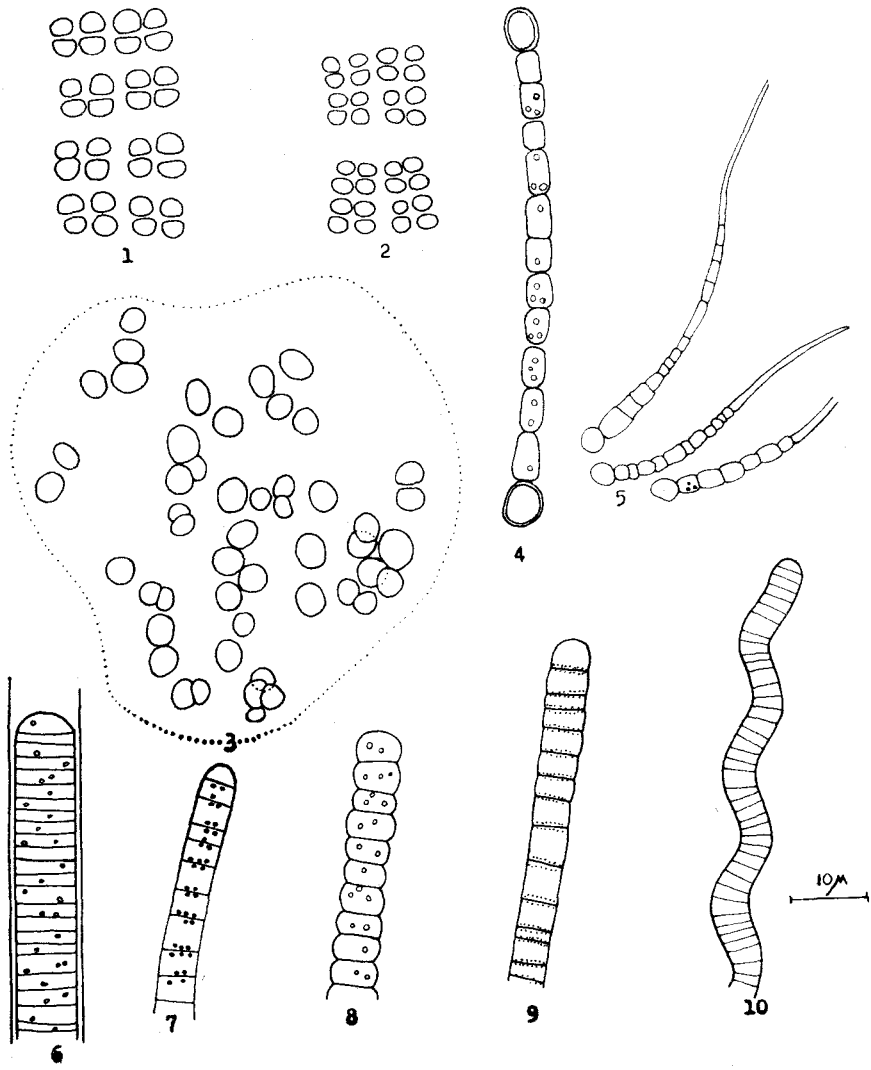

Figure 12. 1. Merismopedia glauca (Ehr.) Naegeli, 2. Merismopedia punctata Meyen, 3. Microcystis aeruginosa Kuetzing, 4. Anabaenopsis cunningtonii. R. Taylor, 5. Gloeotrichia pisum (C.A. Agardh) Thuret, 6. Lyngbya hieronymusii Lemm., 7. Oscillatoria amphibia C.A. Agardh, 8. Oscillatoria iwanoffiana (Nygaard) Geitler, 9. Oscillatoria tenuis C.A. Agardh, 10. Spirulina jenerii (Stizenberger) Geitler.