Turkish Journal of Biology

Volume 26 | Number 4 Article 6

1-1-2002

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Turk J Biol
26 (2002) 221-228

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Received: 01.04.2002

Abstract: The epipelic and epilithic algae of the Yedigöller Lakes were studied qualitatively between June and September 2001. As a result 90 taxa (43 belonging to Bacillariophyta, 33 to Chlorophyta, 11 to Cyanophyta and three to Euglenophyta) were determined. Based on the algal community composition, the Yedigöller Lakes can be characterized as oligotrophic.

Key Words: Epipelic, Epilithic, Algae, Yedigöller Lakes.

Yedigöller'in (Erzurum-Türkiye) Epipelik ve Epilitik Algleri

Özet: Yedigöllerin epipelik ve epilitik alg florası 2001 yılının Haziran-Eylül ayları arasında kalitatif olarak incelenmiştir. İnceleme sonucunda, Bacillariophyta (43), Chlorophyta (33), Cyanophyta (11) ve Euglenophyta (3)'ya ait olmak üzere toplam 90 takson kaydedilmiştir. Yedigöllerin alg kompozisyonu gölün oligotrofik göl karakterinde olduğunu göstermektedir.

Anahtar Sözcükler: Epipelik, Epilitik, Algler, Yedigöller.

Introduction

Given the continual increase in pressure on aquatic biota caused by pollution, it is increasingly urgent to study intact, natural ecosystems prior to their disturbance (1). The Yedigöller Lakes are ideal examples of a natural system unaffected by anthropogenic pollution. These lakes are largely ecologically intact and remote from industrial and agricultural centers.

The Yedigöller Lakes consist of seven small or large lakes between 1 and 5 km^2, on Mount Kızılkaya in Erzurum. The Yedigöller Lakes are glacier lakes, between 3100 m and 3142 m above sea level and located at latitude 40 52' 32'' N, longitude 40 37' 30'' E (Figure 1).

The purpose of this study was to determine the composition of epipelic and epilithic algae of the Yedigöller Lakes and to contribute to the algal flora of Turkey.

Materials and Methods

Ten sampling stations were chosen. Samples were collected during the snow-free period from June to

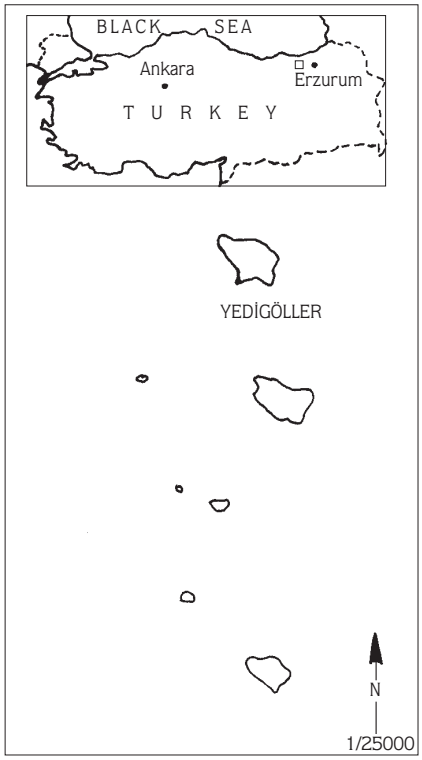

Figure 1. Map of the Yedigöller Lakes.

September 2001, on a monthly basis, from stations 15-30 cm deep and 50-100 cm offshore.

Epipelic community: This community was collected by drawing a glass tube across the surface of the sediments at all stations, allowing it to fill with a mixture of sediment and water, which was transferred to collecting bottles.

Epilithic community: Stones from the lakes (all stations) were brushed clean of algae and the washings cleaned with acid as outlined below.

Permanent slides were prepared after boiling in a 1:1 mixture of concentrated H_2SO_4 and HNO_3 and the clean diatoms were mounted in Naphrax high optical density mounting medium. Three hundred diatom valves were counted on each slide and used to give an estimate of their relative abundance (2,3). All algae except for Bacillariophyta were examined in temporary slides.

At the time of sampling, water temperature and pH were measured using a mercury thermometer and WTW Digi 88 model pH meter respectively. Dissolved oxygen concentration was measured according to the method of Winkler (4).

Taxonomic identifications were made according to Bourrelly and Coute (5), Dillard (6-9), Gontcharov (10), Hardley (11), Hoek (12), Hustedt (13,14), Huber-Pestalozzi (15,16), Kılınç (17), Lenzenweger (18), Lind and Brook (19), Ling and Tyler (20), Patrick and Reimer (21,22), and Prescott (23). The main species of the flora were photographed with an Olympus BH-2 research microscope.

Results

Environmental conditions

The water temperature varied from 9 to 25 °C (mean 17 °C). Low temperatures generally prevailed during June, and the highest temperature was found in August. The pH fluctuated between 6.9 and 7.50 (mean 7.20), indicating a circum-alkaline character. The dissolved oxygen fluctuated between 8.11 and 11.20 mg/l.

Algal flora

A total of 90 species and varieties of algae were recorded from the Yedigöller Lakes. Bacillariophyta was predominant, accounting for 43 species, followed by Chlorophyta with 33 species, Cyanophyta with 11 species and Euglenophyta with three species (Table).

Epipelic algae

A total of 61 taxa were recorded from the epipelic communities, of which 35 belong to Bacillariophyta, 19 to Chlorophyta, six to Cyanophyta and one to Euglenophyta (Table).

While *Cymbella minuta* Hilse ex Rabh. was the most common species, *Didymosphenia geminata* (Lyng.) M.Schmidt, *Pinnularia maior* (Kütz.) Cleve and *Surirella robusta* var. *splendida* (Ehrenb.) Van Heurck were the second in significance in the lakes. Other common epipelic diatoms included *Ceratoneis arcus* Kütz. and *Navicula radiosa* Kütz.

The members of the order *Desmidiales* were the most frequently encountered unicellular Chlorophyta species. Common species were *Cosmarium botrytis* Menegh. ex Ralfs, *C. leave* Rabenh., *C. vexatum* West and *Staurastrum punctulatum* (Bréb.) Ralfs. Common Cyanophyta included *Oscillatoria formosa* Bory, while the members of Euglenophyta were insignificant in the epipelic algal flora.

Epilithic algae

There were 55 species found in the epilithic communities, the majority of which belong to Bacillariophyta. There were also 17 species of Chlorophyta, seven of Cyanophyta and three of Euglenophyta (Table). Common diatoms *Cymbella minuta, C. cymbiformis* (Ag. & Kütz.) Van Heurck and *Didymosphenia geminata.*

Filamentous Chlorophyta were represented by several species, including *Ulothrix* Kütz. and *Zygnema* C.A.Agardh. Common unicellular Chlorophyta were *Cosmarium subcostatum* var. minus (W. & G.S.West) Först, *C. vexatum* and *Staurastrum punctulatum* while *Oscillatoria* spp. (especially *Oscillatoria amoena* (Kütz.) Gomont) were the most frequently encountered Cyanophyta species. Euglenophyta were represented by three species in the epilithic communities.

Discussion

A total of 90 species and varieties of algae were recorded from the Yedigöller Lakes. Bacillariophyta was predominant, accounting for 43 species, followed by Chlorophyta with 33, Cyanophyta with 11 and Euglenophyta with three (Table). There was no difference in the epipelic and epilithic algal flora among the

Table. List of the epipelic and epilithic algae collected in the Yedigöller Lakes. (1: Epipelic, 2: Epilithic).

		1	2
Divisio:	BACILLARIOPHYTA		
Classis:	Centrobacillariophyceae		
Ordo:	Centrales		
	Aulacosira varians A.Ag. (Fig. 2a)	+	
Classis:	Pennatibacillariophyceae		
Ordo:	Pennales		
	Achnanthes minutissima Kütz.	+	
	Amphora ovalis Kütz.	+	+
	Ceratoneis arcus Kütz. (Fig. 2b)	+	+
	C. arcus var. *linearis* Holmboe		+
	Caloneis silicula (Ehrenb.) Cleve	+	+
	Cymbella affinis Kütz.		+
	C. amphicephala var. *intermedia* A.Cl. (Fig. 2c)	+	+
	C. cistula (Hemprick) Grun. (Fig. 2d)	+	+
	C. cymbiformis (Ag. & Kütz.) Van Heurck (Fig. 2e)	+	+
	C. helvetica Kütz.	+	
	C. minuta Hilse ex Rabh. (Fig. 2f)	+	+
	Diatoma vulgare var. *brevis* Grun.	+	+
	Diploneis elliptica (Kütz.) Cleve (Fig. 2g)	+	
	Didymosphenia geminata (Lyngb.) M.Schmidt (Fig. 2h)	+	+
	Eunotia diodon Ehrenb.	+	
	E. monodon var. *maior* (W.Smith) Hust.		+
	E. valida Hust.	+	
	Epithemia argus Kütz. (Fig. 2i)	+	
	Frustulia vulgaris (Thwaites) DeT.	+	
	Gyrosigma acuminatum Ehrenb. (Fig. 2j)	+	
	Gomphonema olivaceum (Lyngb.) Kütz.		+
	G. olivaceum var. *calcarea* (Cl.) Cl.	+	
	G. olivacoides Hust.	+	
	Hantzschia amphioxys (Ehrenb.) Grun.	+	+
	Meridion circulare Agardh		+
	M. circulare var. *constricta* (Ralfs) Van Heurck	+	
	Navicula cryptocephala var. *veneta* (Kütz.) Grun.	+	
	N. radiosa Kütz. (Fig. 2k)	+	+
	N. rhynchocephala Kütz.		+
	Neidium iridis var. *amphigomphus* (Ehrenb.) Van Heurck		+
	Pinnularia borealis Ehrenb.	+	+
	P. maior (Kütz.) Cleve (Fig. 3a)	+	+
	P. viridis (Nitzsch.) Ehrenb.	+	
	P. viridis var. *sudetica* Hust	+	
	Stauroneis sp. (Fig. 3b)	+	+
	Surirella robusta Ehrenb.	+	+
	S. robusta var. *splendida* (Ehrenb.) Van Heurck (Fig. 3c)	+	+
	S. spiralis Kütz. (Fig. 3d)	+	+
	S. tenera Gregory (Fig. 3e)	+	+
	Synedra ulna (Nitzsch.) Ehrenb.	+	+
	Tabellaria flocculosa var. *asterionelloides* Grunow		+
Division:	CHLOROPHYTA		
Classis:	Chlorophyceae		
Ordo:	Chlorococcales		
	Pediastrum boryanum (Trup.) Menegh. (Fig. 4a)	+	+
	P. integrum var. *scutum* Racib.		+

Table. (Continued)

		1	2
Ordo:	Ulotrichales		
	Ulothrix variabilis Kütz.		+
Classis:	Conjugatophyceae		
Ordo:	Mesotaeniales		
	Cylindrocystis brebissonii Menegh.		+
Ordo:	Desmidiales		
	Actinotaenium cucurbita (Bréb.) Teiling ex Ruzicka & Pouzar	+	
	Closterium dianae Ehrenb.	+	
	C. lunula var. *intermedium* Gutw.	+	+
	C. lunula var. *massartii* (Wildemann) Krieger	+	
	C. rostratum Ehrenb. ex Ralfs var. *rostratum*		+
	C. striolatum Ehrenb.	+	
	Closterium sp. (Fig. 4b)	+	
	Cosmarium bioculatum Bréb.	+	
	C. botrytis Menegh. ex Ralfs (Fig. 4c)	+	
	C. blyttii var. *hoffii* B¢rgesen	+	
	C. exiguum var. *subrectangulum* West & West		+
	C. leave Rabenh (Fig. 4d)	+	
	C. margaritiferum Menegh. ex Ralfs		+
	C. speciosum Lund		+
	C. subcostatum var. *minus* (W. & G.S.West) Först		+
	C. subspeciosum var. *validus* Nordst		+
	C. transitorium (Heimerl) Ducellier		+
	C. turpinii var. *podolicum* Gutw.	+	
	C. vexatum West (Fig. 4e)	+	
	Cosmarium sp. (Fig. 4f)	+	
	Euastrum oblongum (Greville) Ralfs	+	
	E. verrucosum var. *alatum* forma *floridense* Prescott	+	
	Netrium digitus (Bréb.) Itzigs & Rothe	+	
	Penium margaritaceum (Ehrenb.) ex Bréb. in Ralfs (Fig. 4g)	+	
	Pleurotaenium trabecula (Ehrenb.) ex Nog.		+
	Roya obtusa (Bréb.) West & West		+
	Staurastrum dispar Bréb.		+
	S. punctulatum (Bréb.) Ralfs (Fig. 4h)	+	+
Ordo:	Zygnematales		
	Zygnema sp. (Fig. 4i)		+
Division:	CYANOPHYTA		
Classis:	Cyanophyceae		
Ordo:	Chroococcales		
	Aphanocapsa rivularis (Carm.) Rabenh. (Fig. 4j)		+
	Merismopedia elegans A.Braun.		+
Ordo:	Hormogonales		
	Anabaena sp.	+	
	Lyngbya aerugineo-caerulea (Kütz.) Gomont		+
	Nostoc sp.		+
	Oscillatoria amoena (Kütz.) Gomont (Fig. 4k)		+
	O. formosa Bory	+	+
	O. limosa (Roth) C.A.Agardh (Fig. 4l)	+	
	O. princeps Vaucher	+	
	O. sancta (Kütz.) Gomont	+	
	O. subbrevis Schmidle	+	+
Division:	EUGLENOPHYTA		
Classis:	Euglenophyceae		
Ordo:	Euglenales		
	Euglena sp.	+	+
	Phacus sp.		+
	Trachelomonas charkowiensis Svirenko		+

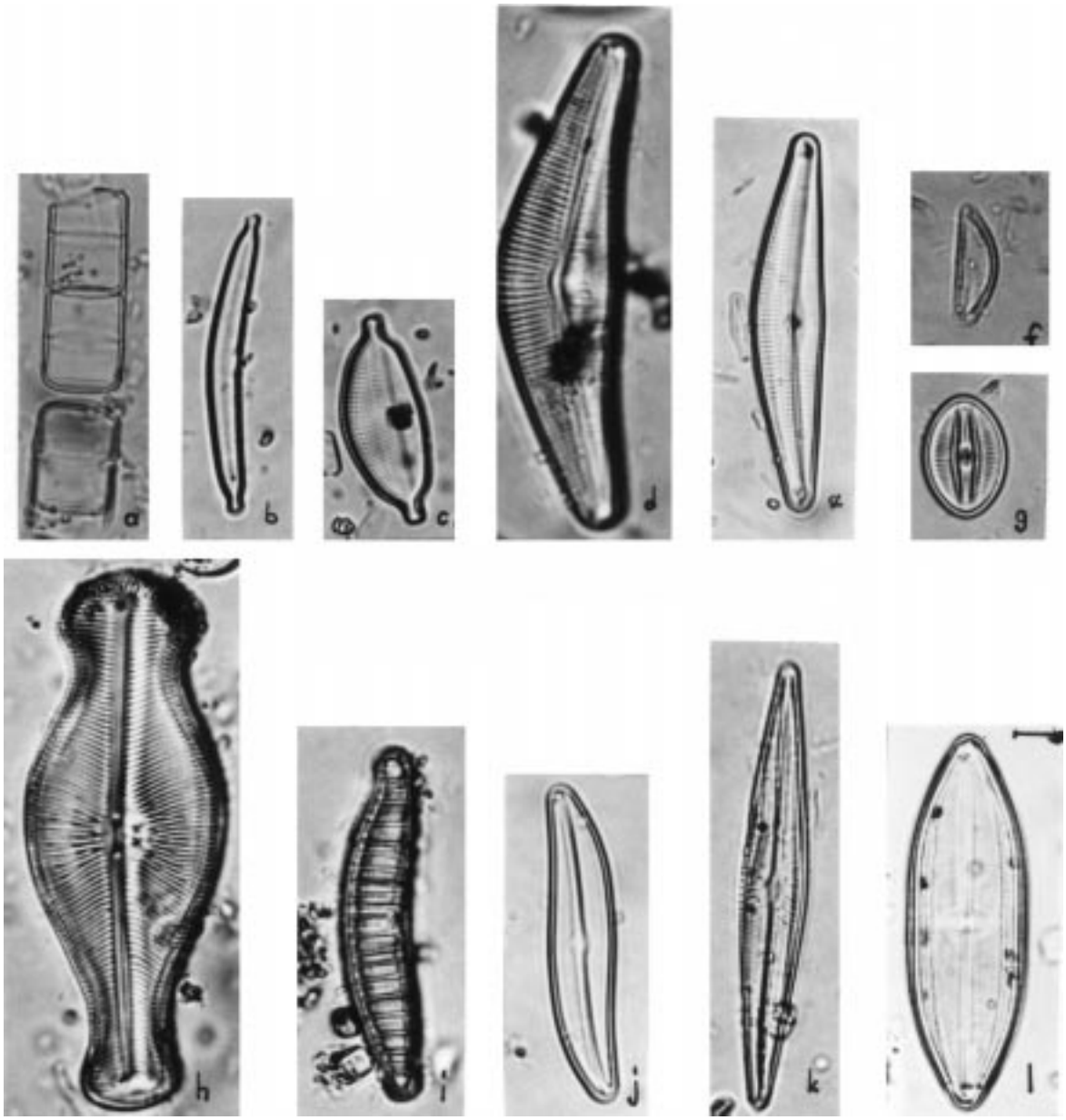

Figure 2. a. Aulacosira varians, b. Ceratoneis arcus, c. Cymbella amphicephala var. intermedia, d. C cistula, e. C. cymbiformis, f. C. minuta, g. Diploneis elliptica, h. Didymosphenia geminata, i. Epithemia argus, j. Gyrosigma acuminatum, k. Navicula radiosa, l. Neidium iridis var. amphigomphus (Scale 10µ).

Yedigöller Lakes. However, the density of species was different from lake to lake. For example, *Cymbella minuta* was the most common species in the algal flora of the Yedigöller Lakes, but its density was not the same in all lakes.

The epipelic and epilithic algal flora identified in the Yedigöller Lakes were almost identical to those of Çakırgöl (24), Aygır and Balıklı (25) and Dağbaşı Lakes (26). The reason for this can be explained by the environmental conditions among the lakes. The elevation (2533 m, 2700 and 2600 m, and 2721 m respectively), photoperiod and weather conditions are approximately the same. Furthermore, the stations were located in the same depth of water (20-30 cm) and 50-100 cm from

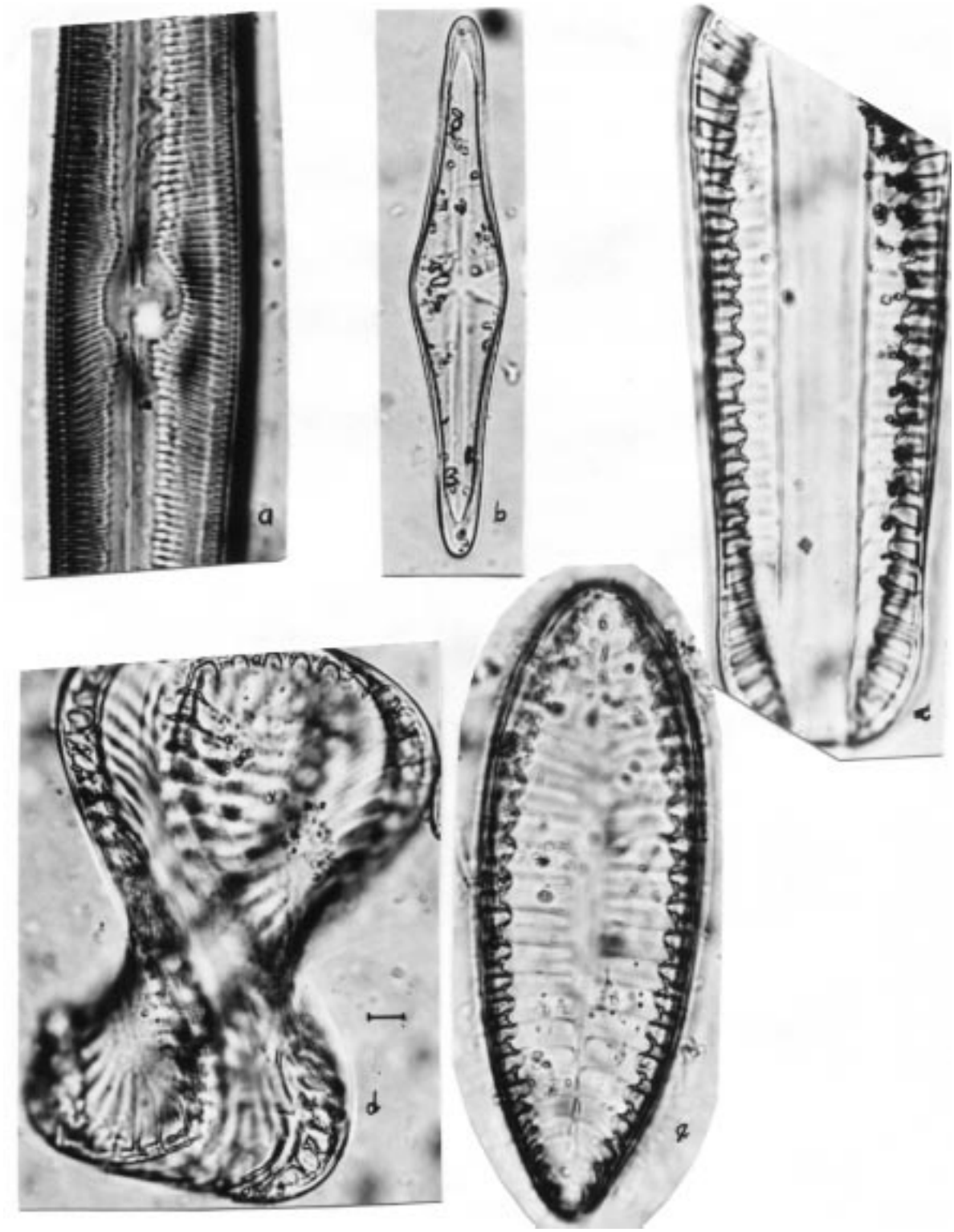

Figure 3. a. Pinnularia maior, b. Stauroneis sp., c. Surirella robusta var. splendida, d. S. spiralis, e. S. tenera (Scale 10µ).

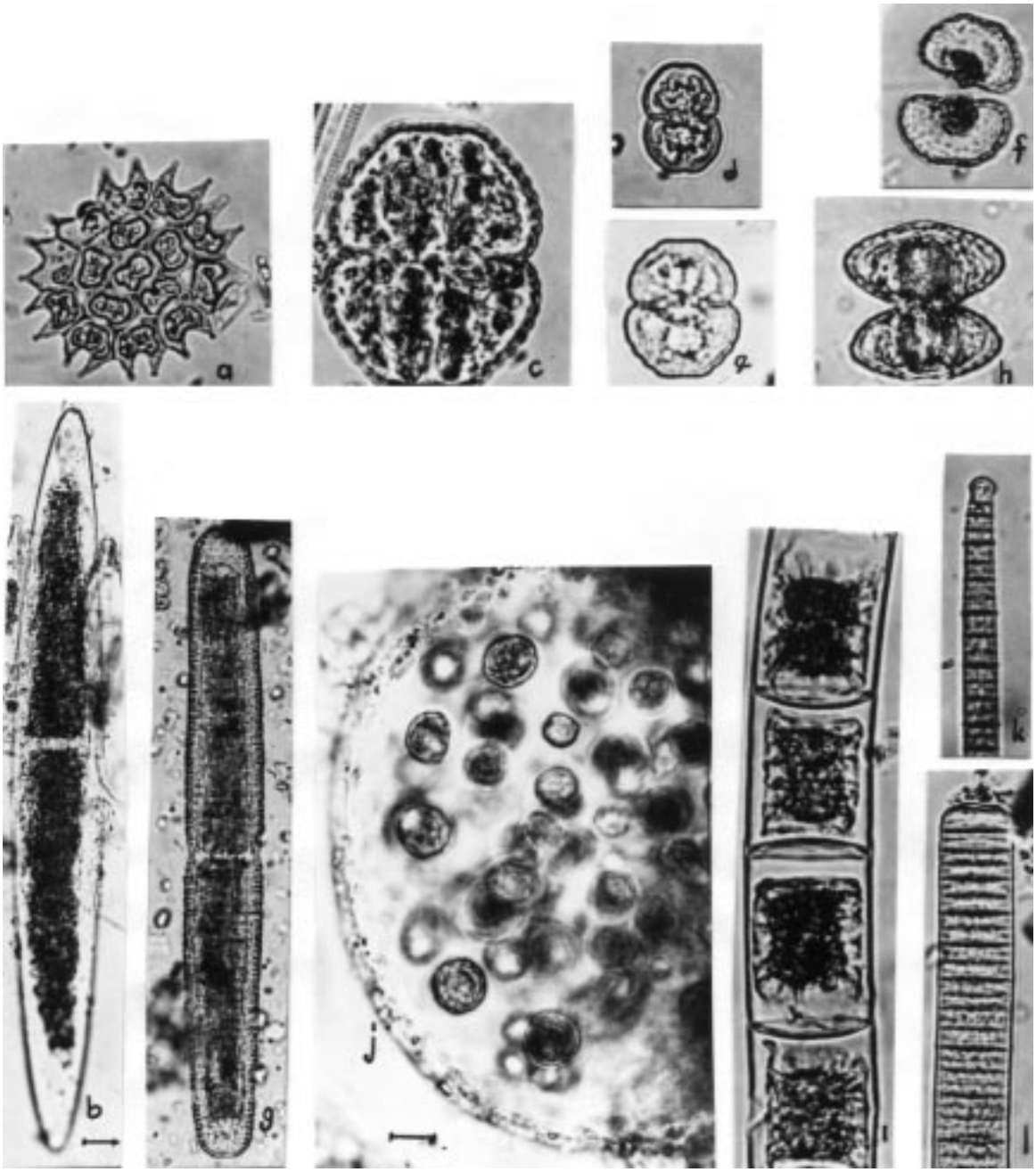

Figure 4. a. Pediastrum boryanum, b. Closterium sp. c. Cosmarium botrytis, d. C. leave, e. C. vexatum, f. C. sp. g. Penium margaritaceum, h. Staurastrum punctulatum, ı. Zygnema sp., j. Aphanocapsa rivularis, k. Oscillatoria amoena, l. O. limosa (Scale 10µ).

shore. In addition, the average values of dissolved oxygen, pH and temperature were almost identical (26).

Palmer (27) pointed out that *Aulacosira varians, Synedra ulna* and members of *Oscillatoria* spp. are indicator species of water pollution. These species were not important in the algal flora of the Yedigöller Lakes.

Many algal species are useful indicators of trophic conditions in lakes and rivers (21). It has been stated that some genera, such as *Eunotia* Ehrenb., *Frustulia* Agardh, *Pinnularia* Ehrenb. and *Neidium* Pfitzer, are commonly found in oligotrophic lakes (28). In addition, *Didymosphenia geminata* and *Tabellaria flocculosa* var.

asterionelloides are good indicators of oligotrophic conditions (29). While *Didymosphenia geminata* and *Pinnularia maior* were second in significance, *Eunotia, Frustulia, Neidium* and *Tabellaria* were observed in varying numbers in the algal flora of the Yedigöller Lakes.

The members of *Desmidiales* are characteristic species of oligotrophic lakes (30). In the Yedigöller Lakes, members of *Desmidiales* (especially *Closterium, Cosmarium* and *Staurastrum*) were the most frequently encountered taxa.

Based on the analysis of the composition of the algal flora, the Yedigöller Lakes can be described as oligotrophic. However, to be precise it will be necessary to conduct a thorough physical and chemical analysis of the lake water.

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