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CILIATED PROTOZOA FROM LAKE MASSACIUCCOLI (WESTERN TUSCANY) (°)

Abstract - In order to increase our knowledge of the life in Lake Massaciuccoli (Natural Park Migliarino-S.Rossore-Massaciuccoli), a study of the ciliated protozoa of the lake was undertaken.
In an attempt to cover expected environmental differences, 4 stations were chosen in four most typical environments of the lake and of its hydric system: Lago, Canale Burlamacca, Canale Collettore and Chiaro.
The study covered one year (13 samples, from June 1992 to July 1993); the ciliate forms sampled in this way belonged to 125 species: 52 were recognized to the genus level, while 73 were identified as species.
In the last four sampling sessions no species, not already found in the previous samples, was identified: this seems to indicate that the list of ciliates of Lake Massaciuccoli we drew up, was very exhaustive.

Key words - Lake Massaciuccoli - Ciliate communities - Hydrobiology.

Riassunto - *Protozoi ciliati del Lago di Massaciuccoli (Toscana occidentale).* Allo scopo di arricchire la conoscenza delle forme viventi del Lago di Massaciuccoli (Parco Naturale Migliarino-S.Rossore-Massaciuccoli), è stato intrapreso lo studio dei protozoi ciliati presenti in queste acque.
Per coprire le probabili diversità ambientali, si sono scelte 4 stazioni tipo, per quattro tra i più evidenti e rappresentativi ambienti di tale sistema idrico (Lago, Canale Burlamacca, Canale Collettore, Chiaro): i campioni raccolti in tali stazioni nel corso di 13 campionamenti circa mensili (giugno 1992-luglio 1993), hanno rivelato una ricchissima varietà delle comunità a ciliati: delle 125 forme osservate, 52 sono state identificate a livello di genere e 73 a livello di specie.
Il fatto che negli ultimi quattro campionamenti non sia stata trovata alcuna specie non già identificata in precedenza sembrerebbe indicare che la nostra descrizione dei ciliati del Lago di Massaciuccoli sia da considerare molto vicina alla completezza.

Parole chiave - Lago Massaciuccoli - Comunità Ciliati - Idrobiologia.

INTRODUCTION

The water system of Massaciuccoli (formed by the Lake and by the canals and the marshes connected to it) is in the Natural Park of Migliarino-S.Rossore-Massaciuccoli and constitutes one of the largest wetland area in Tuscany (about 2,700 hectares): after the paper by Pedreschi (1956) two thorough studies dealt with the Lake's retrodunal origin, its hydrogeology and its relevance for man (Geotecno, 1975; Aquater, 1980).
The communities living in the Lake and in the marshes it had already been carefully studied carefully both qualitatively and quantitatively, as shown by the rich bibliography available in the field: *(a)* the phytoplankton, the macroplankton and the macrobenthos have been described by Brunelli and Cannicci (1942), by Geotecno (1975) and Aquater (1980), by Simoni *et al.* (1984) and by Baldaccini and Bianucci (1987); *(b)* the macrophyta were studied by Tomei *et al.* (1979), Tomei and Garbari (1981 a, b), and by Tomei and Gaspari (1981); *(c)* the fishes, the amphibia and the reptiles were described in Cavalli and Lambertini (1990); *(d)* the birds were described by Baccetti (1980, 1981).
The ciliated protozoa have been almost completely ignored so far, except for short descriptions given by Brunelli and Cannicci (1942) in their paper mainly dealing with the characteristics of other, more general, communities (see above).
On the other hand, while the ciliates represent an important component of every environment (Fenchel, 1987), so far in Italy only Lake Maggiore and Lake Orta (Ruggiu, 1965, 1966), together with a man-made lake in the Appennine Chain (Madoni, 1989) have been studied from this point of view. This is to say that the information already available for the ciliates of Italian lakes is so poor in quantity and so scattered geographically, that a new contribution could not but improve the knowledge and understanding of our fauna. The descriptions of the ciliates of small ponds given by Madoni and Viaroli (1985) and by Madoni (1987, 1990) proved to be some what similar to our findings in some areas of Lake Massaciuccoli, and therefore precious for useful comparison.
Our purpose was double: on the one hand we made one attempt to extend the description of the Italian ciliates (cfr. Dini *et al.*, 1995), on the other we wanted to describe the ciliated protozoa of such an important area as Massaciuccoli.

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SAMPLING STATIONS AND METHODS

We monitored the north-eastern area of the basin of Lake Massaciuccoli (Fig. 1.): it includes the North-Eastern corner of the present lake, the initial reach of the Burlamacca canal (the main tributary and outlet of the lake), a number of canals (called «collettori») connecting the Burlamacca canal to the surrounding marshes, where very shallow ponds (called «chiari») are commonly found.
In this context, 4 stations were chosen (Fig. 1.): the first was chosen at the lake shore («L»); the second lies along the banks of the Burlamacca canal («B"); the third along a «collettore» («Co»), and the fourth in one «chiaro« («Ch»); the four stations were chosen on the basis of their characteristics.

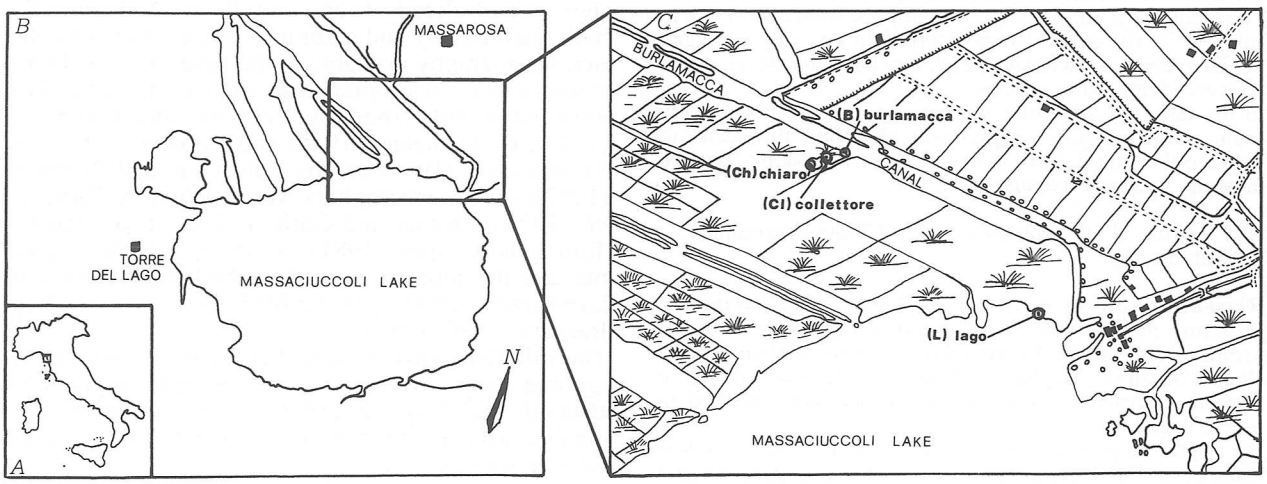

Fig. l - A: the geography of Lake Massaciuccoli; B: general topography; C: the four stations.

Each station represented one of the most common enviroments of the basin.
For each station, two samples were collected every time: the first at the water-sediment interface level (bottom = «b», in Table 1) and the second at the surface level (surface = «s», in Table 1).
Thus with a monthly frequency, eight samples were collected and studied from June 1992 to July 1993.
The «b» samples were collected according to the technique reported by Madoni and Rossi (1977), while for the «s» samples a plankton net (sieves = 30m) was used.
Each sample was taken to the lab and scored within 5-6 hours from its collection: the techniques related to this phase of the study are clearly reported by Madoni (1984).
The papers and handbooks of the following authors were used to recognize and to identify (whenever it was possible) the species: Kahl (1930-1935), Jahn and Jahn (1949), Corliss (1979), Madoni (1981), Foissner *et al.* (1991), Lee *et al.* (1985), Margulis *et al.* (1990) and Patterson and Hedley (1992).

Each species was also characterized by its trophic niche, according to what has already been reported in the literature.

THE SPECIES OF LAKE MASSACIUCCOLI

Our study of the ciliates collected at the four stations identified 125 species ; 103 were collected at the bottom level and 102 at the surface level, 80 being in common to the two levels.
These species are given in the following list , according to the systematic view given by Corliss (1979): the asterisk in parentheses (*) individuates the species not yet reported among the Italian ciliates:

Phylum CILIOPHORA Doflein, 1901

– Class 1. KINETOFRAGMINOPHORA de Puytorac et al., 1974

– Subclass 1. **Gymnostomata** Butschli, 1889

– Order 1. KARYOLECTIDA Corliss, 1974
– Family: **Trachelocerchidae** Kent, 1881
Trachelocerca fusca Kahl, 1928

Loxodidae Butschli, 1889
Loxodes vorax Stokes, 1885

– Order 2. PROSTOMATIDA Schewiakoff, 1896
– Family: **Holophryidae** Perty,1852
Holophrya sp.
Balanophrya collaris (*)Kahl, 1926
Balanophrya garganellae
Kahl,1926

Table 1 - The species found in the four stations of the Massaciuccoli lake: L= Lake, B= Burlamacca canal, Co= Collettore, Ch= Chiaro. They have been characterized by their trophic niches (B= bacterivorous-detritivorous; A= algivorous; C= carnivorous; O= omnivorous), and by the level of the water column they occupy (s surface, b bottom, b\s in common).

trophic niche	SPECIES	STATIONS				trophic niche	SPECIES	STATIONS			
		L	B	Co	Ch			L	B	Co	Ch
C	*Amphileptus sp.*		s	s		C	*Dileptus margaritifer*			b	
B	*Askenasia volvox*	b\s	b\s	b\s	b	B	*Diophrys scutum*		s		
B	*Aspidisca cicada*	b\s	b\s	b\s	b\s	B	*Dysteria sp.*			b	
B	*Aspidisca lynceus*	b	b\s	b\s	b	B	*Enchelys pupa*		b		
B	*Aspidisca turrita*	b		b	b	B	*Epalxella exigua*	b	b\s	b\s	b
B	*Astylozoon sp.*	s				B	*Epistylis sp.*	s			
B	*Balanophrya collaris*	b		b	b	?	*Espejoia sp.*		s	s	
B	*Balanophrya garganellae*		s			B	*Euplotes aediculatus*		b		b
B	*Blepharisma sp.*			b\s	b\s	B	*Euplotes affinis*	b\s	s	b\s	b
B	*Caenomorpha uniserialis*		s	b	b	A	*Euplotes eurystomus*		s	s	s
B	*Carchesium polypinum*		s			B	*Euplotes moebiusi*	b	s	b\s	
C	*Chaenea limicola*			b		O	*Euplotes patella*	s		b\s	b\s
C	*Chaenea vorax*	b\s		b	b\s	B	*Euplotes sp.*	s	b\s	b\s	b\s
A	*Chilodonella sp.*	s	s	b\s	b	B	*Folliculina producta*		b		
A	*Chilodonella uncinata*			b\s		A	*Frontonia atra*			b	
A	*Chlamydodon sp.*			s	b	A	*Frontonia sp.*	b\s	b\s	b\s	b\s
?	*Choanostoma sp.*		s			B	*Glaucoma scintillans*			b	
B	*Cinetochilum margaritaceum*	b\s	b\s	b\s	b\s	B	*Glaucoma sp.*	b	b\s	b\s	b
B	*Climacostomum sp.*	b\s	b\s	s		B	*Halteria grandinella*	b\s	b\s	b\s	b\s
B	*Codonella cratera*		s			A	*Holophrya sp.*	s	b	b	
B	*Cohnilembus sp.*		s			B	*Holosticha fasciola*			b\s	b
O	*Coleps hirtus*	b\s	b\s	b\s	b\s	B	*Holosticha sp.*	b\s	b\s	b\s	b\s
B	*Colpoda sp.*	s				B	*Homalozoon vermiculare*	b\s		b	
O	*Condylostoma vorticella*	b\s	b\s	b		C	*Lacrymaria olor*	b	b	b\s	b\s
B	*Cothurnia sp.*	b\s	b\s	b\s	b\s	C	*Lacrymaria sp.*	s	s	b\s	b\s
B	*Cristigera cirrifera*		b			B	*Lagynophrya conifera*			b	
B	*Cyclidium glaucoma*	b\s	b\s	b\s	b\s	C	*Lagynus cucumis*				b
B	*Cyclidium sp.*	b\s	b\s	b	b\s	O	*Lembadion sp.*	b		b\s	b
C	*Cyclotrichium limneticum*	s	b\s			B	*Leptopharynx sp.*	s			
C	*Didinium nasutum*	s	b\s	s		C	*Litonotus cygnus*	b	b	b\s	b

continue >

Table 1 (*Cont.*) - The species found in the four stations of the Massaciuccoli lake: L= Lake, B= Burlamacca canal, Co= Collettore, Ch= Chiaro. They have been characterized by their trophic niches (B= bacterivorous-detritivorous; A= algivorous; C= carnivorous; O= omnivorous), and by the level of the water column they occupy (s surface, b bottom, b\s in common).

trophic niche	SPECIES	STATIONS				trophic niche	SPECIES	STATIONS			
		L	B	Co	Ch			L	B	Co	Ch
C	*Litonotus fasciola*	b	b\s	b		B	*Spirostomum teres*	b	b\s	b\s	b
C	*Litonotus sp.*	b\s	b\s	b\s	b\s	B	*Spirozona caudata*		s		
B	*Loxodes vorax*	b\s	b\s	b	b	A	*Stentor coeruleus*	s	b\s	b	b
C	*Loxophyllum meleagris*	b\s	b\s	b\s	b\s	A	*Stentor sp.*	b\s	b\s	b\s	
B	*Mesodinium sp.*	b		b	b	B	*Stichotricha sp.*	s	s	b\s	b\s
?	*Metacystis striata*			b		B	*Strombidinopsis gyrans*		s		
B	*Metopus contortus*	b	b	b	b	B	*Strombidium sp.*	b\s	b\s	b\s	b\s
B	*Metopus laminarius*			b\s		A	*Stylonychia mytilus*	s	b\s	b\s	
B	*Metopus sp.*	b	b\s	b\s	b	B	*Stylonychia sp.*		b	s	b
A	*Nassula sp.*			b\s		B	*Tachysoma sp.*		b	b\s	b
B	*Oxytricha sp.*	b\s	b\s	b\s	b\s	B	*Telotrochidium hennenguyi*	s	s		
B	*Paramecium aurelia*	s		b\s		B	*Tetrahymena sp.*	b\s	s		
B	*Paramecium bursaria*		s	b\s	b	B	*Tintinnidium fluviatile*	s	b\s	s	
B	*Paramecium caudatum*	s		b	b	B	*Trachelius ovum*				s
B	*Paramecium putrinum*	b\s		b\s	s	B	*Trachelocerca fusca*		s	b	
B	*Paramecium sp.*	b	s	b	b\s	B	*Trachelophyllum sp.*			b\s	
B	*Paraurostyla sp.*		b\s			?	*Trichodina pediculus*	s	s		s
B	*Paruroleptus musculus*	s		s		A	*Trithigmostoma cucullulus*		b	b	b
A	*Phascolodon sp.*	b	s	b\s		A	*Trithigmostoma sp.*			b	b\s
C	*Phialina coronata*			b		B	*Trochilia palustris*	b		b\s	b
C	*Phialina pupula*			b		B	*Urocentrum turbo*	b\s	b\s	b\s	b\s
A	*Placus ovum*		b			B	*Uroleptus piscis*	b\s	b\s	b\s	b\s
B	*Plagiocampa sp.*	b\s	b			B	*Uroleptus sp.*	b		b\s	b
B	*Plagiopyla sp.*	b	s	b		B	*Uronema elegans*	b		b\s	b
B	*Platynematum sp.*			b	b	B	*Uronema marinum*		b		
B	*Platyophrya sp.*	b		b\s		B	*Uronema sp.*	b\s	b\s	b\s	b\s
B	*Pleuronema sp.*	b\s	b\s	b\s	b\s	B	*Urosoma sp.*			b	b
C	*Prorodon sp.*	b\s	b\s	b\s	b\s	B	*Urostyla grandis*	b	b\s	b	b
B	*Pseudomicrothorax sp.*		b\s	b\s	b	B	*Urotricha sp.*	b\s	b\s	b\s	b
C	*Pseudoprorodon liberkhuni*			b		B	*Vaginicola crystallina*	s	s	b\s	b\s
B	*Saprodinium dentatum*	b	b\s	b\s	b	B	*Vorticella sp.*	b\s	b\s	b	b\s
B	*Sonderia vorax*	s		b	b	B	*Zoothamnium sp.*		s		
C	*Spathidium sp.*	s	b\s	b\s		C					

Metacistidae Kahl, 1926
Metacystis striata (*) Stokes, 1838

Prorodontidae Kent, 1881
Placus ovum (*) Kahl, 1926
Plagiocampa sp.
Prorodon sp.
Pseudoprorodon liberkhüni (*)
Butschli, 1889
Urotricha sp.

Colepidae Ehremberg, 1838
Coleps hirtus Nitzsch, 1817

– Order 3. HAPTORIDA Corliss, 1974
– Family: **Enchelyidae** Ehremberg, 1838
Chaenea limicola (*)
Lauterbourn, 1901
Chaenea vorax
Quennerstendt, 1867
Enchelys pupa (*) O.F. Müller, 1786
Lacrymaria olor O.F. Müller, 1786
Lacrymaria sp.
Lagynophrya conifera (*) Kalh, 1927
Lagynus cucumis (*) Penard, 1922
Phialina coronata (*)
Cleparedè & Lachmann, 1959
Phialina pupula (*) O.F. Müller, 1773
Trachelophyllum sp.

Spathidiidae Kahl in Doflein & Reichenow, 1929
Homalazoon vermiculare Stokes, 1893
Sphatidium sp.

Didiniidae Poche, 1913
Askenasia volvox (*)
Eichwald, 1852
Choanostoma sp.
Cyclotrichium limneticum (*)
Meunier, 1910
Didinium nasutum (*) O.F. Müller, 1773
Mesodinium sp.

– Order 4. PLEUROSTOMATIDA Schewiakoff, 1896
– Family: **Amphileptidae** Butschli, 1889
Amphileptus sp.
Litonotus fasciola
Ehremberg-Wrzeniowski, 1870
Litonotus cygnus O.F. Müller, 1773
Litonotus sp.
Loxophyllum meleagris (*) O.F. Müller, 1773

– Subclass 2. **Vestibulifera** de Puytorac et al., 1974

– Order 1. TRICHOSTOMATIDA Butschli, 1889
– Family: **Plagiopylidae** Schewiakoff, 1896
Plagiopyla sp.
Sonderia vorax (*) Kahl, 1928

Trichospiridae Kahl, 1926
Spirozona caudata Kahl, 1926

– Order 2. COLPODIDA de Puytorac et al., 1974
– Family: **Colpodidae** Ehremberg, 1838
Colpoda sp.

Woodruffidae von Gelei, 1954
Platyophrya sp.

– Subclass 3. **Hypostomata** Schewiakoff, 1896

– Order 1. NASSULIDA Jankowski, 1967
– Family: **Nassulidae** de Fromental, 1847
Nassula sp.

Leptopharingidae Kahl, 1926
Leptopharinx sp.
Pseudomicrothorax sp.

– Order 2. CYRTOPHORIDA Faurè-Fremiet in Corliss, 1956
– Family: **Chilonellidae** Deroux, 1970
Chilodonella sp.
Chilodonella uncinata
Ehremberg, 1838
Phascolodon sp.
Trithigmostoma cucullulus O.F. Müller, 1786
Trithigmostoma sp.

Chlamydodontidae Stein, 1859
Chlamidodon sp.

Dysteridae Clapèrede & Lachmann, 1858
Dysteria sp.
Trochilia palustris (*) Stein, 1859

– Class 2. OLIGOHYMENOPHORA de Puytorac et al., 1974

– Subclass 1. **Hymenostomata** Delage & Hèrouard, 1896

– Order 1. HYMENOSTOMATIDA Delage & Hèrouard, 1896
– Family: **Tetrahymenidae** Corliss, 1952
Tetrahymena sp.

Glaucomidae Corliss, 1971
Espejoia sp.
Glaucoma scintillans
Ehremberg, 1830
Glaucoma sp.

Parameciidae Dujardin, 1840
Paramecium aurelia complex O.F. Müller, 1773
Paramecium bursaria
Ehremberg, 1831
Paramecium caudatum
Ehremberg, 1833
Paramecium putrinum
Claparède & Lachmann, 1859
Paramecium sp.

Frontoniidae Kahl, 1926
Frontonia atra

Ehremberg, 1893
Frontonia sp.

Urocentiidae Claparède & Lachmann, 1858
Urocentrum turbo O.F. Müller, 1786

Lembadioniidae Jankowski,
Lembadion sp.

– Order 2. SCUTICOCILIATIDA Small, 1967
– Family: **Uronematidae** Thompson, 1964
Uronema elegans (*)
Maupas, 1883
Uronema marinum
Dujardin, 1841
Uronema sp.

Cohnilembidae Kahl, 1933
Cohnilembus sp.

Cinetochilidae Perty, 1852
Cinetochilum margaritaceum
Ehremberg, 1831
Platynematum sp.

Pleuronematidae Kent, 1881
Pleuronema sp.

Cyclididae Ehremberg, 1838
Cyclidium glaucoma O.F. Müller, 1773
Cyclidium sp.
Cristigera cirrifera (*) Kahl, 1928

– Subclass 2. **Peritricha** Stein, 1859

– Order 1. PERITRICHIDA Stein, 1859
– Family: **Vorticellidae** Ehremberg, 1838
Carchesium polypinum
Linneaus, 1758
Vorticella sp.
Zoothamnium sp.

Astylozoiidae Kahl, 1933
Astylozoon sp.

Epistylididae Kahl, 1933
Epistylis sp.

Vaginicolidae de Fromental, 1874
Cothurnia sp.
Vaginicola crystallina
Ehremberg, 1830

Trichodinidae Claus, 1874
Trichodina pediculus
Ehremberg, 1830
Opisthonectidae Foissner, 1976
Telotrochidium hennenguyi (*) Kent, 1881

– Class 3. POLIHYMENOPHORA Jannkowski, 1967

– Subclass 1. **Spirotricha** Butschli, 1889

– Order 1. HETEROTRICHIDA Stein, 1859
– Family: **Spirostomatidae** Stein, 1867
Blepharisma sp.
Spirostomum teres
Claparède & Lachmann,1858

Metopidae Kahl, 1927
Metopus contortus (*)
Quennerstedt, 1867
Metopus laminarius (*) Kahl, 1927
Metopus sp.

Condylostomatidae Kahl in Doflein & Reichenow, 1929
Condylostoma vorticella
Ehremberg, 1831

Climacostomatidae Repak, 1927
Climacostomum sp.

Stentoridae Carus, 1863
Stentor coeruleus Pallas, 1766
Stentor sp.

Caenomorphidae Poche, 1913
Chaenomorpha uniserialis (*)
Levander, 1894

Folliculinidae Dons, 1914
Folliculina producta (*) Wright, 1859

– Order 2. ODONTOSTOMATIDA Sawaya, 1940
– Family: **Epalxellidae** Corliss, 1960
Epalxella exigua (*) Penard, 1922
Saprodinium dentatum (*)
Lauterborn, 1908

– Order 3. OLIGOTRICHIDA Butschli, 1887
– Family: **Halteridae** Claparède & Lachmann, 1858
Halteria grandinella O.F. Müller, 1773

Strombididae Faurè-Fremiet, 1970
Strombidium sp.

Strombililiididae Kahl in Doflein & Reichenow, 1929
Strombidinopsis gyrans Kent, 1926

Tintinnidiidae Kofoid & Campbell, 1929
Tintinnidium fluviatile (*) Stein, 1863

Codonellidae Kent, 1881
Codonella cratera Leidy, 1877

– Order 4. HYPOTRICHIDA Stein, 1859
– Family: **Spirofilidae** von Gelei, 1929
Stichotricha sp.

Urostylidae Butschli, 1889
Paraurostyla sp.
Urostyla grandis
Ehremberg, 1830

Holostichidae Faurè-Fremiet, 1961
Holosticha fasciola (*) Kahl, 1932
Holosticha sp.
Paruroleptus musculus (*) Kahl, 1932
Uroleptus piscis O.F. Müller, 1773
Uroleptus sp.

Oxytrichidae Ehremberg, 1838
Oxytricha sp.
Stylonichia mytilus O.F. Müller, 1773
Styloniscia sp.
Tachysoma sp.
Urosoma sp.

Aspidiscidae Ehremberg, 1838
Aspidisca cicada
Dujardin, 1842
Aspidisca lynceus O.F. Müller, 1773
Aspidisca turrita
Ehremberg, 1831

Euplotidae Ehremberg, 1838
Euplotes aediculatus (*) Pierson, 1943
Euplotes affinis
Dujardin, 1841
Euplotes eurystomus (*)
Wrzesniowski, 1870
Euplotes moebiusi (*) Kahl, 1932
Euplotes patella O.F. Müller, 1773
Euplotes sp.
Diophrys scutum
Dujardin, 1842

The same species were also arranged according to alphabetical order (Table 1), to give a more complete picture as far as the following points are concerned: *(a)* the station where each species was found (vertical columns: Lake = L, Burlamacca canal = B, Collettore canal = Co, chiaro = Ch); *(b)* the sample where each species was found: b = bottom (sediment-water interface), s = surface (upper water column); *(c)* the trophic niche of each species (column on the left): A = algivorous; B = bacterivorous; C = carnivorous; O = omnivorous.
The 125 species quoted above, describe a very rich and articulated community, far richer than the three species (*Prorodon ovum*, *Colpidium sp.* and *Ophryoglena flava*) reported by Brunelli and Cannicci (1942). Our findings cannot be considered as conclusive, as far as the description of the species of the ciliates of Lake Massaciuccoli is concerned. However, in the last four months of the monitoring period, all of the specimens we isolated belonged to species already found in the previous samples. This seems to support the idea that, although not complete in absolute, our list should be considered, at least, very thorough.
The large number of the species of ciliates clearly shows how much such a community contributes to the richness of the biodiversity in the Lake we studied. The importance of the ciliates for the life of the entire lake becomes very clear once one takes into account the roles they play, as far as both energy and substance flows are concerned, as stated by the concept of "microbial-loop«, first introduced by Azam *et al.* (1983) and later discussed very clearly by Fenchel (1987).
Several general considerations must now to be made to identify the most typical characteristics of the ciliates of Lake Massaciuccoli.

A - *The species found both at the surface and at the bottom level of the four stations: L (Lake), B (Burlamacca), Co (Collettore), Ch (Chiaro).*

The species most frequently found were *Aspidisca cicada* (Hypotrichida), *Coleps hirtus* (Gymnostomata), which was present in each station throughout the year, *Cinetochilum margaritaceum* (Hymenostomata).
Vorticella sp. (Peritrichida) proved to be more typically present in L and B and more frequently at the surface level; also *Askenasia volvox* and *Strombidium sp.* (Haptorida) were found more frequently in the same L and B.
Oxytricha sp. (Hypotrichida) was mainly found at the level of the bottom of L, B, Co and Ch, while *Cyclidium glaucoma* and *Cyclidium sp.* (Scuticociliatida), *Litonotus sp.* (Pleurostomatida) and *Holosticha sp.*(Hypotrichida) were found commonly in B, Co, Ch and only seldom in L. *Frontonia sp.* and *Pleuronema sp.* (Hymenostomatida), although they were present at both the upper and the lower level of the water column of the four stations, they characterized more clearly the benthic community of Co and Ch.
Stentor sp. and less frequently *S. coeruleus* (Heterotrichida) tended to be present mostly at the surface level of B, while on the contrary *Chaenea vorax* (Haptorida) characterized the bottom levels of L, Co and Ch.

B - *The species characterizing the benthic communities.*

These species prefer anaerobic conditions and tend to settle preferentially at the bottom level, whenever the dissolved oxygen tends to disappear: they are *Epalxella exigua*, *Saprodinium dentatum* (Odontostomatida), *Metopus sp.* (Heterotrichida) and *Loxodes vorax* (Karyolectida). They were found in L, Co and Ch while they never occurred in B.
These species characterize the sulphurete community (Fenchel, 1987), which is a very stressful habitat due to its anoxic conditions, in turn due to the heavy release of H_2S by the sulfobacteria colonizing such a habitat.

C- *The species characterizing the planktonic communities.*

This group of species was found prevalently in L and B:*Carchesium polypinum*, *Zoothamnium sp.* and *Vaginicola crystallina* (Peritrichida). The non-sessile peritrich *Telotrochidium hennenguyi* and the oligotri-

ch *Tintinnidium fluviatile* were found only seldom, but whenever they were present, their number was very high.

D - *The trophic niches.*

The bacterivorous-detritivorous ciliates were far the most commonly found in the four stations, both at the surface and at the bottom levels. The species typically representative of these trophic niche are the following: *Aspidisca cicada, Cinetochilum margaritaceum, Cyclidium glaucoma, Loxodes vorax, Oxytricha sp., Strombidium sp., Tintinnidium fluviatile, Vorticella sp..*
The most common algivorous ciliates are *Stentor sp., S. coeruleus, Frontonia sp., Stylonychia mytilus* and *Chilodonella sp.*. Among the carnivorous species, more frequently settling at the bottom level, the most frequent are *Prorodon sp., Chaenea vorax, Didinium nasutum, Loxophyllum meleagris* and *Litonotus sp.*.
As for the omnivorous ciliates it must be noticed that in spite of their very large number, they are represented by only one species, *Coleps hirtus*, while *Lembadion sp.* and *Condylostoma vorticella* occur only rarely.

Final considerations

The complex of the species of Lake Massaciuccoli up to now found enables us to draw comparisons with the findings of other authors in lakes with similar climatic conditions. Generally speaking, it can be said that the very wide overlapping of the species (both qualitatively and quantitatively) seems to suggest that our data describe a freshwater basin quite similar to these described for other lakes (Laybourn-Parry *et al.*, 1990; Bark, 1981; Madoni, 1989) and for shallow pond (Hatano and Watanabe, 1981; Madoni, 1990).
The same is true also when we compare Lake Massaciuccoli with the other Italian lakes, already mentioned in the introductory remarks: this seems to suggest that the peculiar geo-paleonthological story of this lake does not imply necessarily that the species of ciliates living in its waters differ from those of the other lakes already studied from this point of view.
Coleps hirtus (Nitzsch, 1817) should be mentioned specifically because it was already present, in all of the stations, both at the bottom and at the surface level: this finding well fits with its widespread occurrence not only in ricefields (Madoni, 1986), but also in ponds and in lakes (Madoni, 1989, 1991).
A further general trait of the community of ciliates we found in Lake Massaciuccoli which compares well with those of similar environments, among the different trophic components, is that the filter feeders represent by far the largest percentage (65%-75%) of the entire community. The same numerical ratio between the filter-feeders and the other niches has been observed and described in many lakes (Pratt and Cairns, 1983) and also in a small pond, near Parma (Madoni, 1991).
To conclude the faunistic note, it is important to enphasize that the study *(a)* represents the first and very thorough description of the community of ciliated protozoa in Lake Massaciuccoli, and that *(b)* on the basis of the well known value of these organisms as bioindicators (Ricci,1995), it represents a precious tool for the management of Lake Massaciuccoli itself.

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