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Planktonic communities of Lake Cadagno, Piora Valley

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Abstract-The aim of this study is to analyze the species composition of zooplankton and phytoplankton living in the mixolimnion, monimolimnion, and particularly the chemocline layers of Lake Cadagno. Lake Cadagno, situated in the Piora Valley, has been the subject of significant scientific interest due to its unique water column stratification. A total of 61 species were identified in the lake during sampling conducted across three layers - mixolimnion, chemocline, and monimolimnion - in July 2023. Most species belonged to the ciliate group, comprising 14 species. The mixolimnion layer exhibited the highest species diversity. In the monimolimnion layer, a notable diversity of microalgae was observed, predominantly Chlorophyta and Diatom groups. The most prevalent groups across the three layers were Ciliophorans in the mixolimnion, Chlorophyta, and Diatoms in the chemocline and monimolimnion layers. The significance of Lake Cadagno's unique characteristics in sheltering diverse zooplankton, phytoplankton and bacterioplankton species can be attributed to its physio-chemical conditions.

Keywords- Stratification, Microalgae, Ciliate Group, Sampling, Layers.

I. INTRODUCTION

The Piora Valley, an east-west extending valley of glacial origin [8]. This valley is located in the Canton of Ticino, Switzerland. This area is renowned as one of the cradles of limnology, the study of inland waters, owing to its rich hydrological heritage and diverse limnological processes.

In recent years, scientific attention has been primarily directed towards Lake Cadagno, notable for its unique stratification of the water column, known as meromixis. Meromictic Lake Cadagno is a permanently stratified system with a persistent microbial bloom within the oxic-anoxic boundary called the chemocline [9]. This phenomenon includes two distinct water layers, the mixolimnion (upper, oxic) and the monimolimnion (lower, anoxic), with the chemocline marking the transition between them (the oxic-anoxic boundary). Lake Cadagno serves as a focal point for studies due to meromixis. Among aquatic environments, meromictic lakes are ideal ecosystems to study bacterial diversity in confined and stratified systems [6].

Over two centuries, Piora Valley and Lake Cadagno have been the subject of more than 260 scientific publications, predominantly in the fields of hydrobiology, microbiology, and other natural sciences. While many studies have focused on measuring physicochemical parameters and bacteria, relatively few have included ciliates. However, ciliates are integral components of aquatic microbial food webs, playing essential roles in energy flow and material circulation within aquatic ecosystems [11]. This study specifically targeted planktonic communities, with a particular emphasis on ciliates.

II. METHODS AND MATERIALS

Lake Cadagno is an alpine meromictic lake in the Piora Valley at 1921m in the southern part of Switzerland [9]. This lake reaches a depth of 21 meters. This study was carried out in July 2023. Figure 1 illustrates that sampling was conducted at the deepest point of the lake. The sampling encompassed three layers: mixolimnion (0-9 m), chemocline (12.45 m), and monimolimnion (13.5-16.5 m). One sample was collected from each layer using the standard method, which involved an integrated net haul with a mesh size of 10 µm.

For every layer of the lake, the parameters of temperature (°C), conductivity (MS/cm), turbidity (FTU), and saturation (%) were measured. A multiparameter probe (TD115M, Sea & Sun Technology, Trappenkamp, Germany) was utilized to measure these abiotic parameters.

Species identification relied on literature sources, encompassing identification keys, publications, and books, referring ([3], [4], [5]), [7] and [10]. Additionally, for further species identification, we employed the DAPI method to colorize dead cells.

Samples from each layer were preserved in 2% formaldehyde solution. Two filters were employed: a 1.2 µm cellulose nitrate filter and a 1 µm polycarbonate track etched membrane. We utilized 20 ml of sample from the mixolimnion and chemocline layers, and 40 ml for the monimolimnion layer. Using a pump, the sampling water was filtered through the two membranes. Subsequently, 70 µl of DAPI was added drop by drop with a pipette into the remaining water. After 7 minutes, the water with DAPI was also pumped out. Microscope slides were prepared by placing a polycarbonate membrane and adding a drop of CargilleType A oil.

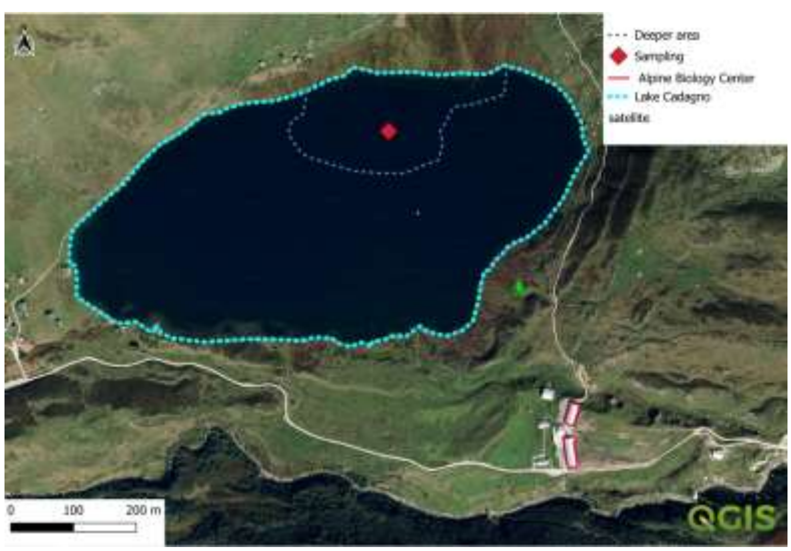

Figure 1. Map of Lake Cadagno and the sampling site.

III. RESULTS AND DISCUSSIONS

Table 1: List of total taxa of planktonic communities in the sampling site for each sampling layer (mixolimnion, chemocline, monimolimnion).

Nr.	Taxa	Mixolimnion	Chemocline	Monimolimnion
	Zooplankton			
	Ciliophora			
	Litostomatea			
1.	*Litonotus cygnus*	+		
2.	*Litonotus lamella*	+		
	Prostomatea			
3.	*Urotrichia sp.*	+		
4.	*Urotrichia pseudofurcata*	+		
	Oligohymenophorea			
5.	*Peritrichia sp.*	+		
6.	*Uronema nigricans*		+	+
7.	*Cyclidium heptatrichum*		+	
8.	*Vorticella aquadulcis*	+		
	Oligotrichea			
9.	*Halteria giurdanella*	+		
	Heterotrichea			
10.	*Spirostomum teres*		+	+
11.	*Metopus es*			+
	Kinetofragminophora			
12.	*Amphileptus procerus*	+		
	Spirotrichea			
13.	*Rimostrombidium lacustris*	+		
14.	*Rimostrombidium sp.*			
	Rotifera			
	Eurotatoria			
15.	*Kellicottia sp.*	+		
16.	*Kellicottia longispina*	+		
17.	*Asplanchna sp.*	+		
18.	*Keratella quadrata*	+		
	Monogononta			
19.	*Ascomorpha sp.*	+		
20.	*Filinia longiseta*	+		
21.	*Collotheca mutabilis*	+		
22.	*Conochilus hippocrepis*	+		
23.	*Polyarthra major*	+		
	Crustacea			
	Branchiopoda			

24.	*Bosminia sp.*	+	+	
25.	*Bosminia longirostris*	+		+
26.	*Bosminia coregoni*	+		
27.	*Daphnia sp.*	+		+
28.	*Nauplius sp.*			+
	Copepoda			
29.	*Eudiaptomus sp.*	+		
30.	*Eudiaptomus gracilis*	+		
31.	*Diaptomus sp.*	+		
	Phytoplankton			
	Dinoflagellata			
	Dinophyceae			
32.	*Ceratium sp.*	+		+
33.	*Ceratium hirudinella*	+		
	Chlorophyta			
	Chlorophyceae			
34.	*Pediastrum sp.*	+		
35.	*Kirchneriella obesa*	+		
36.	*Coenocystis sp.*		+	
37.	*Coenocystis ampla*	+	+	
38.	*Gloeocystis sp.*			+
39.	*Gloeocystis vesiculosa*	+		
40.	*Scenedesmus sp.*		+	+
41.	*Scenedesmus disciformis*	+		
42.	*Chlamydomonas sp.*		+	
43.	*Pandorina sp.*	+		
	Trebouxiophyceae			
44.	*Crucigeniella sp.*	+		+
45.	*Chlorella sp.*			+
46.	*Oocystis sp.*	+		
	Diatomea			
	Bacillariophyceae			
47.	*Gomphonema sp.*	+	+	+
48.	*Navicula sp.*	+	+	
49.	*Cymbella sp.*	+	+	
50.	*Acnanthes sp.*	+		
51.	*Nitzschia sp.*	+		
52.	*Cocconeis sp.*			+
	Fragilariophyceae			
53.	*Asterionella sp.*			+
54.	*Asterionella formosa*	+		
55.	*Fragilaria sp.*		+	+

	Cryptophyta			
	Cryptophyceae			
56.	*Cryptomonas phaseolus*		+	
57.	*Rhodomonas sp.*	+		
	Heterokontophyta			
	Chrysophyceae			
58.	*Uroglena sp.*	+		
59.	*Tabellaria flocculosa*			+
	Bacterioplankton			
	Cyanobacteria			
	Oscillatoriophycideae			
60.	*Oscillatoria sp.*	+		
	Bacteria			
	Gammaproteobacteria			
61.	*Chromatium okenii*		+	+
	Total	44	14	17

A total of 61 taxa of planktonic communities were identified across the three sampling layers: mixolimnion, chemocline, and monimolimnion, with 44, 14, and 17 taxa, respectively, as depicted in Table 1. Among these, 31 zooplankton, 28 phytoplankton species, and 2 bacterioplankton were identified from all samples combined. The highest diversity of species was found in the mixolimnion layer. We hypothesize that the highest species diversity in the mixolimnion layer correlates with ecological condition parameters measured by the probe. Temperature, as measured by the probe, decreases from the mixolimnion layer to monimolimnion layer. Conversely, saturation increases, while turbidity increases from the mixolimnion to chemocline and then decreases form chemocline to the monimolimnion layer (see Figure 3). Based on these parameters, we observe a decrease in the number of taxa from the mixolimnion to chemocline respectively from 44 to 14 taxa (see Table 1).

Ciliophora and Chlorophyta were the most represented groups respectively with 14 and 13 taxa dominated in all three layers. The most represented groups in the three different layers were Ciliophora for mixolimnion, Chlorophyta and Diatomea for chemocline and monimolimnion. The most frequent species found in mixolimnion were *Kellicottia longispina, Eudiaptomus sp., Daphnia sp., Keratella quadrata.* For chemocline the most frequent species were *Chromatium okenii, Chryptomonas sp.* and *Uronema nigricans. Uronema nigricans* is the most frequent species because is a tolerant specie to the low O_2 values. In monimolimnion layers the most frequent species were *Gleocystis sp., Crucigeniella sp., Chromatium okenii, Spirostomum teres.* The development of a rich zooplankton assemblage in this lake is explained by its physic-chemical conditions. The meromictic condition yields a relatively high productivity and provide zooplankton with e refuge against fish predation in the hypoxic and turbid water layers at the edge of the chemocline [1].
In the monimolimnion layer there were a high diversity of microalgae that have been identified. In this layer we found 5 groups with 11 species with a dominance of Chlorophyta and Diatomea. Maybe this is related to the low O_2 tolerance they have, and they can survive for some time in this layer even if there is no light.
In monimolimnion layer it was also frequent *Metopus es* that is an anaerobic ciliate, and it can live in the ecological condition characteristic of this layer. Eukaryotic primary producers in the anoxic zones are dominated by *Cryptomonas phaseolus*, whereas eukaryotic heterotrophs are represented by ciliates, rotifers, and crustaceans. The use of DAPI method helped us to fix and further identify the species.

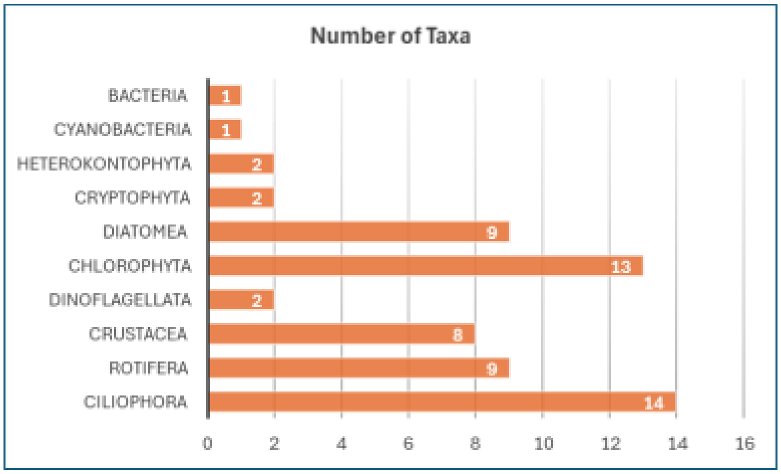

Figure 2. Number of taxa for each group in each sampling layer.

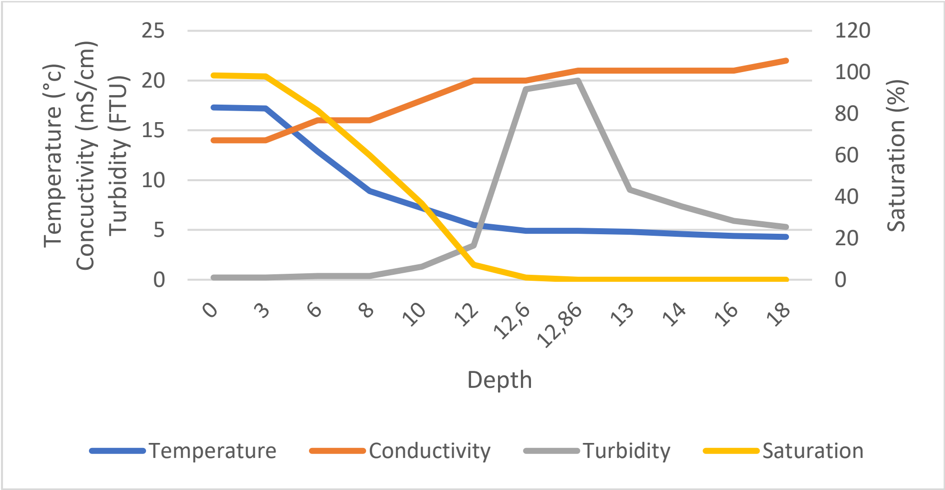

Figure 3. Physical-chemical parameters values in each sampling layer.

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V. CONCLUSIONS

-Lake Cadagno is a meromictic lake boasting a high diversity of planktonic species, particularly Ciliates, other protists, and phytoplankton.

-Within Lake Cadagno, 14 different species of Ciliates and 13 different species of Chlorophytes, which dominate other groups, have been identified.

-The varying ecological conditions of this lake provide habitat for numerous oxen and anoxic species. *Mutopus es*, an anaerobic species, was very frequent in the monimolimnion layer.
-The development of a diverse zooplankton community in this lake can be attributed to its physicochemical condition with a total of 31 zooplankton species recorded.
-Despite the absence of light, the monimolimnion layer shelters a rich diversity of microalgae, with 11 different species, primarily dominated by Chlorophyta and Diatom groups.

REFERENCES

1. Bertoni R., Callieri C. & Pugnetti A.1998. Dinamica del carbonio organico nel Lago di Cadagno e attività microbiche nel mixolimnio. In: Peduzzi, R., R. Bachofen and M. Tonolla (eds), Lake Cadagno: a meromictic alpine lake, Documenta Ist. Ital. Idrobiol., 63: 105-120.
2. Bossard P. *et al.* (2001): Limnological description of the Lakes Zürich, Lucerne and Cadagno. Aquat.sci. 63: 225-249.
3. Foissner W. *et al.* (1992): Taxonomische und ökologische Revision der Ciliaten des Saprobiensystems. Band II: Peritrichia, Heterotrichia, Odontostomatida. Heft 5/92.
4. Foissner W. *et al.* (1994): Taxonomische und ökologische Revision der Ciliaten des Saprobiensystems. Band III: Hymenostomata, Protostomatids, Nassulida. Heft 1/94.
5. Foissner W. *et al.* (1999): Identification and ecology of limnetic plankton ciliates. Reports issue 3/99.
6. Gulati RD, Zadereev ES, Degermendzhi AG Editors. Ecological Studies 228 Ecology of Meromictic Lakes. Springer 2017.
7. Linne von Berg K.-H. *et al.* (2004): Der kosmos-algenfürher. KOSMOS-naturführer.
8. Peduzzi R., Wildi W. (2016): Piora – Lago di Cadagno – Ritom: Natur- und Umweltführer/ A guide to nature and environment. Bellinzona: Centro Biologia Alpina: 95.
9. Saini J. *et al.* (2023): Genomic insights into the coupling of a Chlorella-like microeukaryote and sulphur bacteria in the chemocline of permanently stratified Lake Cadagno. The ISME Journal, 17: 903-915.
10. Streble H. *et al.* (2017): Das leben im wasser-tropfen. KOSMOS-naturfürher.
11. Wang Z. *et al.* (2022): Biodiversity of freshwater ciliates (Protista, Ciliophora) in the Lake Weishan Wetland, China: the state of the art. Marine Life Science & Technology, 4: 429-451.