Transitional Waters Bulletin
TWB, Transit. Waters Bull. 7 (2013), n. 2, 124-132
ISSN 1825-229X, DOI 10.1285/i1825229Xv7n2p124
http://siba-ese.unisalento.it

RESEARCH ARTICLE

Taxonomic composition of the phytoplankton community of Lesina lagoon (Apulia-Italy)

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Abstract

1 - Transitional waters are characterized by specific ecological features and an intrinsic heterogeneity; because of their high vulnerability they need particular conservation and management measures, specifically based on the knowledge of their biological and taxonomic diversity.

2 - In particular, the study of phytoplankton communities is widely used as an important water quality indicator because of its high species richness and sensitivity to environmental factors.

3 - This study investigated the phytoplankton community of the Lesina lagoon, describing its taxonomic composition and abundance in order to provide a systematic list that could be useful to improve our knowledge of the Lesina lagoon biological features and, in general, of transitional water phytoplankton communities.

4 - In the whole sampling area we identified 62 taxa, belonging to 18 classes or groups; Dinophyceae were the taxonomic group with the highest percentage of overall phytoplankton cell density (16.2 %), following by Cryptophyceae (11.0%) and Bacillariophyceae (10.1%). No dominant taxa were found considering all studied area.

5 - Phytoplankton taxonomic structure in the Lesina lagoon was characterized by Dinophyeceae and Bacillariophycea and also by a large number of species of small dimensions (particularly Phytoflagellates and Cryptophyceae), that are typical of the environments, like transitional waters, characterized by high instability in the structural characteristics of the water mass and in resource availability.

Keywords: Lesina lagoon; phytoplankton; taxonomic list.

Introduction

Transitional waters are characterized by specific ecological features and an intrinsic heterogeneity, mainly due to their specific geomorphology, catchment area geology, and geographic location, as well as to differences in freshwater runoff and tidal salt water exchanges. Human activity can also be an important source of habitat heterogeneity, resulting from different land uses in the catchment area (e.g. agriculture, tourism, etc.).

Hence, transitional waters are vulnerable ecosystems that need particular conservation and management measures, specifically based on the knowledge of their biological and taxonomic diversity (Lucena-Maya *et al.*, 2010).

The study of phytoplankton communities is widely used as an important water quality indicator because of its high species richness and sensitivity to environmental factors (Murphy *et al.,* 2002). As primary producers, the phytoplankton is directly influenced by physical and chemical factors. Changes in phytoplankton community status have direct implications for the bio-integrity of the transitional water ecosystem as a whole. Phytoplankton include prokaryotic cyanobacteria and eukaryotic algal groups (such as Chlorophytes, Crysophytes, Cryptophytes, Bacillariophyta and Dinophyta) (Vadrucci *et al.*, 2008). As in other water bodies, they account for the bulk of primary production and play an important role in carbon, nutrient and oxygen cycles in transitional water ecosystems. Studies of algal responses to environmental heterogeneity in transitional waters have demonstrated the direct effects of abiotic factors on their survival, growth and reproduction (Pearl *et al.*, 2005). Various authors (Lucas *et al.*, 1999; Ferreira *et al.*, 2005) have shown that phytoplankton biodiversity and dynamics in transitional waters are controlled by factors such as flushing rate, residence time, depth, salinity, light and nutrient concentrations. These regulate the balance between immigration and emigration of species from the input and output environments (the stochastic component of taxonomic diversity), and determine the competitive advantage of the best-adapted species to actual local environmental conditions (the deterministic component of taxonomic diversity).

Moreover algae generally have high reproduction rates and very short life cycles, making them valuable indicators of short-term (scales of days—weeks) impacts. Anthropogenic factors include enrichment by nutrients and organic material as well as physical and hydromorphological impacts, such as increased turbidity and reduced tidal action from physical constructions (Sommer, 1989; Gallegos *et al.*, 1992; Harding, 1994; Cloern, 2001). Variability in the phytoplankton communities can be observed in terms of the occurrence of individual species, their relative abundances, and the timing and frequency of blooms.

Therefore, phytoplankton provides a good indication of water trophic state, measurable, because of high sensitive to some pollutants which may not visibly affect other aquatic assemblages or may only affect other organisms at higher concentrations (e.g. for herbicides see Nyström *et al.*, 1999; Netherland *et al.*, 2009). Phytoplankton community is a natural bioindicator because of its complex and rapid responses to fluctuations of environmental conditions; hence it can provide finer-scale assessment of changes due to ecological impacts (Livingston, 2001).

The aim of this study was to investigate the phytoplankton community of the Lesina lagoon (Apulia-Italy), describing its taxonomic composition and abundance in order to provide a systematic list that could be useful to improve our knowledge of the Lesina lagoon biological features and, in general, of transitional water phytoplankton communities.

Materials and Methods

Study area

The Lesina Lagoon (Fig. 1), located on the southern Adriatic coast of Italy (Puglia region), is a non tidal transitional water body, characterised by shallow waters (0.7-1.5 m) with an area of 51 km^2. The lagoon is connected to the sea through two channels: Acquarotta (2 km long), and Schiapparo (1 km long). The salinity of the lagoon ranges between 20.0 and 29.5 while water

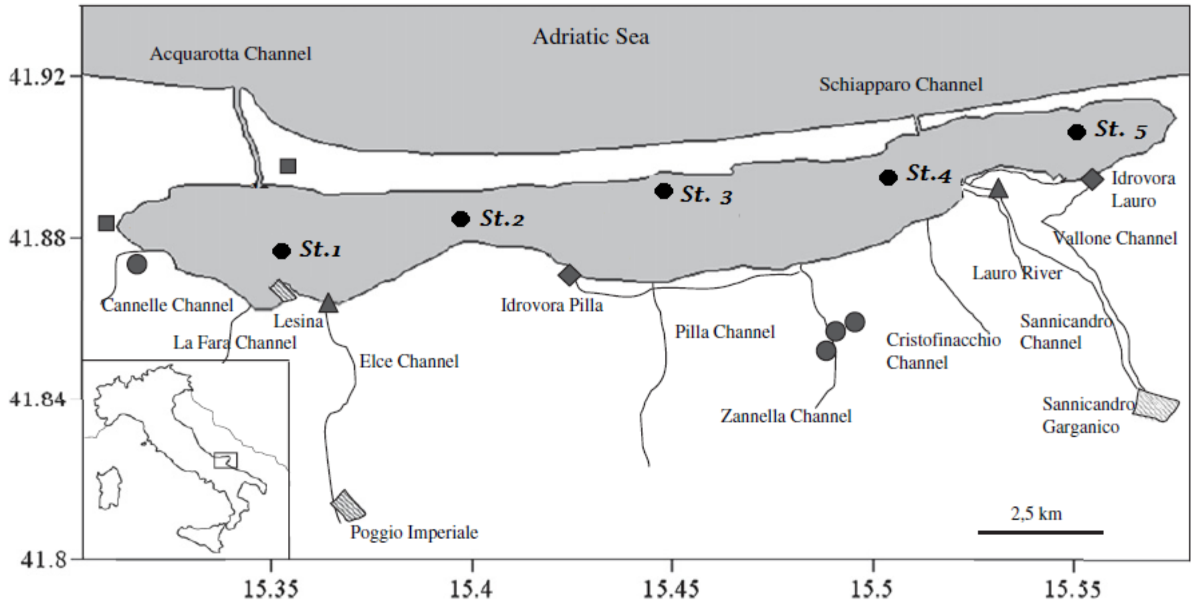

Figure 1. Figure 1: Study site (Lesina lagoon, Apulia-Italy), showing sampling stations: ● Fish farm; ▲ urban wastewater treatment plants; ■ livestock farms; ◆ drainage pumping stations (Idrovora Lauro and Idrovora Pilla (map modified from Roselli at al 2009).

temperature ranges from 10 °C in winter to 29 °C in summer. No stratification exists in the water column. The hydrological heterogeneity in the lagoon is strongly influenced by meteorological conditions, continental inputs and low tidal exchange (Roselli *et al.*, 2009). Numerous watercourses flow into the basin, mainly along its southern edge, entering wastewater discharges from three municipalities with a total of 30000 inhabitants, aquaculture plants and agricultural runoff from 21000 ha of arable land. Nevertheless, potentially the lagoon has a low vulnerability to human activities even though eutrophication events are registered (Vignes *et al.*, 2009). During summer 2008, the whole of the western part of the lagoon was affected by a severe dystrophic crisis resulting in hypoxic conditions for about a month (Roselli *et al.*, 2009) and affecting all ecosystem compartments (Specchiulli *et al.*, 2009; Vadrucci *et al.* 2009). Among the causes of this dystrophic event may have include the extreme climate events, strong microbial decomposition processes and reduced hydrodynamism (Roselli *et al.*, 2009; Vignes *et al.*, 2009).

Biological sampling and identification

The sampling was carried out during the third week of September 2009. Five stations were selected along a gradient of eutrophication from the western to the eastern part of the lagoon (Fig. 1), following the experience achieved with the monitoring programme and the analysis of a dystrophic crisis event in 2008. At each station, 3 replicate water samples were collected for phytoplankton, using a Ruttner bottle. Samples were transferred to PET bottles and immediately fixed with 1% Lugol's solution (15mL per litre of sample). Water samples were kept at 4°C in a dark place and were analyzed no more than two months after sampling.

Taxonomic composition of nano- and

microphytoplankton guilds was assessed using Utermöhl's method (Utermöhl, 1958). Phytoplankton counts were performed using inverted microscope (Nikon T300E, Zeiss IM. 35; Leica, Fluovert Fu), at 400xmagnification, after sedimentation of 5 to 50 ml subsamples. For each subsample, 400 cells of the most abundant phytoplankton species were counted and identified. Rare species were counted and identified by screening the whole bottom of the sedimentation chamber. The minimum cell size considered for counting was 5 µm. Phytoplankton nomenclature followed Tomas (1997), Rampi and Bernhard (1980a; 1980b; 1980c), Schiller (1933-1937), Sournia (1986; 1987), Cupp (1943) and Dodge (1982).

Results and discussion

The list of phytoplankton taxa is shown in Appendix 1. In the whole sampling area we identified 62 taxa, belonging to 18 classes or groups, including 15 Dinophyceae, 9 Bacillariophyceae, 6 Mediophyceae and Coscinodiscophyceae, while the remaining classes (Prymnesiophyceae, Prasinophyceae, Cryptophyceae, Chlorophyceae, Mamiellophyceae, Euglenophyceae, Chrysophyceae, Trebouxiophyceae, Synurophyceae, Phytoflagellates, Pedinophyceae, Cyanophyceae and Bodonophyceae) accounted for less than 4 taxa each.

The stations 1 and 3 recorded the highest value of taxa (39), while the station 5 showed the minimum one (32).

More than 30.6% of phytoplankton taxa were common to all stations, while the 27.4% (19 taxa) were observed in only one station.

Quantitatively, considering the whole ecosystem, Dinophyceae were the taxonomic group with the highest percentage of overall phytoplankton cell density, (16.2 %), following by the Cryptophyceae (11.0%) Bacillariophyceae (9.6%) and Prasinophyceae (8.6%); the other classes remained under the 6 %, with the minimum recorded for the Cyanophyceae (0.3%).

The percentage contribution (% of abundance of cell density) of the identified classes in each station is reported in Table 1. In station 1 the class of Cryptophyceae recorded the highest values of abundance followed by Dinophyceae and Mediophyceae (see Table 1). While, in stations from 2 to 5 the Dinophyceae was the class most abundant, followed by Bacillariophyceae and Cryptophyceae (see Table 1).

In the 5 monitored stations, the dominant taxon was Cryptophyceae undet. although showing a different cumulative abundance (between the 72 and 100 %).

Phytoplankton taxonomic structure in the Lesina lagoon was characterized by Dinophyeceae and Bacillariophycea and also by a large number of species of small dimensions (particularly Phytoflagellates and Cryptophyceae). Similar results have been reported in other studies carried out in estuarine or transitional water ecosystems in temperate regions (Raymont, 1980; Giacobbe *et al.*, 1996; Watson *et al.*, 1997; Mallin *et al.*, 2000), in the Mediterranean basin (Vadrucci *et al.*, 2008), and in the same ecosystem under a dystrophyc event (Vadrucci *et al.*, 2009).

Various authors (e.g. Margalef, 1978; Reynolds, 1997) indicate that these taxa of small dimension are in general typical of the environments characterized by high instability in the structural characteristics of the water mass and in resource availability, which is usual of transitional water ecosystems. In such situations, phytoplankton community organization is weak and primitive, and typically dominated by opportunistic species of small dimensions with high replication rates and high surface/ volume ratios, able to respond rapidly to environmental change. However, there is no certainty about which species arrive first or in what proportions; stochastic processes will thus play a significant role in determining the composition of the community.

This is supported by the significant level of

Table 1 - Percentage contribution (% of abundance of cell density) of the identified classes in each station (maximum values in bold).

	Percentage abundance				
	Stations				
Classes	***1***	***2***	***3***	***4***	***5***
Bacillariophyceae	7.6	14.5	16.9	11.7	7.9
Bodonophyceae	2.7	3.1	0.0	0.0	0.0
Chlorophyceae	5.9	5.8	7.6	4.6	3.1
Chrysophyceae	4.1	2.8	2.4	2.3	3.2
Coscinodiscophyceae	7.2	3.1	4.9	2.3	6.3
Cryptophyceae	**12.5**	8.4	7.4	9.3	8.4
Cyanophyceae	0.0	0.0	0.0	2.3	3.1
Dinophyceae	11.5	**19.4**	**24.0**	**30.1**	**26.5**
Euglenophyceae	2.1	2.7	4.7	4.7	6.0
Mamiellophyceae	5.0	2.6	4.9	2.3	3.1
Mediophyceae	10.2	3.1	0.0	4.7	5.3
Pedinophyceae	2.1	2.8	2.5	2.3	3.1
Phytoflagellates	2.2	2.8	2.4	2.3	2.9
Prasinophyceae	9.6	8.8	7.5	4.6	5.9
Prymnesiophyceae	6.0	8.7	7.3	7.0	9.1
Synurophyceae	2.6	2.8	2.4	2.4	3.1
Trebouxiophyceae	2.0	2.8	2.5	2.4	0.0
Others Phytoflagellates	6.5	5.9	2.5	4.7	2.9

taxonomic heterogeneity.

Ecosystems with high salinity, like Lesina lagoon, are characterized by the presence of marine species with high tolerance to salinity stress; these results could assist the identification of typical phytoplankton associations in transitional water ecosystems determined by geomorphological and hydrodynamic characteristics or geographic location, which is also in accordance with descriptions of associations in freshwater and marine habitats (Harris, 1987; Reynolds, 1997; Smayda, 2002). The knowledge of the interhabitat variability of the phytoplankton guilds and its determining factors it'is fundamental for the definition of the plans of management and conservation of the transition waters.

Acknowledgements

The authors would like to thank dr Lea Roselli and dr Luca Mazzotta for helping with field campaign. This research was supported by the European Union under the 7th Framework Programme, through the project titled WISER: water bodies in Europe: Integrative systems to assess Ecological status and recovery.

References

Cloern JE 2001. Our evolving conceptual model of the coastal eutrophication problem. *Marine Ecology Progress Series* 210: 223–253.

Cupp E 1943. *Marine Plankton Diatoms of the West Coast of North America*. University of California press Berkeley, California.

Dodge JD 1982. Marine Dinoflagellates of the British Isles, London: her majesty's stationary office.

Ferreira JG, Wolff WJ, Simas TC, Bricker SB 2005. Does biodiversity of estuarine phytoplankton depend on hydrology? *Ecological Modelling* 187: 513–523.

Gallegos CL, Jordan TE, Correll DL 1992. Event scale response of phytoplankton to watershed inputs in a subestuary: timing, magnitude and location of blooms. *Limnology and Oceangraphy* 37: 813–828.

Giacobbe MG, Vadrucci MR, Puglisi A, Maimone G, Magazzù G 1996. Ciclo annuale del fitoplankton nello stagno di Acquatina in relazione alle condizioni ambientali. *Società Italiana di Ecologia Atti* 17: 451–454.

Harding L 1994. Long term trends in the distribution of phytoplankton in Chesapeake Bay: roles of light, nutrients and stream flow. *Marine Ecology Progress Series* 104: 267–291.

Harris RP 1987. Spatial and temporal organization in marine plankton communities. In *Organisation of Communities, Past and Present*, Gee JHR, Giller PS (eds). Blackwell Scientific: London.

Livingston RJ 2001. *Eutrophication processes in coastal systems: origin and succession of plankton blooms and effects on secondary production in Gulf Coast estuaries*. Center for Aquatic Research and Resource Management. Florida State University, CRC Press. 327pp.

Lucas LV, Koseff JR, Monismith SG, Cloern JE, Thompson JK 1999. Processes governing phytoplankton blooms in estuaries. II. The role of horizontal transport. *Marine Ecology. Progress Series* 187: 17–30.

Lucena-Moya P, Abrain R, Pardo I, Hermida B, Dominguez M 2010. Invertebrate species list of coastal lagoons in the Balearic Islands. *Transitional Water Bullettin* 4: 1-11

Mallin MA, Burkholder JM, Cahoon LB, Posey MH 2000. North and South Carolina coasts. *Marine Pollution Bulletin* 41: 56–75.

Margalef R 1978. Life forms of phytoplankton as serviva alternatives in an unstable environment. *Oceanologica Acta* 1: 493–509.

Murphy KJ, Kennedy MP, McCarthy V, O'Hare MT, Irvine K, Adams C 2002. A review of ecology based classification systems for standing freshwaters. SNIFFER Project Number: W(99)65, *Environment Agency R&D Technical Report*: E1-091/TR.

Netherland MD, Lembi CA, Poovey AG 2009. Screening of various herbicide modes of action for selective control of algae responsible for harmful blooms. *Technical Note ADA494357, U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg*: 1–12. http://handle.dtic.mil/100.2/ADA494357.

Nyström B, Björnsäter B, Blanck H 1999. Effects of sulfonylurea herbicides on non-target aquatic microorganisms. Growth inhibition of micro-algae and shortterm inhibition of adenine and thymidine incorporation in periphyton communities. *Aquatic toxicology* 47: 9–22.

Pearl HW, Dyble J, Pinckney JL, Valdes LM, Millie DF, Moisander Pia H, Morris JT, Bendis B, Piehler A 2005. Using microalgal indicators to assess human- and climateinduced ecological change in estuaries. In *Estuarine Indicators, Bortone SA (ed.)*. CRC Press: 145–172.

Rampi L, Bernhard M 1980a. Chiave per la determinazione delle diatomee pelagiche mediterranee C.N.E.N.RT/BIO.

Rampi L, Bernhard M 1980b. Chiave per la determinazione delle peridinee pelegiche mediterranee C.N.E.N.RT/BIO.

Rampi L, Bernhard M 1980c. Chiave per la determinazione delle mediterranee C.N.E.N.RT/BIO.

Raymont JEG 1980. Plankton and Productivity in the Oceans. *Phytoplankton*, vol. I (2nd edn). Pergamon Press, Oxford.

Reynolds CS 1997. Vegetation processes in the pelagic: a model for ecosystem theory. In *Excellence in Ecology, Kinne O (ed.)*. Oldendorf/Luhe, Germany.

Roselli L, Fabbrocini A, Manzo C, D'Adamo R 2009. Hydrological heterogeneity, nutrient dynamics and water quality of a non-tidal lentic ecosystem (Lesina Lagoon, Italy). *Estuarine, Coastal and Shelf Science* 84: 539-552.

Schiller J, 1933-1937. Dinoflagellatae (Peridinae). I-II. In L. *Rabenhorst Kriptogamen Flora von Deutschland, Osterreich und der Scweiz, Leipzig, Akad*. Verlag. Vol 10.

Smayda TJ, 2002. Adaptative ecology, growth strategies and the global bloom expansion of dinoflagellates. *Journal of Oceanography* 58: 281–294.

Sommer U 1989. Nutrient status and nutrient competition of phytoplankton in a shallow, hypertrophic lake. *Limnology and Oceanography* 34: 1162–1173.

Sournia A 1986. *Atlas du Phytoplancton Marin Volume I: Introduction, Cyanophycées, Dictyochophycées, Dinophycées et Raphidophycées*. Éditions du C.N.R.S., Paris.

Sournia A 1987. Atlas du Phytoplancton Marin Volume III: Diatomophycées. Éditions du C.N.R.S., Paris.

Specchiulli A, D'Adamo R, Renzi M, Fabbrocini A, Scirocco T, Florio M, Cilenti L, Breber P, Focardi SE, Vignes F, Basset A 2009. Fluctuations of physico-chemical characteristics in sediments and overlaying water during an anoxic event: a case study from Lesina lagoon. III Congresso Lagunet 1-4 october. Orbetello.

Tomas RC 1997. *Identifying Marine Phytoplankton*. Academic Press, San Diego.

Utermöhl H 1958. Zur Vervolkommnung der quantitativen Phytoplankton-Methodik. Mitteilungen der Internationalen Vereneinigung fur Theoretischeund Angewandte. *Limonologie* 9: 1-38.

Vadrucci MR, Sabetta L, Fiocca A, Mazziotti C, Silvestri C, Cabrini M, Guardiani B, Konjka E, Evangelopoulos A, Koutsoubas D, Basset A 2008. Statistical evaluation of differences in phytoplankton richness and abundance as constrained by environmental drivers in transitional waters of Mediterranean basin. *Aquatic conservation: Marine and freshwater ecosystems* 18: 88-104.

Vadrucci MR, Fiocca A, Vignes F, Fabbrocini A, Roselli L, D'Adamo R, Ungaro N, Basset A 2009. Dynamics of phytoplankton under dystrophic pressures in Lesina lagoon. *Transitional Water Bulletin* 3: 89–103.

Vignes F, Barbone E, Breber P, D'Adamo R, Roselli L, Ungaro N, Focardi S, Renzi M, Basset A 2009. Spatial and temporal description of the dystrophic crisis in Lesina lagoon during summer 2008. *Transitional Waters Bulletin* 3(2): 47-62.

Watson SB, McCauley E, Dowing JA 1997. Patterns in phytoplankton taxonomic composition across temperate lakes of different nutrient status. *Limnology and Oceanography* 42: 487–495.

Appendix 1- List of phytoplankton taxa identified in the 5 stations.

STATIONS	***1***	***2***	***3***	***4***	***5***
Bacillariophyceae					
Achnanthes sp.			●		
Ceratoneis closterium Ehrenberg (1839)	●	●	●	●	
Cocconeis scutellum Ehrenberg (1838)				●	
Cocconeis sp.	●	●		●	●
Navicula transitans Cleve (1883)		●	●		
Navicula sp.	●	●	●	●	●
Nitzschia sp.		●			
Thalassionema sp.			●		
Bacillariophyceae undet.			●		
Bodonophyceae					
Rhynchomonas nasuta (Stokes) Klebs (1892)	●	●			
Chlorophyceae					
Carteria sp.	●		●		
Chlamydomonas sp.	●	●	●	●	
Chlorophyceae undet.	●	●	●	●	●
Chrysophyceae					
Chromulina sp.	●				
Ollicola vangoorii (Conrad) Vørs (1992)	●	●	●	●	●
Coscinodiscophyceae					
Coscinodiscus sp.		●			
Melosira nummuloides Agardh (1824)	●		●		
Melosira sp.					●
Thalassiosira sp.	●		●		
Thalassiosiraceae undet.	●			●	●
Cryptophyceae					
Hillea sp.	●	●		●	
Rhodomonas sp.	●				
Cryptophyceae undet.	●	●	●	●	●
Cyanophyceae					
Merismopedia sp.				●	●
Dinophyceae					
Akashiwo sanguinea Hansen & Moestrup (2000)				●	●
Amphidinium carteri Hulburt 1957				●	●
Amphidinium sp.	●		●	●	●
Gymnodinium sp.	●	●	●	●	●
Oxytoxum sp.		●	●	●	●
Prorocentrum micans Ehrenberg (1833)		●			
Prorocentrum minimum (Pavillard) Schiller (1933)			●	●	
Prorocentrum scutellum Schröder (1900)			●	●	

Appendix 1 - Continued.

STATIONS	***1***	***2***	***3***	***4***	***5***
Dinophyceae					
Prorocentrum sp.	●	●	●	●	●
Protoperidinium depressum (Bailey) Balech (1974)			●		
Protoperidinium steinii (Jorgensen) Balech (1974)				●	
Protoperidinium sp.	●	●	●	●	●
Scrippsiella trochoidea (Stein) Balech ex Loeblich III (1965)				●	
Dinophyceae undet. (athecate)	●	●	●	●	●
Dinophyceae undet. (thecate)	●	●	●	●	●
Euglenophyceae					
Euglena sp.	●	●	●	●	●
Trachelomonas sp.			●	●	●
Mamiellophyceae					
Mamiella sp.	●	●	●	●	●
Micromonas sp.	●		●		
Mediophyceae					
Cerataulina pelagica (Cleve) Hendey (1937)					●
Chaetoceros decipiens Cleve (1873)	●			●	
Chaetoceros tenuissimus Meunier (1913)	●				
Chaetoceros wighamii Brightwell (1856)	●				
Chaetoceros sp.	●	●		●	●
Mediophyceae undet.			●	●	●
Pedinophyceae					
Resultor sp.	●	●	●	●	●
Prasinophyceae					
Pterosperma sp.	●		●		
Pyramimonas sp.	●	●			
Tetraselmis sp.	●	●	●	●	●
Prasinophyceae undet.	●	●	●	●	●
Prymnesiophyceae					
Imantonia sp.	●	●	●	●	●
Phaeocystis sp.	●				
Coccolithophorideae undet.		●	●	●	●
Prymnesiophyceae undet.	●	●	●	●	●
Synurophyceae					
Boekelovia sp.	●	●	●	●	●
Trebouxiophyceae					
Chlorella sp.	●	●	●	●	
Phytoflagellates					
Phytoflagellates undet.	●	●	●	●	●
Others phytoflagellates					
Algae undet.	●	●	●	●	●