Spatial and Temporal Distribution of Plankton in the Waters of Tomini Bay, Gorontalo City

[2]Thomas Tammu, [1,2]Femy M. Sahami, [2]Miftahul Khair Kadim

[1] femysahami@ung.ac.id
[2] Department of Aquatic Resources Management, Faculty of Fishery and Marine Sciences, Universitas Negeri Gorontalo

Abstract

This study aims to determine the spatial and temporal distribution of plankton in the waters of Tomini Gulf, Gorontalo City and Bone Bolango Regency, Gorontalo Province. Sampling was carried out at three stations, namely at Leato (Station I), Molotabu (Station II) and Olele (Station III) using a plankton net with a mesh size of 25 µm which is taken horizontally at night and during the day, once a month, i.e. from the month of February to April 2018. Observations show that the daily temporal distribution of phytoplankton is more concentrated during the day on the surface of the waters, on the contrary at night zooplankton is more concentrated on the surface. Meanwhile, monthly distribution shows that plankton concentration was higher in February. Spatially, the plankton is more concentrated at Station I (near the estuary).

Keywords: Plankton; spatial distribution; temporal distribution; Tomini.

Introduction

Plankton is an important component in aquatic life because of its important biological function as the most basic link in the food chain and an organism that occupies a major key in the marine ecosystem (Sediadi, 1986). Phytoplankton with its photosynthetic process acts as the largest primary producer in the sea (Nybakken, 1992), while zooplankton acts as primary consumers, thus becoming a link between phytoplankton and biota at the higher level of the food chain, such as yellowfin and skipjack tuna (Awwaludin, et al. 2005; Roger, 1994). The presence of plankton in waters can reflect the level of water fertility (Sachlan, 1980 in Sagala, 2009). Waters that have high primary productivity are generally characterized by a high abundance of plankton (Raymont, 1984; Simon, et al, 2009).

Information on the spatial and temporal distribution of plankton in the waters of Tomini Gulf, Gorontalo Province, has not been widely published. Tomini Gulf is one of the largest gulfs in Indonesia, with an area of about 59,500 km2, in the Fisheries Management Area 715 (WPP 715), including Maluku Sea and Seram Sea. The waters of Tomini Gulf are deep oceanic with an average depth of > 1,500 m, shaped as a funnel that opens to the East and is directly connected to the Maluku Sea, Tolo Gulf and the Sulawesi Sea (Setyadji and Priatna, 2011). The waters of Tomini Gulf in Gorontalo Province cover five districts/cities, including Gorontalo City and Bone Bolango Regency.

One of the potential fish species in the waters of Gorontalo City is Nike (Awaous sp.). Meanwhile, the utilization of Bone Bolango Regency waters is in addition to fishery activities, there are also many uses as a beach tourism site. Currently in Molotabu Village there is a Steam Power Plant (PLTU) which might have an impact on the surrounding marine waters. In the marine waters of Olele Village, there is a Regional Marine Conservation Area (KKLD) which has also been developed as a diving tourism destination.

The purpose of this study is to determine the spatial and temporal distribution of plankton in the waters of Tomini Gulf, Gorontalo City and Bone Bolango Regency, Gorontalo Province.

Research Methods

This research was conducted from January to

June 2018 in the waters of Tomini Gulf, Gorontalo City. The research location is divided into three stations each consists of three sub-stations (Figure 1). Sampling was carried out at each station with three occasions of collection on the elevenths (11th) of February, March, and April. Plankton samples were taken using a plankton net with a mesh size of 25 μm, which was stretched horizontally as far as 10 m and then put into a 100 ml sample bottle preserved with *lugol* solution (Awwaludin, et al, 2005; S Understand, et al., 2017).

Plankton identification was carried out at the Integrated Laboratory of Agriculture, State University of Gorontalo. Plankton types were identified using an identification book (Mizuno, 1979); and (Davis, 1955). Nitrate content analysis was carried out at Telaga Biru Water Quality Laboratory. The research location is shown in Figure 1.

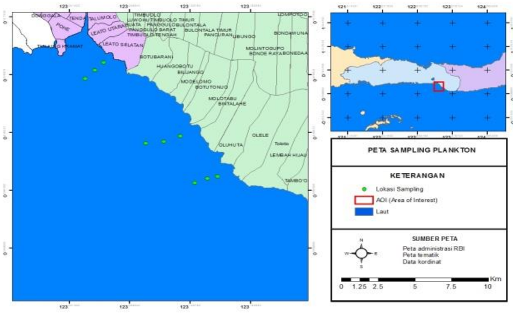

Figure 1. Sampling sites in research location

Measurement of water quality conditions was carried out before taking phytoplankton samples. The parameters measured were temperature (°C), dissolved oxygen (mg / l), acidity (pH) and nitrate content.

The abundance of phytoplankton and zooplankton was calculated using the formula in Sournia (1978). The data obtained were tabulated in the form of tables and figures. Data analysis was carried out descriptively.

Results and Discussion

Physical and chemical properties of the waters

The average value of the measured temperature at night is generally 28.5°C and 30.4°C during the day. The range of oxygen concentration values at night averaged 6.2 mg / l and at noon an average of 5.9 mg / l. The range of pH values during the observation at night averaged 6.6 and an at day time averaged 6.8. Analysis of Nitrate content measured at a range of 1.1 to 2 mg / l. The results of measuring the condition of water quality parameters during the study are presented in Table 1.

Table 1. Results of measurements of water qualities

No.	Parameters	February		March		April		Average	
		Night	Day	Night	Day	Night	Day	Night	Day
1	Temp. (°C)	28,8	30,5	28,4	30,7	28,4	30,1	28,5	30,4
2	DO (mg/l)	6,4	6,2	5,9	5,6	6,1	5,8	6,2	5,9
3	pH	7,0	7,4	6,5	6,9	6,3	6,2	6,6	6,8
4	Nitrate (mg/l)	1,8		1,0		0,7		1,1	

In general, the range of measured temperature values during the observation is still optimal for plankton growth. As stated by Wyrtki (1961) in Asih (2014), that the optimal temperature for plankton growth ranges from 25ºC to 32ºC. Furthermore, Handayani (2009) in Nursyarah (2017) states that water temperature is one of the important physical factors that affect the life of aquatic animals and plants, including plankton. The range of DO values during the study was still optimal for plankton growth. This is in accordance with Wijayanti (2011), that plankton can live well at oxygen concentrations of more than 3 mg / l. Furthermore, Sanusi (2004) in Yazwar (2008) states that the value of dissolved oxygen which ranges from 5.45 to 7.00 mg / l is good enough for the life processes of aquatic biota.

The pH values found during the study are still in optimal conditions for plankton growth. As stated by

Perdana (2016), the normal pH range for plankton growth is 6.5-8.5. Furthermore, Pescod (1973) in Pratiwi (2015) states that this pH value is influenced by several factors, including biological activity such as photosynthesis and respiration of organisms, temperature and the presence of ions in these waters. The results of the analysis of Nitrate content were found that during the whole study, it was still optimal for plankton growth. This is in accordance with the statement of Wardoyo (1982) in Iswanto (2015) which states that the optimal nitrate content for plankton growth ranges from 0.9-3.5 mg / l. Furthermore, Sidjabat (1973) in Hermana (2007) states that the distribution of nitrate in the open ocean can be said to be uniform both vertically and horizontally.

Plankton composition

The phytoplankton found during the study consisted of 12 phyla, namely Ciliphora (1 class), Crysophyta (6 classes), Chlorophyta (1 class), Cyanobacteria (2 classes), Chyanophyta (1 class), Dinoflagellata (1 class), Euglenaceae (1 class).), Hemiaulaceae (1 class), Chlorellaceae (1 class), Heterokontophyta (1 class), Radiozoa (1 class), and Rhodophyta (1 class). Phytoplankton found during the study had a fairly different spread. The Bacillrariophyceae (Diatom), Coscinodiscophyceae, Cyanophyceae and Dinophyceae classes were found at all observation stations between February and April 2018 (Table 2).

Table 2. Phytoplankton found during sampling

No	Phylum	Class	FEBRUARY						MARCH						APRIL					
			LT		MT		OL		LT		MT		OL		LT		MT		OL	
			N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D
1	Ciliophora	*Oligothrichea*	-	+	+	+	-	-	-	+	-	+	+	+	+	-	-	+	+	+
2	Crysophyta	*Bacillariophyceae*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3		*Coscinodiscophyceae*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+
4		*Cosanodiscaceae*	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-
5		*Charophyceae*	-	+	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-
6		*Mediophyceae*	+	-	+	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-
7		*Threbouxiophyceae*	+	+	+	+	-	+	-	-	-	+	+	-	+	+	+	-	+	-
8	Chlorellaceae	*Chlorophyceae*	-	-	-	-	+	+	+	-	-	+	-	-	-	-	-	-	-	-
9	Chlorophyta	*Micractiniaceae*	+	-	+	+	+	+	-	-	-	-	+	-	-	+	+	+	+	+
10	Cyanobacteria	*Cyanophyceae*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+
11		Cyanobacteria	-	+	-	-	-	+	-	+	-	-	-	+	-	-	-	-	-	-
12	Chyanophyta	*Nostocaceae*	-	+	-	-	-	+	-	+	-	-	-	+	-	-	-	-	+	-
13	Dinoflagellata	*Dinophyceae*	+	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+
14	Euglenaceae	*Euglenoidae*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
15	Hemiaulaceae	*Hemiaulaceae*	-	+	-	-	-	+	+	+	+	-	+	+	+	-	+	-	+	-
16	Heterokonphyta	*Fragilariophyceae*	-	-	-	+	-	+	+	-	+	-	-	-	-	+	+	-	+	+
17	Radiozoa	*Acantharia*	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
18	Rhodophyta	*Florideophyceae*	+	-	+	-	+	-	-	-	+	-	-	-	-	-	+	-	-	-

Remarks: LT = Leato; MT = Molotabu; OL = Olele; N = Night; D = Day; (+) = Present; (-) = Absent

Table 2 shows that the Bacillariophyceae is a class of phytoplankton found and scattered in all observation stations. Bacillariophyceae is the most tolerant type of phytoplankton and is able to adapt well to its aquatic environment, besides that Bacillariophyceae has a greater reproductive ability than other phytoplankton groups (Nurfadillah, et al, 2012). Apart from being tolerant to the environment, other factors that support the distribution of plankton during the study are the physico-chemical parameters measured during the study relatively support the growth of phytoplankton in the research location. Kennish (1990); Skaloud and Rezacova (2004) in Wulandari (2011) state that the phytoplankton which are generally found in the sea are usually in groups and consist of two dominant groups, namely Diatoms (Bacillariophyceae class) and Dinoflagellates.

The Euglenoidae and Acantharia classes were the least phytoplankton found during the study. This can be seen in Table 2 that the Euglenoidae and Acantharia classes were only found in February at Station 3 (Olele waters). According to Andriani (2016), the observation time did not significantly influence the abundance of phytoplankton in the Euglenoidae and Acantharia classes. This is in line with the results of research where the Euglenoidae and Acantharia classes were only found once in February in Olele waters. These two groups are found only in small numbers.

Unlike the case with the distribution of zooplankton found during the study, the crustacean class is a zooplankton class found at all observation stations. The distribution of zooplankton found during the study is presented in Table 3.

Table 3. Zooplankton found in sampling

No	Phylum	Class	FEBRUARY						MARCH						APRIL					
			LT		MT		OL		LT		MT		OL		LT		MT		OL	
			N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D
1	Annelida	*Polichaeta*	+	-	+	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-
2	Artopoda	*Crustacea*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3		*Hexanauplia*	-	+	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
4		*Insecta*	+	+	-	-	+	+	+	+	+	-	+	+	+	+	+	-	+	+
5		*Malacostraca*	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
6		*Maxillopoda*	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+
7	Rotifera	*Monogononta*	+	+	-	+	+	+	-	-	-	-	+	+	-	-	-	-	+	-
8		*Eurotatoria*	+	+	+	-	+	+	-	-	+	-	+	+	-	-	-	-	+	+

Remarks: LT = Leato; MT = Molotabu; OL = Olele; N = Night; D = Day; (+) = Present; (-) = Absent

Zooplankton found during the study consisted of 3 phyla, namely Artopoda (5 classes), Annelida (1 class) and Rotifera (2 classes). Table 3 shows that the zooplankton found during the study had a fairly different distribution. Crustacean, Malacostaca, and Maxillopoda classes were the dominant zooplankton classes found during the study. Zooplankton species found in all observation stations are Nauplius sp. of the Crustacean class.

Sulawesty (2007) in Setiawati (2017) states that the zooplankton group of the Crustacean class is a group that has a wide distribution and can live in various types of water and its distribution depends on the availability of feed, oxygen, sunlight and wind. In addition, the distribution pattern is also influenced by nutrients such as nitrates and phosphates. Nitrates and phosphates do not have a direct effect on zooplankton but have an effect on phytoplankton which is a source of food for zooplankton. If the phytoplankton is reduced, the food supply for zooplankton will also decrease and if the food is reduced, the zooplankton will decrease. Furthermore, Elijonnahdi, et al (2012) in Setiawati (2017) stated that zooplankton depends on phytoplankton for its nutrient source.

Temporal distribution of phytoplankton

The highest phytoplankton abundance occurred in February, with a total abundance of 59,068 ind / l at night and 114,510 ind / l during the day. Meanwhile, the lowest phytoplankton abundance was found in April, namely 32,604 ind / l at night and 65,340 ind / l during the day. The low abundance of phytoplankton in April is thought to be influenced by nitrate content. As the research results show that the lowest nitrate content value was found in April.

The phytoplankton group that had the highest abundance value was the Bacillariophyceae class with an average value of 22,242 ind / l at night and 57,047 ind / l during the day. This is slightly different from the research of Sahami, et al. (2017) which states that the phylum Chyanophyta is a phytoplankton phylum with the highest abundance, which ranges from 22.93-29.514 ind/l Phytoplankton class Bacillariophyceae (Diatom) is one of the phytoplankton that dominates all types of phytoplankton worldwide (Nybakken 1992). Research on the abundance and distribution of phytoplankton by Damar (2003); Yuliana (2012) and Wulandari (2014) also show that Bacillariophyceae (Diatom) is the most dominant.

Bacillariophyceae is the most tolerant type of phytoplankton and is able to adapt well to the aquatic environment, besides that Bacillariophyceae has a greater reproductive ability than other phytoplankton groups (Nurfadillah et al., 2012). The temporal distribution of phytoplankton found during the study is presented in Figure 2.

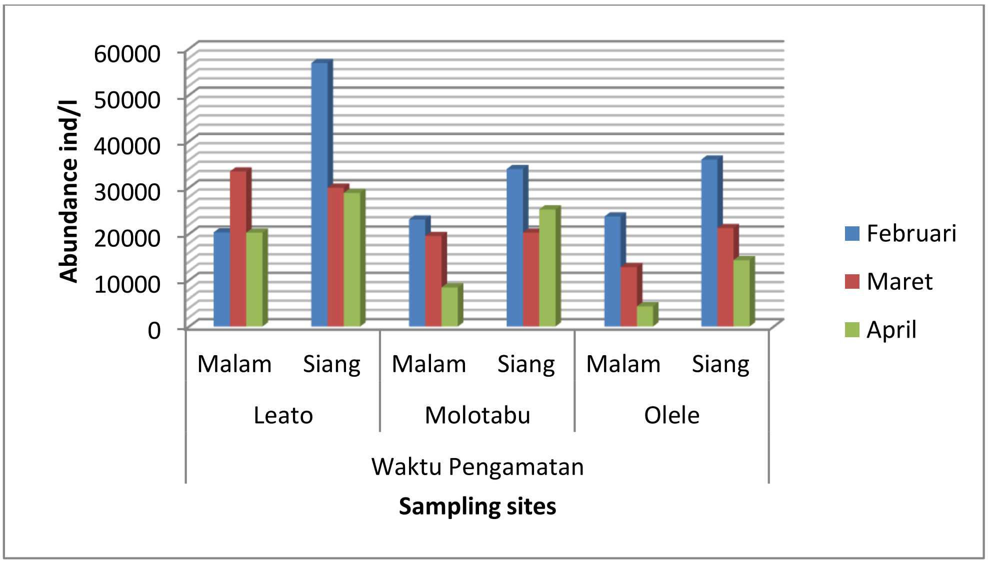

Figure 2. Temporal distribution of phytoplankton

Temporal distribution of zooplankton

The abundance of zooplankton ranges from 6,270 ind / l to 41,646 ind / l which are spread over all observation stations. The group that had the highest abundance value was the crustacean class with an average value of 12,584 ind / l (at night) and 2,508 ind / l (during the day), crustaceans were a zooplankton group that had a high proportion of abundance and species (Table 3). The high abundance composition in the crustacean class generally occurs in tropical waters, whether in lakes, ponds, reservoirs, or rivers (Neves, et al, 2003) in Nursyarah (2017).

According to Thakur et al., (2013) in Nursyarah (2017) zooplankton from the Crustacean group can live in various water conditions, even tend to be eutrophic. Furthermore, Das et al., (1996) in Nursyarah (2017) stated that crustaceans can survive and adapt better than other zooplankton groups. Zooplankton from the crustacean group that are mostly found at the research location are the species Nauplius sp., Acartia sp., and Clanus pacificus. The census results at all observation stations showed that Nauplius sp. available at all observation stations. Nauplius sp. found in sufficiently abundant quantities. According to Dumont (1983) in Nursyarah (2017), the genus Crustacea with the highest number of species is Nauplius sp. and Clanus pacificus, which is considered the most distinctive and most frequently found in tropical waters. Furthermore, according to Nybakken (1992) that crustacean is the most important type of zooplankton for fish both in freshwater and marine waters. The lowest abundance of zooplankton is from the Pholichaeta class. The temporal distribution of zooplankton found during the study is presented in Figure 3.

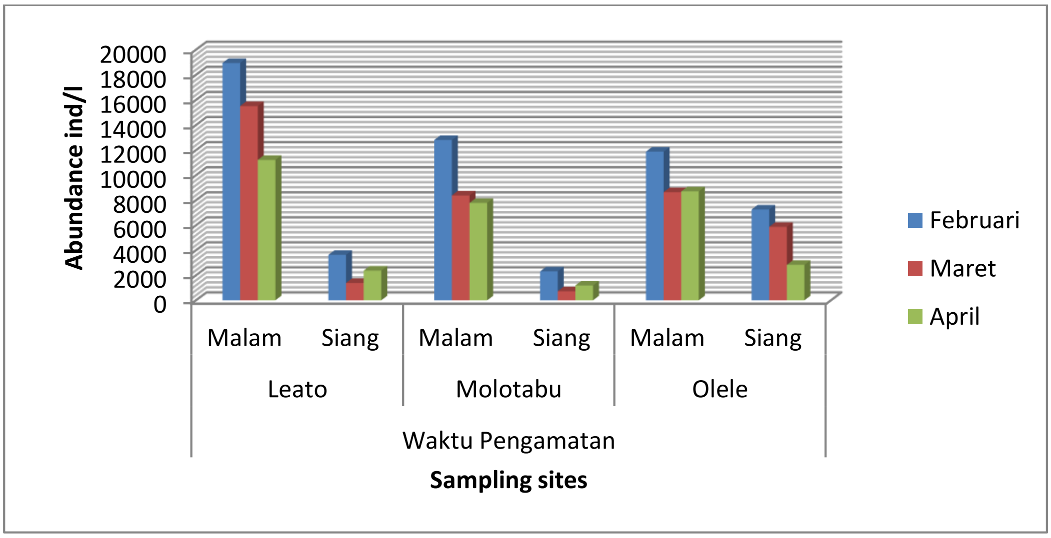

Figure 3. Temporal distribution of zooplankton

Spatial distribution of phytoplankton

Figure 4 shows that the highest phytoplankton abundance is the class Bacillariophyceae. The highest abundance of the Bacillariophyceae class occurred at Station I, namely Leato waters, then in Olele and Molotabu waters in February. Likewise in March and April the abundance of Bacillariophyceae is dominant at Station I (Leato). This is presumably because the waters of Leato are directly opposite the mouth of the Bone River, which is the main source of nutrients carried by the river flow.

Setyadji and Priatna (2011) stated that the highest plankton abundance tends to collect at the mouth of the river. Geographically, Leato's waters are near the mouth of river Bone-Boalngo connecting to Tomini Gulf.

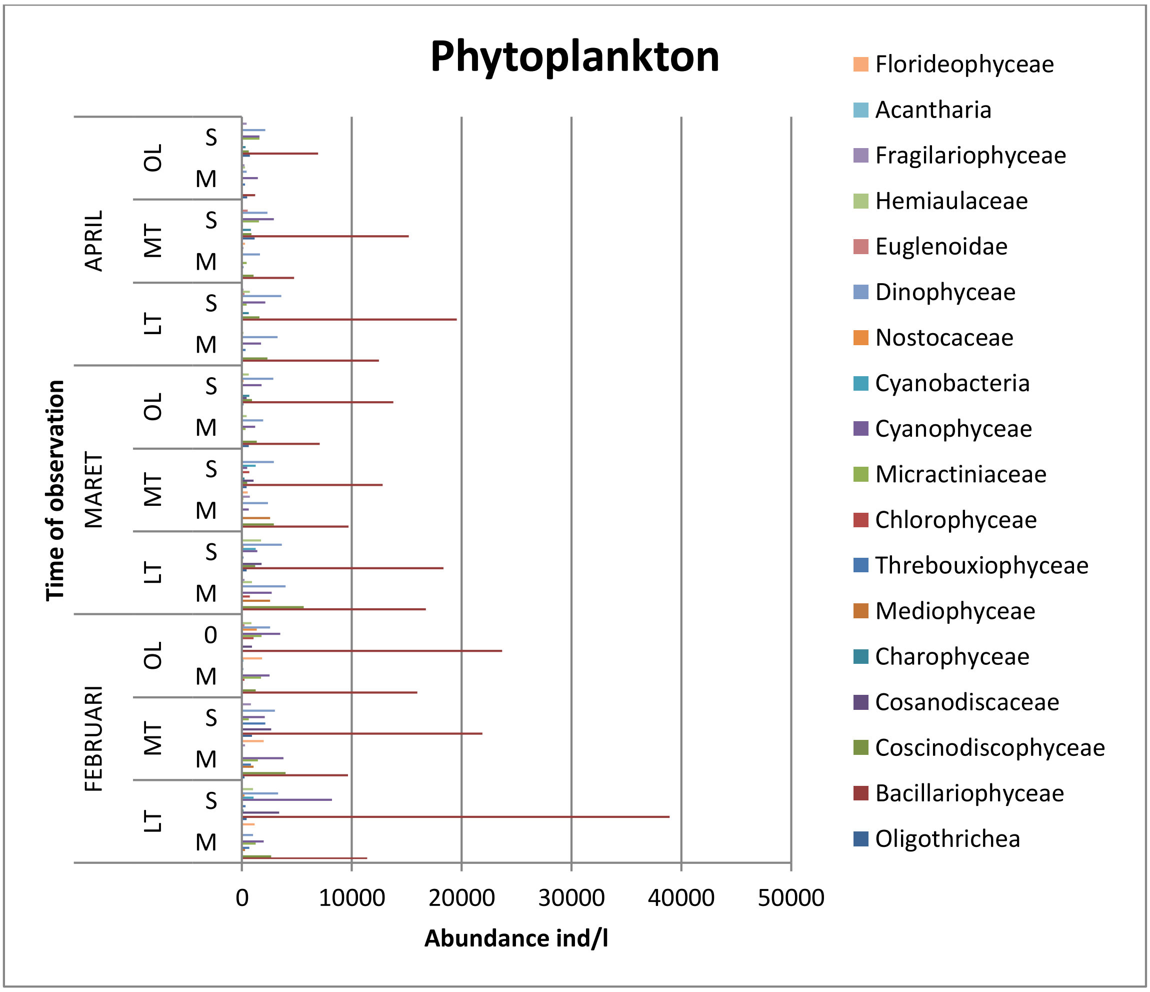

Figure 4. Spatial distribution of Phytoplankton

Spatial distribution of zooplankton

The highest zooplankton distribution is found at Station I, namely Leato waters. This is consistent with the abundance of phytoplankton found at the station (Figure 5). Elijonnahdi, et al (2012) stated that zooplankton depend on phytoplankton for its nutrient source. Furthermore, Setiawati (2017) states that if the phytoplankton is reduced, the food supply for zooplankton will also decrease and if the food is reduced, the zooplankton will decrease. Zooplankton spatial distribution is presented in Figure 5.

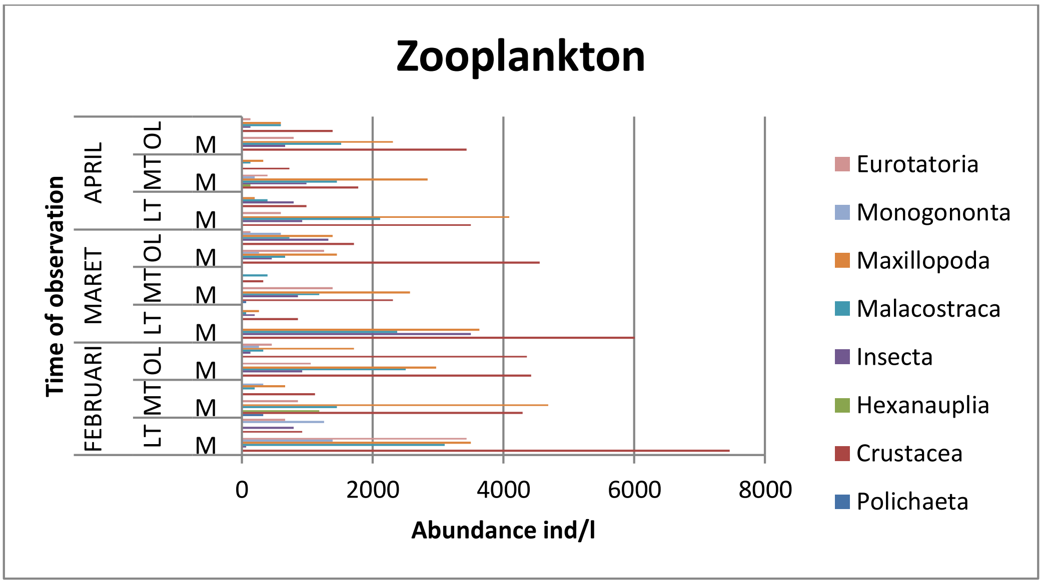

Figure 5. Spatial distribution of Zooplankton

Zooplankton abundance and distribution tends to decline in March and lowest in April. This is presumably because in March and April the abundance of phytoplankton also decreased so that the supply of nutrients and zooplankton food also decreased. The abundance of zooplankton in these waters is potential enough to support pelagic marine life, because generally zooplankton is the main food for various types of pelagic fish such as flying fish (*Decapterus macarellus*), mackarel (*Rastreliger kanagurta*), *tembang* and others (Wiadnyana, 1998 in Aisah, 2016; Awwaludin, et al, 2005).

In a normal environment, the swarming of marine life is always closely related to the number of prey forage in the waters. The concentration of the abundance of zooplankton scattered in the waters of Leato, Molotabu and Olele seems to be correlated with the abundance of phytoplankton which is also scattered around the observation site.

Conclusion

Based on the results of the study it can be concluded that the daily temporal distribution of phytoplankton during the day is more concentrated on the surface of the water, on the contrary at night zooplankton is more concentrated on the surface. Meanwhile, the monthly distribution shows that the plankton concentration was higher in February. It spatially shows that plankton abundance is higher at Station I (near the estuary).

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