Distribution of microalgae as bioindicator for *Sardinella lemuru* in Bali Strait

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Abstract. The Bali Strait waters become a place for various development activities that connect Java Island and Bali Island so that it is thought to have an impact on the life of microalgae that play an important role in the wealth of their water resources. This study aims to explore the distribution of marine microalgae, which has the potential as a bioindicator for *Sardinella lemuru*, as well as their relationship with the environmental characteristics of the Bali Strait waters. The research was conducted at the 8 with different waters characteristic. The data obtained were analyzed using Principal component analysis (PCA) and Correspondence analysis (CA). Spatially, salinity, ammonia, nitrate and lutein have significantly different value between stations. *Chaetoceros gracilis* and *Tripos lunula* are the main food of selection for *Sardinella lemuru* as an indicator their presence, located at station 5 (Pang-pang Bay), characterized by high nitrate content which is thought to be utilized by these types of microalgae.

1. Introduction

One of the waters in Indonesia that has a high potential for capture fisheries is the Bali Strait, with its main fishery resource, namely lemuru fish (*Sardinella lemuru*). Lemuru is an especially important and specific fishery resource in the waters of the Bali Strait because it has a role in the business and economic activities of the local community [1]. Lemuru is a type of fish that has a high Omega-3 content. Research conducted [2] states that lemuru has high omega-3 unsaturated fatty acids, which is around 36.96%. The content of omega-3 fatty acids is relatively high compared to other types of pelagic fish, namely anchovies, selar, and mackerel.

*Sardinella lemuru* is a small pelagic fish containing high omega-3 which is distributed in the eastern Indian Ocean including the southern coast of East Java, Bali and Lombok. Lemuru including high fat fish with varying fat content. These different fat content depend on fish size, maturity, season, diet and so on. This is because lemuru in nature eat a lot of plankton and microalgae which produce a lot of omega-3 fatty acid components. Thus, plankton is the key to forming omega-3 in lemuru because marine phytoplankton is the primary producer of omega-3 in the food chain.

Lemuru production in the waters of the Bali Strait fluctuates greatly from year to year, where at certain times the production is quite low but at other times the production is quite high. Based on fish landing data at the Muncar Fishing Port, in 2006 and 2007 there was an abundance of lemuru.
production which reached more than 50,000 tons per year. This high potential is inseparable from the fact that the Bali Strait has high water productivity due to the upwelling phenomenon that occurs seasonally in the southern waters of Java associated with the Indian Ocean. However, in the last few years, lemuru production has decreased significantly. This is presumably due to changes in environmental conditions and overfishing [3].

The presence of fish in the waters is greatly influenced by temperature. Water temperature is one of the important factors in the life of organisms in the sea, it can affect the metabolic activity and reproduction of these organisms, as well as an indicator of the phenomenon of climate change [4]. However, the presence of fish is also thought to be influenced by other environmental parameters such as the spread of phytoplankton. Phytoplanktonic act as primary producers in the food chain in waters, which in turn can affect the fertility of the waters and the presence of fish.

Water fertility indicators can be measured from the chlorophyll-a content. Chlorophyll-a is the most common pigment found in phytoplankton and plays a role in the photosynthesis process [5]. The presence of high chlorophyll-a concentrations, especially in coastal areas, indicates the presence of sufficient plankton to maintain the viability of economically important small pelagic fish [6]. Some conditions that have a direct effect on sea surface temperature and chlorophyll-a are the upwelling phenomenon and the direction of the Armondo current (Indonesian Monsoon current), so it is assumed that in the east monsoon there is more upwelling with a higher value of chlorophyll-a and the number of points in the eastern monsoon. Low temperature waters surrounded by warm temperatures around it, then the Armondo current brings lower temperatures to the waters of the Bali Strait compared to the western monsoon, because in the east monsoon Armondo brings low temperature water masses from the Indian Ocean [7].

Potential fishing areas can be identified by looking for information on oceanographic parameters preferred by lemuru, so that later it can save operational costs of fishing and prevent illegal fishing size. Therefore, research is needed to determine the oceanographic and biological parameters of the marine environment, especially microalgae as bioindicators and food for lemuru in the waters of the Bali Strait which are closely related in determining potential lemuru fishing areas.

2. Materials and Methods

2.1. Composition of lemuru stomach content

The total 20 lemuru caught in the fishing ground were taken to determine the average body length of the fish and their hulls were taken to analyze the composition of the phytoplankton and zooplankton therein. The amount of plankton found in the stomach of lemuru is calculated using the volumetric method, while the composition of lemuru food is calculated using the index of preponderance [8]. To determine the type of plankton which is the main choice for lemuru food, an index of electivity is carried out by comparing the amount of plankton in the stomach of lemuru with the abundance of plankton types in the waters using the formula.

2.2. Analysis of omega-3 fatty acid levels from fish meat

Fatty acid extraction was carried out by the method [9] and then methylated using the method [10]. 3 Lemuru organism were taken for each sampling and cleaned on their abdomen, then heated in the sun to dry. The dried fish meat is taken from the dorso-lateral part of the body (the three fish are mixed), then weighed as much as one gram, then crushed in a glass cup and extracted by adding 10 ml of petroleum ether (PE), centrifuged at 3000 rpm for 2 minutes later filtered. After filtering, let the mixture sit for about 15 minutes so that the petroleum ether evaporates and gets its fat. The fat that has been separated from the meat is then methylated by adding 10 ml of BF3 in 20% methanol (BF3CH3OH) then shaken with a shaker for about 30 minutes. The top layer is the fatty acid methyl ester which is separated and analyzed using Gas Chromatography (GC) at Vicma Lab Laboratory, Cibinong.
2.3. *Aquatic environment parameter sampling*

The measurement of physical-chemical parameters is carried out in two ways, namely in situ and ex situ. Measurements of environmental physical-chemical parameters were carried out at each observation station. Water quality parameters measured in-situ include dissolved oxygen (DO) using a DO meter, YSI brand, type 550A, which is also a temperature measurement in degrees Celsius, and salinity using a refractometer. The physical-chemical parameters of the waters which were measured specifically, including phosphate, ammonia, and nitrate were tested at the Surabaya Industrial and Standardization Research Institute. Sampling at the research location and sample analysis in the laboratory refer to the APHA method [11]. The test is done in duplicate.

2.4. *Microalgae (phytoplankton) sampling*

Sampling of microalgae (phytoplankton) was carried out by filtering 50 L of seawater using Wildco 12 "100 μm Nitex® mesh plankton net, rope length = 2 M [12]. The filtered water in the plankton net is then collected into a 250 ml sample bottle, 10% lugol solution is added, until it is tea-colored and deposited for 4 days [13,14], then the sediment is taken and identified using an identification book. The samples were analyzed in the Laboratory of Environmental Biology, Sidoarjo Marine and Fisheries, Polytechnic

2.5. *Identification and calculation of microalgae abundance*

Identification of the types of microalgae was carried out using references [15–17]. The abundance of microalgae cells is calculated based on the following equation [14].

\[
N = \frac{n \times (Ls/Lp) \times (vol.1/vol.s)}{vol.2}
\]

**Explanation:**

- \(N\) = microalgae abundance (cell/ml)
- \(n\) = the number of cell (sel)
- \(Ls\) = total of *Sedgewick rafter cell area* (mm\(^2\))
- \(Lp\) = the area of *Sedgewick rafter cell was observed* (mm\(^2\))
- \(vol.1\) = the volume of water sample from precipitation (ml)
- \(vol.2\) = the volume of water precipitated (ml)
- \(vol.s\) = the volume of *sedgewick rafter cell* (ml)

2.6. *Data analysis*

Data analysis was referred to Bengen (2000), using XLSTAT and SPSS 22 software [18]. This physical-chemical parameter environmental data collection aims to analyze the effect of habitat characteristics on the diversity and presence of lemuru indicator microalgae in the Bali Strait, which is based on the spatial and temporal physical-chemical variations of the aquatic environment at each station analyzed using Principal Component Analysis (PCA). Meanwhile, the relationship between the characteristics of the aquatic environment and the types of marine microalgae was analyzed using Correspondence Analysis (CA).

3. *Result and discussion*

3.1. *Composition of lemuru stomach contents (Sardinella lemuru)*

Lemuru which was caught in the eastern season (August 2020) in the fishing ground in the Bali Strait has an average length of 17 cm (Figure 1). This size is relatively large compared to the same season in Soerjodinoto’s study [19]. In his research in the June-August period, lemuru sizes ranged from 11.5 to 12.5 cm, which was called protolan.
Based on the analysis of the stomach contents of lemuru fish, it is known that this fish food is plankton, which is dominated by 98% phytoplankton and the rest is zooplankton (2%). Previous research conducted in the same season found that the stomach contents of lemuru (Sardinella longiceps) were dominated by phytoplankton species [20].

The total length of the fish was ± 17 cm. The results of the analysis of the stomach contents found that in the stomach of lemuru fish, 92% of the phytoplankton of the Bacilariophyceae class were found (Rhizosolenia stolterfothii, Rhizosolenia hebetate, Chaetoceros gracilis and Coscinodiscus sp), the rest were 6% Dinophyceae class (Ceratium lumula, Peridinium granti, Ceratium longisimus, Dynophysis truncata, Amphisolenia bidentata and Amphisolenia thrinex). While the remaining 2% are copepods (Microsetella norvegica, Cyclopoid sp., Nauplius of Pareuchaeta norvegica) (Figure 2).

The type of plankton found in the stomach content of lemuru is Chaetoceros gracilis which has the highest abundance in water compared to other types. This indicates the suspicion that lemuru is selective in choosing food, but these fish also eat other types of food available in the water.

Although lemuru are not selective towards the plankton class as food, the type of plankton is the main selective (preference) as food for lemuru, namely by performing a selection index analysis [8]. which is presented in Table 1.

| No | Spesies                     | Selection index (E) |
|----|-----------------------------|---------------------|
| 1  | Rhizosolenia stolterfothii  | -0.01               |
| 2  | Amphisolenia bidentata      | 0.32                |
| 3  | Dynophysis truncata         | 0.45                |
| 4  | Rhizosolenia hebetata       | 0.67                |
| 5  | Peridinium grani            | 0.51                |
| 6  | Coscinodiscus sp            | 0.72                |

Figure 1. Lemuru caught in the Bali Strait.

Figure 2. The composition of the stomach content of lemuru in the eastern season (August 2020).
From the selection index analysis, it is known that *Chaetoceros gracilis*, *Ceratium lunula*, *Ceratium longisimus*, *Amphisolenia thrinex* are the main food choices for lemuru with an index close to +1. (Table 1). While types. Another plankton with an index number of -1 which is a type of food to avoid.

3.2. *Spasial variations in the characteristics of the Bali Strait water environment*

Data on the characteristics of the aquatic environment collected from the study area Figure 3, from 8 stations are presented in Table 2.

![Figure 3. Research station in the Bali Strait waters.](image)

**Table 2.** The physical-chemical parameters of water at 8 research stations in the Bali Strait

| Stasiun | Tem. (°C) | Salinity (Psu) | DO (mg/L) | Phosphate (mg/L) | Ammonia (mg/L) | Nitrate (mg/L) | Lutein (mcg/g) |
|---------|-----------|----------------|-----------|------------------|----------------|----------------|---------------|
| St.1    | 28.07     | 32.67          | 7.88      | 0.02             | 0.00           | 2.13           | 14.33         |
| St.2    | 28.33     | 33.00          | 7.52      | 0.21             | 0.00           | 1.23           | 12.33         |
| St.3    | 27.77     | 24.00          | 7.33      | 0.03             | 0.00           | 2.13           | 21.67         |
| St.4    | 27.93     | 30.00          | 7.84      | 0.18             | 0.00           | 1.87           | 21.00         |
| St.5    | 27.53     | 26.33          | 7.58      | 0.03             | 0.03           | 2.33           | 23.00         |
| St.6    | 27.17     | 32.00          | 10.80     | 0.29             | 0.00           | 0.30           | 12.00         |
Samples were taken at 8 different stations. Station 1 was at Tabuhan Island, Station 2 at Menjangan Island, Station 3 at the Ketapang-Gilimanuk ferryage, Station 4 at Muncar Port, and Station 5 at Pang-pang Bay. Stations 1 and 2 are small islands in the northern part of the Bali Strait and there are no river mouths flowing in the area. Stations 3 and 4 are areas occupied by human activities, both vessel crossings area and fishing industries. While Station 5 is in bays with river mouths influenced by the sea and freshwater. The influence of the sea and freshwater fluctuates depends on tides and the inputs of freshwater so that nutrients from the land come together in the bay. Stations 6, 7 and 8 are waters that form land products of refined land, as the entry route for fishing boats to Pengambengan Port. Sampling was conducted at each location (station) at three times.

The results of the principal component analysis indicate that the information describing the relationship between the physical-chemical parameters of the waters to the observation station is formed by two main axes (F1, F2, and F4) with a cumulative characteristic root of around 88.31%. This means that the information obtained from the analysis using the three axes is 88.31% of the total information. The information is explained respectively by the F1 axis of 59.72%, the F2 axis of 25.34% and the F4 axis of 3.25% (Figure 4).

![Figure 4. Analysis of the main components of the distribution of the characteristics of the aquatic environment at the research location; formed by the axes F1, F2, and F4.](image)

The three main axes form four groups of the relationship between the physical-chemical parameters of waters with the research station. Two groups are identified to be on the F1 axis, while one group is identified respectively on the F2 and F4 axes.

The first group on the F1 axis illustrates that in distribution, both Station 5 in Pang-Pang Bay and Station 3 (the Ketapang-Gilimanuk crossing) which are in the Bali Strait are characterized by several physical-chemical parameters of the waters, where the F1 group is characterized by nitrates. with a correlation value (0.9491) and lutein content (0.8032), it has a higher value than the other four stations. This group contributes to the formation of a positive F1 axis. The high nitrate content value is because the waters of Pang-Pang Bay are a bay area that receives more ammonia waste from
aquaculture activities which also occurs at the Ketapang-Gilimanuk crossing when compared to the other six stations, so that the nutritional content of ammonia that enters the waters at the Station 5 and 3 stations are well oxidized to become Nitrate which can be used as a source of nutrients that support the formation of lutein pigments for microalgae during photosynthesis. [21]. The high nitrate content during the day in Ketapang-Gilimanuk is influenced by the presence of a river mouth that carries a load of waste from the activities of the surrounding population. Nitrate plays a role in distinguishing the high and low abundance of phytoplankton. The difference in nitrate content in the waters results in differences in phytoplankton abundance. The increase and growth of phytoplankton populations in waters is related to the availability of nutrients and light [22].

Marlian et al. (2015) stated that waters close to the mainland (rivers, estuaries, and the edge of the bay) have high nutrient content, followed by high horizontal distribution of chlorophyll-a, and waters far from the mainland (middle of the bay and outermost of the bay) has a low nutrient content, followed by a low horizontal distribution of chlorophyll-a [23]. These nutrients come from land or run off, so that they provide an especially important contribution to water fertility, especially for phytoplankton biomass (chlorophyll-a) in bay waters. The high nitrate content value at Station 5 (Pang-Pang Bay) is also thought to be related to the research location, which is located in the mangrove vegetation area, aquaculture area and is a bay area. Mangrove vegetation areas provide the greatest nutrients to the waters. Mangrove leaf litter that falls into the water will decompose so that it can provide additional nutrients for the growth of phytoplankton. Mangrove plant litter is also a source of carbon and nitrogen for the forest itself and its surrounding waters [24]. The dissolved nutrients in the mangrove area will be utilized by plankton. This plankton community, especially phytoplankton, plays an important role in the mangrove ecosystem and the productivity of phytoplankton in mangrove waters is four times higher than in the open ocean [25]. The source and concentration of nitrogen in the media influence the properties of growth and composition as well as the addition of microalgae cells [26]. Hussain et al. (2014) suggested that microalgae make use of ammonia, nitrite and nitrate as growth media [27]. Most microalgae utilize ammonia as a simpler molecule and are ready to be used for growth.

Nitrogen compounds such as ammonia are extremely high in metabolite toxic and very dangerous, which can cause poisoning to almost all organisms for the water. Excessive nitrogen can stimulate algae growth in the waters (algae bloom). The increase in ammonia compounds will increase the growth and density of phytoplankton.

The high density of phytoplankton causes a population explosion event (blooming), which is followed by mass death phytoplankton. These abundant algae can form a layer on the surface of the water, which in turn can inhibit the penetration of oxygen and sunlight, making it less beneficial for aquatic ecosystems. When the waters contain enough phosphate, algae accumulate phosphorus in the cells beyond their needs. This phenomenon is known as luxury consumption [28]. Regulation of the State Minister for the Environment No. 1/2010 concerning Water Pollution Control Procedures stipulates that the maximum ammoniac content in the waters is 8 mg / L. The ammonia content in the waters of the Bali Strait is in normal conditions in the range of 0.001 to 0.035 mg / L, so that the presence of ammonia in the waters of the Bali Strait is safe for aquatic ecosystems and is able to function as a source of nutrition for microalgae growth.

The second group provides an overview of the distribution at Station 6,7,8 in the refined land area of Pengambengan Port in the waters of the Bali Strait characterized by physical-chemical parameters such as DO, salinity and high phosphate with a correlation value of (-0.5490). This group contributes to the formation of a negative F1 axis, characterized by phosphate content with a correlation value (-0.8317), DO with a correlation value (-0.7625) and Salinity (-0.7082) High salinity at Station 6,7,8 because these waters are refined soil, which is formed by sediment from the dynamics of trapped marine activity due to the presence of the dock at Pengambengan Port and has no river flow, so that in the east or dry season there is absolutely no fresh water input, resulting in higher salinity [29]. High salinity causes the distribution and abundance of pigments by microalgae to be smaller [12].
The third group provides an overview of the distribution at Station 1 on Menjangan Island and Station 2 on Tabuhan Island, which is located in the waters of the Bali Strait characterized by physico-chemical parameters in the form of high temperature with a correlation value of (-0.5490). This group contributes to the formation of the negative F2 axis. The temperature is high at Station 1 and Station 2 because these waters are sandy islands so that in the eastern or dry season during the day it is very hot, and because on this sandy island there is no river flow, from these 8 stations the ammonia content is very small and at all there is no freshwater input from the mainland. The fourth group describes the condition of Station 4 (Muncar Harbor) which is in the Bali Strait with very general water conditions in the formation of a positive F4 axis.

3.3. Spatial distribution of microalgae in Bali Strait waters

Microalgae data collected from research locations are presented in Table 3. The number of microalgae species listed in each of the 8 research stations varies widely. Table 3 explains that the distribution of microalgae from the Bacillariophyceae group, has a higher presence level, there are 8 species, consisting of Bacteriastrum elongatum, Trieres chinensis, Chaetoceros gracilis, Fragilariopsis cylindrus, Leptocylindrus danicus, Navicula distans, Rhizosolenia hebetate, group compared to the Dinophyta. There are only 2 species, namely Ceratium longisimus and Ceratium lunula. The composition based on the microalgae class found at each station in the Bali Strait was dominated by the Bacillariophyceae Class (Table 3). This condition is common in marine waters as stated by Nybakken and Bertness (2004) that the composition of phytoplankton in the sea is dominated by the Bacillariophyceae group [5]. According to Effendi et al. (2016) Bacillariophyceae is a type of algae that is sensitive, has a very wide level of environmental tolerance, and is able to adapt to various types / environmental conditions, both changes in the physical, chemical and biological conditions of the aquatic environment [12].

| Station | Bacillariophyceae | Dinophytae |
|---------|------------------|-------------|
|         | Be   | Tc   | Cg  | Fc  | Ld  | Nd  | Rh  | Tl  | Clo | Clu |
| St.1    | 7    | 0    | 0   | 0   | 1.3 | 14  | 0   | 0   | 0   |     |
| St.2    | 5    | 0    | 0   | 0   | 0   | 1   | 16  | 0   | 0   | 2.6 |
| St.3    | 7.6  | 1    | 0   | 58  | 0.6 | 13.3| 4   | 0   | 0   |     |
| St.4    | 3.1  | 1.3  | 0   | 0   | 0   | 5.6 | 0   | 11  | 0   |     |
| St.5    | 0.6  | 31.6 | 0   | 0   | 3.6 | 3.6 | 0   | 0   | 25.3|     |
| St.6    | 19   | 0    | 0   | 0   | 2.3 | 36  | 7   | 0   | 0   |     |
| St.7    | 18   | 0    | 0   | 0   | 1   | 24  | 0   | 0   | 0   |     |
| St.8    | 10   | 0    | 0   | 0   | 1   | 8   | 1   | 0   | 0   |     |

Be = Bacteriastrum elongatum, Tc = Trieres chinensis, Cg = Chaetoceros gracilis, Fc = Fragilariopsis cylindrus, Ld = Leptocylindrus danicus, Nd = Navicula distans, Rh = Rhizosolenia hebetate, Tl = Thalassiothrix fravenfeldi, To = Ceratium longisimus, Tlu = Ceratium lunula

Distribution of diversity according to microalgae species using correspondent analysis (Figure 5). The results of the correspondent analysis of the types of microalgae in the waters of the Bali Strait showed the contribution of 2 main axes F1 (41.25%) and F2 (30.45%) with a total variance value of 71.70%.

Table 3. Composition and Abundance of the Bali Strait Microalgae

| Station | Bacillariophyceae | Dinophytae |
|---------|------------------|-------------|
|         | Be   | Tc   | Cg  | Fc  | Ld  | Nd  | Rh  | Tl  | Clo | Clu |
| St.1    | 7    | 0    | 0   | 0   | 1.3 | 14  | 0   | 0   | 0   |     |
| St.2    | 5    | 0    | 0   | 0   | 0   | 1   | 16  | 0   | 0   | 2.6 |
| St.3    | 7.6  | 1    | 0   | 58  | 0.6 | 13.3| 4   | 0   | 0   |     |
| St.4    | 3.1  | 1.3  | 0   | 0   | 0   | 5.6 | 0   | 11  | 0   |     |
| St.5    | 0.6  | 31.6 | 0   | 0   | 3.6 | 3.6 | 0   | 0   | 25.3|     |
| St.6    | 19   | 0    | 0   | 0   | 2.3 | 36  | 7   | 0   | 0   |     |
| St.7    | 18   | 0    | 0   | 0   | 1   | 24  | 0   | 0   | 0   |     |
| St.8    | 10   | 0    | 0   | 0   | 1   | 8   | 1   | 0   | 0   |     |

Be = Bacteriastrum elongatum, Tc = Trieres chinensis, Cg = Chaetoceros gracilis, Fc = Fragilariopsis cylindrus, Ld = Leptocylindrus danicus, Nd = Navicula distans, Rh = Rhizosolenia hebetate, Tl = Thalassiothrix fravenfeldi, To = Ceratium longisimus, Tlu = Ceratium lunula
Figure 5. Correspondent analysis results (CA) of the abundance of microalgae in the waters of the Bali Strait; (a) formed by the F1 and F2 axes, Be = Bacteriastrum elongatum, Tc = Trieres chinensis, Cg = Chaetoceros gracilis, Fc = Fragilariopsis cylindrus, Ld = Leptocylindrus danicus, Nd = Navicula distans, Rh = Rhizosolenia fravenfeldi, Trix = Thalassiothrix, Clo = Ceratium longisimus, Clu = Ceratium lunula.

The results of the Principal Component Analysis (PCA) and Correspondence Analysis (CA) show that there is a relationship between the distribution of microalgae and the characteristics of the aquatic environment as an indicator of the microalgae habitat. The first group on the positive F1 axis, Chaetoceros gracilis with a contribution value of (0.6769), and Ceratium lunula with a contribution value of (0.5739) found at Station 5 (Pang-Pang Bay), characterized by nitrate with a correlation value (0.9491) and lutein content (0.8032) for med by microalgae.

The second group on the positive F2 axis, Fragilariopsis cylindrus with a contribution value of (0.7890) is mostly found at Station 3 (Ketapang-Gilimanuk Crossing) which is also characterized by a high nitrate content capable of producin g lutein.

The third group in the swollen land area at stations 6, 7 and 8 (Pengambengan Port), mostly found Thalassiothrix fravenfeldi. On the F4 axis, with a contribution value of (0.9637) which is characterized by high phosphate, DO, and salinity content.

The fourth group, Rhizosolenia hebetate, has a contribution value of (-0.5888) on the F5 axis, located at Station 2 (Menjangan Island) which is characterized by high temperatures.

The fifth group, Ceratium longisimus, is on the F3 axis, at Station 4 (Muncar Harbor) which is in the Bali Strait with very general water conditions.

Based on the data presented in Table 3, there are species of Navicula distans, Bacteriastrum elongatum and Trieres chinensis, evenly distributed at five stations, both temporally and spatially, both characterized by phosphate, DO, and high salinity content in refined seaport soils. Pengambengan, high temperatures on Tabuhan Island and Menjangan Island, as well as characterized by high nitrate content in the waters of Pang-pang Bay, and Ketapang-Gilimanuk, by high ammonia content in Muncar waters.
4. Conclusion
The waters of the Bali Strait have different physical-chemical characteristics in eight research stations. Spatially, salinity, ammonia, nitrate and lutein have significantly different values between stations. The *Chaetoceros gracilis* and *Tripos lunula* species are the main food of choice for lemuru as an indicator of the presence of lemuru, located at Station 5 (Pang-Pang Bay), characterized by high nitrate content which is thought to be utilized by these types of microalgae to form lutein pigment.

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