



Analysis of abundance and diversity of plankton in the Awarange Coastal Area Barru Regency, Indonesia

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Abstract

The study aims to determine the level of abundance, diversity, uniformity, and dominance of plankton on the Awarange coast, Barru Regency, Indonesia. This research was conducted from July to August 2024 using a random sampling method on the coast of Awarange, Barru Regency, Indonesia, using 3 station points, namely Station 1 (ST 1), namely Lasonrai Beach, which is also a beach tourist spot; Station 2 (ST 2) around the Awarange port, Barru Regency; and Station 3 (ST 3) around the Awarange shipyard, Barru Regency. Plankton sampling using plankton net No. 25. The samples were then taken to the laboratory for identification. The collected data were then processed and analyzed using descriptive analysis. The results of the study showed that the highest abundance and dominance of plankton were at ST 2, namely the station located around the Awarange port. The highest plankton diversity at the research location was at ST 3, namely around the Awarange shipyard, at 0.2014654, and the lowest at ST 2 around the Awarange port, at 0.1662495. The highest plankton uniformity was at ST 3, namely around the Awarange shipyard, namely 0.10353275, and the lowest uniformity was at ST 1, namely Lasonrai Beach, a tourist spot, namely 0.07491288. Furthermore, the level of diversity and uniformity of plankton in the three research locations is still relatively low, and no plankton dominates.

Keywords: Abundance, diversity, plankton, Awarange

Introduction

Waters are an ecosystem that has a very large influence on the lives of living things (Rahmatiza *et al.*, 2020) ^[35]. Coastal areas are areas that are very intensive for human activities such as government centers, settlements, industry, ports, fisheries, tourism, and others (Dahuri, 2001) ^[7]. This causes coastal areas to be potential and vulnerable to environmental damage. This damage is caused by increasing human activities that produce polluting waste, both from industrial waste and other human activities (Evita *et al.*, 2021) ^[8]. Biotic ecosystem is a component of life consisting of various living things, including microorganisms, namely plankton. Furthermore, the beach is a place where land and sea meet, which is influenced by processes that occur on land and sea (Sari *et al.*, 2013) ^[44].

The problem that often occurs in coastal areas is pollution, which results in a decrease in the carrying capacity and biological resources of the coast and sea (Hamuna *et al.*, 2018) ^[14]. Various anthropogenic activities along the coast, such as settlements, fisheries cultivation, and marine transportation, have the potential to produce pollutants in the form of organic and inorganic waste (Utomo *et al.*, 2014) ^[52]. These activities can directly and indirectly cause negative impacts and disruption to the environment and cause pollution (Rahmawati *et al.*, 2014) ^[36]. In line with the development of ecological conditions of a nature reserve conservation area in the future, there will be changes in the composition of the biota so that there will be changes in the structure and function ecologically. Therefore, it is very important to know the composition of plankton as a supporter of the productivity of a waters (Anggara *et al.*, 2017) ^[2]. As one of the dominant communities found in coastal waters, several types of plankton are known to be sensitive and have variations in response to changes in water quality (Rizqina *et al.*, 2018) ^[38]. Due to these properties, plankton can be used as a marker of environmental quality

and a quality indicator (Thakur *et al.*, 2013) ^[50]. The carrying capacity of a body of water can be calculated from the phytoplankton and zooplankton sides. Unpolluted waters have a balance of plankton numbers and no toxic plankton species. Polluted waters cause changes in the structure of the plankton community, especially in the abundance and diversity of species (Gunawan, 2015) ^[13]. Plankton can be used to predict the characteristics of species in a community and monitor pollution in waters (Basmi, 2000) ^[5]. The existence of plankton greatly determines the balance of the ecosystem of waters (Rofiki *et al.*, 2019) ^[39].

Plankton are floating organisms and are passive so that their movement follows the current. Plankton are divided into two, namely phytoplankton and zooplankton. Phytoplankton are plankton that are plant-like and act as primary producers and are found in waters that are still penetrated by sunlight. Zooplankton are plankton that are animal-like and act as primary consumers in waters (Prasetyaningtyas, 2012) ^[33]. Plankton are tiny organisms that move following water currents, where they play a major role in contributing the most oxygen on earth and as producers of the aquatic food chain (Fitriani *et al.*, 2019) ^[11]. Plankton plays an important role in the marine ecosystem because plankton is a food source for various types of other marine animals (Salamah *et al.*, 2018) ^[42], can be used as a study to determine the quality of fertility of waters, which is very much needed to support water productivity (Nurruhwati *et al.*, 2017) ^[25], and can be the basis of life, especially in pelagic aquatic life (Novrilianty *et al.*, 2022) ^[23], living floating in the waters, and their swimming ability is very weak so that their movements are greatly influenced by the presence of water currents around them (Silaban *et al.*, 2022) ^[48]. In addition, almost all marine animals start their lives as plankton, especially at the egg and larval stages (Odum, 2000) ^[29]. Phytoplankton are also able to photosynthesize to produce organic matter because they have chlorophyll. Therefore,

phytoplankton are often referred to as primary producers (Mukayat, 1994) ^[21]. Plankton has a very important ecological role in supporting life in waters (Pramudji, 2010) ^[32].

According to Kartikasari (2013) ^[18], plankton can be used as one of the bioindicators to determine the primary productivity of waters because it has a role as a producer. Usman *et al.* (2013) ^[51] stated that plankton plays an important role in waters as a producer. Plankton is autotrophic because it can produce its own food by recycling inorganic materials into organic materials with the help of sunlight. Plankton plays an important role in supporting life in the waters. However, if its growth is uncontrolled, it will be dangerous and cause losses (Sachoemar and Hendiarti, 2006) ^[41].

Phytoplankton have the ability to grow rapidly in abundant numbers. The event of increasing phytoplankton biomass in waters and making the water color cloudy is called blooming (Rashidy, 2013) ^[37]. Phytoplankton are autotrophic plant plankton, which means they have the ability to photosynthesize and can convert inorganic compounds into organic compounds. Red tide is formed through a combination of biological, hydrographic, and meteorological conditions. Rofiki *et al.* (2019) ^[39]. Phytoplankton that cause red tide are positively phototactic, so they move towards the light. These phytoplankton can swim actively on the surface because they have tails (Sanaky, 2003) ^[43]. Rashidy (2013) ^[37] stated that phytoplankton are the primary producers in natural waters that play an important role in the food chain. Phytoplankton can be used to monitor the quality of waters and primary productivity by looking at the composition and abundance of plankton and changes in environmental parameters. Phytoplankton, also called plant plankton, is a plant that lives floating or drifting in the sea (Rahmatiza *et al.*, 2020) ^[35]. According to Gimin (2015) ^[12], its size is so small that it cannot be seen with the naked eye. Phytoplankton utilizes nutrients for growth (Faza, 2012) ^[10].

Zooplankton are the primary consumers, acting as intermediaries between primary producers and secondary consumers. In the food web, zooplankton eat phytoplankton, which are then eaten by larger carnivorous animals. In addition, zooplankton can respond to reduced dissolved oxygen in water, nutrient levels, toxic contamination, poor food quality or food abundance, and the presence of predators (Wenno and Wenno, 2011) ^[53]. Zooplankton are organisms that float in water and have limited swimming ability so that they are easily swept away by water movement. Generally, zooplankton are found in waters that have low current speeds (Simanjutak & Marojahan, 2009). Zooplankton are generally very sensitive to changes in water quality (Ahmad, 2014). In waters, zooplankton act as intermediaries in energy transfer and indicators of the presence of phytoplankton. Changes in the environment and food availability in waters will affect the abundance of zooplankton (Ahmad, 2014).

The Awarange coastline of Barru Regency is one of the coastal areas in Barru Regency that has the potential to experience damage and pollution because around the Awarange coastline, various activities have been used such as a national port that can transport people and goods to various regions in Indonesia, it has been made into one of the tourist attractions, namely La Sonrai beach tourism, there is a shipyard that is being built and the use of the

surrounding community as a place of livelihood such as fishermen and various other activities that can cause environmental damage, and one way to detect it is research on the condition of plankton around these waters so that later information will be obtained regarding the current condition of the Awarange waters in terms of plankton aspects.

Materials and Methods

Research location

This research was conducted from July to August 2024 using a random sampling method on the coast of Awarange, Barru Regency, Indonesia, using 3 station points, namely Station 1 (ST 1), namely Lasonrai Beach, which is also a beach tourist spot; Station 2 (ST 2) around the Awarange port, Barru Regency; and Station 3 (ST 3) around the Awarange shipyard, Barru Regency.

Sampling method

The sampling method in this study used the vertical method. Vertical plankton sampling was carried out using plankton net no. 25 equipped with a collection bottle and weights. The plankton net is slowly lowered to a depth of 3 m and then pulled up so that the filtered sample enters the plankton net. The last step is transferring the sample to a sample bottle, then giving it 4 drops of 4% formalin solution, then the sample bottle is closed and labeled based on the sampling station and then stored in a cool box. Next, the samples were observed under a microscope and identified using the plankton identification book in the Chemistry and Water Laboratory of the Pangkep State Agricultural Polytechnic with reference to Munthe *et al.* (2012) ^[22]. The data collected consisted of the number of plankton, plankton abundance, plankton diversity, plankton uniformity and plankton dominance.

Plankton Abundance

Phytoplankton abundance was calculated based on the APHA formula (2005) ^[3]:

$$N = \frac{T}{L} \times \frac{p1}{p2} + \frac{v1}{v2} \times \frac{1}{w}$$

Where:

N: Plankton abundance (ind/L)

T: Number of boxes in SRC (1000)

L: Number of squares in one field of view

p1: Number of Plankton observed

p2: Number of SRC boxes observed

v1: Volume of water in sample bottle

v2: Water volume in SRC box

w: Volume of filtered water

Plankton Diversity Index

The Diversity Index (H') is based on the Shannon Wiener formula (Odum, 1998; Hariyanto *et al.*, 2008) ^[15, 28]:

$$H' = - \sum_{t=1}^n p_i \cdot \ln p_i$$

Where:

H': Shannon-Wiener Diversity Index

Ni: Number of genera to-i
 N: Total number of genera
 With the criteria (Odum, 1998) [28]:
 H' < 1: Low diversity
 1 < H' < 3: Diversity is medium
 H' > 3: High diversity

Plankton Uniformity index

The uniformity of plankton types can be determined by using the uniformity index (Akhrianti *et al.*, 2014) [1] with the formula:

$$E = \frac{H'}{H_{maks}}$$

Where:
 E: Uniformity index
 H': Diversity index
 H_{maks}: Maximum diversity

The uniformity index value ranges from 0-1. If the index approaches 0, it indicates that the number of individuals is concentrated in one or several types, while if the index

approaches 1, it indicates that the number of individuals in each species is the same/almost the same.

Plankton Dominance Indeks

The plankton dominance index can be calculated using the following formula (Odum, 1998) [28]:

$$D = \sum_{t=0}^n (ni/N)^2$$

Where:
 D: Simpson dominance index
 ni: Number of individuals of the type to-i
 N: Total number of individuals

With the criteria (Odum, 1998) [28]:
 D: Approaching 0, then no species dominates
 D: Approaching 1, then there is a species that dominates

Analysis of data

Descriptive analysis is used to examine the collected data. This research technique, called descriptive analysis, collects data according to reality, compiles, processes, and analyzes the data to provide a summary of the problems raised in the research.

Results

Amount of plankton

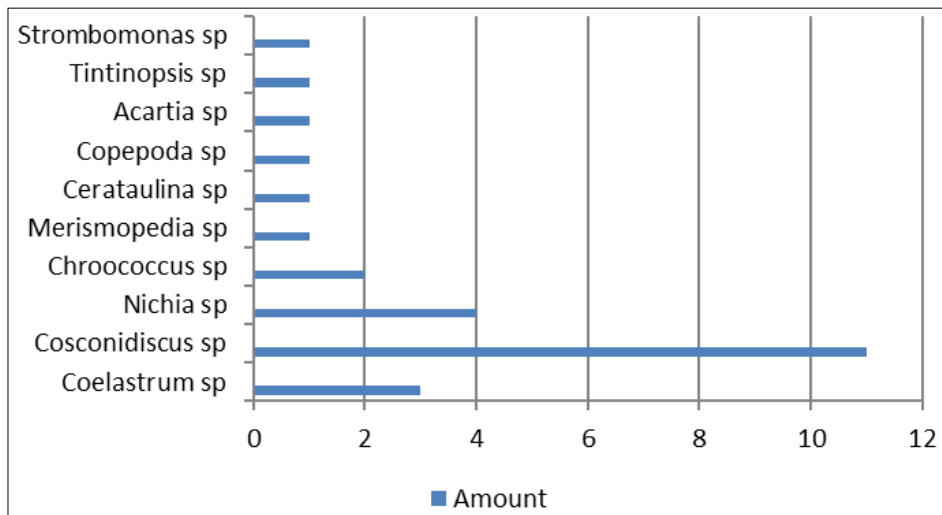


Fig 1: Types and amounts of plankton on Lasonrai Beach

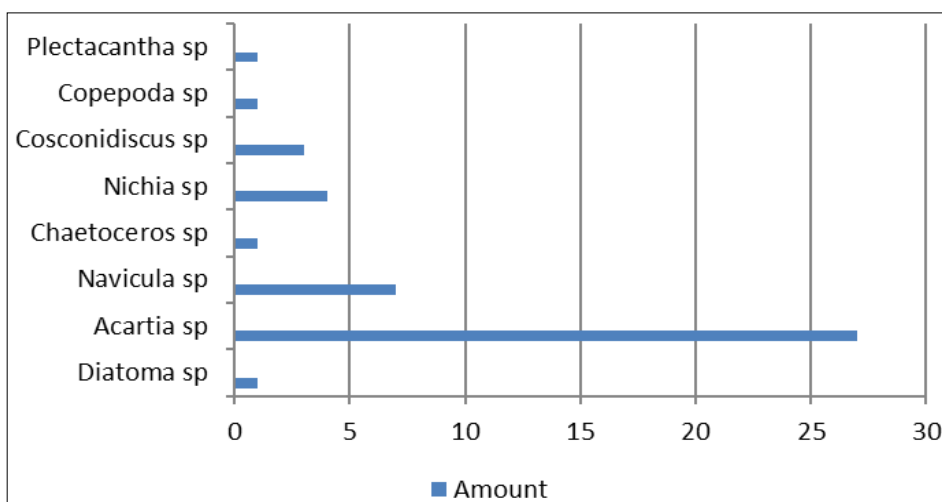


Fig 2: Types and amounts of plankton around Awarange Harbor

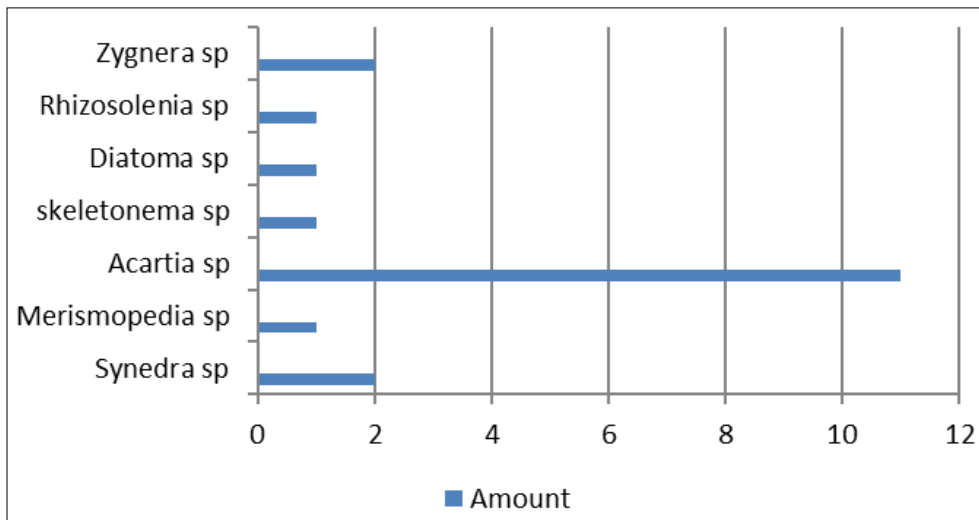


Fig 3: Types and amounts of plankton around the Awarange Shipyard

Plankton Abundance

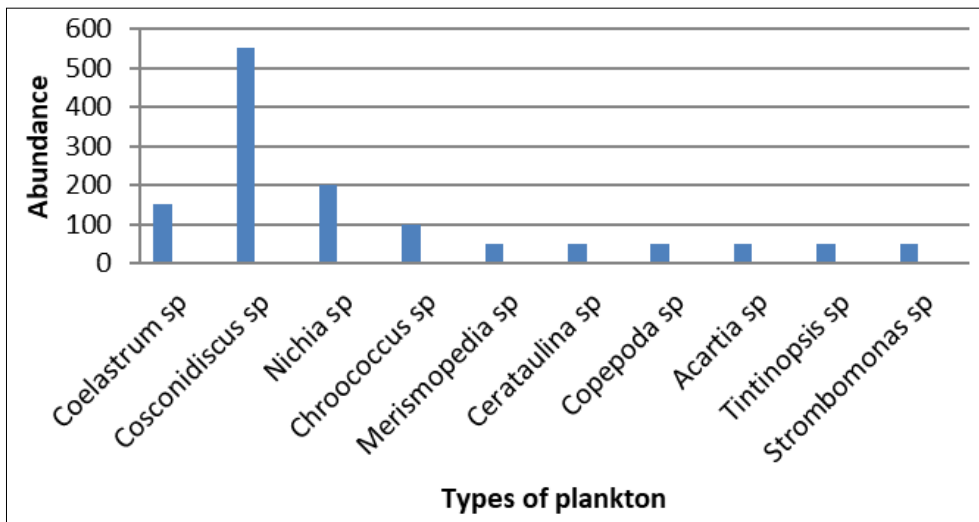


Fig 4: Abundance of Plankton at Lasonrai Beach

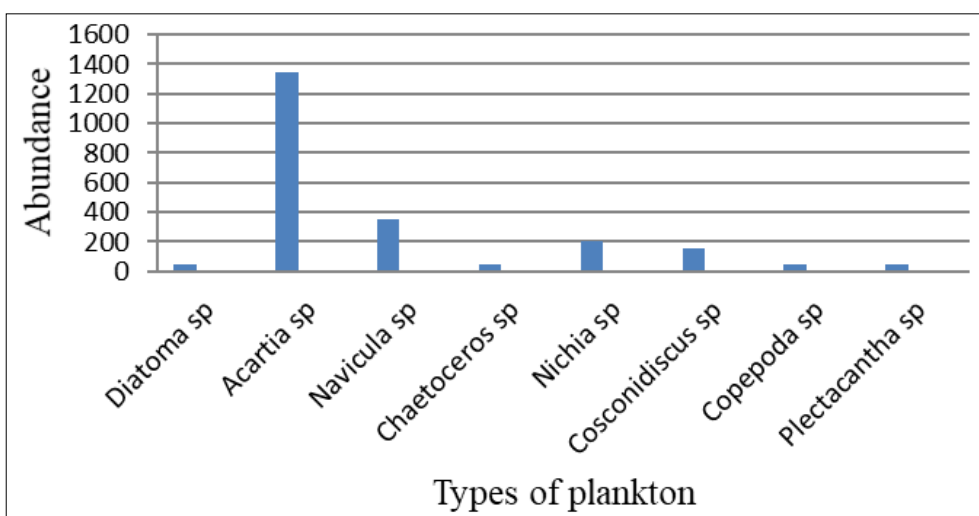


Fig 5: Abundance of Plankton around Awarange Harbor

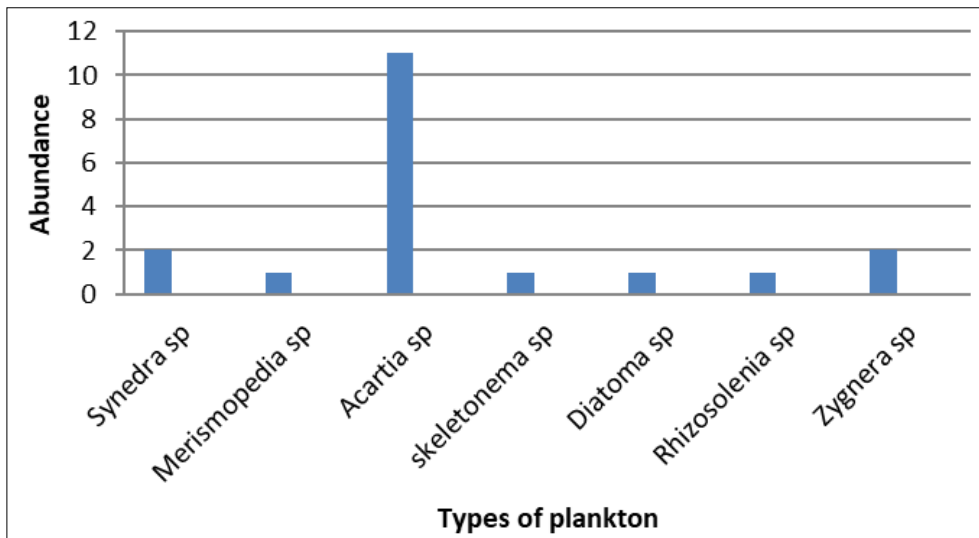


Fig 6: Plankton Abundance at Awarange Shipyard

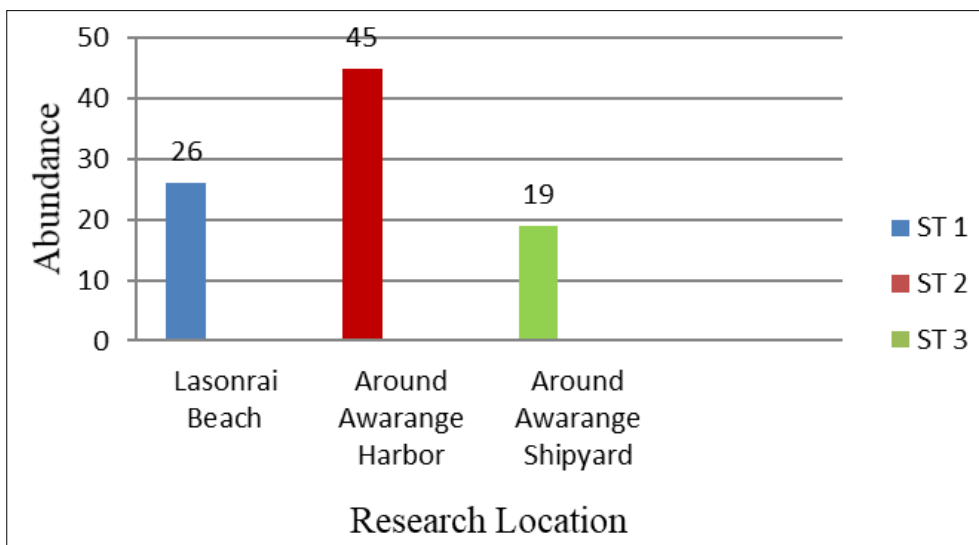


Fig 7: Plankton abundance from the three research locations

Diversity of Plankton

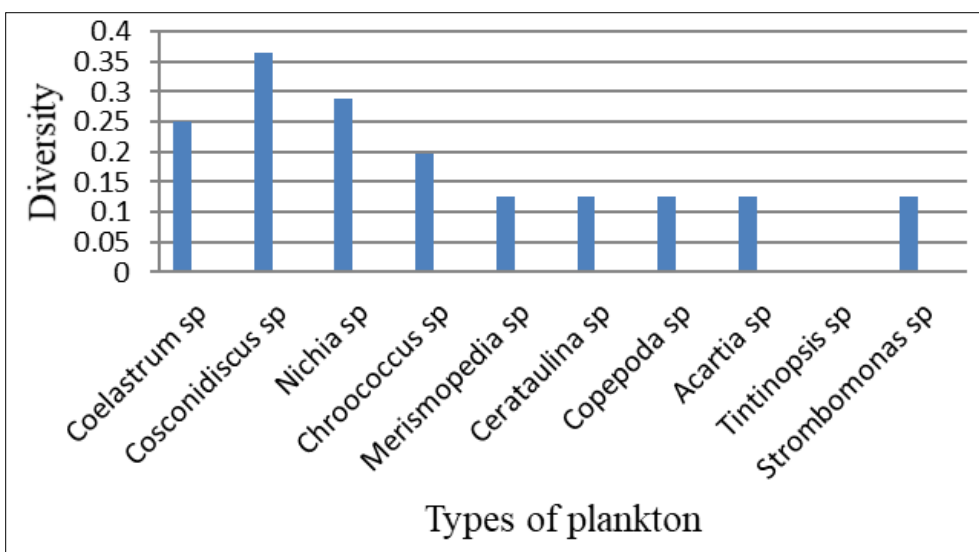


Fig 8: Diversity of plankton at Lasonrai Beach

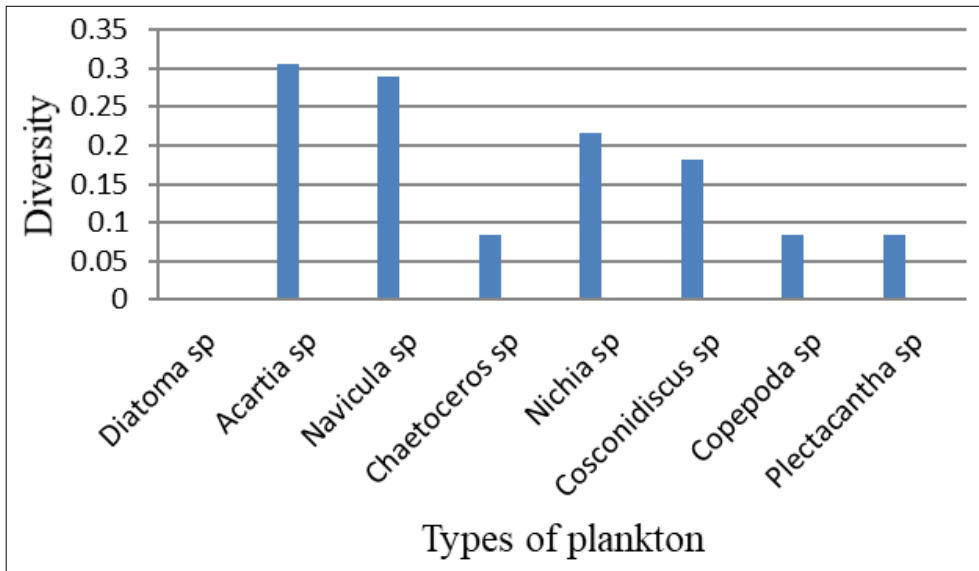


Fig 9: Plankton diversity around Awarange Harbor

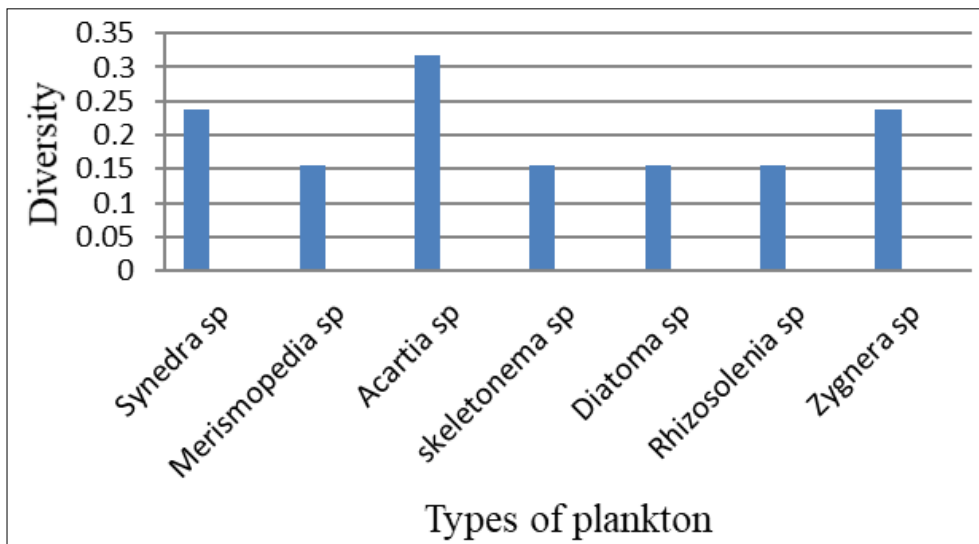


Fig 10: Plankton diversity around the Awarange Shipyard

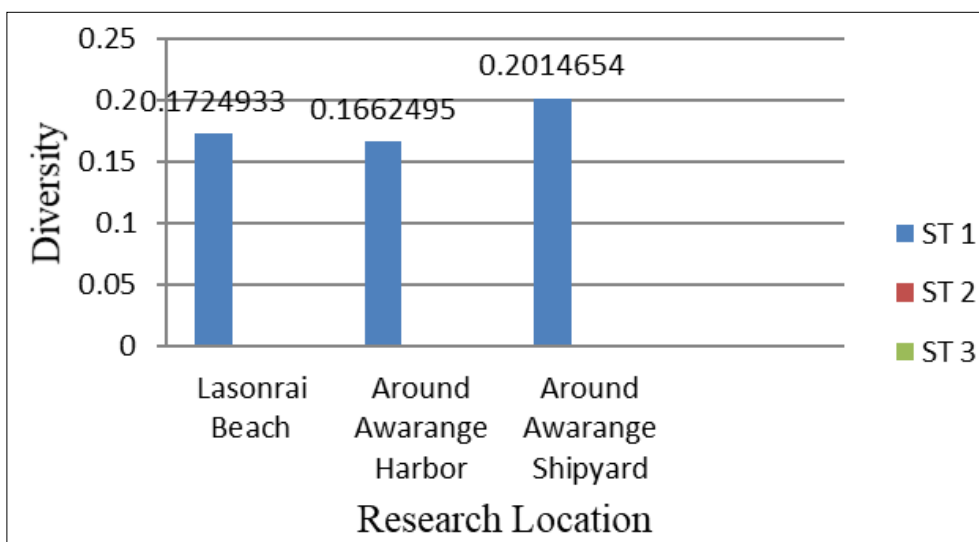


Fig 11: Plankton diversity at three research locations

Uniformity of Plankton

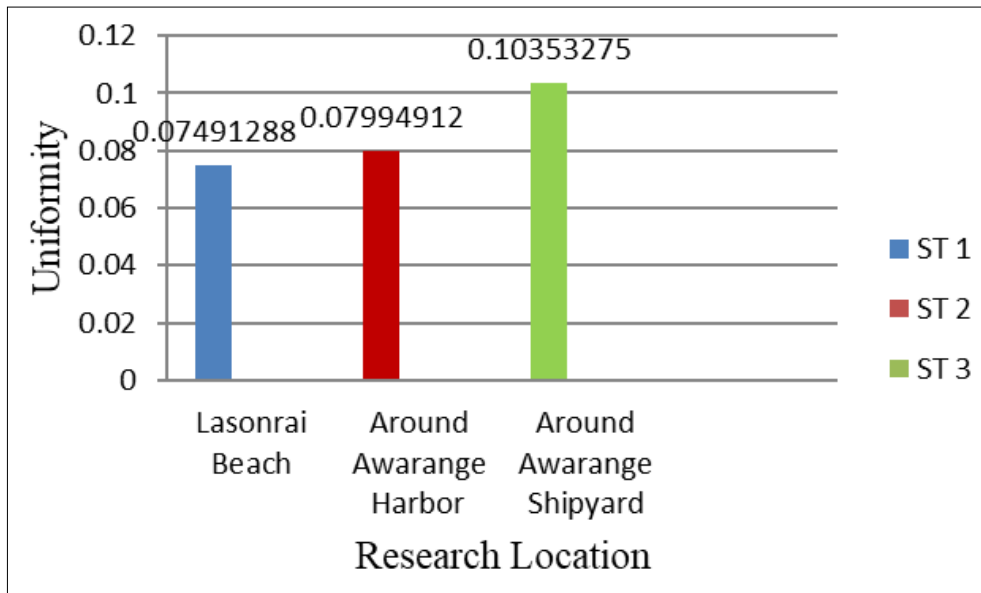


Fig 12: Level of plankton uniformity at three research locations

Plankton Dominance ($n_i/N = p_i$)

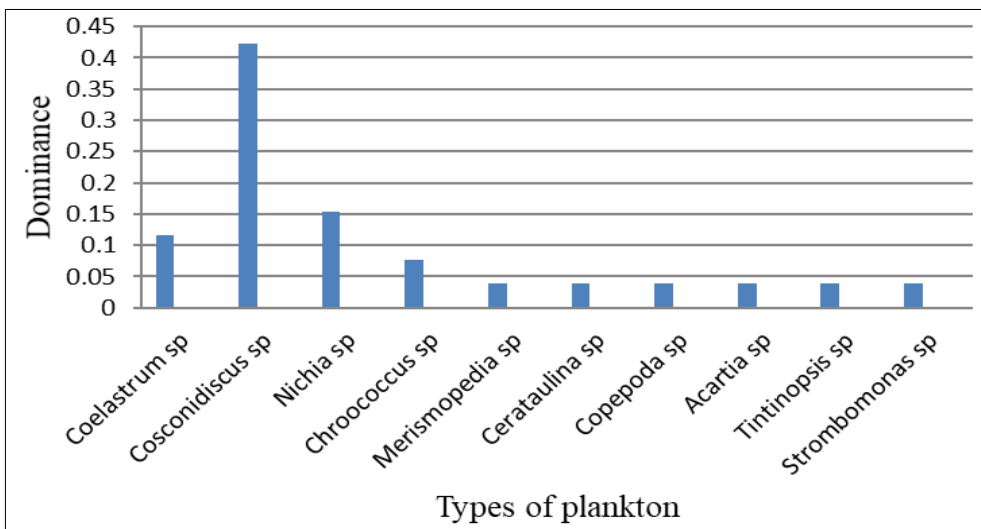


Fig 13: Dominance of plankton at Lasonrai Beach

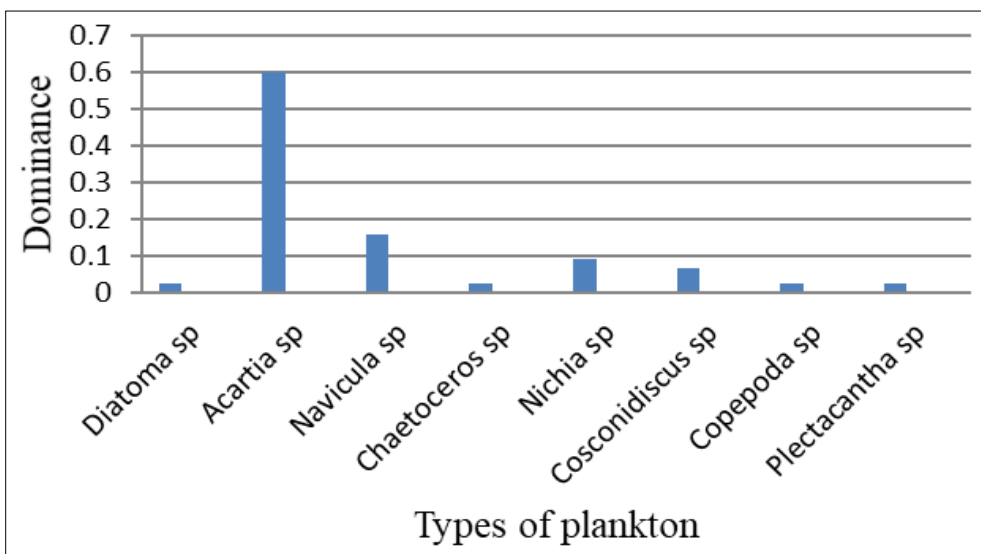


Fig 14: Plankton dominance around Awarange Harbor

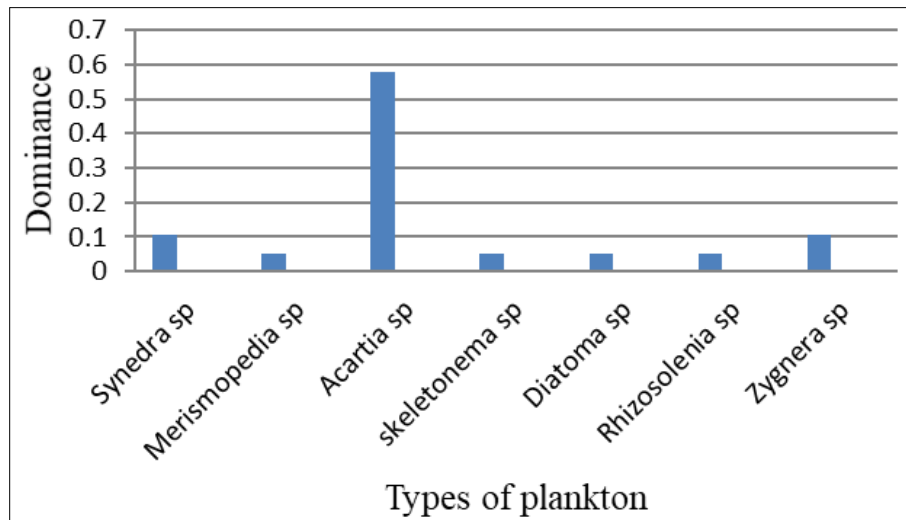


Fig 15: Plankton dominance around the Awarange Shipyard

Discussion

Amount of plankton

Fig 1 shows that the type of plankton most frequently found during research on Lasonrai Beach, Barru Regency, was *Cosconidiscus* sp., followed by plankton types *Coelastrum* sp. and *Chroococcus* sp. Meanwhile, the plankton with the smallest number were *Strombomonas* sp, *Tintinopsis* sp, *Acartia* sp, *Copepoda* sp, *Cerataulina* sp, and *Merismopedia* sp, each with the same amount of plankton. Fig 2 shows that the type and number of plankton most frequently found around Awarange port during the research were *Acartia* sp. plankton, followed by *Navicula* sp., *Nichia* sp., and *Cosconidiscus* sp. Meanwhile, the types of plankton with the lowest number of plankton are *Plectacantha* sp., *Copepoda* sp., *Chaetoceros* sp., and *Diatoma* sp. Fig 3 shows that the most plankton found is *Acartia* sp, followed by *Zygnera* sp and *Synedra* sp with the same amount of plankton. Meanwhile, the least common types of plankton found were *Rhizosolenia* sp., *Diatoma* sp., *Skeletonema* sp., and *Merismopedia* sp.

Plankton Abundance

Fig 4 shows that the abundance of plankton at Lasonrai Beach, a tourist spot, is highest for the plankton type *Cosconidiscus* sp, which is 550 (ind/L), followed by the plankton type *Nichia* sp, which is 200 (ind/L), *Coelastrum* sp, which is 150 (ind/L), and the plankton with the lowest abundance are each plankton type *Merismopedia* sp, *Cerataulina* sp, *Copepoda* sp, *Acartia* sp, *Tintinopsis* sp, and *Strombomonas* sp, each 50 (ind/L). Fig 5 shows that the abundance of plankton around Awarange port is highest in the plankton type *Acartia* sp, namely 1350 (ind/L), followed by plankton type *Navicula* sp, namely 350 (ind/L), *Nichia* sp, namely 200 (ind/L), and *Cosconidiscus* sp, namely 150 (while the plankton types with the lowest abundance are *Diatoma* sp, *Chaetoceros* sp, *Copepoda* sp, and *Plectacantha* sp, each 50 (ind/L). Fig 6 shows that the highest abundance of plankton around the Awarange shipyard in Barru Regency when the highest research was conducted was in the plankton type *Acartia* sp, namely 11 (ind/L), followed by plankton types *Synedra* sp and *Zygnera* sp, each 2 (ind/L). While the types of plankton with the lowest abundance were each plankton type, *Merismopedia* sp, *Skeletonema* sp, *Diatoma* sp, and *Rhizosolenia* sp, each 1 (ind/L). Fig 7 shows that the highest plankton abundance of

the three research locations was at Station 2 (ST 2) around Awarange port, namely 45 (ind/L), followed by Station 1 (ST 1), namely Lasonrai beach, which is also a beach tourism spot, namely 26 (ind/L), and the lowest plankton abundance was at Station 3 (ST 3) around the Awarange shipyard, Barru Regency, namely 19 (ind/L). Plankton abundance is plankton found in a body of water per liter of water (Nurruhwati *et al.*, 2017) [25]. In this study, the highest plankton abundance occurred in ST 2, which is a location around the Awarange port in Barru Regency. This is thought to be because the water movement at that location is greater than in other locations. This is in accordance with the opinion of Thoha (2003), who stated that the abundance of phytoplankton populations is influenced by various environmental factors. Furthermore, Setyowardani *et al.* (2021) [46] stated that the abundance of phytoplankton has a positive relationship with water fertility. Several factors that affect the abundance of plankton include temperature, brightness, nitrate-nitrite, phosphate, and silicate (Sachoemar and Hendiarti, 2006) [41]. Rahayu (2007) [34] states that plankton in a body of water (taxa and abundance) is determined by nutrients concentrated in the water. Changes in abundance and number of species can be used as indicators of water fertility in the area, as an impact of changes in environmental conditions (Fajrina, 2013) [9]. Odum (1994) [27] stated that the presence of zooplankton, which is lower than the phytoplankton found, is a natural condition, as organisms occupy a higher trophic level compared to phytoplankton. The high or low density of a zooplankton species in waters is not only determined by the nutrient factors of phosphate and nitrate, but other environmental factors and predators also greatly influence the existence of zooplankton (Hidayat, 2013) [17].

Diversity of plankton

Fig 8 shows that the highest plankton diversity at Lasonrai Beach as a tourist attraction is the plankton type *Cosconidiscus* sp, and the lowest are the plankton types *Chroococcus* sp, *Merismopedia* sp, *Cerataulina* sp, *Copepoda* sp, *Acartia* sp, *Tintinopsis* sp, and *Strombomonas* sp, with the same diversity. Fig 9 shows that the highest plankton diversity is found in the plankton type *Acartia* sp. and the lowest is found in the plankton types *Chaetoceros* sp., *Copepoda* sp., and *Plectacantha* sp. Fig 10 shows that the highest plankton diversity is found in the plankton type

Acartia sp., then followed by other types of plankton. Fig 11 shows that the level of plankton diversity in the three highest research locations at ST 3, namely the location around the Awarange Shipyard, is 0.2014654, followed by ST 1, namely the location that is Lasonrai Beach as well as a tourist spot, which is 0.1724933, and the location with the lowest plankton diversity, namely ST 2, namely the location around the Awarange Port, which is 0.1662495. The level of plankton diversity for all research locations is classified as low.

Species diversity is a parameter commonly used to determine the condition of a particular community; this parameter characterizes the species richness and balance in a community (Pirzan, 2008) [31]. In this study, plankton diversity was in the range of 0.1662495 to 0.2014654. Odum (1994) [27] states that plankton diversity $0 < H < 2.3$ is included in the low category. Meanwhile, according to Heip *et al.* (1998) [16], $1 \leq H \leq 3$ indicates moderate species diversity, sufficient water productivity, fairly balanced ecosystem conditions, and moderate ecological pressure. The high and low levels of plankton diversity in waters are influenced by abiotic factors including DO, BOD, pH, temperature, and current speed (Oktavia *et al.* 2015) [30]. Higher phytoplankton diversity indicates that the aquatic ecosystem at the research location is still relatively stable, with the number of phytoplankton species as the main producers being higher than zooplankton as the main consumers of phytoplankton directly (Oktavia *et al.* 2015) [30]. Stable waters with high phytoplankton diversity allow for the presence of more biota with higher trophic levels so that aquatic productivity will also increase (Anggara *et al.*, 2017) [2]. Furthermore, Kusmeri & Dewi (2015) [20] stated that plankton have high abundance and diversity values at relatively shallow depths. Sari *et al.* (2021) [45] stated that differences in environmental characteristics and parameter values from each station also affect plankton diversity. Rizal *et al.* (2017) stated that species diversity is greatly influenced by the species that occupy the habitat, so it will affect the amount obtained. In addition, the low diversity value indicates that the community of organisms in these water conditions is less diverse (Novrilianty *et al.*, 2022) [23]. To increase this productivity, the stability of the aquatic ecosystem is needed, for example, in terms of the availability of food and oxygen so that the supporting components of aquatic biota are maintained (Anggara *et al.*, 2017) [2].

Uniformity of plankton

Fig 12 shows that the plankton uniformity at the three highest locations at ST 3, namely the location around the Awarange Shipyard, Barru Regency, is 0.10353275, followed by ST 2, namely the location around Awarange Port, namely 0.07994912, and the lowest at ST 1, namely Lasonrai Beach, a tourist spot, namely 0.07491288. The plankton uniformity index in this study was in the range of 0.07491288 - 0.10353275. According to Nugroho (2006) [24], if the uniformity index (E) approaches 0, then the uniformity between species is low, while if the uniformity index (E) approaches 1, then the uniformity between species is relatively even. Thus, the plankton uniformity index in this study is in the category of low uniformity between species. A moderate uniformity index indicates that each type of plankton is evenly distributed across all observation locations. This allows there to still be species that are not

well distributed so that they experience pressure that can reduce their survival or, conversely, can dominate the waters (Anggara *et al.*, 2017) [2]. Brower and Zar's (1989) [6] species uniformity index, if the value is close to 1, indicates that the condition is relatively good because the number of individuals is relatively the same so that the waters can be said to be balanced. The provisions of the uniformity index value at each station consist of only two categories, namely moderate uniformity and high uniformity (Halipatulfikri *et al.*, 2020). Suwandana *et al.* (2018) [49] showed that a high uniformity index value indicates that each biota has the opportunity to utilize the nutrients available in the waters simultaneously, even though the nutrient content in the waters is limited.

Plankton dominance

Fig 13 shows that at the research location of Lasonrai Beach, a tourist attraction, plankton is dominated by plankton of the *Cosconidiscus* sp. type. While at the research location around Awarange Port and the location around Awarange Shipyard, plankton is dominated by plankton of the *Acartia* sp. type (Fig 14). Odum (1971) [26] stated that if the index value approaches 0, it means that there is no dominant species, while if it approaches 1, it indicates that there is a certain species that dominates. Kusmeri & Dewi (2015) [20] state that the species dominance index value approaching 0 indicates that there is no dominant organism in the community; conversely, if the dominance index value approaches 1, it indicates that there is a dominant organism in the community. The dominance index value in this study was below 0.5. The plankton dominance index value in Tlogo Dringo is $0.5 \leq C \leq 1$, indicating that there is no dominant species (Anggara, 2017) [2]. Nugroho (2006) [24]: If the dominance index (C) approaches 0, then there is almost no species that dominates a body of water, whereas if the dominance index (C) approaches 1, then one species dominates the other species. The dominance index used in this study is the Simpson dominance index with a value range of 0-1. An index value approaching 1 indicates high dominance, and conversely, an index value approaching 0 indicates low dominance or no species dominates (Krebs, 1978) [19]. Each type of plankton is able to associate well in an ecosystem so that no factors are found that cause ecological pressure from certain types of plankton. This also indicates that there are no specific locations that have significant differences in the number/type of plankton (Anggara *et al.*, 2017) [2]. The dominance of a type of phytoplankton in waters is determined by the comparison of the types of nutrients dissolved in the waters (Nurruhwati *et al.*, 2017) [25]. This is because each type of phytoplankton has a different response to the comparison of the types of nutrients present, especially nitrogen and phosphorus in the waters (Barus, 2004) [4].

Conclusion

The highest abundance of plankton is at ST 2, which is a station located around the port of Awarange. However, the abundance of plankton on the Lasonrai coast is highest in the plankton type *Cosconidiscus* sp. at the location around the port of Awarange and around the Awarange shipyard, the highest plankton type is *Acartia* sp. The highest plankton diversity at the research location was at ST 3, namely around the Awarange shipyard, which was

0.2014654, and the lowest at ST 2 around the Awarange port, which was 0.1662495. The highest plankton uniformity was at ST 3, namely around the Awarange shipyard, which was 0.10353275, and the lowest uniformity was at ST 1, namely Lasonrai Beach, a tourist spot, which was 0.07491288. The dominance of plankton on Lasonrai beach is highest in the plankton type *Cosconidiscus* sp. in the location around Awarange port and around the Awarange shipyard, the highest plankton type is *Acartia* sp.

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