Dominancy of *Trichodesmium* sp. in the Biawak Island

**D J Prihadi**

Faculty of Fishery and Marine Science, Padjadjaran University  
*Email: donny.juliandri.prihadi@unpad.ac.id*

**Abstract.** The Biawak Island is one of the small islands in West Java Province with an abundance of marine biological resources. This research was conducted to collect the primary producer zooplankton and water quality parameters. Direct observation is done by field surveys and measurement in situ for plankton and environmental parameters such as temperature, water transparency, water current, salinity, dissolved oxygen, and pH. *Trichodesmium* sp. was found dominance in where some other types of zooplankton were found in the area, like *Scenedesmus* sp., *Sagitta* sp., *Acartia* sp. also occurred. Further, the most abundance of *Trichodesmium* sp. was found in southern of Biawak Island where mangroves, coral and seagrass ecosystem provide nutrients which indirectly support the abundance of planktons. *Trichodesmium* sp. is plankton that can survive in water with minimum nutrient.

1. **Introduction**

Indonesia is the largest archipelago in the world with a vast sea and land territorials of about 7.7 million km$^2$. The nation comprises of 17,504 islands with the shoreline length of 95,181 km$^2$ stretching from Sabang to Merauke. The difference in values for the length of coastlines in some islands occurs because of climate change that has a great affect (the existence of the islands is submerged, coastal erosion of seawater) and there’s also a difference in the calculation methods. About 75% of the area consists of coastal and ocean waters, including the territorial sea and 3.1 km$^2$ islands, as well as 2.7 million km$^2$ of the exclusive economic zone (EEZ). Indonesia is one of the countries which has a large potential in the sector of marine fisheries [1]. As an island nation with the longest coastline in the world i.e., 81,000 km$^2$, Indonesia has a potential of 10.28 million tons of fish production every year [2]. The number of islands that have been registered to the United Nations is about 13,466 islands, but now already 16,065 islands have been ratification to the United Nations.

The study of marine resources in the Biawak Island can be done by looking at the aspects of hydro-oceanography (currents, tides, waves, temperature, etc.), its ecology (ecosystems, mangroves, coral reefs, seagrass and associated biota) and bio-geochemistry (aquatic chemistry, biochemical substrate, etc.). However, this research is only a small part of the study resources and this research was conducted to find out the existing plankton communities in the waters of the Biawak Island. Planktons are the smallest organisms in nature that made life in the diverse marine waters possible. Myriads of marine organisms depend on the presence of planktons (phytoplankton and zooplankton) that exist in the Biawak Island for survival. The cluster of the Biawak Island has been designated as a conservation area sea area (KKLD) according to Decree of Regent Indramayu No. 556/Kep Diskanla 528/2004 dated April 7, 2004 [3].

The purpose of this study is to (i) identify the types of zooplankton that live in and surrounding waters of the Biawak Island (ii) conduct assessments of the water condition in and around the Biawak Island. The benefits of this research are to increase the availability of data and update information about zooplankton communities that live in the waters of the Biawak Island. This research will be published
in national and international levels to be a useful information resource of diversity and biodiversity in Indonesia.

Local governments have established this area as one of the marine conservation area regions (KKLD), including the Biawak Island, Gosong Island and Candikian Island. Unfortunately, data related to the natural resources in the area is still very low and have not been integrated with one another. It results in the inconsideration of the marine resource’s status and condition in the Biawak island (including its surrounding waters) as a whole.

Much of the island is about 26 miles (± 50 km) from the mainland of Indramayu, Indramayu Regency, and has climate type D (temperate) with an average annual rainfall of 1,428 mm. The daily temperature ranges from 26–27 °C the highest and 18–30 °C the lowest and air humidity ranges between 70–80 %. Western and Eastern wind alternates more or less every six months. The Western wind blows from December to April and the Eastern wind from May to October. Ocean waves in the Biawak Island and its surrounding areas are affected by seasonal waves, namely East and West as well as the season of passage altitude reaches 0.5 to 0.8 m.

2. Methods
The study was conducted in the Biawak Island, Province of West Java and the surrounding waters from July to November 2013. The map of the location of the research can be seen in figure 1.

![Figure 1. Research location in Biawak Island.](image)

Direct observation was done by field surveys and measurement in situ for plankton and environmental parameters such as temperature, water transparency, water current, salinity, dissolved oxygen, and pH. The stages of this research consist of collected data that begins with the study of the literature related to the general condition of the location. The literature study of the biological resources and research on planktons and further data collection was done in the field (surveys) to get primary data. After the data and information were collected, the next step was data processing and analyzing to get a picture of a community resource and biodiversity of marine planktons that existed in the Biawak Island.
The coordinate point of observation station ecosystem.

| Observation /Sampling Station | Coordinates Ecosystem Observation | Ecosystem Characteristics |
|-------------------------------|----------------------------------|---------------------------|
| 1                             | 05°52'07.0" LS 108°24'18.8" BT   | Coral Reefs               |
| 2                             | 05°52'07.0" LS 108°24'19.3" BT   | Coral Reefs               |
| 3                             | 05°56'05.6" LS 108°22'53.0" BT   | Coral Reefs               |
| 4                             | 05°48'12.6" LS 108°25'29.2" BT   | Coral Reefs               |
| 5                             | 05°56'05.5" LS 108°23'05.1" BT   | Seagrass                  |
| 6                             | 05°55'59.3" LS 108°23'11.0" BT   | Seagrass                  |

For the data collection of plankton, sampling was performed on 6 locations spread over the Biawak Island, where station 1–4 were located in the coral reef ecosystem around Biawak Island and the 5–6 station located in seagrass ecosystem around Candikian Island. The method used was random sampling/retrieval especially using plankton net, with a depth of 0.50–1 m below sea level. In this research, samples of phytoplankton were filtered with a 20 µm plankton net.

3. Results and Discussion

The condition of environmental parameters for temperature, salinity, DO, pH and water current had been calculated and obtained from different sample retrieval time (morning, afternoon and evening) (table 2). The sampling was undertaken in the Biawak Island water column which depth ranged from 19–54 m below sea level. The results of measurements of parameters such as chemical physic SST (Sea Surface Temperature) ranged from 29.80–2.20 °C. Temperatures ranged from 27.6–32.8 °C, salinity ranged from 26–33 ‰, DO range from 4–5 mg L⁻¹ and a pH range from 7.47–7.86 as for the brightness when sampling on-site research i.e. 1.8–7 m.

| Temperature (°C) | Transparency (m) | Current (m·s⁻¹) | Salinity (‰) | DO (ppm) | pH    |
|------------------|------------------|-----------------|--------------|----------|-------|
| 30.50            | 6.00             | 0.28            | 30.00        | 5.10     | 7.61  |
| 31.10            | 5.30             | 0.34            | 30.00        | 5.30     | 7.86  |
| 29.80            | 5.00             | 0.30            | 30.00        | 5.90     | 7.50  |
| 30.30            | 4.70             | 0.32            | 31.00        | 5.70     | 7.70  |
| 30.70            | 4.70             | 0.31            | 27.00        | 5.70     | 7.65  |
| 31.40            | 5.50             | 0.25            | 27.00        | 5.80     | 7.75  |
| 30.10            | 5.00             | 0.20            | 26.00        | 5.00     | 7.47  |
| 31.60            | 5.40             | 0.21            | 27.00        | 4.70     | 7.55  |
| 32.20            | 5.10             | 0.37            | 33.00        | 4.00     | 7.50  |

The condition of the waters of the island of the Biawak Island can be explained as follows:

a. According to [4], the order Aspidochirotida larvae is a characteristic that lives in tropical waters 4.70–6 m of transparency is good for marine plankton lived under seawater.

b. The Biawak Island waters of temperatures ranging between 29.80–31.60 °C, the water temperature has a role in regulating the life of aquatic biota, especially in the process of metabolism. The temperature increase led to the increase in oxygen consumption, therefore,
resulted in the decline of the solubility of oxygen in water [5]. According to [6], larval sea cucumber is zooplankton as well has optimum temperature ranges between 28–29 °C.

c. Salinity value range has been obtained on the waters of 26–33‰. In time measurements were done differently at each station but in character location at each station are likely to be the same. The salinity is one of the factors that affect the existence and life of biota in the waters, including marine plankton [6].

d. The pH of the Biawak Island waters ranged on 7.50–7.86. It was classified as alkaline pH, so still supporting the biota life. Coastal waters had more stable pH and had a narrow range, which usually ranges between 7.7–8.4 [8]. The pH level is essential considering that most of the aquatic biota and also marine plankton are sensitive to changes in pH and pH value of around 7–8.5 [5].

e. Dissolved oxygen (DO) has a significant role in the aquatic life biota at once become the limiting factor for life in sea life. The Biawak Island waters had the average value DO 5.3–6 mg·L⁻¹, which classified as the normal range. The dissolved oxygen levels which are suitable for marine organisms is 5–7 mg·L⁻¹ [9]. Per increment DO may be followed by the decrease in the number of plankton [5]. DO effect on plankton respiration and against the availability of water.

The presence of planktons in the water plays an important role in regulating marine life. Plankton serves as a natural food source for biota [9]. The base of the marine being the presence of phytoplankton in seawater affects the existence of small reef fish and larvae of free-living marine life that need phytoplankton as a food source. Furthermore, small fish and other marine life would be preyed by other fish as a necessity of survival in an aquatic biological resources sustainability management for coastal and sea areas to be maintained and preserved. In the absence of plankton, interferences will occur at the level as plankton is very important organisms in the aquatic food web. The presence of sunlight can increase the productivity of phytoplankton.

Table 3. Distribution of plankton in the Biawak Island

| No. | Species     | Sampling Stations |
|-----|-------------|-------------------|
|     |             | 1 | 2 | 3 | 4 | 5 | 6 |
| 1   | Closterium sp. | 2 | - | - | 7 | - | - |
| 2   | Thallasiotrix sp. | - | - | 3 | - | - | - |
| 3   | Trichodesmium sp. | 8 | - | 3 | 114 | 5 | 5 |
| 4   | Coscinodiscus sp. | 15 | - | 1 | 3 | - | - |
| 5   | Scenedesmus sp. | 21 | - | 1 | - | 9 | 9 |
| 6   | Fragillaria sp. | - | 5 | - | - | 6 | 6 |
| 7   | Merismatedia sp. | - | - | - | 4 | 4 | - |
| 8   | Melosira sp. | 4 | - | - | 15 | - | - |
| 9   | Thallasionema sp. | - | - | - | 7 | - | - |
| 10  | Ceratium sp. | - | - | - | 15 | - | - |
| 11  | Rhizosolenia sp. | - | - | - | 6 | - | - |
| 12  | Sagitta sp. | - | 30 | - | - | - | - |
| 13  | Nauplius sp. | 3 | 7 | - | - | - | - |
| 14  | Proates sp. | - | 1 | - | - | - | - |
| 15  | Acartia sp. | - | 12 | 4 | 7 | - | - |
| 16  | Glaucussp. | 1 | - | - | - | - | - |
|     | Number of individual (in 100 L) | 54 | 55 | 12 | 174 | 24 | 24 |
|     | Number of Species (S) | 7 | 5 | 5 | 8 | 4 | 4 |
|     | Abundace (ind. 10 L⁻¹) | 5 | 6 | 1 | 17 | 2 | 2 |
According to table 3, station 4 was located on the southern of the Biawak Island and it has the highest abundance of plankton with diverse species compared to other stations. From this observation, we suggest that station 4 is an excellent habitat for plankton, followed by station 2 and 1. The smallest number of plankton was found in station 3. There are several factors that cause a large population of plankton in the Biawak Island. The factors were the existence of mangrove ecosystems and seagrass ecosystems. In the Biawak Island, the coral reef covers were categorized as a medium condition at station 4, 2 and 1. However, note that the *Trichodesmium* sp. are abundant in station 4. *Trichodesmium* spp. is a type of Cyanobacteria plankton that could live in the waters with low nutrient levels. In the condition where there are a high nutrient availability and other supportive conditions, blowout (blooming) could occur. The blooming of *Trichodesmium* spp. will initiate the onset of anoxic conditions and deaths as the ones in shellfish shells in India [10]. This phenomenon can cause negative effects and disadvantageous for marine biotas such as fish and some other marine invertebrates. It causes a decrease in the amount dissolved oxygen due to the process of decomposition by bacteria.

One possible factor is the existence of mangrove, coral reef, and seagrass ecosystems in the Biawak Island. We postulate that these ecosystems play a profound role in providing nutrient for the plankton growth. Hence, the population of plankton is abundant in this region. The smallest abundance observed in station 3 may relate to the absence of mangrove and bad condition of the coral reef ecosystem. Less plankton abundance is also observed in station 5. This might be due to the region were covers of the sandbar and lacks marine ecosystem.

The importance of mangrove ecosystems for the growth and survival of planktons is derived from the presence of nutrients from mangrove leaves that have dried up and fell to seawater, as well as mangrove roots that pose multitudes of nutrients in the area that can be used by planktons. Seagrass ecosystems can affect the presence of planktons. Many types of planktons that live in seagrass leaves are known as periphyton. A variety of planktons can utilize the presence of dead seagrass leaves as a source of food (nutrient), as well as shelter.

It is important to note that the *Trichodesmium* sp. is abundant in station 4. *Trichodesmium* sp. is a type of plankton from the group Cyanobacteria that can live at low nutrient levels and can experience a blowout (blooming) when there’s high nutrient availability. The location of station 4 is nearby the ship dock. The abundance of *Trichodesmium* spp. in this station might be due to leaked oil from the dock which carried by the ocean current. Further research is needed to test this hypothesis.

The blooming of *Trichodesmium* sp. will initiate the onset of anoxic conditions and deaths as the ones in shellfish shells in India [11]. This condition can also bring adverse effects, and it is not advantageous for marine biotas such as fish and some other marine invertebrates. It causes a decrease in the amount dissolved oxygen due to the process of decomposition by bacteria. *Trichodesmium* sp. can only have a high population in certain months, the further study is necessary to investigate the ability of this species to tie up nitrogen in the sea. Seawater, where many of this species lives, looks bright blue and different from the average sea color. However, at the end of the research, the color difference is not visible. Monitoring aquatic environments in the Biawak Island should start from local government as the manager and participation of the people in Indramayu Regency.

The previous study on the presence of phytoplankton and zooplankton in the Biawak Island shows that Bacillariophyceae, Cyanophyceae, Dynophyceae, and some genus of phytoplankton Cyanophyceae were found as Spirulina, Gloeotrichia, and *Trichodesmium*. For the Bacillariophyceae and Bacteriastrum were found from Dynophyceae such as Ceratium and Peridinium [10].
Meanwhile, zooplanktons found in the Biawak Island comprises Calanus and Diaphanosoma (Maxillophoda), Synchaeta and Brachionus (Rotifers). Specifically, *Calanus* sp. was found all around the island. *Calanus* sp. is abundant in the morning rather than in noon and evening [10].

Manta rays gather in places where there are lots of zooplanktons like *Acartia* sp. Manta point in Bali Nusa Penida is one of the water territories that are often used as a gathering place for manta rays (*Manta birostris*) [12]. In the coastal area, the region has a lot of *Acartia* sp. and it is favored by sea organisms like whales, manta rays and whale sharks.

4. Conclusion and Suggestion

4.1. Conclusion
The present study shows that the existence of mangrove, seagrass and coral reef ecosystems play a fundamental role in determining plankton population obtained in the Biawak Island. Planktons obtained
on the island is diverse with the abundance of plankton are quite diverse is dominated by *Trichodesmium* sp. Zooplankton that exists in this region may have strengthened marine food chain and fishes that live in the coral reef ecosystem. Further research concerning the abundance, diversity, and distribution of plankton community in the waters of Biawak Island, and Candikian Island is required to investigate the connection between fish and other marine biotas in the areas.

4.2. *Suggestion*

Research suggests the need for further research concerning the abundance, diversity, and distribution of existing plankton communities in the waters of the Biawak Island and Candikian Island. Moreover, other research to learn more about the connections between fish and sea life in the presence of planktons as the most important producers in the food chains in the sea and coastal areas.

References

[1] Dahuri R 2004 *Sumber Daya Wilayah Persisir dan Laut* (Jakarta: PT. Pradnya Paramita)
[2] Dahuri R 2016 *Pengelolaan Sumberdaya Pesisir dan Laut di Indonesia General Seminar* (Bandung: Padjadjaran University)
[3] Purba N P, Taofiqurohman A and Yusuf M A 2012 *Laporan Akhir* (Bandung: Universitas Padjadjaran Jatinangor)
[4] Bakus G J 1973 *The Biology and Ecology of Holothurians* (New York: Academic Press)
[5] Effendi H 2003 *Telaah Kualitas Air bagi Pengelolaan Sumberdaya dan Lingkungan Perairan* (Yogyakarta: Penerbit Kanisius)
[6] Hyman L 1955 *The Invertebrates Echinodermata Vol IV* (New York: Mc Graw-Hill Book Company)
[7] Nybakken J W 1988 *Biologi Laut: Suatu Pendekatan Ekologis* (Jakarta: PT. Gramedia)
[8] Gufran M H, Kordi K and Tanjung A B 2007 *Pengelolaan Kualitas Air Dalam Budidaya Perairan* (Jakarta: Penerbit Rineka Cipta)
[9] Nontji A 2006 *Plankton* (Jakarta: Pusat Penelitian Oceanografi)
[10] Thillai R, M Rajkumar, J Sun, Prabu V A and Perumal P 2009 Seasonal Variations of Phytoplankton Diversity in The Coleroon Coastal Waters, Southeast Coast of India (Sinica: Acta Oceanologica)
[11] Cuncun H 2012 *Struktur Komunitas Fitoplankton Kaitannya dengan Distribusi Nutrien di Perairan Pulau Biawak Kabupaten Indramayu* (Bandung: Padjajaran University Press)
[12] Prihadi D J 2011 *Analysis of Plankton Structure Related to Ecotourism in Manta Point Nusa Lembongan Bali Indonesia* (Pekalongan: Proceeding of International Seminar)