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ECHINODERMS AS A BIOINDICATOR OF WATER QUALITY OF WEDA WATERS, CENTRAL HALMAHERA DISTRICT

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ABSTRACT

Echinoderms are deposit feeders that digest most of the sediment. Echinoderms are also a good aquatic bioindicators, because Echinodermata are relatively calm or have low mobility, so they are highly influenced by environmental factors. This study aimed to determine the community structure of Echinoderms and their distribution relationship with several aquatic physico-chemical factors. Echinodermata sampling was carried out using the belt transect method using three stations. Data were collected in the form of the number of echinoderms in the transect and physico-chemical parameters of the waters including temperature, salinity, turbidity, pH, dissolved oxygen, ammonia, nitrite, and nitrate. From the results of research at three station points in the waters of Weda waters, 9 species of Echinodermata were found, namely Protoreaster nodosus, Linckia laevigata, Culcita novaeguineae, Diadema setosum, Diadema savigny, Echinometra mathaei, Tripneusteus gratilla, Holothuria atra, Holothuria edulis which were grouped into 3 classes, 4 orders, 6 families, and 7 genera with a total of 139 individuals. The diversity index of Echinodermata in Weda waters was classified as moderate with an average value of 1.05, the uniformity index was classified as moderate with an average value of 0.56, and the average dominance index value was 0.28 meaning that no species dominated.

INTRODUCTION

Indonesia has thousands of islands with the total area of the sea being around 5 million km^2 so it has a coastline of 108,920 km (Suharsono, 2014). Indonesia is known

as one of the largest *marine mega biodiversity areas* in the world due to its high marine diversity (Setiawan et al., 2018). Echinoderms are one of diverse biological such and are the most animals found in each sea beach. This is in accordance with statement by (Costa et al., 2014) that the existence of Echinodermata was found starting from the shallow zone to the deep zone.

Echinodermata is a phylum that consists of invertebrate animals or animals without backbones. Echinodermata comes from two words namely echinos (thorn) and derma (skin), so this animal is called an animal whose skin is thorny in Greek. The phylum Echinodermata has five classes, namely class Asteroidea which is known as starfish; class Echinoidea or sea urchins; class Ophiuroidea or snake stars; class Crinoidea, or sea lilies, and class Holothuroidea or sea cucumbers. All echinoderms are bilaterally symmetrical as larvae and radially symmetrical as adults. They have a calcified substance in their endoskeleton and a vascular system, as well as the ability to regenerate lost or damaged body parts (Schories, 2016).

Echinoderms in marine waters besides having ecological benefits also act as cleaners. This statement is based on Hudha and Zaenab (2002) in (Astuti et al., 2020) who stated that Echinoderms are waste-eating animals. Organic so that the sea becomes clean and also has high economic value such as sea cucumbers and sea urchins. Echinoderms are good aquatic bioindicators because Echinodermata can only live in good water conditions. This statement is supported by (Jalaluddin, 2017) who state that Echinoderms can also be used as bioindicators of marine water quality. Ecologically, the existence of Echinodermata has a very important influence on the level of fertility of the bottom substrate because indirectly Echinoderms are *deposit feeders* that digest most of the sediment so by (Pallo & Lewaherilla, 2018) stated that Echinoderms also play a role as a component in the food chain in the sea.

Bioindicators are biotic components used as guidelines. According to Sumenge (2008) in (Aulia et al., 2020), the existence of this bioindicator can show changes in water quality caused by human activities and natural damage. Echinoderms as macro-benthic invertebrates (macrozoobenthos) are bioindicators that help provide precise information about water conditions rather than information on chemical and microbiological factors by providing short-term fluctuations (Mieszkowska et al., 2013). Analysis of the community structure of benthic animals can provide an overview of whether or not water

is disturbed. The factor underlying the use of benthos as an indicator organism for water quality is due to the nature of benthos which is relatively calm or has low mobility so it is highly influenced by the environment (Fachrul, 2007). Water quality that is said to be good usually has high species diversity and conversely, bad or polluted waters have little species diversity, including macrozoobenthos. The distribution and diversity of macrozoobenthos can indicate the quality of river waters. In unpolluted waters, the number of individuals is relatively even among all existing species. Conversely, in polluted waters, the distribution of the number of individuals is uneven and there tends to be a species that dominates (Odum, 1994).

Weda waters are waters consisting of Weda Beach which is in the Weda sub-district, Central Halmahera district, and Weda Bay which is on Halmahera island, North Maluku. Weda Beach crosses three villages, namely the villages of Wedana, Were, and Fidi Jaya. This beach has a 20 km long coastline and a muddy sand substrate overgrown with seagrasses. The current condition of the beach is a harbor, fisheries, and settlements. The density of fishermen's settlements and surrounding residents on the Weda coast directly increases various types of activities that produce industrial waste and other domestic waste that can disrupt the balance of aquatic ecosystems in coastal areas. More activities in the area generally will produce waste that can pollute the beach. One of the efforts that can be made to see the condition of waters is through the parameters of marine biota which are used as bioindicators. Water quality that is said to be good usually has high species diversity and conversely, bad or polluted waters have little species diversity, including echinoderms.

Research on marine biota as aquatic bioindicators has been widely carried out (Tarwotjo et al., 2018); Supriyati et al., 2019; Aulia et al., 2020; Bahri et al., 2021), but studies on the community structure of echinoderms as bioindicators are still minimal. Knowing the community structure and habitat preferences of Echinoderms is important because this biota has ecological significance in balancing the ecosystem in the ocean. Therefore, this research was conducted to identify Echinoderm species, habitat preferences, and community structure. Given the importance of this group of Echinoderms in the balance of coastal ecosystems, the findings of this research and the data obtained will contribute to the management and conservation of Echinoderms in the area.

Study this aim to know the structure of community Echinodermata animals in various stations along Weda Beach. Additionally, to know the connection spread with several factors chemical physics waters.

MATERIALS AND METHODS

Materials

Equipment used in this research consist of basic diving equipment (mask, snorkel, and fins), 100 m tape measure, 5 m x 5 m square transect frame, small scope, sample bag, label paper, GPS (*Global Positioning System*), thermometer, refractometer, pH meter, DO meter, spectrophotometer, camera, stationery, and identification book.

Sampling station

Determination of the location for sampling Echinoderms was carried out using the purposive sampling method, which was based on certain objectives and consideration of certain criteria for the location to be studied. Sampling locations were divided into 3 stations and determined based on the number of community activities. The first station is a coastal area where there are many community activities and has a sandy mud substrate. The second station is a beach where there are not too many community activities and has a sand and coral reef substrate. While the third station is an area where community activity rarely occurs and has sand and coral reef substrates. All three stations are overgrown with seagrass.

Echinodermata sampling was carried out using the belt transect method using three stations. At each station, a quadratic transect is made by drawing a straight line from the lowest ebb along 100 m seaward and 50 m following the shoreline. In one transect five plots are measuring 5 x 5 m, and the distance between plots is 15 meters.

Measurement factor chemical Physics waters at each station namely pH, salinity, temperature, turbidity, and oxygen dissolved (DO) were measured in the field whereas measurement nitrates, nitrites, and ammonia were analyzed in the Central Halmahera District Health Office laboratory. This measurement aims to describe environmental physico-chemical factors that can support the survival of Echinoderms (Melvia et al., 2017).

Data Analysis

Index Diversity (H')

Diversity in a place is analyzed using the Shannon-Wienner (H') index formula as follow:

$$H' = -\sum pi \ln pi$$

Description:

H' = Index Diversity

pi = Abundance relatively species (ni /N)

ni = Number of individuals of species i

N = The total number of individuals

Table 1. Criteria Index Diversity

H'	Criteria
H' < 1.0	Diversity is low, very low productivity is an indication exists heavy pressure, and the ecosystem has no stable
1.0 < H' < 3.32	Diversity medium, productivity enough, ecosystem conditions enough balance, pressure ecological currently
H > 3.32	Diversity high, stability ecosystem balance, productivity high hold to pressure ecological

(Odum, 1994)

Index Uniformity (E)

The uniformity index was analyzed using the Evenness (E) formula (Odum, 1994) as follow:

$$\boldsymbol{E = \frac{H'}{Hmax}}$$

Description:

E = Index Uniformity

H' = Index diversity

Hmax = ln S

Ln S = Total taxa

Table 2. Criteria Index Uniformity

H'	Criteria
E < 0.4	Uniformity species low
0.4 < E < 0.6	Uniformity species currently
E > 0.6	Uniformity species tall

(Odum, 1994)

Index Dominance

Index Dominance can be counted with the use of Index Dominance from Simpson, as follow:

$$C = \sum\left(\frac{ni}{N}\right)^2$$

Description:

C = Index Dominance

ni = Number of individuals of species i

N = Total number of individuals

Table 3. Criteria Index Dominance (Odum, 1994)

H'	Criteria
0 < C < 0.5	Nothing dominating species
0.5 < C < 1	There are dominating species

RESULTS AND DISCUSSION

Composition Echinodermata species

Based on observations and identification of Echinoderm species in Weda coastal waters, 9 species of Echinoderms were found on Weda Beach which were grouped into 3 classes, 4 orders, 6 families, and 7 genera with a total of 139 individuals spread over 3 stations. Echinodermata observation results are presented in **Table 4**.

Table 4. Species composition of Echinodermata in Weda Beach waters

No	Class	Species Name	Amount Individual			Amount
			Station 1	Station 2	Station 3	
1	Ateriodea	*Protoreaster nodosus*	0	0	33	33
		Linkia laevigata	0	0	27	27
		Culcita sp	0	0	11	11
2	Echinoidea	*Diadema cetosum*	2	2	5	9
		Diadema savigny	0	0	20	20
		Echinometra mathaei	0	0	5	5
		Tripneusteus gratilla	0	3	0	3
3	Holothuroidea	*Holothuria atra*	2	4	8	14
		Holothuria edulis	4	6	7	17
Amount Species			3	4	9	139

Based on the results of research on Echinoderms in the waters of Weda Beach, 9 species from 3 classes were found. The 3 classes are Asteriodea, Echinoidea, and Holothuroidea whereas Ophiroidea and Crinoidea not are found. Crinoidea class is not

found because according to (Triacha et al., 2021), the habitat of Crinoidea is at the bottom of the high seas or coral reef ecosystems that have strong currents, clear waters, and sufficient oxygen levels. In line with (Yusron, 2016), several species of the Crinoidea class are rarely found because their habitat is usually in steep areas, temporary location studies are in waters shallow. According to (Yusron, 2011), Crinoidea lives in areas of steep coastal cliffs to protect themselves from being hit by waves. The number of Echinodermata species found in this location (9 species) is less than the number of Echinodermata species found in the coastal waters of East Lombok, (14 species) (Patech et al., 2020).

The composition of Echinodermata species at each observation station had different results. The highest number of species was found at station 3, namely 9 species, station 2 found 4 species, and station 1 found 3 species. This difference is caused by each Echinoderm having different food needs and living abilities depending on environmental factors. This statement is based on Astuti et al., (2020) which states that the highest abundance of a species is because the species can adapt to that environment. This shows that the species has a fairly wide range of environmental factors including substrate, can reproduce quickly, and can utilize resources in the region. Therefore, species found in an observation plot show broad tolerance to their environment and can survive in the abiotic conditions of that area. Meanwhile, animals that have a wide tolerance will be found at all observation stations.

Holothuroidea was found at all observation stations. This is thought to be environmental factors such as habitat consisting of muddy, sandy, sand with seagrass substrates, coral and coral fragments as well as water quality such as salinity, pH, temperature, and brightness which is still stable so that it supports the life of sea cucumbers. This is by the statement by Napitupulu et al., (2018) that sea cucumbers (Holothuroidea) are the most commonly found marine biota. This animal is often found on coral reefs and rocky or muddy beaches. According Handayani et al., (2017) stated that Holothuridae generally prefers clear waters, fine sandy bottoms, or sand mixed with mud with plants that can protect indirectly from the heat of the sun such as seagrass and seaweed so the highest number of sea cucumbers was found at station 3 which is located slightly far from villages, has a coral sand substrate with clear waters.

Index Diversity, Indeks Uniformity, and Indeks Dominant

The diversity index states the condition of a species population mathematically or shows the level of diversity of the species. Diversity depends on the number of species and the number of individuals of that species. Analysis results Index Diversity, Indeks Uniformity, and Indeks Dominant is presented in **Table 5**.

Table 5. Index Echinoderm Diversity, Uniformity, and Dominance

Station	Value		
	Station 1	Station 2	Station 3
Index diversity (H')	0.63	1.00	1.52
Index uniformity (E)	0.30	0.48	0.83
Index dominant (D)	0.37	0.29	0.17

Analysis results showed that the Index average value diversity of 1.05 is in the category of the medium. The index diversity at stations 2 and 3, diversity species medium productivity was enough, ecosystem conditions was enough balance, pressure ecological was medium. Index diversity station 1 was low. The very low productivity as an indication of exists heavy pressure and the ecosystem was no stable due to lacks activity community and settlement in station 2 whereas station 1 is in settlements and ports as well as place disposal waste carapace shrimp. According to Erlangga et al., (2018), pressure ecological causes low diversity can originate from activity settlement, transportation, or fisheries around the location. According to Yusal et al., (2019) state that activity settlement, transportation, or fisheries can affect the quality of coastal waters and biota in the intertidal zone.

The uniformity index describes the tendency of the distribution of individuals between different species. Analysis results from index uniformity showed that station 3 has a high uniformity species, station 2 has medium uniformity species, and station 1 has low uniformity species. According to Radjab et al., (2014), high species uniformity is due to the absence of dominance of a particular species. Low evenness at station 1 because the distribution of the individuals of each species is not evenly distributed, because in this habitat only one species is seen that lives very abundantly in the number of individuals, namely *Holothuria edulis.* However, on average, the index of Echinodermata uniformity on the Weda coast is classified as medium around 0.56.

The dominance index describes the level of dominance of a particular species group. In general, the dominance index value for each research station is < 0.5. This means there is no dominant species. This result was different to Bahri et al. (2021) who

reported that the dominance index on Gerupuk Beach value was 0.88 which is classified as a high category with a dominant species. According to (Radjab et al., 2014) the smaller dominance value, the higher species diversity indicated more diverse community. Furthermore, it was said that domination occurs because there is a result of the process of competition between individuals against one another or due to the habitat characteristics of certain species that life spread out in almost all existing zones (Leksono, 2007).

Physico-Chemical Profile of Aquatic

Measurement of physico-chemical parameters waters done in each station research in the waters of Weda Beach. The results of measurements of physico-chemical factors water served on **Table 6**.

Table 6. Average Value of Aquatic Physico-Chemical Parameters

Physico-Chemical Parameters	Unit	Station		
		1	2	3
Temperature	^{0}C	30.8	30.2	29.7
Salinity	‰	30	30	30
Turbidity	NTU	2.88	2.77	2.37
pH	-	7.9	8.1	8.1
Oxygen dissolved	mg/L	6.02	6.18	6.86
Ammonia	mg/L	1.10	0.50	0.26
Nitrite	mg/L	0.032	0.012	0.027
Nitrate	mg/L	0.024	0.032	0.005

The temperature of the waters of the Weda coast on each station observation showed range of between 29.7°C – 30.8°C. This temperature was suitable for Echinodermata life. Maleko et al. (2017) stated that Echinodermata animals can live in temperature range between 28 ^{0}C-30 ^{0}C. Salinity level of Weda Beach waters are at 30 ‰. According Triacha et al., (2021) the appropriate salinity For Echinoderm's life ranges between 30-36 ‰, whereas according to Astuti et al., (2020), animal echinoderms can adapt to salinity 30-37. Turbidity level at the station range between 2.37-2.88 NTU. Factors causing turbidity was the presence of organic and inorganic materials suspended and dissolved in water such as mud and fine sand, as well as organic and inorganic materials in the form of plankton and other microorganisms. Decree of the Minister of Environment No. 51 in 2004 stated that the maximum turbidity limit for marine life is less than 5 NTU.

The pH value ranges from 7.9-8.1. According to Decree of the Minister of Environment No.51 in 2004, the pH of seawater in the range of 7-8.5 is considered normal. Very alkaline or very acidic of water conditions can affect the body metabolism

of biota therefore it interferes with their survival (Hamuna et al., 2018). Oxygen value Dissolved (DO) waters of Weda Beach range between 6.02-6.86 mg/L. According to the Decree of the Minister of Environment No.51 in 2004 the DO level is in the appropriate normal category with raw quality for marine life that is ≥ 5mg /L.

Ammonia levels in the waters of the Weda coast range between 0.26-1.30 mg/L. Based on the Decree of the Minister of Environment No. 51 in 2004, the ammonia level in the waters of Weda Beach is still low and is within the normal threshold for marine life and < 3.0 mg/L. Station 1 has the highest concentration value of ammonia while station 3 has the lowest ammonia concentration value. The high concentration of ammonia in this station affected by environmental factors, the location of station 1 is a residential location population, activity harbor, and become a place for disposal waste carapace shrimp which causes a large amount of organic matter around the sampling point.

Nitrite concentration broadcast ranges between 0.012-0.032. According to Effendi (2003), nitrite levels in rare waters >1mg/L. Nitrite levels of more than 0.05 mg/L can be toxic to organisms. The highest nitrate concentration located at station 1, this possible oxygen levels dissolved at station 1 are lower compared to station other. (Iklima AS et al., 2019) stated that the content of nitrite compounds will increase the lower the dissolved oxygen.

Nitrate levels in the coastal Weda waters revolve around 0.005-0.032 mg/L. Patty (2015) suggested that the range of nitrate concentrations of 0.3-0.9 mg/l is the normal limit for biota growth while value > 3.5 mg/l was harmful for biota life. Effendi (2003) stated that water nitrate concentrations > 0.2 mg/l caused eutrophication so that phytoplankton grew rapidly (*blooming*). From the results of measuring the environmental parameters of the Weda waters, it shows that the values are still suitable for the survival of Echinoderms.

CONCLUSION

Echinoderms found in the waters of the Weda coast had nine species, that is *Protoreaster nodosus*, *Linckia laevigata, Culcita* sp, *Diadema setosum, Diadema savigny, Echinometra mathaei, Tripneusteus gratilla, Holothuria atra, Holothuria edulis.* The Index diversity of Echinoderms in the waters of the Weda coast currently with an

average value of 1.05, the index uniformity belong currently with an average value of 0.56, and the average value of the index dominance i.e. 0.28 means no there are dominating species.

REFERENCES

Astuti, L., Hudha, A. M., Husamah, H., & Setyawan, D. (2020). *Afinitas antar spesies dan klasifikasi komunitas Echinodermata di Kawasan Pantai Parang Dowo Kabupaten Malang*.

Aulia, P. R., Supratman, O., & Gustomi, A. (2020). Struktur Komunitas Makrozoobentos Sebagai Bioindikator Kualitas Perairan Di Sungai Upang Desa Tanah Bawah Kecamatan Puding Besar Kabupaten Bangka. *Ilmu Perairan*, *2*(April), 17–30. http://journal.ubb.ac.id/index.php/aquaticscience

Bahri, S., Patech, L. R., Zulhalifah, Z., Septiani, D. A., & Siswadi, S. (2021). Distribution and Diversity of Echinoderms in the Coastal Waters of South Beach of Lombok Island. *Jurnal Biologi Tropis*, *21*(1), 22–31. https://doi.org/10.29303/jbt.v21i1.2320

Costa, V., Mazzola, A., & Vizzini, S. (2014). Holothuria tubulosa Gmelin 1791 (Holothuroidea, Echinodermata) enhances organic matter recycling in Posidonia oceanica meadows. *Journal of Experimental Marine Biology and Ecology*, *461*, 226–232. https://doi.org/10.1016/j.jembe.2014.08.008

Erlangga, Y., Afdhal El Rahimi, S., & Nanda Devira, C. (2018). Community Structure of Echinoderms in Gapang Beach, Iboih Village, Sukakarya District, Sabang. *Jurnal Ilmiah Mahasiswa Kelautan Dan Perikanan Unsyiah*, *3*(1), 92–101.

Hamuna, B., Tanjung, R. H. R., Suwito, S., Maury, H. K., & Alianto, A. (2018). Study of Seawater Quality and Pollution Index Based on Physical-Chemical Parameters in the Waters of the Depapre District, Jayapura. *Jurnal Ilmu Lingkungan*, *16*(1), 35–43. https://doi.org/10.14710/jil.16.135-43

Handayani, T., Sabariah, V., & Hambuako, R. R. (2017). Komposisi Spesies Teripang (Holothuroidea) Di Perairan Kampung Kapisawar Distrik Meos Manswar Kabupaten Raja Ampat. *Jurnal Perikanan Universitas Gadjah Mada*, *19*(1), 45. https://doi.org/10.22146/jfs.26946

Iklima AS, R., Diansyah, G., Agussalim, A., & Mulia, C. (2019). Analisis Kandungan N-Nitrogen (Amonia, Nitrit, Nitrat) dan Fosfat di Perairan Teluk Pandan Provinsi Lampung. *Jurnal Lahan Suboptimal : Journal of Suboptimal Lands*, *8*(1), 57–66. https://doi.org/10.33230/jlso.8.1.2019.377

Jalaluddin, A. (2017). 435-812-1-Sm. *IDENTIFIKASI DAN KLASIFIKASI PHYLUM ECHINODERMATA DI PERAIRAN LAUT DESA SEMBILAN KECAMATAN SIMEULUE BARAT KABUPATEN SIMEULUE*, *6*(1), 81–97.

Maleko, M. C., Ramadhan, H. A., & Djirimu, M. (2017). Keanekaragaman Echinodermata di Peraiaran Pantai Labuan Desa Montop Kecamatan Bulagi Utara Kabupaten Banggai Kepulauan dan Implementasinya Sebagai Media Pembelaaran Biologi. *E-Jip Biol*, *5*(1), 72–78.

Melvia, Y. C. S., Sarung, M. A., & Ulfah, M. (2017). Kabupaten Batu Bara Provinsi Sumatera Utara Diversity of Echinoderms and Environmental Conditions in the Shallow Waters of Pandang Island Batu Bara Regency Sumatera Utara. *Jurnal Ilmiah Mahasiswa Kelautan Dan Perikanan Unsyiah*, *2*(1), 97–103.

Mieszkowska, B, L. F., & C, and M. B. (2013). Impacts of climate change on India. *Impacts of Climate Change on Intertidal Habitats*, *November*, 180–192. https://doi.org/10.14465/2013.arc19

Napitupulu, H. G., Rumengan, I. F. M., Wullur, S., Ginting, E. L., Rimper, J. R. T. S. L., & Toloh, B. H. (2018). Jurnal Ilmiah Platax ISSN : 2302-3589 Jurnal Ilmiah Platax ISSN : 2302-3589. *Jurnal Ilmiah Platax*, *6*(1), 29–41.

Pallo, B. C., & Lewaherilla, N. (2018). Jenis–Jenis Teripang (Holothuroidae) di Perairan Kampung Auki Distrik Padaido Kabupaten Biak Numfor, Papua. *Jurnal Biologi Papua*, *3*(1), 24–31. https://doi.org/10.31957/jbp.545

Patech, L. R., Syukur, A., & Santoso, D. (2020). Kelimpahan dan Keanekragaman Spesies Echinodermata sebagai Indikator Fungsi Ekologi Lamun di Perairan Pesisir Lombok Timur. *Jurnal Sains Teknologi & Lingkungan*, *6*(1), 40–49. https://doi.org/10.29303/jstl.v6i1.148

Patty, S. I. (2015). Karakteristik Fosfat, Nitrat dan Oksigen Terlarut di Perairan Selat Lembeh, Sulawesi Utara. *Jurnal Pesisir Dan Laut Tropis*, *3*(2), 1. https://doi.org/10.35800/jplt.3.2.2015.9581

Radjab, A. W., Rumahenga, S. A., Soamole, A., Polnaya, D., & Barends, W. (2014). Keragaman dan Kepadatan Ekinodermata di Perairan Teluk Weda, Maluku Utara. *Jurnal Ilmu Dan Teknologi Kelautan Tropis*, *6*(1), 17–30.

Schories, D. & G. K. (2016). *King george island, antarctica* (GESCHE KOHLBERG (ed.); 1st ed., Vol. 67, Issue 2). Dirk Schories Publications.

Setiawan, R., Atmowidi, T., Widayati, K. A., & Purwati, P. (2018). Preferensi Habitat Spesies Ophiuroidea Di Zona Intertidal Pantai Pancur Taman Nasional Alas Purwo. *Jurnal Kelautan: Indonesian Journal of Marine Science and Technology*, *11*(2), 151. https://doi.org/10.21107/jk.v11i2.4741

Suharsono. (2014). *Biodiversitas Biota Laut Indonesia* (Issue June 2014).

Supriyati, H., K, S. D., Ahzami, A., Sodiq, F., & Khoiriyah, S. (2019). Echinoderms Diversity and Abundance in Gunung Kidul Beach Yogyakarta. *Biology, Medicine, & Natural Product Chemistry*, *8*(1), 23–26. https://doi.org/10.14421/biomedich.2019.81.23-26

Tarwotjo, U., Rahadian, R., & Hadi, M. (2018). Community structure of

macrozoobenthos as bioindicator of pepe river quality, Mojosongo Boyolali. *Journal of Physics: Conference Series*, *1025*(1). https://doi.org/10.1088/1742-6596/1025/1/012039

Triacha, Z. I. E. C., Pertiwi, M. P., & Rostikawati, R. T. (2021). Keanekaragaman Echinodermata di Pantai Cibuaya Ujung Genteng , Jawa Barat Echinoderms Diversity in Cibuaya Beach Ujung Genteng , West Java. *Jurnal Ilmu Dasar*, *22*(1), 9–18.

Yusal, M. S., Marfai, M. A., Hadisusanto, S., & Khakhim, N. (2019). Analisis Ekologis Meiofauna Sebagai Bioindikator Di Pesisir Pantai Losari, Makassar. *Bionature*, *19*(1), 15–22. https://doi.org/10.35580/bionature.v19i1.7308

Yusron, E. (2011). Keanekaragaman Jenis Ophiuroidea (Bintang Mengular) Di Perairan Wori, Minahasa Utara, Sulawesi Utara. *MAKARA of Science Series*, *14*(1), 75–78. https://doi.org/10.7454/mss.v14i1.464

Yusron, E. (2016). Struktur Komunitas Ekhinodermata (Holothuroidea, Echinoidea Dan Ophiuroidea) Di Daerah Padang Lamun Di Pantai Gunung Kidul, Yogyakarta. *Zoo Indonesia*, *24*(2), 73–82.