Ecological and Anthropological Impact on Diversity Echinodermata in the South Beach Area, Indonesia

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Abstract. The Sancang Beach is overgrown by various types of seagrass, algae, coral reefs, and mangroves so it has the potential for the life of marine biota, including the Echinoderms phylum. This research aims to describe the diversity of the Echinoderms phylum in Sancang Beach, Garut District. This research was conducted from November 2019 to December 2020. The type of research conducted is descriptive research using the purposive sampling method located in Ciporeang to Cibako. Echinoderm data was collected using the Belt Transect technique along 100 m which was drawn perpendicularly from the coast to the sea with a plot measuring 1 × 1 m. Data analysis used the Shannon-Wiener diversity index formula. Identification is done by comparing the morphological species obtained with the morphological characteristics in the Identification book. Overall observation results obtained Echinoderms as many as 12 species consisting of 5 classes, 7 orders, and 7 families with an average diversity index value on the beach of Sancang Garut District, namely $H' = 1.07$. The conclusion is that the level of diversity in Sancang Beach, Garut District is moderate.

Keywords: Diversity · Echinoderms · Sancang Beach

1 Introduction

Sancang Coast is overgrown with various types of seagrass, seaweed, coral reefs, and mangroves so that it has the potential for the growth of marine life. Marine biota that can be found on Sancang Coast is fish, lobster, shrimp, shellfish, starfish, and various other marine life [1]. Seagrass beds have a very important role as a habitat for several species of fish and invertebrates [2]. In addition, coral reefs are also an ecosystem that acts as a habitat for marine life, especially echinoderms [3].

Echinodermata is a phylum known as having a thorn-skinned body because the skin of its members has thorn-like protrusions. The body of the phylum Echinodermata can

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be divided into five parts that surround the central axis [4] and have 5 classes, including Asteroidea (sea star), Ophiuroidea (serpent starfish), Crinoidea (sea lily), Echinoidea (sea urchin), and Holothuroidea (sea cucumber). The phylum Echinodermata can be found in marine waters, especially in areas with extensive coral reefs. This phylum is often known as the key to marine ecology that plays a role in maintaining the balance of marine ecosystems because echinoderms are able to eat the remains of organisms (organism carcasses).

Based on the obtained information and data, a study on the phylum Echinodermata has been conducted in 2012 which is located at the estuary of the Cipalawah river and the estuary of the Cikolomberan river. However, recent studies on the diversity of the phylum Echinodermata in Sancang Coast, Garut have not been reported yet. Therefore, in order to update the information, it is necessary to conduct a study there. Observation has been carried out in January 2020 and this area is known to have various kinds of ecosystems, such as coral reefs, seagrass, and algae. The purpose of this study is to determine the species or types of the phylum Echinodermata found in Sancang Coast, Garut, and to describe their diversity index. The results of this study are learning media in the form of wet preserves and a pocketbook that explains the species of the phylum Echinodermata found in Sancang Coast, Garut.

2 Methods

2.1 Research Location

This study was conducted at Sancang Coast, Garut, West Java on 19–21 July 2020 in 3 different stations (see Fig. 1). Station I was located in Ciporeang with rock and coral substrate. Moreover, Station II was located in Cikujangjambe with a sandy substrate overgrown with algae. At last, Station III was located in Cibako which is dominated by seagrass and algae. The study was conducted at 3 stations to compare the diversity and uniformity at each station. In addition, these 3 stations are the closest locations and their ecological environment allows for conducting research.

Fig. 1. Research Location

Sampling was carried out using the belt transect method which was drawn perpendicularly from the coast to the sea along 100 m. Sampling was carried out at 3 stations and each station had 100 plots with a size per plot of 1 × 1 m. Measurement of the physicochemical conditions of the environment at each station, such as temperature, salinity, pH, and dissolved oxygen, was carried out around 07.00–09.00 am.

The applied data analysis techniques were the formulas for species density, relative density, Shannon- Wiener diversity index, uniformity index, and dominance index. Species density was calculated to determine the total of individuals in the area of observation. Relative density was calculated to determine the ratio of the density of an Echinoderm species to the total species of Echinoderms. The diversity index was calculated to determine the level of diversity of echinoderms in Sancang Coast, Garut. The uniformity index was calculated to determine the individual composition between echinoderms found in Sancang Coast, Garut. Furthermore, the dominance index was calculated to determine whether a species dominates in the research location.

The identification of the phylum Echinodermata was conducted by comparing the morphology of the species obtained with the morphological characteristics in the identification book entitled 'A GUide to Common Echinoderms of Andaman and Nicobar Islands' composed by Raghunathan et al. (2013) [5] and scientific articles based on shape, color, spines, and patterns of the species. The tools used in this study were a digital pH meter, digital DO meter, digital thermometer & anemometer, digital salinometer, roll meter, raffia rope, camera, stationery, label paper, ruler, tray, jar, clamp, and identification book. Meanwhile, the materials used in this study were 2 liters of distilled water (Aquades) and 70% alcohol.

3 Results and Discussion

3.1 Results of the Observation of the Phylum Echinodermata at Sancang Coast, Garut

Based on the results of this study that has been carried out at 3 stations in Sancang Coast, Garut, researchers found 12 species belonging to 5 classes. The results of the observation of the phylum Echinodermata found in Sancang Coast, Garut can be seen in Table 1.

3.2 Distribution of the Phylum Echinodermata in Sancang Coast, Garut

Based on the results of the study that has been carried out at Sancang Coast, Garut, it is found out that at Station I (Ciporeang) with an observation area of 100 m^2, researchers found 6 species of echinoderms consisting of 221 individuals, at Station II (Cikujangjambe), researchers found 7 species consisting of 1,797 individuals, and at Station III (Cibako), researchers found 10 species consisting of 1,280 individuals (see Table 2).

Linckia laevigata (blue sea star) is a species from the family Ophidiasteridae. The surface of its body has small granules and no spines. Its main characteristics are the symmetrical body shape with striking blue body color. It has 5 long arms with rounded ends. In the oral part, it has a mouth, while in the aboral, it has a madreporite and anus. This kind of sea star is detritus eaters and is only found at Station III (Cibako) with a rocky coral substrate.

Table 1. Results of the observation of the phylum Echinodermata in Sancang Coast, Garut

Class	Order	Family	Genus	Species
Asteroidea	Valvatida	Ophidiasteridae	Linckia	*Linckia laevigata*
Ophiuroidea	Ophiacanthida	Ophiocomidae	Ophiocoma	*Ophiocoma aethiops*
				Ophiocoma echinata
				Ophiocoma scolopendrina
				Ophiocoma sp.
Crinoidea	Comatulida	Colobometridae	Oligometra	*Oligometra serripinna*
Echinoidea	Diadematoida	Diadematidae	Diadema	*Diadema setosum*
	Camarodonta	Echinometridae	Heterocontrotus	*Heterocentrotus trigonarius*
	Stomopneustoida	Stomopneustidae	Stomopneustes	*Stomopneustes variolaris*
Holothuroidea	Holothuriida	Holothuriidae	Holothuria	*Holothuria cinerescens*
				Holothuria leucospilota
				Holothuria sp.

Ophiocoma aethiops is a species from the family Ophiocomidae. It has 5 arms and a blackish-brown body. The distinctive features of this species are the parallel spines on both sides of the arms and a regular hexagon- shaped arm plate. On the oral side, it has a mouth, while, on the side of the back of the disc (aboral), it has a white line that looks faint. This species was found at all stations. However, it was more dominant at Station II (Cikujangjambe) with a sandy substrate overgrown with algae.

Ophiocoma echinata is a serpent starfish with a brown body and has 5 arms attached to a central disc. The brown color of the central disc is darker than the color of the arms. The distinctive feature of this species is that it has erect spines on both sides of its arms. This species is a precipitate eater (takes small particles directly from the substrate) and a filter eater (takes particles from the surrounding water mass). This kind of serpent starfish was found at all stations. However, it was more dominant at Station III (Cibako) with a rocky coral substrate.

Ophiocoma scolopendrina has 5 arms attached to the central disc. The arms of this species alternate dark and light and each arm has short spines on either side of the arm. The distinctive feature of this species is a faded green color with blackish lines on the aboral part. Meanwhile, the color of the oral part is yellowish. This species was similar

Table 2. Distribution of the phylum Echinodermata at research stations

No	Spesies	Stations		
		I	II	III
1	*Linckia laevigata*	-	-	1
2	*Ophiocoma aethiops*	35	712	207
3	*Ophiocoma echinate*	29	277	279
4	*Ophiocoma scolopendrina*	152	715	755
5	*Ophiocoma sp.*	1	88	-
6	*Oligometra serripinna*	-	-	1
7	*Diadema setosum*	-	-	4
8	*Heterocentrotus trigonarius*	-	-	5
9	*Stomopneustes variolaris*	3	2	14
10	*Holothuria cinerescens*	-	-	4
11	*Holothuria leucospilota*	1	2	-
12	*Holothuria sp.*	-	1	10
	Total	221	1,797	1,280

to other Ophiocoma, which was found at all stations. However, it was more found at Station III with a rocky coral substrate.

Ophiocoma sp. is a serpent starfish with a brownish-yellow body and has 5 arms attached to the central disc. This type of sea snake star has short and erected spines on either side of the arm. The central disc is yellow with white patches. Meanwhile, the color of the oral parts is yellowish. This species was found at Station I (Ciporeang) and station II (Cikujangjambe) with a rocky and sandy substrate overgrown with algae.

Oligometra serripinna (a kind of sea lilies) has a body shape like a flower. This species can be distinguished from other species by observing its long pinnula with red and white stripes. This species does not have a stalk but has characteristics that extend in the oral part. Sea lilies have no economic value but have an important role in the food chain cycle, namely food for coral fish species. Furthermore, the presence of sea lilies can increase the aesthetics of the sea so that the sea is more beautiful to look at. This species is a plankton eater and suspended matter. This species of sea lily was only found at Station III (Cibako) with a coral reef habitat. Diadema setosum (a kind of sea urchins) has a round shape with long and pointed spines that surround its body. The color of the body and spines of this type of sea urchin is black. Its mouth is located on the oral side and the anus is on the aboral side. This species can be distinguished from other species in the genus Diadema by observing the presence of 5 white dots in the oral area. Furthermore, each point is located between the segments. In the middle of the aboral,

to be precise in the anus, this species has a bluish red ring. The food of this type of sea urchins is algae and seagrass. This species was found at Station III (Cibako) with a coral reef habitat. This type of sea urchins can be eaten by local fishermen.

Heterocentrotus trigonarius (a kind of sea urchins) is a species from the family Echinometridae which has large spines and is brownish-green in color. This species is characterized by its spines, which are very large and thick like a pencil. Its mouth is located on the oral side, and the anus is on the aboral side. In the oral part, this type of sea urchin has a bright purple color and thick small spines around it. Meanwhile, in the aboral part, this species has brown color and longer spines. The food of this species is algae and seagrass. This type of sea urchins is only found at Station III (Cibako) with the rocky reef area.

Stomopneustes variolaris is a species from the family Stomopneustidae that has an oval-shaped body and black color. The spines are elliptical with a tapered tip and greenish-black color. This type of sea urchin was found at all stations and often hides in crevices in rocks.

Holothuria cinerascens is a species from the family Holothuriida that has a blackish-brown body. This species can be distinguished from other species by the presence of small light brown spines that spread all over its body. On the dorsal part, the dorsal surface is covered with evenly distributed papillae. On the ventral part, there are many podia that are small and blunt. This species was only found at Station III (Cibako) with a hard substrate, namely rocky corals.

Holothuria leucospilota is a sea cucumber with an elliptical blackish body. This type of sea cucumber has rough skin because there are spines that spread all over its body surface. The distinctive feature of this type of sea cucumber is the color of the thorns that contrasts with the color of its body, which is black. In the anterior part, this species has a mouth that is surrounded by many tentacles. Furthermore, on the posterior part, this species has the anus. This type of sea cucumber was found at Station I (Ciporeang) and Station II (Cikujangjambe) with a sandy substrate.

Holothuria sp. is an elliptical sea cucumber. This type of sea cucumber is characterized by a round pattern with a brownish brown color that is scattered randomly on the surface of its body. This species has few papillae on the dorsal but has many podia evenly distributed in the ventral. This species was found at Station II (Cikujangjambe) and Station III (Cibako) with a coral sand substrate. The description of each research station can be seen in the following elaboration.

Station I (Ciporeang)

Station I, which is located in Ciporeang, has a coordinate point of 107°52′26″ E - 7°44′24″ S. This station is the inside part of the eastern area and is directly connected to the river mouth. For the water conditions, this station is shallow and calm waters and has no waves because, during the observation process, this station is in the low tide condition. The substrates at this station are rocks, sand, live coral, and dead coral. However, the substrates of this station are dominated by dead rocks and corals.

Based on the observation that has been carried out, Station I is the location where echinoderms have been found at least, namely 6 species consisting of 3 classes, 3 orders, and 3 families, totaling 221 individuals with an observation area of 100 m^2 (see Fig. 2). The most species in number is Ophiocoma scolopendrina, totaling 152 individuals. It is

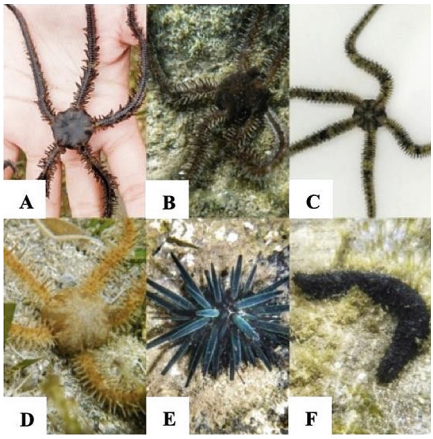

Fig. 2. Ophiocoma aethiops (A). Ophiocoma echinata (B). Ophiocoma scolopendrina (C). Ophiocoma sp. (D). Stomopneustes variolaris (E). Holothuria leucospilota (F). Source: Researchers' Documentation

assumed that this species has a high adaptation to environmental factors at this station. In addition, the dominant substrate of dead rocks and corals at this station supports this species to protect itself from predators. This is supported by findings of a study conducted by Chartock (1983) in Aziz et al. (2015: 71) [6] that Ophiocoma scolopendrina, a species of serpent starfish, is always found on coastal areas with dead coral substrates.

Station II (Cikujangjambe)

Station II, which is located in Cikujangjambe, has a coordinate point of 107°52′38″ E - 7°44′19″ S. This station is located between Station I (Ciporeang) and Station III (Cibako). For the water conditions, this station is shallow waters and has small waves during the observation process. The substrates at this station are live coral, dead coral, and sand. The area of this station is dominated by a sandy substrate overgrown with algae. However, there are rocky substrates in several observation plots of the phylum Echinodermata.

Based on the observation that has been carried out, Station II (Cikujangjambe) is the location where there are quite a lot of echinoderms found, namely 7 species consisting of 3 classes, 3 orders, and 3 families, totaling 1,797 individuals (see Fig. 3). This is due to the sandy algae substrate that dominates and the lack of community activity at this station. The class Ophiuroidea, especially Ophiocoma scolopendrina, has a higher number of individuals at this station compared to that at Station I (Cikujangjambe). The large number of Ophiocoma scolopendrina found at this station (Cikujangjambe) is presumed to be due to the sandy substrate overgrown with algae that dominate this station so that it supports the life of Ophiocoma scolopendrina to shelter and find food. In addition, the lack of community activity is also considered to affect a large number of the species.

Station III (Cibako)

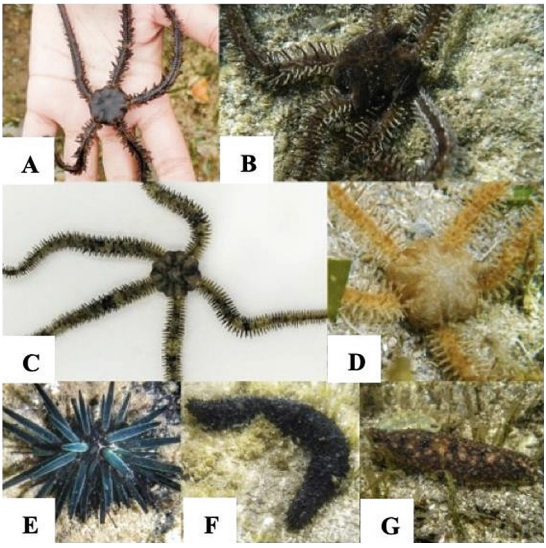

Fig. 3. Ophiocoma aethiops (A). Ophiocoma echinata (B). Ophiocoma scolopendrina (C). Ophiocoma sp. (D). Stomopneustes variolaris (E). Holothuria leucospilota (F). Holothuria sp. (G). Source: Researchers' Documentation

Station III, which is located in Cibako, has a coordinate point of 107°52′9″ E - 7°44′19″ S. This station is an area that is very far from the entrance to Sancang Coast so that there are no tourists visiting this station. For the water conditions, this station is similar to Station II, which is shallow waters and has small waves during the observation process. The substrates at this station are seagrass, live coral, dead coral, and mud. This station is dominated by seagrass and algae.

Based on the observation that has been carried out, Station III (Cibako) is the location where echinoderms have been found at most, namely 10 species consisting of 5 classes, 7 orders, and 7 families, totaling 1,280 individuals (see Fig. 4). Ophiocoma scolopendrina from the class Ophiuroidea is the species most commonly found in the three stations (Ciporeang, Cikujangjambe, and Cibako). However, based on the collected data, the largest number of Ophiocoma scolopendrina is found at Station III (Cibako). It is assumed that Station III (Cibako) is an ideal habitat for the growth of Ophiocoma scolopendrina because this station is dominated by seagrass, dead corals, and the large number of algae found in several observation plots so that they may support the life of Ophiocoma scolopendrina for shelter and foraging. This is supported by the statement from Aziz (1996: 40) [7] that the serpent starfish from the genus Ophiocoma have special adaptations, such as living in association with green macroalgae to obtain food and hide from predators.

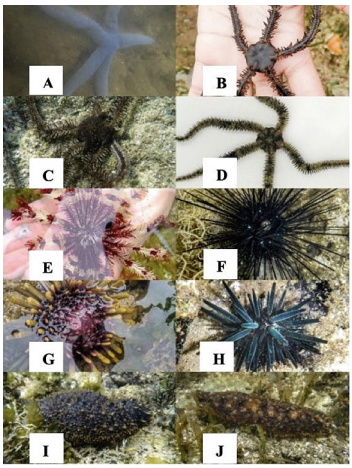

Fig. 4. Linckia laevigata (A). Ophiocoma aeth (B). Ophiocoma echinata (C). Ophiocoma scolopendrina (D). Oligometra serripinna (E). Diadema setosum (F). Heterocentrotus trigonarius (G). Stomopneustes variolaris (H). Holothuria cinerascens (I). Holothuria sp. (J). Source: Researchers' Documentation

3.3 Results of Environmental Parameters in Sancang Coast, Garut

In this study, environmental parameters were measured at 07.00–09.00 am at each station. These environmental parameters include temperature, pH, salinity, and dissolved oxygen (see Table 3).

The results of temperature measurements at each station are not much different and the temperature at those three stations is a general temperature in which the phylum Echinodermata can still tolerate for survival. Seawater temperature is influenced by the depth of the sea and the penetration of sunlight, meaning that in shallow seawater, the temperature will rise, while in the deep sea, the temperature will drop. This is due to the penetration of sunlight entering the bottom of the water. The high temperature at Station II is due to the shallow waters in Ciporeang compared to that in Cikujangjambe and Cibako so that the amount of heat absorbed is greater.

The pH measurement results at each station are not much different and the pH level at those three stations still shows the optimum pH range for the life of the phylum Echinodermata. Changes in seawater pH can be caused by community activities and freshwater input. Station I (Ciporeang) has the lowest pH compared to other stations

Table 3. Results of the observation of the phylum Echinodermata in Sancang Coast, Garut

Stations	Temperature (°C)	pH	Salinity (‰)	Dissolved Oxygen (mg/l)
I	28.3	8.33	32.2	5.64
II	27.8	8.40	33.7	5.72
III	27.9	8.38	34.0	5.54

because the location of this station is close to the river mouth and wastewater from various human activities which may change the pH of the water in that location. Station II (Cikujangjambe) has the highest pH compared to other stations due to the low discharge of wastewater from various community activities in this location.

The salinity measurement results at each station range from 32.2 to 34.0 ‰. The salinity of seawater can be affected by river flow, meaning that the salinity will decrease due to the influence of freshwater entering these waters. Station I (Ciporeang) has the lowest salinity value compared to other stations. This is because the location of Station I is close to the mouth of the river so that the supply of fresh water through the river that empties at the station location may occur. Station II (Cikujangjambe) and Station III (Cibako) have a higher salinity value than Station I (Ciporeng) because the locations of both stations are very far from the river mouth. The results of the dissolved oxygen measurement at each station are not much different and the dissolved oxygen at those three stations is classified as suitable for the life of the phylum Echinodermata. The oxygen level in seawater will increase in line with the low temperatures and low waste disposal from various human activities. Station II (Ciporeang) has a higher dissolved oxygen value compared to other stations. This is presumed to be due to the low discharge of wastewater from various human activities at that location. Furthermore, the temperature at Station II (Ciporeang) is lower than that of Station I (Cikujangjambe) and Station III (Cibako).

3.4 Results of Observation of Ecological Index in Sancang Coast, Garut

In this study, the ecological index covers species density, relative density, diversity index, uniformity index, and dominance index (see Table 4).

The highest density is found at Station II (Cikujangjambe) which reaches a value of 17.97 individuals/m^2. This is because this station has the highest total of individuals compared to other stations. The highest diversity and uniformity indexes are found at Station II (Cikujangjambe) which reaches values of 1.19 and 0.61 respectively. This is because the distribution of individuals between species at Station II (Cikujangjambe) is more even and the highest total number of echinoderms is found at Station II. However, the highest dominance index is found at Station I (Ciporeang) which reaches a value of 0.51. This is because there are species that dominate this station, namely Ophiocoma scolopendrina, meaning that the total number of individuals of this species is found more than the total number of individuals of other species. The ecological index is

Table 4. Results of ecological index calculation

Statisiun	Indeks Ekologi				
	SD	RD	H′	U	D
I	2.21	100	0.92	0.51	0.51
II	17.97	99.99	1.19	0.61	0.34
III	12.80	99.99	1.09	0.47	0.42

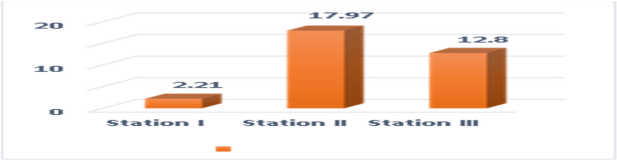

Fig. 5. The diagram of species density at each station

calculated using a predetermined formula and is used to determine the diversity of the phylum Echinodermata in Sancang Coast, Garut. The following is a description of the ecological index of each research station.

Species Density

Based on Fig. 5, it can be seen that Station II (Cikujangjambe) has the highest Echinoderm density value among other stations, which is 17.97 individuals/m2. Meanwhile, the lowest Echinoderm density value is found at Station I (Ciporeang) with a value of 2.21 individuals/m^2. This is because the total number of individuals as a whole at Station II (Cikujangjambe) is more than the other stations so that Station II (Cikujangjambe) has the highest density value.

The difference in species density at each station is presumed to be due to differences in the dominant substrate and differences in the level of community activity. Station II (Cikujangjambe) is dominated by a sandy substrate overgrown with algae while Station I (Ciporeang) is dominated by rocks and dead corals so that Station II (Cikujangjambe) is found more echinoderms than Station I (Ciporeang). In addition, the low level of community activity at Station II (Ciporeang) also supports the life of the phylum Echinodermata. This is in line with a study conducted by Putra et al. (2017: 523) that the difference in the number of echinoderms found is presumed to be due to differences in the physical and chemical characteristics of water, food availability, and availability of protection from predators due to differences in habitat diversity in the study locations.

Relative Density

Based on the number of echinoderms found at each research station, the obtained relative density value can be seen in Table 5.

The class Ophiuroidea, especially Ophiocoma scolopendrina, has a higher relative density than other species. This is because Ophiocoma scolopendrina can live in a variety of habitats and depths, such as coral reef areas, seagrass beds, live coral colonies, and dead corals. This is evidenced by the discovery of Ophiocoma scolopendrina at each station with more numbers than other species. According to Chartock (1983) in Aziz et al. (2015: 71) [6], Ophiocoma scolopendrina, a type of serpent starfish, always occupies the initial formation of the coral reef area, may also be seen on dead coral coasts, or may be covered by coral chunks and coral fragments.

The species of the phylum Echinodermata that has the lowest relative density was Holothuria sp. The low value of relative density in this species is indicated by that only 1 individual is found at the research location. This is presumed to be influenced by several factors, such as competition and habitat selection that could occur.

Table 5. Results of the calculation of relative density at each station

Spesies	Stations		
	I	II	III
Linckia laevigata	–	–	0.08%
Ophiocoma aethiops	15.84%	39.62%	16.17%
Ophiocoma echinate	13.12%	15.41%	21.80%
Ophiocoma scolopendrina	68.78%	39.79%	58.98%
Ophiocoma sp.	0.45%	4.90%	–
Oligometra serripinna	–	–	0.08%
Diadema setosum	–	–	0.31%
Heterocentrotus trigonarius	–	–	0.39%
Stomopneustes variolaris	1.36%	0.11%	1.09%
Holothuria cinerescens	–	–	0.31%
Holothuria leucospilota	0.45%	0.11%	–
Holothuria sp.	–	0.05%	0.78%
Total	100%	99.99%	99.99%

Diversity Index

In Fig. 6, it can be seen that the diversity index value at each station is not much different. The average value of the diversity index (H′) at those three stations is 1.07 so that the diversity of the phylum Echinodermata in Sancang Coast, Garut is classified into the moderate category. This is supported by the statement of Odum (1971) in Aziz et al. (2015: 72) [6] that the diversity index is categorized as low if it is $H' < 1$, is categorized as moderate if it is $1 < H' < 3$, and is categorized as high if it is $H' > 3$.

The highest diversity index is found at station II (Cikujangjambe), namely 1.19, which is classified into the moderate category. This is because the total number of individuals found at Station II (Cikujangjambe) is more than that in other stations. Furthermore, the number of individuals between species is more evenly distributed. Meanwhile, the lowest diversity index is found at Station I (Ciporeang), namely 0.92, which is classified into the low category. This is because the number of individuals of

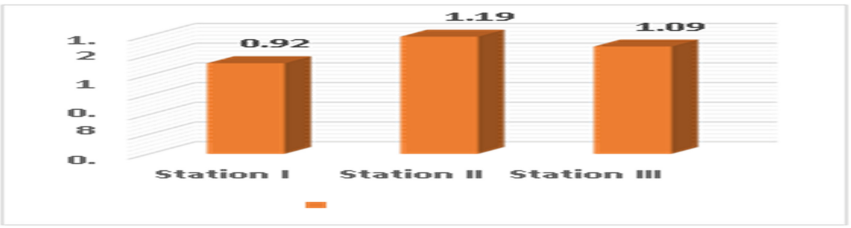

Fig. 6. The diagram of the diversity index at each station

each species is not evenly distributed and there are species that are found to dominate, namely Ophiocoma scolopendrina. Furthermore, the total number of individuals found as a whole is less than that found at other stations. From the elaboration above, it can be concluded that the diversity index is influenced by the number of individuals of each species and the total individual as a whole found at each research station. This is supported by Supono & Arbi (2010: 335) [8] that the high and low species diversity index can be caused by various factors, such as the number of individuals obtained, the presence of several species found in abundance, substrate homogeneity, and the conditions of 3 important ecosystems in the coastal areas, namely seagrass beds, coral reefs, and mangrove forests.

Uniformity Index

In Fig. 7, it can be seen that the uniformity index value at each station is not much different. The average value of the uniformity index at those three stations is 0.53 so that the uniformity of the phylum Echinodermata in Sancang Coast, Garut is classified into the moderate category. This is supported by the explanation of Odum (1971) in Aziz et al. (2015: 68) [6] that the uniformity index is categorized as low if it is $E \leq 0.4$, is categorized as moderate if it is $0.4 < E < 0.6$, and is categorized as high if it is $E \geq 0.6$.

The highest uniformity index is found at Station II (Cikujangjambe), namely 0.61, which is classified into the high category. This shows that the distribution of individuals between species at Station III (Cibako) is more evenly distributed than in other stations. Meanwhile, the lowest uniformity index is found at Station III (Cibako), namely 0.47, which is classified into the low category. This shows that, at Station III (Cibako), there are species that dominate, namely Ophiocoma scolopendrina. These findings are in line with what is explained by Aziz et al. (2015: 72) [6] that if the uniformity index value approaches the number 0, there will be a dominance of species in the ecosystem caused by the instability of environmental factors. Conversely, if the uniformity index value approaches the number 1, the ecosystem is in a stable state, namely the number of individuals is relatively the same or no species dominates.

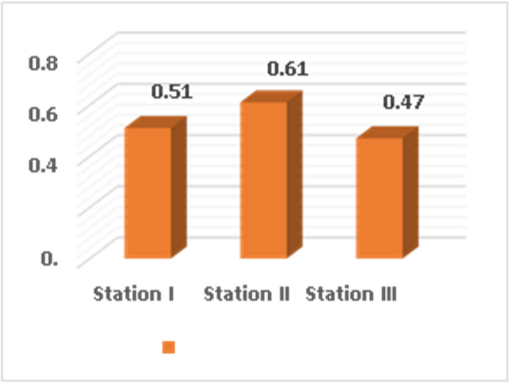

Fig. 7. The diagram of the uniformity index at each station

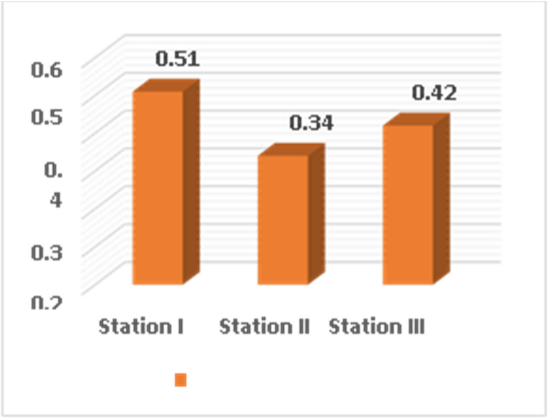

Fig. 8. The diagram of the dominance index at each station

Dominan Index

Based on Fig. 8, it can be seen that the dominance index value ranges from 0.34 to 0.51. The average dominance index value at those three stations after being calculated is 0.42 so that the dominance of the phylum Echinodermata in Sancang Coast, Garut is classified into the low category. This is in line with what is explained by Rappe (2010) in Arifah et al. (2017: 123) [9] that the dominance index is considered to be low if the value is in the range of 0–0.5. The higher the dominance index value is, the higher the dominance of one species in a population will be.

The highest dominance index is found at Station I (Ciporeang), namely 0.51, which is classified into the moderate category. This means that at Station I (Ciporeang), there is one species that dominates, namely Ophiocoma scolopendrina. In other words, the number of individuals found of this species is more than the number of individuals of other species. The dominance of Ophiocoma scolopendrina is due to the characteristics of the substrate that dominates at Station I (Ciporeang), which supports the life of this species as its habitat. Meanwhile, the lowest uniformity index is found at Station II (Cikujangjambe), namely 0.34. This means that, at Station II (Cikujangjambe), the distribution of the number of individuals between species is more evenly distributed compared to other stations. Physical and chemical environmental factors, such as temperature, pH, salinity, and dissolved oxygen, do not affect the dominance of the phylum Echinodermata in a community. This is supported by a study conducted by Salmanu & Arini (2018: 188) [10] that the distribution of an individual may be limited by their habitat selection behavior factors. Furthermore, physical and chemical environmental factors do not affect the dominance of echinoderms because this phylum has the ability to move from one place to another place.

4 Conclusion

The diversity of the phylum Echinodermata from 3 research stations in Sancang Coast, Garut is classified into the moderate category with the average diversity index (H′) value of 1.07, in which the diversity index (H′) value of Station I is 0.92, that of Station II is 1.19, and that of Station III is 1.09. Furthermore, there are 12 species of the phylum Echinodermata discovered, consisting of 5 classes, 7 orders, and 7 families.

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