Original Research Article

The Relationship Of Megazoobenthos Association With Seagrass Ecosystem Conditions In Ujung Genteng Waters, Sukabumi

ABSTRACT

XXXThe purpose of this study was to establish the association pattern and the correlation of megazoobenthos to seagrass ecosystem conditions. This research was conducted in May-June 2019. The research location was divided into 3 stations, station 1 (medium seagrass cover), station 2 (high seagrass cover), station 3 (seagrass cover very high), the method used was a survey method by conducting a survey direct observation of the stations that have been determined. The results obtained include 3 types of seagrass found, namely *Thallasia hemprichii*, *Cymodoceae rotundata* and *Enhalus acoroides*. The highest density of seagrass was found in station 2 with the type of seagrass *Thallasia hemprichii* as much as 207 ind/m^2. Where as the megazoobenthos that were captured were 15 species from 3 phylum.. Species megazoobenthos found that *Diadema setosum*, *Tripneustes depressus*, *Tripneustes gratilla*, *Ophiothrix fragilis*, *Ophiocoma erinaceus*, *Holothuria atra*, *Squilla mantis*, *Calappa hepatica*, *Scopimera globosa*, *Dendrodoris sp*, *Turbo sp*, *chlamys sp*, *Anadara antiquate*, *Cypraea ventriculus*, and *Cypraea annulus*. The megazoobenthos Diversity Index at the observation station is included in the medium category that is 2.33 - 2.66 and the evenness index is 0.63 - 0.84. Correlation of seagrass density with megazoobenthos obtained by 0.92 shows that there is a very strong relationship between seagrass density with megazoobenthos. The calculation result χ2 shows that there are 4 patterns of close association and 2 patterns of very close association. *Ophiocoma erinaceus* of the ophiuroidea class has a pattern of very close positive associations with seagrass *Cymodoceae rotundata* and *Dendrodoris sp* of the order nudibranchia has a pattern of very close negative associations with seagrass *Cymodoceae rotundata.*

Keywords: Ujung Genteng, Megazoobenthos, Seagrass, Association, and Correlation.

1. INTRODUCTION

Ujung Genteng is a coastal area south of West Java that is included in the administrative area of Sukabumi Regency. The waters of the tile end support the life of marine organisms such as megazoobenthos and seagrass. According to Regional Environmental Management Agency of West Java Province (2008), there is a seagrass ecosystem in the waters of the tip of the tile which is dominated by *thalassia sp*.

Seagrass beds are complex shallow-water ecosystems, having high biological productivity. Seagrass beds are therefore an important marine resource both ecologically and economically (Arifin and Jamaluddin 2005). The bioecological functions of seagrass beds include nurseries, spawning areas, foraging areas, and areas to seek protection for various types of marine biota such as fish, crustacea, mollusks, echinoderm, etc (Arifin

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Comment [A6]: Fifteen megazoobenthos species were identified representing 3 phyla.
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and Jamaluddin 2005). Seagrass vegetated waters have a higher diversity and abundance of associated organisms when compared to seagrass vegetation. For this reason, seagrass ecosystem management is needed to maintain the productivity of fisheries resources and the preservation of natural resources in coastal areas (Riniatsih and Munasik 2017).

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Megazoobenthos is an organism whose survival depends on seagrass ecosystems. Megazoobenthos which will be examined in this study is divided into three categories such as echinoderms, mollusks, and crustaceans. The high megazoobenthos diversity is influenced by the quality and condition of the seagrass ecosystem itself, meaning that the better the condition and quality of the seagrass ecosystem, the higher the diversity of the megazoobenthos. Considering the important bioecological function and the observation of megazoobenthos organisms in seagrass beds and the study of its existence is still not much, this study still needs to be done.

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2. METHODOLOGY

The study was conducted in May 2019 - June 2019. Data were taken 3 times every 2 weeks during the study. The research location is at Ujung Genteng Beach, Sukabumi. The research method used was a survey method. The sampling used in research by *purposive sampling*. Sampling and sample observation were carried out at 3 predetermined locations. Station 1 has medium seagrass cover conditions, station 2 has high seagrass cover conditions, and station 3 has very high seagrass cover conditions (Figure 1).

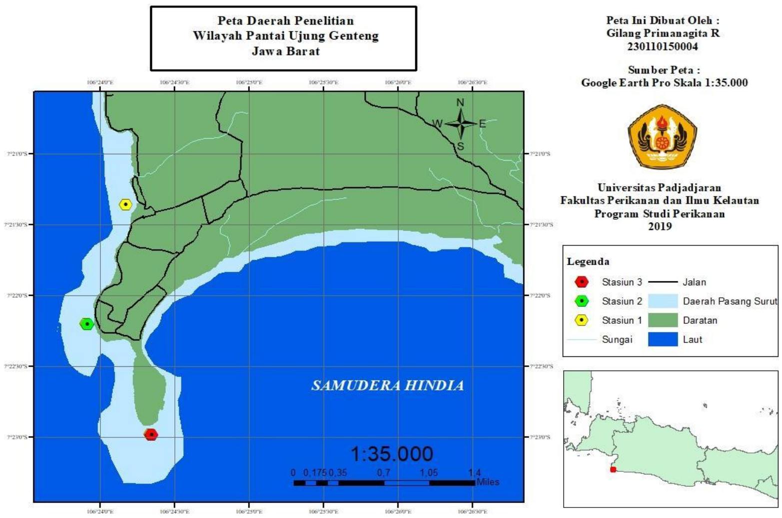

Fig. 1. Research location map

2.1 Research Procedure

Observation of seagrass samples was carried out by stretching three-line transects in a position perpendicular to the coastline towards the edge ± 50 meters, on each line, three plots were laid. In each observation plot, a 1 x 1 meter squared transect is divided into 25 sections with a size of 20 cm x 20 cm each. The distance between the transect squares ranges from 25 meters or adjusted to the existing seagrass area. Megazoobenthos observations were carried out together with recording the type and number of seagrass stands. To support field data, physical parameters are also measured and chemical measurements of physical parameters are temperature, transparency, depth, and current. While the chemical parameters are DO, pH, salinity, and nutrient content in the substrate. XXX

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2.3 Data Analysis

Seagrass biota is analyzed by calculating Species Density (Di), Relative Density (RDi), Species Frequency (Fi), Relative Frequency (RFi), Coverage Species (Ci), Relative Closure (RCi) and Importance Value Index (IVI) of Brower & Zar (1989). Whereas the megazoobenthos biota was analyzed by calculating the Abundance Index (K), Diversity Index (H'), and the Evenness Index of Odum (1993). Megazoobenthos abundance relationship with seagrass density calculation using the correlation coefficient *Pearson* (Pearson's *Product Moment Correlation Coefisientof*). And the association between species of seagrasses and between species of megazoobenthos uses the calculation *presence-absence* or contingency table and then proceed with the Chi-square test χ2.

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3. RESULTS AND DISCUSSION

3.1 General Condition of Research Location

Treatment station at the study site has different regional characteristics. Station 1 is at the coordinate point 7º 21 '33' 'LS - 106º 24' 10 " East. Station 1 has a seagrass cover condition with sediment texture included in the Sand category with a composition of 92% sand, 3% dust, and 5% clay. Station 2 is at coordinates 7º 22 '4' 'LS - 106º 24' 1 " BT. Station 2 has a very high seagrass cover condition with sedimentary textures including the Sand category with a composition of 90% sand, 4% dust, and 6% clay. And Station 3 is at the coordinate point 7º 14 '20' 'LS - 106º 31' 7 " East. Station 3 has a high seagrass cover condition with sediment textures including the Sand category with a composition of 92% sand, 3% dust, and 5% clay.

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3.1.1 Physical And Chemical Parameters Of The Waters

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Table 1. Environmental Quality Parameters

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No	Parameter Quality of the Circle of	Research Station		
		I	II	III
1	Temperature (ºC)	28.5-31.6	28.8-31.2	28.3-31.4
2	pH	6, 8-7.5	6.4-7.4	6.8-7.5
3	Salinity (‰)	31-33	31-33	31-33
4	DO (mg / L)	6.3-7.5	7- 8.8	6.5-8.2
5	Depth (cm)	0-100	0-100	0-100
6	Transparency (%)	100%	100%	100%

Based on Table 1 the temperature obtained in Ujung Genteng waters is 28.5- 31.6ºC. The temperature needed for seagrass to photosynthesis around 28-35ºC. As for growing, seagrasses require optimal temperatures between 28-30ºC (Kepmen LH No. 51 of 2004).

The results of pH measurements obtained in Ujung Genteng waters range from 6.4 to 7.5. The pH value in the Ujung Genteng waters can still be tolerated for seagrasses and megazoobenthos organisms. According to Kepmen LH No. 51 of 2004 concerning the quality standard of acidity (pH) in seagrass ecosystems ranges from 7 - 8.5. Water conditions that are very acidic or very basic will cause the survival of organisms disturbed.

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Seagrass species have different tolerance abilities to salinity. However, in general, the range of salinity that can be tolerated by seagrass is 10–40‰ and the optimum value is

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35‰ (Yusuf et al., 2013). While the range of salinity that can be tolerated for live megazoobenthos is 15-35 ‰. Salinity measurement results obtained in Ujung Genteng waters are 31-33%o. The salinity value is classified as good for growing seagrass species and living species megazoobenthos.

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The results of DO measurements in Ujung Genteng waters range from 6.3-8.8 (mg / L), the condition is quite good for growing seagrass species. According to the Decree of the KEPMEN LH No 51 of 2004 the optimum seagrass species grow in waters with DO values > 5 (mg/L). The dissolved oxygen conditions above can also support the life of megazoobenthos and other marine organisms. Almost all marine organisms like the condition of dissolved oxygen concentration > 5 mg/L (Effendi, 2003).

The depth of the water ranges from 0-100 cm and the brightness is constant at each observation, which is 100% shows the penetration of sunlight into the bottom of the water.

Current data are taken consist of May 2019 to June 2019. The maximum current speed in May is 0.219 m / s and the minimum current speed is 0.072 m / s. The maximum current speed in June is 0.174 m / s and the lowest current value is 0.07 m / s. The results of the current velocity obtained in Ujung Genteng waters are of moderate current because the average current velocity in the east season is still below 0.5 m/s (Setyawan and Pamungkas 2017).

Table 2. Analysis of Nutrient Content and Substrate Type

Station	C-org (%)	N-total (%)	C / N	P_2O_5 (ppm)	Texture (%)			Type Substrate
					S	Si	C	
I	0.52	0.07	7	10.42	92	3	5	Sand
II	0.94	0.10	10	9.19	90	4	6	Sand
III	0.81	0.11	7	12.01	91	3	5	Sand

Based on table 2, the highest Nutrient content is at station 2 and the lowest is at station 1. The high nutrient content at station 2 causes this station to have a high seagrass rate.

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3.2 Seagrass

3.2.1 Composition of Seagrass Species

In Ujung Genteng waters, 3 seagrass species were found for all observation stations. At station 1 found 2 species of seagrasses, *Thallasia hemprichii* and *Cymodoceae rotundata*. At stations 2 and 3 found 3 species of seagrasses, *Thallasia hemprichii*, *Cymodoceae rotundata* and *Enhalus acoroides*.

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Table 3. Seagrass Species in Ujung Genteng Waters

No	Seagrass Type	Station 1	Station 2	Station 3
1	*Thallasia hemprichii*	√	√	√
2	*Cymodoceae rotundataCymodoceae rotundata*	√	√	√
3	*Enhalus acoroides*	-	√	√

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3.2.2 Density of Seagrass

In all stations *T. hemprichii* has the highest density value than other types of seagrass this is caused because *T. hemprichii* has a good adaptation to environmental conditions.

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The highest density of seagrass is at station 2, namely *T. hemprichii* with a density of 207 ind/m^2 and the lowest at station 1 is *E. acoriudes* with a density of 0 ind/ m^2 which means that the species is not found in station 1 (Figure 2).

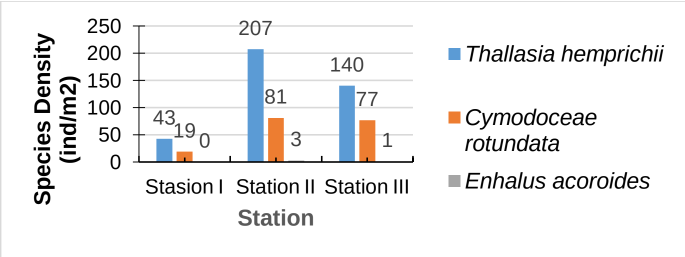

Fig. 2. Density of seagrass

3.2.3 Frequency of Seagrass

Based on (Figure 3) *T. hemprichii* and *C. rotundata* species were found at all stations while *E. acoroides was* only found at station 2 and 3.

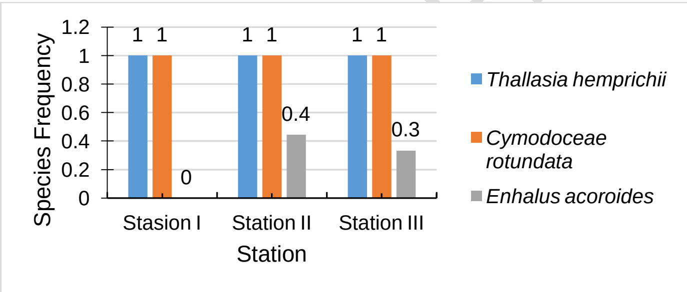

Fig. 3. Frequency of seagrass

3.2.4 Coverage of seagrass

Based on (Figure 4) Station 1 has a total seagrass cover of 45% which is classified as a low seagrass coverage category, Station 2 has a total seagrass cover of 95% classified as a seagrass coverage category is very dense, while Station 3 has a total seagrass cover of 75% classified as a dense category. seagrass coverage in the low category has a cover range of 26-50%, dense seagrass coverage has a cover range of 51-75%, and seagrass coverage in the very dense category has a cover range of 76-100% (Hutomo & Nontji 2014).

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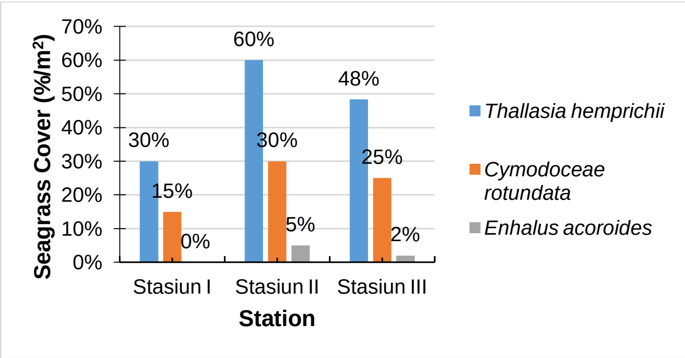

Fig. 4. Coverage of seagrass

3.2.5 Important Value Index

T. hemprichii had the highest importance value index value of the species C. rotundata and E. acoroides that is equal to 1.8 and belong to the category of being, even though belonging to the category of being a role T. hemprichii effect on other seagrass species. This is evidenced by the existence of T. hemprichii which is almost found in all stations and has a high seagrass density (Figure 5).

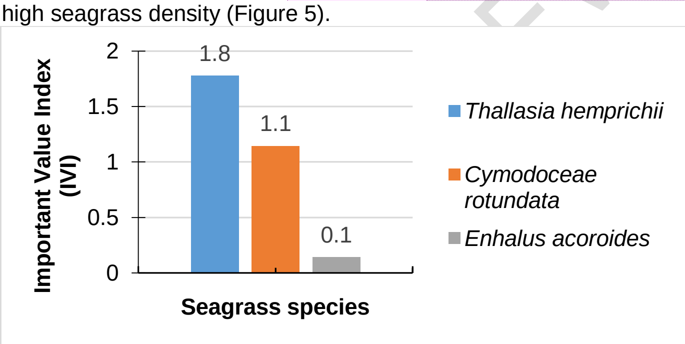

Fig. 5. Coverage of seagrass

3.3 Megazoobenthos

Megazoobenthos found at the study site contained 15 species of 2 phylum and 1 class (Echinoderms, crustaceans, and mollusks). There are 6 species of phylum echinoderms, namely *Diadema setosum*, *Tripneustes depressus*, *Tripneustes gratilla*, *Ophiothrix fragilis*, *Ophiocoma erinaceus*, and *Holothuria atra*. There are 3 species of crustacean species, *Squilla mantis*, *Calappa hepatica* and *Scopimera globosa*. There are 6 species of phylum mollusk, namely *Dendrodoris sp*, *Turbo sp*, *Chlamys sp*, *Anadara antiquate, Cypraea ventriculus,* and *Cypraea annulus*.

Ophiocoma erinaceus and *Ophiothrix fragilis* are the most abundant megazoobenthos found at the research location. As many as 46% of *Ophiocoma erinaceus* was found at the study site and as many as 20% *Ophiothrix fragilis was* found at the study site (Figure 6).

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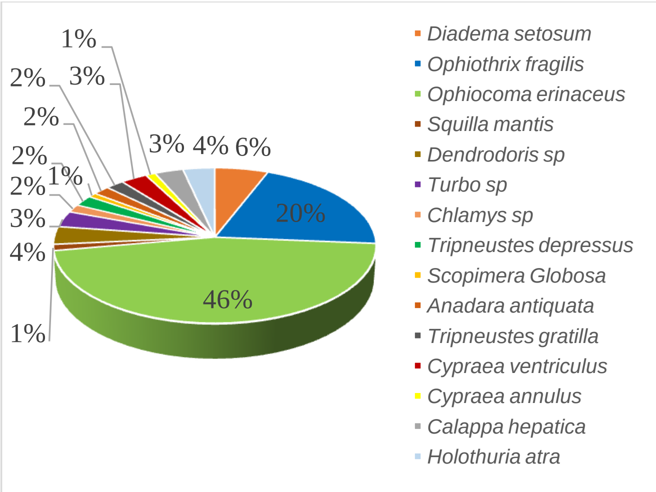

Fig. 6. Megazoobenthos Species in Ujung Genteng Waters

3.3.1 Abundance, Diversity, and Evenness Indeks Megazoobenthos

Table 4. Abundance, Diversity, and Evenness Indeks Megazoobenthos

Station	Abudance (K)	Diversity (H')	Evenness (E)
I	4 ind/m^2	2,66	0,84
II	9 ind/m^2	2,33	0,63
III	7 ind/m^2	2,41	0,70

The highest abundance of megazoobenthos is at station 2 of 9 ind / m^2. This is because the density of seagrass at station 2 is very tight so that food sources for several types of megazoobenthos are abundant at station 2, megazoobenthos species that have a high number of individuals at station 2 namely from the species *Ophiothrix fragilis* and *Ophiocoma erinaceus* (Table 4).

Station 1 has a diversity index value of 2.66, Station 2 has a diversity index value of 2.33, and Station 3 has a diversity index value of 2.41. The megazoobenthos diversity index of each station includes the category of moderate diversity, this is according to Odum's (1993) statement that megazoobenthos has a moderate diversity index of 1 <H '<3.00 (Table 4), diversity that is showing the distribution of the number of individuals per moderate species, moderate community stability and moderate productivity. The highest diversity is found in station 1 and the lowest diversity is found in station 2. Even though the number of species of station 2 is greater but the abundance of individuals in each species at station 1 is better than station 2. According to Minarni et al (2016) states that the high and low diversity index values types can be caused by various factors, including the number of types or individuals obtained and the presence of several species found in quantities that are more abundant than other types. XXX

The evenness index (E) (Table 4) ranges from 0-1. If the value is close to 0, it means that the uniformity is low because there is a type that dominates, and if it is close to 1, a high uniformity indicates that no species dominates. At station 1 it has an evenness index of 0.84, station 2 has an evenness index of 0.63, and station 3 has an evenness index of 0.70. In Ujung Genteng waters have a high population evenness because of the value of E> 0.6. A high evenness index indicates that there is a stable community. This is due to

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the distribution of individual megazoobenthos which are still the same between stations. XXX

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3.4 Relationship of Seagrass Vegetation with Megazoobenthos

Correlation test results obtained a correlation value of 0.92. The correlation value includes the category of a very strong relationship. The relationship between the density of seagrass vegetation and the abundance of megazoobenthos obtained shows a directly proportional relationship. The higher the density of seagrass, the higher the abundance of living megazoobenthos, this occurs because the density of seagrass vegetation affects the increased production of litter and available nutrients. Seagrass also has many bioecological functions that are very important as a spawning area and care for various types of marine organisms such as megazoobenthos (Riniatsih and Munasik, 2017). XXX

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3.5 Associations of Megazoobenthos with Seagrass

The association pattern of megazoobenthos species with seagrass species was found as many as 38 pairs of species with positive associations and 7 pairs of negative associations (Table 5).

Table 5. Patterns of association megazoobenthos species with seagrass species

Patterns of Associations Megazoobenthos with Seagrass															
Spesies Seagrass	Species Megazoobenthos														
	Ds	Td	Tg	Of	Oe	Ha	Sm	Ch	Sg	De	Tu	Ch	Aa	Cv	Ca
Th	+	+	+	+	+	+	+	+	-*	+	+	+	+	+	+
Cr	+	+	+	+	+**	+	+	+	+	-**	+	+	+	+	+
Ea	-	+	+	+	+*	+	-	+	-	-	-	+*	+	+	+*

** = close associations   ** = very close associations*
Seagrass : Th : Thallasia hemprichii, Cr : Cymodoceae rotundata, Ea : Enhalus acoroides
Megazoobenthos : Ds : Diadema setosum, Td : Tripneustes depressus, Tg : Tripneustes gratilla, Of : Ophiothrix fragilis, Oe : Ophiocoma erinaceus, Ha : Holothuria atra, Sm : Squilla mantis, Ch : Calappa hepatica, Sg : Scopimera globosa, De : Dendrodoris sp, Tu : Turbo sp, Ch : Chlamys sp, Aa : Anadara antiquate, Cv: Cypraea ventriculus, dan Ca : Cypraea annulus

Table 6. Patterns of association megazoobenthos species with seagrass species

No	Species Megazoobenthos	Species Lamun								
		Thallasia hemprichii			*Cymodoceae rotundata*			*Enhalus acoroides*		
		a	E (a)	χ^2count	a	E (a)	χ^2count	a	E (a)	χ^2count
1	*Diadema setosum*	27	26.0	1.56	26	25.6	0.16	6	8.00	1.07
2	*Tripneustes depressus*	12	11.6	0.54	11	11	0.02	6	3.56	2.80
3	*Tripneustes gratilla*	11	10.6	0.49	11	10	1.02	4	3.26	0.28
4	*Ophiothrix fragilis*	58	57.8	0.09	57	55.6	1.96	18	17.78	0.02
5	*Ophiocoma erinaceus*	64	63.6	0.45	65	61.1	18.04**	23	19.56	4.66*
6	*Holothuria atra*	18	17.3	0.89	18	16.7	1.85	7	5.33	0.95
7	*Squilla mantis*	7	6.7	0.29	7	6.5	0.61	1	2.07	0.87
8	*Calappa hepatica*	14	13.5	0.89	14	13.0	0.52	8	4.15	6.14*
9	*Scopimera globosa*	4	4.8	3.97*	5	4.6	0.43	0	0.00	0.00
10	*Dendrodoris sp*	16	15.4	0.77	10	14.9	28.22**	0	0.00	0.00
11	*Turbo sp*	18	17.3	0.89	18	16.7	1.85	2	5.33	3.81
12	*Chlamys sp*	9	8.7	0.39	9	8.3	0.81	4	2.67	1.07
13	*Anadara antiquate*	10	9.6	0.44	10	9.3	0.91	3	2.96	0.00

14	*Cypraea ventriculus*	16	15.4	0.77	16,0	14.8	1.60	7	4.74	1.91
15	*Cypraea annulus*	11	5.8	0.25	6	5.6	0.52	4	1.78	4.26*

** χ^2 table with a standard error of 5% = 3.84*

The association pattern of megazoobenthos species with seagrass species was found as many as 38 pairs of species with positive associations and 7 pairs of negative associations (Table 5).

Megazoobenthos in the phylum Echinoderms occurs positive associations between the types of megazoobenthos with seagrass species. Species of the Echinoderms that are positively associated with seagrasses are sea urchins (*Diadema setosum, Tripneustes depressus, Tripneustes gratilla*). This is proven by statements Azkab (2014) sea urchin, one of the organisms classified as megazoobenthos, has been known to be active in eating seagrasses, both those observed in nature and research conducted in the laboratory. However, there is one species of sea urchins that are negatively associated with seagrasses, namely *Diadema setosum* species with species *E. acoroides*. This condition is caused by *E.* acoroides having low density and also an uneven distribution of *E. acoroides* can only be found at station 2 and station 3 which causes the association of *Diadema setosum* to *E. acoroides* is negative. In addition, other species that positively associate with the Echinoderms phylum are the snaking star species (*Ophiothrix fragilis* and *Ophiocoma erinaceus*) as well as the sea cucumber species (*Holothuria atra*). this is in accordance with the statement of Dissanayake and Stefansson (2012), active sea cucumbers live in seagrass ecosystems, sea cucumbers are deposit-eating organisms and will gather in seagrasss that have high densities. This has been proven to be found in sea cucumbers only at station 2 and station 3 with high seagrass density.

Megazoobenthos in the class of crustaceans occurs positive associations also negative associations of seagrass species. Positive associations of crustacean species to seagrass occur in the shrimp species *squash mantis* of *T. hemprichii* and *C. rotundata* species, crab species for *Calappa hepatica* all seagrass species namely *T. hemprichii*, *C. rotundata* and *E. acoroides*, andspecies *cropScopimera globosa* againstseagrass species *C. rotundata*. Aswandy (2008) states, some active crustaceans live in seagrass ecosystems such as crustaceans, crustaceans, which prey on other small animals that live attached (epizoa) to leaves or other parts of seagrass.

Megazoobenthos in mollusk phylum occurs positive and negative associations with seagrass species, megazoobenthos type of mollusk phyla that are actively associated with seagrass species, namely from the gastropod and Bivalvia classes. Gastropods that are actively associated with seagrass species are *Dendrodoris sp, Turbo sp, Cypraea ventriculus,* and *Cypraea annulus*. This is proven by Azkab's statement (2014) that a food chain event occurred between a gastropod and a seagrass, seagrass litter was used as a food source. Bivalves that are actively associated with seagrass species are *Chlamys sp,* and *Anadara antiquate*. Seagrasses and bivalves are related, one of which has the same substrate type characteristics that serve as habitat. In addition, the association between seagrass and bivalves has a strong connection in the food cycle. Evidenced by the statement of Allifah and Rosmawati (2018) litter on seagrass will settle to the bottom of the waters which are then broken down by microorganisms that become bivalve food.

The calculation result χ^2 shows (Table 6) that there are 4 patterns of close association and 2 patterns of association are very tight consisting of 1 pattern of associations between species is strongly negative and 3 patterns of association of species are closely positive, 1 pattern of association is very close negative and 1 pattern of association is very close positive. The pattern of negative inter-species associations is very close, that is, the species of the nudibranchia *Dendrodoris sp* against seagrass species *C. rotundata. It* is suspected that *Dendrodoris sp* does not like the presence of seagrass species *C. rotundata* as evidenced by the presence of this species only at station 1 which has a cover medium seagrass and species density is *C. rotundata* not so abundant. The

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Comment [A68]: seagrass

Comment [A69]: Rephrase unclear statement

Comment [A70]: Review very confusing paragraph pattern of positive inter-species associations that are very close to *Ophiocoma erinaceus* against seagrass species is *C. rotundata* evidenced by the presence of *Ophiocoma erinaceus* and *C. rotundata which are* quite high and are found in all stations. *Ophiocoma erinaceus* is a class of snaking stars that is negative phototaxis, *Ophiocoma erinaceus* takes shelter in the species of seagrass *C. rotundata* which has a high density to avoid direct sunlight. In addition, *Ophiocoma erinaceus* utilizes litter from the leaves of seagrass *C. rotundata* as a food source.

4.1 CONCLUSION

The relationship of seagrass density with megazoobenthos is directly proportional, which means the density of seagrass has an impact on the abundance of megazoobenthos in Ujung Genteng waters. The pattern of association between megazoobenthos and seagrass species is positive and negative. *Ophiocoma erinaceus* of the ophiuroidea class has a pattern of very close positive associations with seagrass *Cymodoceae rotundata* and *Dendrodoris sp* of the order nudibranchia has a pattern of very close negative associations with seagrass *Cymodoceae rotundata.*

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Comment [A71]: Review

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