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Environmental Characteristic of *Phyllophorus* sp. (Echinodermata, Holothuroidea, Phyllophoridae) Habitat in the Madura Strait, Indonesia

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Abstract

Information on the environmental characteristics of many sea cucumber habitats is limited, despite these species exhibiting rapid exploitation and may lead to depletion. The present study combined a survey of many seawaters and sediment characteristics of habitat valuable Aspidochirote holothurian, Sea Ball Cucumber, and *Phyllophorus* sp. to compare with the location with no sea cucumber in Madura Strait, Indonesia. Data from detailed surveys were used to compare both locations with measures of physical and chemical seawater parameters including temperature, salinity, dissolved oxygen, pH, phosphate, nitrate, ammonia, chlorophyll-a, total suspended solids, light transparency, and depth of water. The comparison was also carried out on physical and chemical parameters of surface sediment, i.e. phosphate, nitrate, ammonia, chlorophyll-a, grain size, total organic matter, and carbon-organic content. The data then were analyzed using Mann-Whitney U-Non ParametricTest with SPSS v. 16. The result revealed significant differences between sediment characteristics of the Sea Ball Cucumber habitat and no Sea Ball cucumber location, but not for seawater. The seawater parameter value in Madura Strait showed in the range required for its life. This analysis proved the importance of sediment characteristics for *Phyllophorus* sp. As benthic deposit feeders, they utilize substrate underneath the body for their habitat and primarily to supply their natural food.

Keywords: Sea Ball Cucumber, Phyllophorus, Kenjeran Waters, Madura Strait, sediment

INTRODUCTION

Madura Strait is located between East Java at the west and south, Madura Island at the north, and Bali Strait in the east. The strait is connected to the Java Sea through the narrow, shallow channel of Surabaya Strait (SS) which is 14 km wide at the eastern entry, 2.4 km at its narrowest part, and 4.6 km at the north exit (Nugrahadi *et al*., 2013). This strait has been used for fishing, sea transportation, and shrimp cultivation (Nugrahadi and Yanagi, 2003). Many species were fished in this area, such as fish (Purwangka *et al*., 2018), shellfish, shrimp, crab (Istiqomah *et al*., 2019), and sea cucumber (Putri *et al.,* 2013; Purnayudha *et al*., 2014; Rahmayati, 2018; Widianingsih, 2018; 2019).

As the highest diversity of dried sea cucumber (trepang) supplier to world markets for decades (Purwati *et al*., 2010), Indonesia still faces limited information on species identification and habitat characteristics of many sea cucumber species. As one producing area, Madura Straits, are rich with several species of sea cucumber, such as *Holothuria* sp, *H. sanctori*, *H. forskali, H. turriscelsa (*Winarni *et al*., 2012), *Colochirus quadrangularis, Acaudina molpadiodes* (Rahmayati, 2018), *Paracaudina australis* (Widianingsih *et al*., 2018a,b; 2019) and *Phylloporus* sp. (Putri *et al*., 2013; Purnayudha *et al*., 2014).

Phylloporus sp., known as Ball Sea Cucumber, has a local name of "Terung". Belongs to the Phyllophoridae family (Holothuridae; Echinoderms), *Phylloporus* sp. has a 10-15cm length spherical body. Those freshly dug-up are more U-shaped ovals with the mouth and backside facing the surface (Lane *et al*., 2003) with white, beige, brownish, and sometimes orangey color. Many tube feet and tiny filaments (papulae) evenly cover the entire body. These help grip the sand and keep the animal anchored underground. Feeding tentacles translucent white with branched tips that are darker. Usually, only the feeding tentacles stick out above the sand while the entire animal remains buried. It gathers edible bits from the water surrounding its body with mucus-covered feeding tentacles (Davidon *et al*., 2008). Its body wall is thick and soft. Color in alcohol whitish or cream, with numerous black bands or patches (Liao *et al*., 2007).

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Commonly caught from Madura Strait and landed in Kenjeran coastal area, *Phyllophorus* sp. were processed as snack food such as crackers, chips, dried terung, etc, and never consume fresh. It contains a high protein value (44.39%) and has potency as an immuno-stimulant against the bacteria *Mycobacterium tuberculosis* (Winarni *et al*., 2012). The increasing demand for sea cucumber crackers as an icon food from Surabaya and commonly traded in Surabaya, Sidoarjo, Lamongan, and Gresik (Andriyono *et al*., 2016), has resulted in massive catching of *Phyllophorus* sp in Madura Strait, Kenjeran Waters, Gresik, and surroundings area (Andriyono *et al*., 2015). This extensive exploitation may lead to the depletion of the natural stock.

The natural environment directly or indirectly controls the presence and abundance of macrobenthos (Schückel *et al*., 2015; Foulqquier *et al*., 2020), such as sea cucumber. Water quality (Meirinawati *et al*., 2020) and water movements through the transport of sediment and organic material, also strongly affect this bottom community (Koumianaki *et al*., 2013). Tanita and Yamada (2019) stated that environmental characteristics, both physical and chemical parameters, greatly affected the species composition, population, and distribution of sea cucumbers in their ecosystem. Therefore, the present work aimed to determine the environmental characteristic of the habitat of *Phyllophorus* sp and to compare it to that with no sea cucumber in Madura Strait, Indonesia. Understanding the environment influences the abundance of natural resources will give insight into consideration for its exploitation and management.

MATERIALS AND METHODS

This study was conducted along the Kenjeran waters of Madura Strait. This strait is known to have a strong anthropogenic influence from rivers and surrounding cities due to their economic activities such as industry, ponds, and sea transportation (Nugrahadi & Yanagi, 2003). This area yet still has rich natural resources fished by the fisheries community (Istiqomah *et al*., 2019). The sampling was conducted at 22 stations with no *Phyllophorus* sp and with *Phyllophorus* sp., during August, September, and October 2016 (Figure 1). A five-L-Niskin bottle collected the seawater samples for phosphate, nitrates, ammonia, and chlorophyll-a analysis from oVe-meter depth. Salinity, temperature, pH, and dissolved oxygen in the seawater were measured in situ using a U-50 series Multi-parameter water quality checker. Sediment samples were collected from each station using a Van Veen grab (0.1 m^2). For the sediment analysis, a small sub-sample of each collected grab was used to determine phosphate, nitrate, ammonia, C-organic, total organic matter, chlorophyll-a, and grain size. When seawater and sediment sampling was done, sea cucumber samples were collected using *garit* or a sharp nailed iron-frame dredge.

The analysis of seawater and sediment samples was carried out in the Oceanography Laboratory of the Department of Marine Science, Faculty of Fisheries and Marine Science, Diponegoro University, Semarang. Phosphate, nitrate, and ammonia in the seawater were analyzed using procedures of Parsons *et al*. (1984); IOC (International oceanography Commission, 1993); and Lawson and Robertson (2016), and the absorbance were read in a Shimadzu UV-VIS Optima spectrophotometer SP 3000 at 885nm for phosphate, 543 nm for nitrate, 430 nm for ammonia respectively. Nemeth and Nowlis (2001) methods were used to measure TSS in which 1 L of seawater was filtered through a pre-weighed glass fiber filter, rinsed with distilled water to remove salts, oven-dried at 100^{o}C, and cooled in a desiccator before weighing. Chlorophyll-a was representative of microalgae in seawater and measured by spectrophotometer using 90% acetone method (Johan *et al*., 2014). Before spectrophotometric analysis, all extractions were centrifugated for 10 min at 4030 rpm. The absorbance value was measured using a Shimadzu UV-VIS Optima spectrophotometer SP 3000, with selected wavelengths at 750 nm, 664 nm, 647 nm, and 630 nm. 90% acetone was used as a blank in the spectrophotometer. Then, the absorbance at 750 nm was subtracted from those three wavelengths to give the turbidity-corrected value. The chlorophyll-a concentration in the seawater was calculated following Johan *et al*. (2014) formulae.

Phosphate in the sediment was analyzed spectrophotometrically using the Olsen method as has been used by Paena *et al*. (2017). Nitrate was determined with Continuous flow analyzer (dissolution in potassium chloride) and ammonia using continuous flow analyzer (dissolution in potassium chloride) Double Indicator-Neutralization titration (Bao, 2000; Ma, 2011)

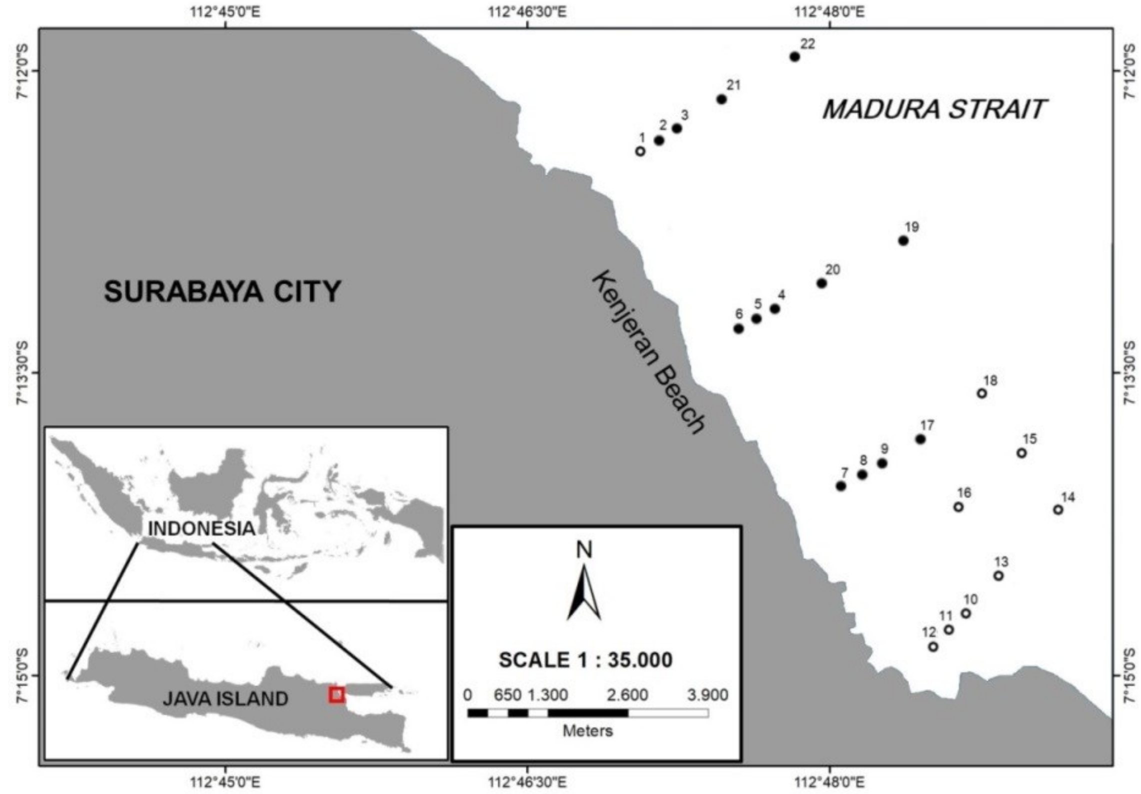

Figure 1. Map of sampling stations of Kenjeran Waters, Madura Strait, Indonesia (● : Station with no *Phyllophorus*; ○ : Station with *Phyllophorus* sp)

C-organic in the sediment were analyzed using the method of Kristensen and Andersen (1987), while the ash method of Wang *et al.* (2011) was used to analyzed the total organic matter in the sediment. The concentration of chlorophyll-a as representative of the biomass of microphytobenthos in the sediment was measured following the method of De Jonge *et al*. (2012) and a modification of the Sumanta *et al.* (2014)'s method. After centrifugation, the absorbance of the supernatant was measured in a Shimadzu UV-VIS Optima spectrophotometer SP 3000 with 1 nm spectral bandwidth and optically matched 4 cm micro-cuvettes at 750, 665, 645, and 630 nm against 90% acetone. The chlorophyll-*a* concentrations were calculated with the formula of Montani *et al*. (2012). Sediment samples of 100 g were also sieved and weighed to determine their grain size composition using Romano *et al*. (2017) methods. To determine the influence of seawater and sediment quality to the presence of *Phylophorus* sp, data on environment characters were non-parametrically analyzed using Mann-Whitney-U-Test with SPSS v 16.

RESULTS AND DISCUSSION

Phyllophorus sp usually tend to be round, sometimes inflated into translucent white balls when found above ground, sometimes floating in the water. Like other sea cucumbers, it will eject its guts (evisceration) if it feels threatened. Its body was cylindrical and the posterior end was more or less tapering, tube feet small, scattered on the body wall, and numerous ventrally (Liao *et al*., 2007; Davison *et al*., 2008). In Madura Straits, *Phyllophorus* sp was inhabitat in 13 Stations i.e. Station 2-9, 17, 19, and 20-22. The locations with none sea cucumber were 9 stations i.e. Station 1, 10-16, and 18). The average of the physical and chemical characteristics of seawater in the station without *Phyllophorus* sp. and with *Phyllophorus* sp. in Madura Strait were presented in Tables 1 and 2 respectively. Those values as still in the range of sea cucumber requirements for life.

According to PCA analysis showed that there were two principal components. All variables were into 2 principal components. The first component was variable data consisting of temperature, salinity, DO, pH, transparency, and depth. The second component was silt, coarse sand, and fine sand. Furthermore, the eigenvalue for temperature has a value > 1 (3.922). It meant that temperature has an effect on the existence of Phyllophorus. Additionally, the statistical analyses were performed using the Mann-Whitney-U-non-parametric test. Table 3 showed that there was no significant difference in the mean value of temperature, salinity, pH and light transparency, phosphate, nitrate, ammonia, chlorophyll-a, dissolved oxygen, and total suspended solids in the sea waters of the Station without *Phyllophorus* sp. and with *Phyllophorus* sp. in Madura Strait ($P < 0.05$). Madura Strait was located downstream of the Brantas River that diverged into the Surabaya River which passed through the heart of the city of Surabaya and the Porong River which builds as a flood control canal. The freshwater discharges of these rivers varied seasonally and influenced the water salinity in the strait.

Although salinity is a limiting function of the distribution of marine organisms, especially for sea cucumber (Asha and Muthiah, 2005; Xie *et al*., 2013), this value (29,0-30,70ppt) was still in the range for the life of *Phyllophorus* sp. (Table 1). The average temperature range in Madura strait was narrow (29,43-31,80°C), and will not influence the *Phyllophorus* sp. metabolic activity. Dong *et al*. (2010) and Günay *et al*. (2015) stated that the temperature was one of the physical factors that significantly affected the sea cucumber metabolic system and growth. The pH value in the sea waters tended to be constant and neutral because sea waters had a buffer mechanism to prevent changes in pH values. The range of measured pH values in the Kenjeran Waters of Madura Strait was 7.0-7.81 (Table 1), this was in the range of its suitability for sea cucumber (Asha *et al*., 2015).

Table 1. The average measurement value of the physical characteristic of seawater in the Station without *Phyllophorus* sp. and with *Phyllophorus* sp. in Madura Strait

Station	Temperature (°C)	Salinity (ppt)	pH	Light-Transparency (cm)	Depth (m)
1	29.43	29.00	7.23	73	3,0
2	29.70	29.43	7.23	47	3,5
3	29.87	29.83	7.3	55	7,0
4	30.00	30.30	7.23	50	4,0
5	29.97	29.93	7.27	50	3,2
6	29.97	29.30	7.17	42	2,7
7	29.53	29.73	7.27	42	2,6
8	29.70	29.73	7.37	57	2,8
9	30.07	30.10	7.27	57	3,0
10	29.87	29.77	7.0	53	2,0
11	29.97	29.87	7.1	22	2,0
12	29.07	29.87	7.17	25	2,0
13	31.30	30.10	7.81	80	2,5
14	31.80	30.20	7.81	150	5,0
15	31.70	30.40	7.73	100	5,0
16	31.60	30.30	7.73	70	3,0
17	31.50	30.30	7.73	70	2,5
18	31.80	30,40	7.59	100	4,5
19	31,80	30,50	7,60	90	6,0
20	31,60	30,70	7,60	90	3,5
21	31,40	30,40	7,53	75	13,0
22	31,30	30,70	7,51	75	15,0

The light transparency in Kenjeran waters of Madura Strait was in the range of 22-150 cm. The highest seawater brightness was at Station 14 (150 cm) which had a depth of 5 meters. This showed that the site has good light penetration so it allowed microalgae to do photosynthesis, which ultimately caused high chlorophyll-a content of 26.28 µg.L^{-1} (Table 1). Fluctuations in water chlorophyll-a content also depended on physical, chemical, and biological factors such as temperature, currents, phosphate, nitrates concentration (Jamshidi and Bakar, 2011), and suspended particulate matter. The latter is closely related to the penetration of light and nutrients related to its function in enzymatic reactions. Nugrahadi *et al*. (2013) stated that Madura Strait received significant seasonal and spatial variations in nutrient supply. The largest nutrient input was during the rainy season, and the Porong River has the most significant contribution due to high river discharge. In contrast, during the dry season was a deficient concentration of nutrients (Jennerjahn *et al*., 2004). Thus, besides nutrient supply and light, other physical processes such as water residence time might play a very important role in controlling biological activity in the coastal water of the area.

P (phosphorus) is one of the nutrients that is a biological limiting factor (Maslukah *et al*., 2020). The average value range of seawater phosphate content at 22 stations was 0.05-.62 mg.L^{-1}. Compared to that measured in Teluk Awur Jepara which is the habitat of *H. atra* ranged from 0,0023-0.0172mg.L^{-1} (Hartati *et al*., 2017b; 2020b) and 1.05±0.3 µg.L^{-1} in Mannar Bay Waters, Southeastern Coast of India (Asha *et al*., 2015), the value of phosphate content in the Kenjeran Waters of Madura Strait was greater than in those areas. It could be due to high domestic waste that carries phosphate compounds. High phosphate concentrations may lead to eutrophication (Howarth and Paerl, 2008), which is undoubtedly a danger to the coastal ecosystem.

Table 2. The average concentration value of the chemical characteristic of seawater in the Station without *Phyllophorus* sp. and with *Phyllophorus* sp. in Madura Strait

Stasiun	Phosphate (mg.L^{-1})	Nitrate (mg. L^{-1})	Ammonia (mg.L^{-1})	Chlorophyll-a (µg.L^{-1})	Dissolved Oxygen (mg.L^{-1})	Total Suspended Solid (mg.L^{-1})
1	0.20	0.99	0.09	6.81	3.50	251
2	0.12	0.64	0.01	8.75	4.00	244
3	0.19	0.70	0.07	6.92	4.07	218
4	0.07	0.49	0.04	9.66	4.20	270
5	0.05	0.57	0.03	10.99	4.13	330
6	0.10	0.66	0.03	8.80	3.87	289
7	0.07	0.97	0.07	5.22	4.17	184
8	0.10	0.64	0.02	14.36	4.40	130
9	0.07	0.45	0.02	12.78	4.40	116
10	0.04	0.54	0.05	14.06	3.37	163
11	0.06	0.54	0.01	12.36	3.40	109
12	0.04	0.56	0.01	9.33	3.67	151
13	0.46	0.97	0.22	8.42	4.90	75
14	0.42	1.13	0.07	26.28	5.50	64
15	0.51	1.08	0.10	18.78	3.80	64
16	0.51	1.02	0.04	19.29	5.70	68
17	0.55	1.11	0.11	8.99	4.50	67
18	0.62	1.23	0.09	2.99	4.10	54
19	0.57	1.07	0.10	4.97	4.60	74
20	0.62	1.03	0.07	0.81	4.50	67
21	0,51	1.19	0.02	7,61	5.00	71
22	0.61	1.12	0.03	7.92	4.20	65

Another nutrient, such as nitrate, was also high in the range of 0.45-1.23 mg.L^{-1}, this value was higher than in other areas (Hartati *et al*., 2017b). Nitrate compounds were the result of nitrite and ammonia compounds breakdown (Zehr and Kudela, 2011). This may be due to a large amount of domestic waste from dense residents along the West Coast of Surabaya. The high content of nitrites can result in increased eutrophication; hence nitrate is a limiting factor for nutrients in coastal water ecosystems (Howarth and Marino, 2006). While the average concentration value of ammonia in Kenjeran waters, Madura Strait had a range of 0.01-0.22 mg.L^{-1}.

The nutrient content might be influenced by total suspended solid concentration (suspended solids charge). Total suspended solids (TSS) were particles larger than 2 microns found in the water column. Most suspended solids were made of inorganic materials, though bacteria and algae can contribute to the total solids concentration (Langland and Cronin, 2003). These solids include anything drifting or floating in the water, from sediment, silt, and sand to plankton and algae. Organic particles from decomposing materials can also contribute to the TSS concentration. As algae, plants, and animals decay, the decomposition process allows small organic particles to break away and enter the water column as suspended solids. Johari *et al*. (2016) stated that the total phosphate content positively correlated with the concentration of suspended solids. The average value of total suspended solids (TSS) in the Kenjeran Water, Madura Strait was in the range of 54-330 mg.L^{-1}, this was a significant factor in observing water clarity. The distribution of suspended solids was related to brightness or light transparency (Brito *et al*., 2010).

The result of physical and chemical characteristic analysis of sediment in the station with and without *Phyllophorus* sp. in Madura Strait was presented in Table 4. The statistical Man-Whitney-U-non parametric test (Table 5) showed that there was a significant difference between the mean value of phosphate, total organic matter content, and C-Organic content in the sediment in both stations ($P < 0.05$), but not for nitrate, ammonia, and chlorophyll-a. The average content value of phosphate, nitrate, total organic matter, and C-organic of sediment in all stations with and without *Phylloporous* sp showed that the habitat of *Phyllophorus* sp had got lower phosphate and higher nitrate in its sediment, meanwhile higher content of the total organic matter and C-organic (Table 6). De Falco *et al*. (2004) stated that sediment texture strongly conditioned organic carbon and related to total organic matter (Hartati *et al*., 2020b). In later analysis (Figure 2) showed that sediment texture had a significant effect on *Phylloporus* sp. habitats.

Organic matter in sediment consists of carbon and nutrients. Sediment organic matter is derived from plant and animal detritus, bacteria, or plankton formed in situ, or derived from natural and anthropogenic sources in catchments (Rustiah *et al*., 2019). While total Organic Carbon (TOC)

Table 3. The comparison between the mean value of seawater physical and chemical characteristic in the Station without *Phyllophorus* sp. and with *Phyllophorus* sp. in Madura Strait

Parameter	Value of Mann-Whitney U-test	Asymp.Sig (2-tailed)	Exact Sig. (1-tailed)
Temperature	51.500	0.639	0.647
Salinity	54.500	0.789	0.794
pH	53.500	0.737	0.744
Light-Transparency	44.500	0.349	0.357
Phosphate	54.500	0.789	0.794
Nitrate	52.500	0.688	0.695
Ammonia	44.500	0.346	0.357
Chlorophyll-a	36.000	0.133	0.144
Dissolved Oxygen	41.000	0.242	0.262
Total Suspended Solid	37.000	0.151	0.164

refers to the amount of organic matter preserved within the sediment. Strokal and Kroeze (2013) stated that the amount of organic matter found in sediment was a function of the number of various sources reaching the sediment surface and the rates at which different types of organic matter are degraded by microbial processes during burial. Table 6 showed that the habitat of *Phyllophorus* sp. had less total organic matter and c-organic than those areas with no sea cucumber. Holothurians were able to assimilate low content of organic matter such as diatoms, bacteria, and detritus (Rashidi *et al*., 2018). They had specific feeding and movement characteristics in which organic material and sediment were grounded into finer particles, mixed up the substrate, and recycle the detrital material on the top layers of the sediment (Zamora and Jeffs, 2012). Efficient organic uptake drives nutrient recycling/regulation in coastal sediments.

Sediment nutrients in the present work were assessed as phosphate and nitrate and they have inorganic as well as organic sources. Present work revealed that the phosphate concentration in water was higher than in the sediment (See Table 1 and 4). The phosphate was directly deposited to the sediment pore through sedimentation, adsorption, and precipitation. That is the cause that sediment played an essential role in eutrophication, primarily acting as a reservoir and source of phosphate (Rustiah *et al*., 2019). The phosphorus/phosphate compound bound to the sediment can be decomposed with bacteria or through abiotic processes that can produce dissolved phosphate, which diffuses in the water column (Paytan and McLaughlin, 2007). Phosphorous also had an important role in marine productivity and its existence in various fractions (soluble and non-soluble). Bioavailability phosphorus in sediment corresponded to that the amount that can be released easily, for algal (Mohanty *et al*., 2018) (in this case microphytobenthic) growth, which was with the bacteria acted as the food of sea cucumber (Hartati *et al*., 2017a; 2020b). In this case, the value of phosphate in the habitat of *Phyllophorus* sp. was less than the other one, because it was utilized for microphytobenthic to grow. The benthic microphytes had a significant effect on the sediment/water flux of both NH_4 and $N0_3$+$N0_2$, although it was clearer for fluxes of NH_4 (Sébastien *et al*., 2010). The presence of an active microalgal community at the sediment surface has been found to influence the rate, as well as the vertical zonation, of denitrification both seasonally and diurnally. The increase of microphytobenthos biomass has a general, significant positive effect on total bacterial and denitrifier abundances, so affect the nitrate in the sediment (Decleyre *et al*., 2015). The average value of nitrate in the location with was significantly higher than those without *Phylloporus* sp.

The sediment grain size of the sediment in the location without and with *Phyllophorus* sp. was also analyzed, and the result was shown in Table 7. The non-parametric variant test showed that there was a significant difference in the mean value of clay, fine sand, and coarse sand percentage in the sediment between stations where *Phylloporus* sp. was present and stations where there was no *Phylloporus* sp. ($P < 0.05$) (Table 8). The grain size was the basic feature of the marine environment, which has to be characterized because it influences biotic and abiotic aspects. Sediment texture strongly conditioned macro and meiobenthic communities (Baptist *et al*., 2006; Magno *et al*., 2012) such as sea cucumber. Textural characteristics of sediments and their distribution were also key factors for the ecological characterization of benthic habitats (Romano *et al*, 2012). This research showed that the percentage of clay, fine and coarse sand of the sediment significantly influenced the presence of Phyllophorus in Kenjeran waters of Madura Strait. *Phyllophorus* sp. preferred less silt and more fine and coarse sand sediment to life (Table 7; Figure 2). *Phyllophorus* sp. was usually buried in sandy areas (Lane *et al*., 2003). There was a very strong positive relationship between grain size in the sediment and in the sea cucumber alimentary canal (digestive system) which showed ththeeeding selectivity of the sediment. Sea cucumbers also fed efficiently by taking advantage of the high TOM content and high abundance of microphytobenthic (presented as chlorophyll-a) in their natural habitats (Hartati *et al*., 2020a). The present result proved and confirmed the previous study that sediment had a significant role in the sea cucumber feeding process. In this research location, the grain size distribution was influenced by estuarine inputs, as a source of suspended particulate matter, and wave exposure, which induces sediment remobilization, influenced in opposite directions the grain-size distribution and the organic matter contents of sediments (Carvalho *et al.*, 2018).

Table 4. The average concentration value of the chemical characteristic of sediment in the Station with and without *Phyllophorus* sp. in Madura Strait

Station	Phosphate ($mg.g^{-1}$)	Nitrate ($mg.g^{-1}$)	Ammonia ($mg.g^{-1}$)	Chlorophyll-a ($mg.m^{-2}$)	Total Organic Matter (%)	C-Organic (%)
1	0.04	0.21	0.002	81.58	3.73	2.15
2	0.04	0.19	0.002	132.19	4.57	2.67
3	0.03	0.21	0.005	228,29	5.10	2.96
4	0.03	0.22	0.004	203.91	5.48	3.20
5	0.03	0.20	0.006	146.41	3.17	1.80
6	0.02	0.20	0.023	85.63	3.45	2.01
7	0.04	0.20	0.008	228.04	7.37	4.78
8	0.05	0.25	0.008	149.75	1.83	0.98
9	0.02	0.23	0.002	118.,44	2.02	1.35
10	0.37	0.10	0.018	945.31	15.68	9.11
11	0.04	0.22	0.010	408.59	13.87	8.10
12	0.10	0.36	0.002	467.08	12.52	7.44
13	0.10	1.47	0.010	347.90	13.99	8.24
14	0.10	1.17	0.007	122.22	17.82	10.02
15	0.09	1.46	0.005	122.76	18.0	10.48
16	0.09	1.12	0.009	225.06	21.8	11.62
17	0.07	0.57	0.002	143.22	4.83	2.75
18	0.09	1.03	0.004	122.76	2.8	1.67
19	0.10	0.69	0.014	102.30	12.52	7.21
20	0.10	0.45	0.004	143.22	6.41	3.37
21	0.09	0.64	0.003	122.76	8.60	4.72
22	0.07	0.35	0.002	61.38	5.09	2.64

Table 5. The comparison of the mean value of sediment physical and chemical characteristic in the Station without *Phyllophorus* sp. and with *Phyllophorus* sp. in Madura Strait

Parameter	Value of Mann-Whitney U-test	Asymp.Sig (2-tailed)	Exact Sig. (1-tailed)
Phosphate	24.500	0.021*	0.021
Nitrate	33.000	0.088*	0.096
Ammonia	45.500	0.380	0.393
Chlorophyll-a	40.000	0.261	0.235
Total Organic matter	20.500	0.011*	0.009
C-Organic	20.000	0.010*	0.009

Table 6. The average content value of phosphate, nitrate, total organic matter and C-organic of sediment in all stations with *Phylloporus* sp and with *Phylloporous* sp

Station	Phosphate ($mg.g^{-1}$)	Nitrate ($mg.g^{-1}$)	Total Organic Matter (%)	C-Organic (%)
1	0.11	0.01	13.36	7.65
2	0.04	0.19	4.57	2.67

Table 7. The results of grain size analysis of sediment in the Station without *Phyllophorus* sp. and with *Phyllophorus* sp. in Madura Strait

Station	Clay (%)	Silt (%)	Fine Sand (%)	Coarse Sand (%)	Gravel (%)
1	0	24.48	53.25	21.47	0.8
2	0	7.37	67.47	23.53	1.63
3	0	24.35	54.92	17.33	3.4
4	0	20.15	52,75	26.1	1.0
5	0	4.2	74.42	20.1	1.38
6	0	24.05	49.63	24.43	1.88
7	0	31.87	49.23	16.5	2.4
8	0	6.42	66.27	25.1	2.22
9	0	27.77	52.97	18.1	1.18
10	43.17	54.77	1.93	0.13	0
11	45.17	53	1.73	0.1	0
12	49.33	48.63	1.97	0.07	0
13	4	92.2	3.25	0.55	0
14	0	23.85	32.65	9	34.35
15	4	81.9	11.6	2.5	0
16	0	15.1	36.15	29.5	19.25
17	4	87.8	6.9	1.3	0
18	3	82.4	11.9	2.7	0
19	0	16.9	59.3	18.5	5.3
20	3	82,1	12	2.9	0
21	3	92.35	3.85	0.8	0
22	0	12.8	46.9	17.3	23

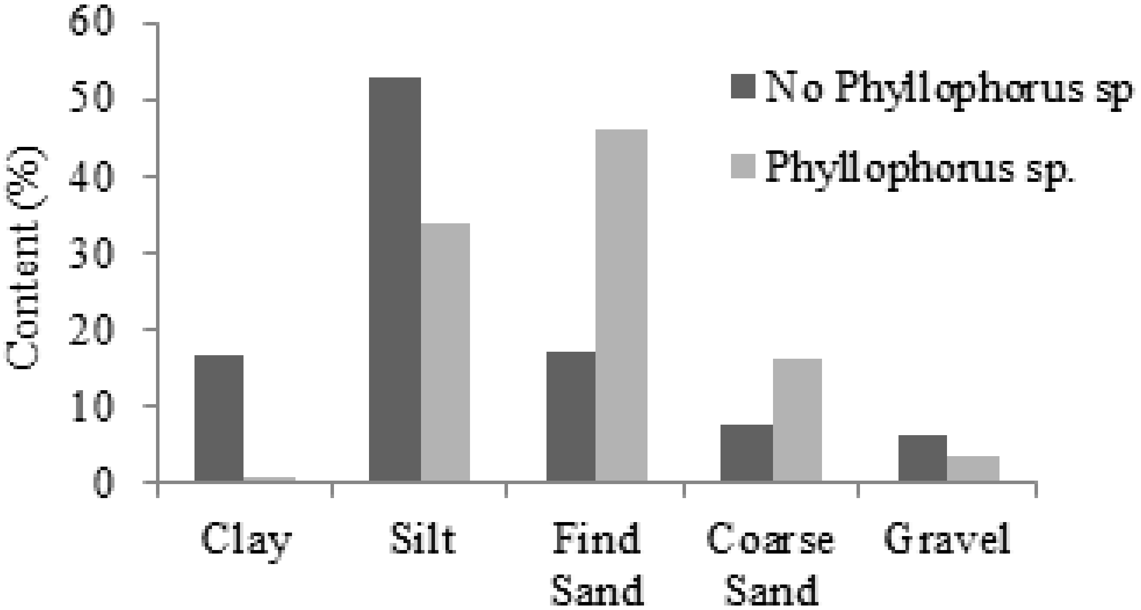

Figure 2. The average grain characteristic of all stations with *Phylloporus* sp and with *Phylloporous* sp.

Table 8. The difference of the mean value of sediment grain size characteristic in the Station without *Phyllophorus* sp. and with *Phyllophorus* sp. in Madura Strait

Parameter	Value of Mann-Whitney U-test	Asymp.Sig (2-tailed)	Exact Sig. (1-tailed)
Clay	27.000	0.018*	0.036
Silt	36.000	0.133	0.144
Fine Sand	18.000	0.007*	0.006
Coarse Sand	29.000	0.048*	0.051
Gravel	37.000	0.137	0.164

CONCLUSION

The environment characteristic as the seawater parameter value in Madura Strait showed in the range requirement for *Phyllophorus* sp. life. There were significant differences in the physical and chemical characteristics of the sediment between the Sea Ball Cucumber habitat and no Sea Ball cucumber location, especially for phosphate, nitrate, total organic matter, and C-organic. Among grain size, the clay, fine and coarse sand revealed significantly affected the presence of *Phyllophorus* sp. in the locations. This analysis proved the importance of sediment characteristics for *Phyllophorus* sp. As a benthic deposit feeder, it not only use the sediment substrate underneath the body for its habitat but also primarily to supply its natural food.

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