

Characteristic sediment and water column chlorophyll-a in the sea cucumber's *Paracaudina* sp. habitat on the Kenjeran Water, Surabaya

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Abstract. The study of characteristic sediment and water column chlorophyll-a has an important role in the sea cucumber habitat. Sediment chlorophyll-a represents a productivity primer for the benthic community. This research has a purpose to investigate characteristic sediment and water column chlorophyll-a on the Kenjeran water, Surabaya. Sediment samples were collected by the ekman grab for analysis, grain size and nutrient. The sample for sediment chlorophyll-a was taken by core sampler. The water samples were taken with Nansen Bottles. According to the research result, the values of sediment chlorophyll-a at station 10, 11 and 12 were higher than the other stations. In contrast, the value of chlorophyll-a in the column water had almost the same value for each station. The sediment chlorophyll-a value on clay and silt sediment type was higher than the fine sand and coarse sediment type. The suitable habitat characteristic for *Paracaudina* sp. was clay and silt sediment with sediment chlorophyll concentration ranging from 347.82 mg·m⁻² to 1135.52 mg·m⁻².

1. Introduction

Kenjeran waters are semi-enclosed waters located in the Madura Strait, Surabaya. There are many marine resources such as sea cucumber, bivalve, gastropod and others marine benthic organisms. In these area, there are seven species of sea cucumber such as *Phyllophorus* sp., *Paracaudina australis*, *Colochirus quadrangularis*, *Holothuria* sp., *Holothuria sanctori*, *H. forskali* and *H. turrisicelsa* [1]. Sea cucumber *Phyllophorus* sp. and *Paracaudina* sp. were dominant species in the Kenjeran Water [1]. The abundance of these two species is largely determined by habitat and environmental conditions.

Most of the sea cucumbers are sediment feeder which passes large amounts of sediment through their gut system to assimilate a fraction of the low content of organic matter, mainly benthic diatom (microphytobenthos), bacteria and detritus [2]. Sea cucumbers play an important role for recyclers of inorganic nutrient and thus a part of the close cycling of materials. According to the research, high sea cucumber densities in experiments may reduce microphytobenthos production and biomass [2].



In the shallow water, the benthic microalgae play an important role as primary producers. The primary production in the benthic ecosystem is the main food resources for most all benthic organisms such as micro-zoobenthic, meiobenthic, macrozoobenthos and macrobenthos organisms. Most all of benthic microalgae such as benthic diatom can excrete high extra-polymeric substance (EPS) that contribute to supply food resources for many benthic organisms [3]. Furthermore, benthic microalgae can significantly reduce the release of nutrients when the benthic microalgae diffuse across the surface and indirectly by oxygenating surface sediment [4, 5].

The value of microalgae benthic is represented by sediment chlorophyll-a which depend on the nutrients content not only in the water column but also in the benthic ecosystem. There is a relationship between the dynamic of nutrient in the water column and the benthic ecosystems. Recently, most of the researches in the Kenjeran Water, were about sea cucumber biology, nutrition content, the population of marine biota such as bivalve, crustacea and fish [1, 6]. However, some studies of the physical and chemical characteristic of sea cucumber habitat on Kenjeran Water Surabaya have not explored yet. This research aimed to determine characteristic sediment and water column chlorophyll-a in the habitat of sea cucumber *Paracaudina* sp, the Kenjeran Water, Surabaya.

2. Materials and Methods

2.1. Sampling

This research was conducted in the Kenjeran Waters, Surabaya. Sediment samples and water samples were taken from August to October 2016. Samples were taken each per month. Sediment and water samples were taken from 12 stations (figure 1).

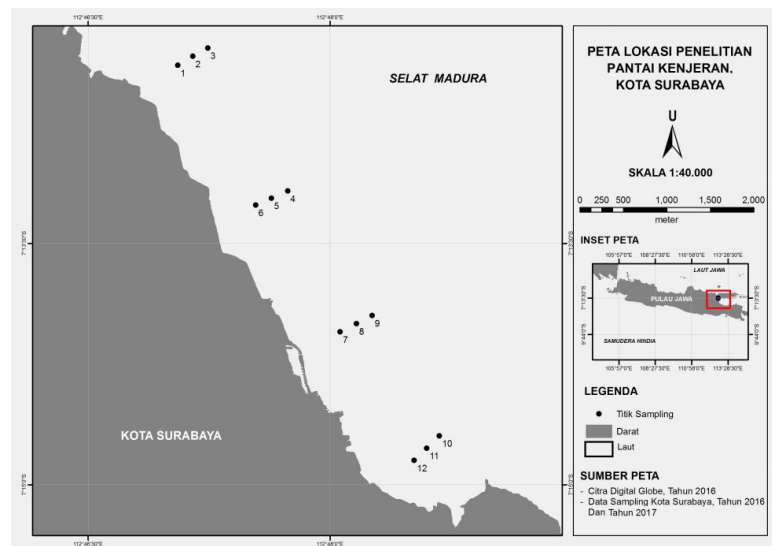


Figure 1. Sampling Station at the Kenjeran Waters, Surabaya.

Sediment samples were taken by sediment grab (Eikman Grab) and core samples. The uppermost layer of sediment was sliced in 0–1 cm. Water samples for measuring Chlorophyll-a were taken by Nansen Bottle. Salinity in the water column was measured directly in situ by refractometer ($S\text{-mill}^{-1}$, Atago, Japan).

2.2. Analysis

Lorenzen Method has been used for analysis of sediment chlorophyll-a content [7]. Grain size was analyzed by ASTM (American Society of Testing Material) method. A spectrophotometric method was used to analyze orthophosphate, nitrate, and water chlorophyll-a content [8].

Sediments grain size were determined by sequential sediment-sieving, using analytical sieve shaker, to evaluate the relative abundance (% dry weight) of > 1000, 1000–500, 500–250, 250–125, 125–63 and < 63 μm size fraction. Sediments were classified into sediment type according to the method from Folk 1954 [3]. Organic matter was measured as ash-free dry weight (AFDW) loss by ignition after 5 hours at 550 °C.

SPPS 16 was used to analyze the normality variable chlorophyll-a in the sediment and the column water. Comparing averages between variable were analyzed using one-way ANOVA and non-parametric Kruskal-Wallis [9].

3. Result and Discussion

3.1. Result

3.1.1. Chlorophyll-a in Sediment and Water Column. According to the research, from station 1 to 9 chlorophyll-a in the sediment fluctuated not only in August and September but also on October 2016. The highest value of chlorophyll-a in sediment was found at station 10 in September as amount 1135.52 $\text{mg}\cdot\text{m}^{-2}$, and then followed by August 2016 as amount 1104.83 $\text{mg}\cdot\text{m}^{-2}$ (figure 2). The magnitude of the chlorophyll-a content in the sediment at stations 10, 11 and 12 compared to stations 1 to 9 were also followed by the amount of total organic matter, percentage C-organic, phosphate and nitrate value (figure 4 and 5).

On the graph shows that the value of chlorophyll-a concentration in the water column on August showed greater than on September and October 2016 (figure 2). The value of concentration chlorophyll-a tended to decrease from August to October 2016. The effect of La Nina throughout 2016 can cause heavy rainfall in some parts of Indonesia. Of course, this can affect the primary productivity of waters that indicated by the decreasing chlorophyll-a concentration in the water column in September and October compared to August (figure 2).

Furthermore, according to Kolmogorov-Smirnov test, the chlorophyll a content distribution in sediment at 12 sampling sites on 3 months (August, September and October 2016), showed that the chlorophyll-a normal distribution was not found in sediment (Asymp sig (2-tailed) = 0.014 < 0.05). The test non-parametric was continued with Kruskal-Wallis analysis. According to the result, showed that the Chi-square value was 1,195 df 3 (7.81) at $P = 0.05$ was smaller than Chi-square table (df = 3, $P = 0.05$). It concludes that there were no significant differences between the variables chlorophyll-a content in the sediment for sampling time in August, September and October 2016.

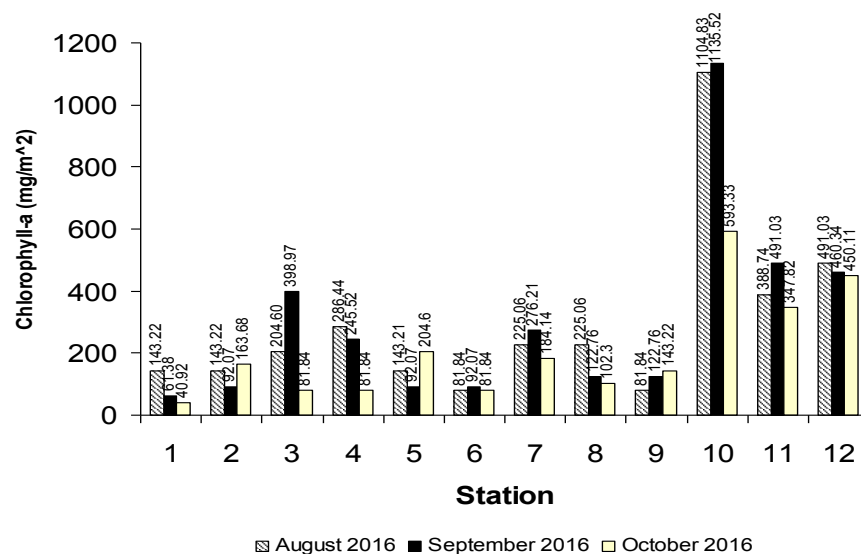


Figure 2. Chlorophyll-a Content in Sediment from Kenjeran Water, Surabaya.

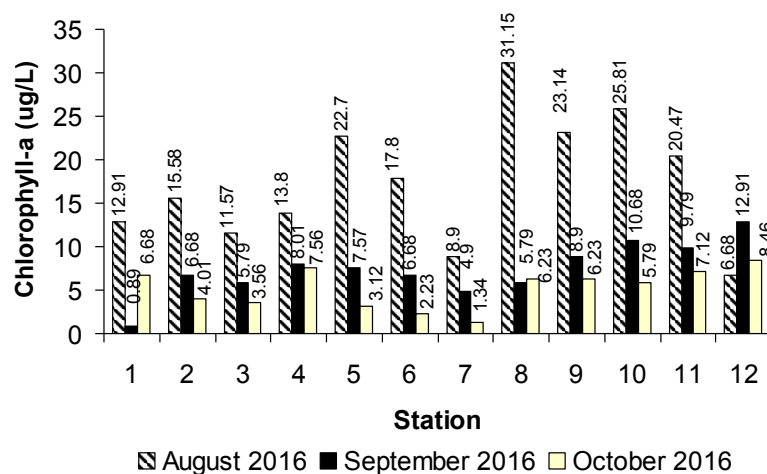


Figure 3. Chlorophyll-a Content in Water Column from Kenjeran Water, Surabaya.

According to one sample Kolmogorov-Smirnov test (SPSS 16 test), the distribution of chlorophyll a in the water column for 3 months (August, September and October 2016) was normal (value of asymp sig. (2-tailed) = 0.114 was higher than 0.05). After that, one-way ANOVA test was continued. The result showed that there was significant different content chlorophyll-a in the water for August, September and October 2016. Difference between months (August, September and October 2016) influence the chlorophyll-a content in the water column (One-Way ANOVA; $F_{3, 44} = 18,217$, $P < 0.01$).

3.1.2. Nutrients in the Sediment and Water Column. The concentrations of ortho-phosphate in the sediment station 10–12 were higher than other stations (station 1 to 9). Moreover, at the station 11 and

12, on August, the concentration of nitrate was higher than others stations. The concentration value of nitrate in the sediment on October 2016 at station 8, 9 and 12 were higher than the others stations (figure 5). Contrastly, at the station 10. the concentration of nitrate was lower than the other stations.

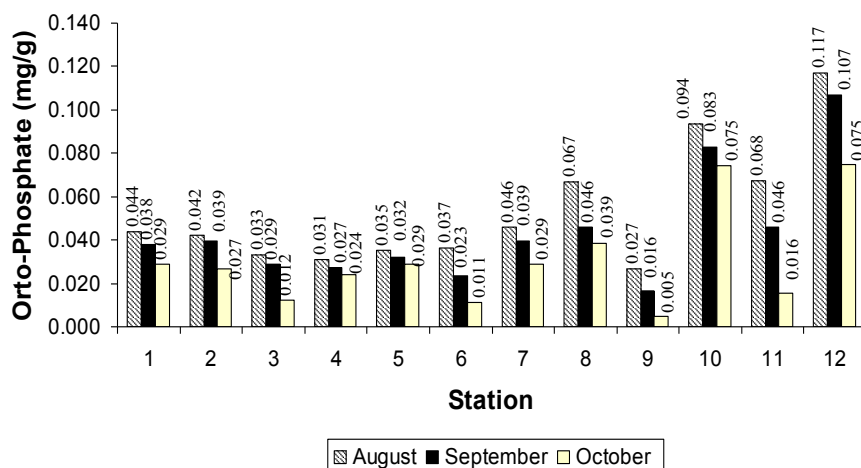


Figure 4. Orto-Phosphate content in the sediment from Kenjeran Water, Surabaya.

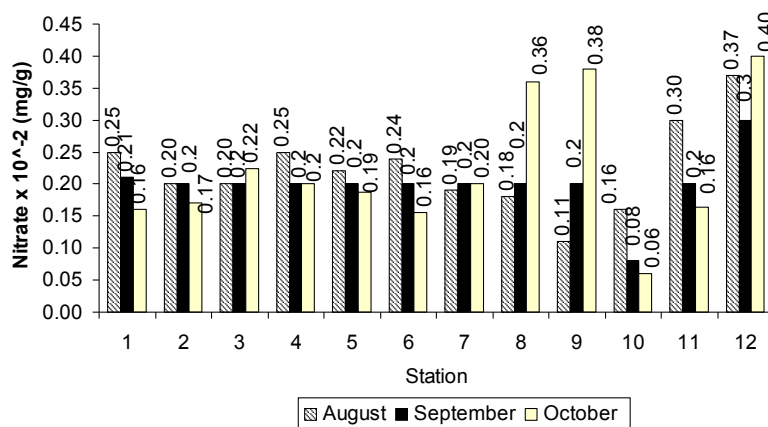


Figure 5. Nitrate content in the sediment from Kenjeran Water, Surabaya.

According to the variance homogeneity test (Levene statistic sig. = 0.024 < 0.05), showed that the nitrate content variant in the sediment was not homogenous. Whereas, the variant data distribution was normal (One-sample Kolmogorov-Smirnov test, Asymp. Sig. (2-tailed) = 0.063 > 0.05). Therefore, time for sampling (August, September and October) had no influence on Nitrate content in the sediment (One Way Anova; F2, 33 = 0.360, P > 0.05).

The variance homogeneity test showed that concentration of phosphate in the water column was homogenous. However, according to statistic analysis, there is no significant differences concentration phosphate within August, September and October 2016. Besides, Nitrate content in the water column showed a normal distribution (One-sample Kolmogorov-Smirnov test, Asymp. sig. (2-tailed) = 0.201

> 0.05). The variation in the nitrate content in the water column of the months (August, September, October) was significantly different (One-way Anova; $F_{2, 33} = 5,156$, $P < 0.05$).

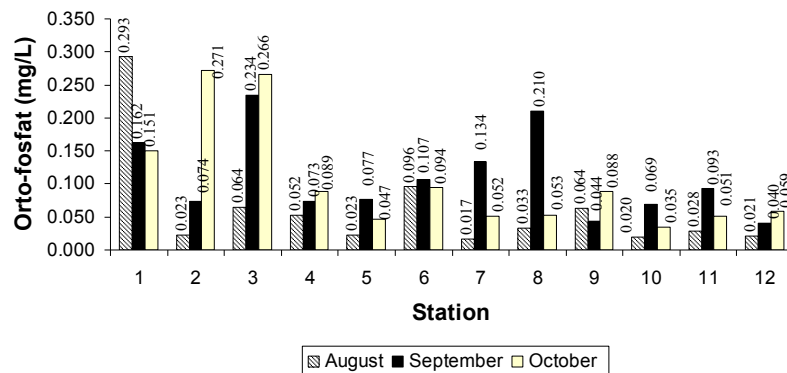


Figure 6. Ortho-Phosphate Content in the water column from Kenjeran Water, Surabaya.

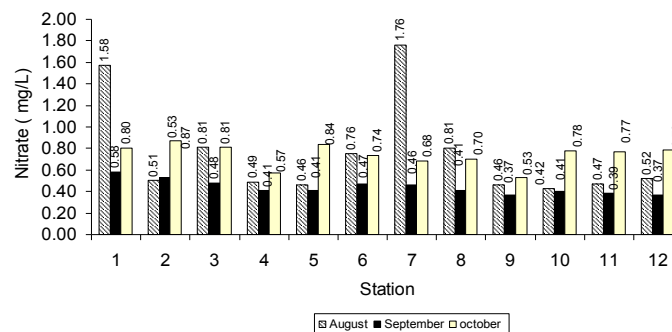


Figure 7. Nitrate Content in the water column from Kenjeran Water, Surabaya.

3.1.3. Grain Size Sediment. According to the research result, station 10, 11 and 12 were dominated by clay sediment ranging 35 to 58 % and silt sediment ranging from 41 to 61 % (figure 8, 9,10). On the other hand, on the station 1 to 9 was dominated by fine sand which values ranging from 35 to 87 % (figure 10). The chlorophyll-a concentration values in the sediment at station 10, 11 and 12 were higher than other stations. In the shallow water, the processes of physical conditions such as hydrodynamic (bottom current, surface current, and tidal process) were affecting the particles grain size [10].

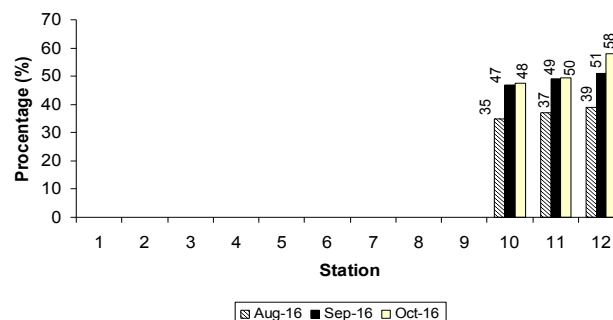


Figure 8. Percentage (%) clay for each station on the Kenjeran Water, Surabaya.

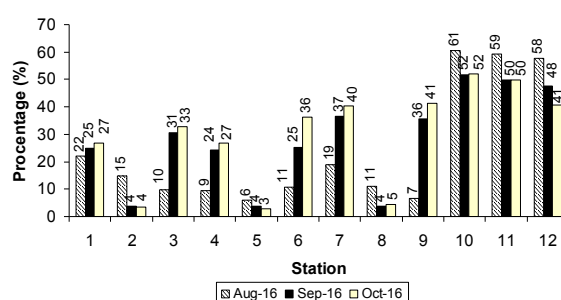


Figure 9. Percentage (%) silt for each station on the Kenjeran Water, Surabaya.

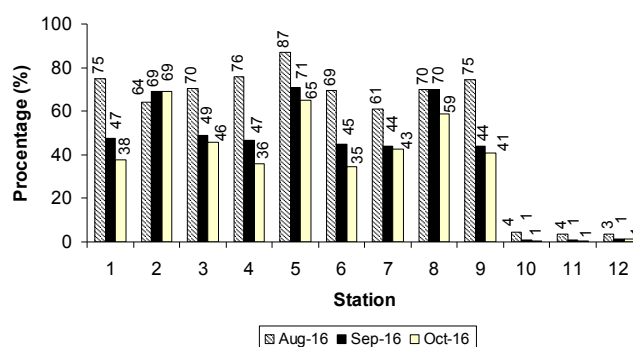


Figure 10. Percentage (%) fine sand for each station on the Kenjeran Water, Surabaya.

3.2. Discussion

The phytoplankton in the water column, as measured by chlorophyll-a concentration, was a function of the concentration of total nitrogen and phosphate [5]. Moreover, phytoplankton and micro-phytoplankton (benthic microalgae) affect organic matter turnover and nutrient cycling in the shallow water [11].

On August 2016, the station 1 showed the highest phosphate concentration $0.293 \text{ mg}\cdot\text{L}^{-1}$ compared to other stations. Additionally, the highest concentration of nitrate value was found at station 7 ($1.76 \text{ mg}\cdot\text{L}^{-1}$). As for the other stations had almost the same value (figure 5). The value of chlorophyll-a in sediment could be caused by the physical mixing of the sediment, bioturbation and nutrient content in the sediment [5].

The characteristic of sediment strongly affects the nutrient (phosphate and nitrate) and physical conditions within the sediment, which is reflected in kind of microphytobenthos [12]. Some research revealed that there was a stronger correlation between chlorophyll-a sediment and characteristic type of sediment. Physical factor is one of the environmental factors have an effect on sediment stability against biological ones. The type of sandy sediments can be easily transported to the water column by the bottom current. On the contrary, cohesive sediments resist erosion. Some microphytobenthos can secrete mucus on the surface sediment and sediment become more cohesive. Sediment composition impacts biofilm shaping by providing a more or less favorable habitat for microphytobenthos, leading to differences in microphytobenthos content between sediment mixtures composition [10]. There is a relationship between sediment grain-size and biofilm age on epipelagic microphytobenthos resuspension [10].

Base on this research result, sea cucumber *Paracaudina* sp. was widely caught at stations 10, 11 and 12. Meanwhile, for station 1-9 were found a lot of marine organisms such as *Pinna* sp., *Saxostrea* sp., shrimp, *Perna viridis*, shells, *Corbicula javanica* (Kupang), fish, crab, and another kind of sea cucumber (*Phyllophorus* sp.). *Phyllophorus* sp. were found at the station 3, 4, 5, 6, 8 and 9 (table 1).

Table 1. Marine animals caught on every observation station in the Kenjeran Water.

Location/ Station	Marine Animal
1	<i>Perna viridis</i>
2	<i>Perna viridis</i> , <i>Pinna</i> sp.
3	<i>Phyllophorus</i> sp.
4	<i>Phyllophorus</i> sp.
5	<i>Phyllophorus</i> sp, shrimp, crab
6	<i>Phyllophorus</i> sp, shrimp, crab
7	<i>Corbicula javanica</i>
8	crab, <i>Phyllophorus</i> sp, <i>lorjuk kerang</i>
9	<i>Phyllophorus</i> sp.
10	<i>Paracaudina</i> sp.
11	<i>Paracaudina</i> sp.
12	<i>Paracaudina</i> sp.

Even though, although there is no effect of sampling time on chlorophyll a content (Kruskal-Wallis test, Chi-square = 1.195 df 3 (7.81) at $P = 0.05$. was smaller than Chi-square table (df = 3, $P = 0.05$) but at the stations 10, 11 and 12 found many Holothurid. *Paracaudina* sp. was found on sediment which was higher in chlorophyll-a content (station 10, 11 and 12). Those station had value of chlorophyll-a concentration within range 347,82–1135,52 $\text{mg}\cdot\text{m}^{-2}$. Chlorophyll-a content in the sediment is high because there are a lot of communities of benthic microalgae that inhabit the intertidal flats of water, from dense and highly productive diatom-dominated biofilms at the surface the fine sand grain sediment [13]. This fit with this research, the high chlorophyll-a content in sediment affected the abundant of *Paracaudina*. These species prefer to live in the clay and silt sediment type. In the meantime, *Phyllophorus* preferred habitat with fine sand sediment type and less chlorophyll-a concentrations compared to the habitat of *Paracaudina* sp.

4. Conclusion

In the waters of Kenjeran, *Paracaudina* sp prefers habitats with clay and silt sediment types and high concentration of chlorophyll-a in the sediment, and high value of the nutrient. The high value of nutrient (phosphate and Nitrate) is a need for growing microphytobenthos (benthic microalgae) as food resources for marine benthic organisms such as *Paracaudina* sp. The high and low chlorophyll content in the water column does not affect the presence of *Paracaudina* sp.

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