Water quality in the ecosystem of sea cucumber *Acaudina* sp. in the Delta Wulan Waters, Central of Java, Indonesia

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**Abstract.** Sea cucumber *Acaudina* sp. is one of the benthic animals which has a very important role for the benthic ecosystem in a waters. One of its roles is to maintain sediment stability and is also known as a bioturbation animal. The research aims are to study the water quality in the ecosystem of sea cucumber in the Delta Wulan Waters, Demak. The research was conducted for 4 months (May, June, July and August 2020). Based on the research result, the type of substrate in the Delta Wulan Waters is silt has a range 87.4–96.70%. The salinity has a range value is 29.25 to 33.50 ppt. The value of the water temperature is 28.6–29.9 ºC. The DO value has a range is 5.04–8.13 ppm. The pH value range is 6.05–7.56. Furthermore, the average concentration of Pb in sediment has range 4.77–5.10 mg/kg. The average concentration of Cu in sediment has range 15.93–16.06 mg/kg. The average concentration of Cd in sediment has range 0.02–0.07 mg/kg. In the sediment, the average concentration of ortho-phosphate content has range 0.014–0.027 mg/g, nitrate has range 0.035–0.073 mg/g and chlorophyll-a has range 268–805 mg/m². In conclusion, water quality in Delta Wulan Waters can still support population growth of *Acaudina* sp..

**Keywords:** *Acaudina* sp.; Delta Wulan; Demak; sea cucumber; water quality

1. Introduction

*Acaudina* sp. has a wide distribution of clay-sandy habitats in tropical waters, taxonomically this sea cucumber is belonging to family Caudinidae, Order Molpadida and Class Holothuroidea [1, 2]. The existence of population sea cucumber *Acaudina* sp. is determined by the water quality including the substrate condition in the benthic ecosystem. Each species of sea cucumber has specify water quality conditions, substrate type, and kind of ecosystems such as sea grass ecosystem, coral reef ecosystem, and etc.. Sea cucumber *Holothuria atra* live in Seagrass bed habitat where has sediment type that is mostly dominated by find sand as amount 60.20–90.90% in the Bandengan Waters and 42.70–67.90% in the Teluk Awur Waters, Jepara [3].

Furthermore, the sea cucumbers *Paracaudina* sp. live in habitat where has clay composition 35–58% and silt type has composition 41–61% [4]. Sea cucumber from family Stichopodidae can be adapted to grain size type such as sand, sand-silt, dead coral, rubbles and boulder [5]. Each species of sea cucumber lives in different substrate environment.
Furthermore, seagrass bed and intertidal area are a favorite habitat for some sea cucumbers such as *Holothuria atra*, *H. edulis*, *H. leucospiota*, *H. scabra* [3, 6-8]. Additionally, family Stichopodidae are found in coral reef ecosystem [9]. Whereas, Family Caudinidae are mostly found in habitats that have substrate grain size types of silt, and clay [4]. This family Caudinidae can live with salinity range 29.00–30.70 ppt, temperature range 29.07–31.80°C, chlorophyl-a content in sediment have range 61.38–945.31 mg/m³, ortho-phosphate content has range 0.02–0.10 mg/g and nitrate content in the sediment have range 0.10–1.47 mg/g [4, 10].

Considering the role of sea cucumber *Acaudina* sp in the benthic habitat is very important in maintaining ecosystem stability through bioturbation contribution in sediment [11], this research aims to study water quality in the habitat of *Acaudina* sp in Delta Wulan Waters, Demak.

2. Material and methods

Water quality measurements were carried out every month in May, June, July, and August 2020. Measurement of water quality samples were conducted insitu in the Delta Wulan Waters, where is the habitat for *Acaudina* sp (figure 1). Parameters of water quality measured were salinity, temperature, DO, pH, nitrate content in sediment, ortho-phosphate content in sediment, heavy metal content of Pb, Cd, Cu and Hg in sediment, grain size, and Chlorophyll-a content in sediments. Water quality checker was used for measuring salinity, temperature, DO and pH. Ekman grab was used for sediment sampling. Measurement of chlorophyll-a, nitrate, ortho-phosphate content in sediments using the spectrophotometric method. Determination of heavy metal analyze used AAS method (Atomic Absorption Spectrophotometry) with analyze procedure referring to Galanopoulou [12].

![Figure 1. Map of sampling on Delta Wulan Waters, Demak Regency.](image)

3. Result and discussion

3.1. Parameter of water quality in the delta wulan waters

Based on the results of salinity measurements, the highest average value of salinity was at station 3 with a value of 33.5 ppt (figure 2). Furthermore, the range of average value from station 1 to 6 in observations in May to August 2020 were around 29.25–33.50 ppt (figure 2). The levels of salinity and temperature in the waters can not be separated from one another. This is because the aspect of the distribution pattern of chemical parameters and biological processes is a function of temperature, thus temperature is a function of determinant while salinity is a function of limiting distribution of marine organisms [13].
Based on observations of the average value, the highest temperature was found at the sampling in July 2020 with a value range of 29.4–29.9°C. The highest temperature measurement values were found at station 2 and 3 in the observation in July 2020 with a value of 29.9°C (figure 3). Meanwhile, the lowest value was found in the measurement in May 2020 with a range of 28.6–29.0°C (figure 3).

**Figure 2.** Average value of Salinity (ppt) at Station 1–6 on Delta Wulan Waters, Demak Regency.

**Figure 3.** Average value of Temperature (°C) at Station 1–6 on Delta Wulan Waters, Demak Regency.

According to observations of dissolved oxygen (DO) content measurements, Observations in June 2020 showed the lower result value compared to other month observations. The range of values for the dissolved oxygen measured in June 2020 has a range of 5.04–6.40 ppm (figure 4). Furthermore, at the station 4, measurements of May and August 2020 showed that the dissolved oxygen was 8.13 ppm (figure 4).
According to measurement the pH value, the lowest measured value was 6.05 at station 4 (observation on July 2020). While the highest value was found in the measurement on May 2020 at station 6 with a pH value of 7.56 (figure 5). When compared with the quality standard value KepMen-LH No. 51 Year 2004, the measured pH value is still within the range of quality standard value ranging from 7–8.5. The pH value in the Delta Wulan Waters is still the same as the pH value in the Army Dock Waters, Pandanga Village, Morotai Island Regency [14] and Kenjeran Waters Surabaya [4, 10].

3.2. Sediment characteristics

The depth of the place where the *Acaudina* sp were collected was quite varied between station 1, 2, 3, 4, 5, and 6, although they were taken at almost the same coordinates (figure 6). This indicates that the sediments in which sea cucumbers are living in an unstable condition and the sediments are greatly

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**Figure 4.** Average value of DO (ppm) at Station 1–6 on Delta Wulan Waters, Demak Regency.

**Figure 5.** Average value of pH at Station 1–6 on Delta Wulan Waters, Demak Regency.
influenced by the movement of the bottom current. Based on the depth measurement, stations 4 and 5 have a lower depth compared to station 6, while stations 1, 2, and 3 have almost the same depth (figure 6).

According to grain size observations from May to August 2020, the silt was dominant with a value ranging from 87.40–96.70% (figure 7), followed by clay with a value ranging from 2.00–8.90% (figure 8). There is a relationship between the chlorophyll-a content in the sediment with grain size type, it can be seen that the high chlorophyll-a content at station 1, 2, 3, and 4 have a type of grain size that is dominated by silt. This is in accordance with the result of research by [15] where the pigment content in the muddy habitat is greater than sandy habitat in the coastal waters. Furthermore, the sediment with a size of 1 mm gave a good growth effect compared to the sediment grain size of 7 mm in juvenile *Holothuria tubulosa* [16]. Therefore, the grain size in the sedimen greatly affects the existence of juvenile sea cucumbers.

![Figure 6](image_url)

**Figure 6.** Average value of depth (m) at Station 1–6 on Delta Wulan Waters, Demak Regency.

![Figure 7](image_url)

**Figure 7.** Percentage of Silt (%) at station 1 to 6 on Delta Wulan Waters, Demak Regency.
Based on the results, heavy metal Cu concentration have value ranging 15.93–16.06 mg/kg (table 1). When compared to the Tugu Coastal Waters of Semarang City, the average value of Cu content in the Delta Wulan Waters is higher than the Coastal Tugu Waters Semarang City which has value 1.7–11.91 mg/kg [17]. Pb Concentration of heavy metal in the Delta Wulan Waters had range 4.77–5.10 mg/kg. This value is lower than Pb in Coastal of Tugu Waters Semarang which measured 3.94–10.45 mg/kg [17]. The concentration of heavy metal Pb and Cu in the Delta Wulan Waters is higher than measured Pb (0.429 mg/kg) and Cu (0.119 mg/kg) concentration in the waters of Ambon Bay [18]. Whereas, the content of Hg (0.004 mg/kg) in the sediment is higher than seawater quality standart from KepMen-LH No. 51 Year 2004. The content of heavy metals in sediments is determined by the pH value of the waters. The movement of heavy metals into and from the sediment is strongly influenced by the changes of pH. The acidic nature of seawater and sediment will change the reaction so that alkaline salts will release the heavy metal into acidic sediment [19, 20].

![Figure 8. Percentage of Clay (%) at station 1 to 6 on Delta Wulan Waters, Demak Regency.](image)

The concentration of ortho-phosphate has a value ranging from 0.014 – 0.022 mg/l, and for nitrate concentration has a value ranging from 0.035 - 0.073 mg/l (table 1). In the Delta Wulan Waters, the average concentration of ortho-phosphate is lower when compared to the result in Bandengan Waters where is habitat for sea cucumber Holothuria atra that has a value ranging from 0.12 – 0.92 mg/l and in the Teluk Awur Waters that has a concentration from 0.31 – 2.2 mg/l [3]. Habitat for H. atra in the Mannar Bay Waters has ortho-phosphate concentration as amount 1.05±0.3 µg/l [21]. However, the average concentration of phosphate and nitrate can still support the large chlorophyll-a content in the sediment.

Ammonia, nitrite, and nitrate compounds have huge solubility in the waters. In the waters, ammonia consists of 2 forms, namely un-ionized ammonia (NH₃) and ionized ammonium (NH₄⁺) [22]. The presence of ammonia in waters greatly determines the nitrite and nitrate content in a waters. The result of nitrate concentration measurement at the six observation stations has a average nitrate value in the range of 0.0035 – 0.073 mg/l (table 2.). The results of nitrate measurements in the Delta Wulan Waters were still lower than the results of sediment nitrate measurements in Bandengan ranging from 0.045 to 1.02 mg/l and in the Teluk Awur Waters has ranging from 0.17 to 0.332 mg/l [3].

The utilization of ortho-phosphate and nitrate compounds contained in the sediment is indicated by the value of the chlorophyll-a content in the sediment. This can be seen from the relationship between the nitrate content in the sediment and the chlorophyll-a content in the sediment, showing a pattern that
the higher the nitrate content in the sediment, the higher the chlorophyll-a content (regression equation $Y = 13949 X - 212.09; R^2 = 0.8234$ and the correlation value $r = 0.91$). Based on the regression analysis, it was seen that there was a fairly close relationship between chlorophyll-a content in the sediments and the organic matter content (regression equation $Y = 0.0264X + 3.657; R^2 = 0.4795$; $r = 0.69$).

### Table 1. Heavy metal content in the sediments in Delta Wulan Waters.

| Heavy metal | June 2020 | July 2020 | Agusts 2020 |
|-------------|-----------|-----------|-------------|
| Pb          | 4.77      | 5.10      | 4.94        |
| Cu          | 16.06     | 15.93     | 15.99       |
| Cd          | 0.02      | 0.07      | 0.05        |
| Hg          | 0.004     | 0.004     | 0.004       |

### Table 2. Average values of phosphate, nitrate, chlorophyll-a and sedimentary organic matter in Wulan Delta waters during measurements for May, June, July and August 2020.

| Station | Ortho-Phosphate (mg/g) | Nitrate (mg/g) | Chlorophyll-a (mg/m²) | Organic substance (%) |
|---------|------------------------|----------------|-----------------------|-----------------------|
| 1       | 0.022                  | 0.073          | 805                   | 22.35                 |
| 2       | 0.019                  | 0.047          | 535                   | 20.57                 |
| 3       | 0.027                  | 0.061          | 673                   | 21.85                 |
| 4       | 0.014                  | 0.038          | 372                   | 18.75                 |
| 5       | 0.024                  | 0.047          | 268                   | 15.79                 |
| 6       | 0.021                  | 0.035          | 273                   | 16.78                 |

### 4. Conclusion

In the observation for May to August, 2020, the range of average salinity from station 1 to 6 were 29.25–33.50 ppt. The average temperature from May to August were in the range of 28.6–29.9°C and the highest temperature was observed in July 2020 with a value ranging from 29.4–29.9°C. The average value of dissolved oxygen concentration from observations of May, June, July and August 2020 were in the range 5.04–8.13 ppm. Likewise, the average pH had a range of 6.05–7.56. Based on the measured water quality parameter from May to August 2020, the Delta Wulan Waters is the habitat for many inthic organisms especially sea cucumber *Acaudina* sp. The Delta Wulan Waters is an appropriate habitat for the growth of marine benthic organism such as sea cucumber *Acaudina* sp. and several others benthic organisms. However, the average value of nitrate and phosphate content is still in the low catagory. Meanwhile, the chlorophyll-a sediment content at stations 1, 2, 3, and 4 is classified as high due to the high silt content in the Delta Wulan Waters. However, the heavy metal concentration of Pb, Cu, Cd and Hg in the sediment is quite high. However, the population of *Acaudina* sp is still abundant in the Delta Wulan Waters, Demak. In conclusion, according to observations show that water quality in Delta Wulan Waters can still support population growth of *Acaudina* sp.

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