EEET ECOLOGICAL ENGINEERING & ENVIRONMENTAL TECHNOLOGY

Ecological Engineering & Environmental Technology 2022, 23(5), 198–204
https://doi.org/10.12912/27197050/152116
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Received: 2022.06.30
Accepted: 2022.07.20
Published: 2022.08.01

Correlation between Ecological Status of Sedati Waters and Gonadosomatic Index of Short-Necked Clam (*Paratapes undulatus*)

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ABSTRACT

Catching is one way to get Short necked-clam so the demand also increases. The gonadosomatic index (GSI) of short necked-clam is a study to maintain the availability of short-necked-clam in waters. Another thing that can be obtained from this study is to know its relation to the ecological status (quality of water, substrate, and the abundance of plankton) in the waters of Sedati, Indonesia. The strategy utilized in deciding the choose point is based on the purposive inspecting strategy did some time recently with attempting to take samples at a few point within the range of brief necked-clam angling ground. To decide the relationship of the environmental status with GSI used regression, and correlation is further illustrated by descriptive statistical analysis. Based on the regression analysis, water quality has a relationship to the gonadosomatic index of short-necked clam either directly with a value of -0.1278 or through nutrients that are worth 0.6813. While the nutrient has a relationship to the gonadosomatic index of -0.99583 and substrate of 0.2525. The results showed ecological status that correlates most strongly is plankton abundance of 94.39% (very strong) but negative correlated, with dissolved oxygen of 83.92% (very strong) and with the temperature of 62,98% (strong).

Keywords: ecological health, water quality index, paratapes, soil substrate, coastal marine ecosystems.

INTRODUCTION

Short necked-clam (*Paratapes undulatus*) is one species of mollusk that's worth financial both in Indonesia and overseas (FAO, 1998). Short necked-clam is one Veneridae member who lives within the seawater is broadly utilized. Short necked-clam meat can be eaten and the shells can be utilized as a workmanship (Ambarwati and Trijoko, 2010). The generation of clams catches as numerous 12359.4 tons in 2013 and 2014 as much as 9586.1 tons (DKP, 2014). Whereas the number of clams sends out in 2015 summed to 7812 tons with a esteem of 20,759 USD (KKP, 2015).

Short necked-clam production generation is still inferred from the capture. The tall advertise request for short-necked clams, causing capture weight to extend. FAO (1998) expressed that brief necked-clam accounted for 4.1% of the overall world needs clams in Asia (barring Japan) in 1986. Be that as it may, right now, there's no later data can be found on this information in many a long time (Del Norte- Campos and Villarta, 2010).

Besides, according to Saputra et al., (2019), the level of gonad maturation is needed to determine the size of the first adult gonad in the clam. Determination of the primary measure of gonad

maturity is used as a reasonable measure of catching on clams so that the size of clam with immature gonads is not captured, and clam availability in the waters will be better maintained. Serious management is urgently needed to maintain the existence of short necked-clam. For this reason, biological and reproductive data of short-necked clam are required to know the monthly reproductive cycle, as an illustration of its reproductive pattern.

One effort that can be done so that the availability of short necked-clam populations is maintained is to conduct the assessment and deepening of gonadosomatic index of short necked-clam. And its correlation to the ecological status (quality of water, substrate, and the abundance of plankton) in the waters of Sedati, Indonesia.

The purpose of this study is to determine the influence, regression and correlation of ecological status (water quality, nutrient, and substrate) to the gonadosomatic index of short-necked clam (*Paratapes undulatus*) in the waters of Sedati, Indonesia. The benefit of this research is that it is expected that the results of the study can provide information on the influence of ecological status on the gonadosomatic index of short-neked clam *(Paratapes undulatus*) in the waters of Sedati so that they can be used as a basis for further research and as a reference in the management of short-necked clam *(Paratapes undulatus)* resources which sustainable in the waters of Sedati, Indonesia.

MATERIALS AND METHODS

The study area

The study area was located in the seashore of the Banjar Kemuning river, Sedati Waters, Sidoarjo, Indonesia which is a coastal area. A sampling of short-necked clam, water samples, and substrate was carried out at two stations with a distance of 1.5 km and 2.5 km from the shoreline, which is a fishing ground area of short-necked clam and is considered to have represented the research location. The coordinates of the sampling point are as follows (Figure 1):

- A. S 07 ° 24,484 ‘E 112 ° 52,385’
- B. S 07 ° 23.139 ‘E 112 ° 52.354’

Study methods

This research used a swept area sampling method. Determination of the point of taking is based on the purposive sampling method previously done, namely by trying to take samples at several points, which are the fishing ground of short-necked clam. Samples of clams taken were 60 live clams, where there were two stations, meaning that one station was taken as many as 30 short-necked clams. Taking the number of samples based on research Nabuab et al. (2010).

Clams were packed in ice for transport to the laboratory where specimens were weighed, measured, and dissected. Clam length and clam width were

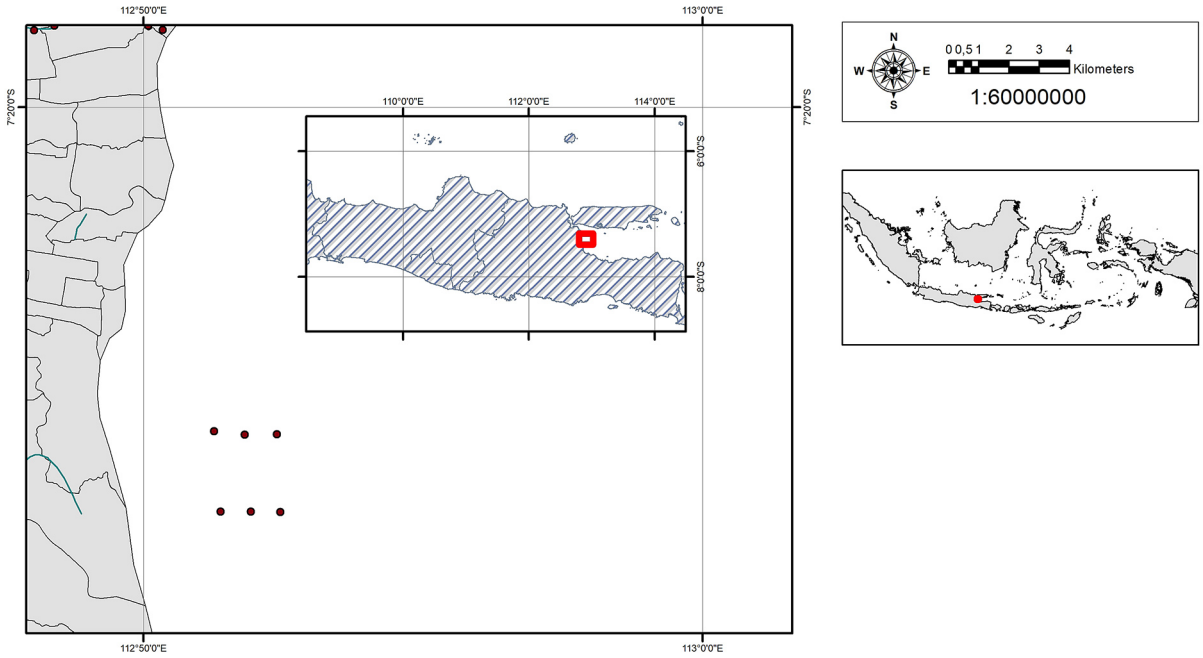

Figure 1. Location study

measured to the nearest 0.05 mm using a vernier caliper. The gonadosomatic index of each individual was computed using Equation 1 (Effendie, 1997).

$$\text{GSI} = \frac{Wg}{W} \times 100 \quad (1)$$

where: GSI – gonadosomatic index (%);
Wg – gonad weight (g);
W – total weight (g).

Statistical analysis

To find out the correlation between the gonadosomatic index and the ecological status of Sedati Waters used regression analysis using Partial Least Square Path Modeling (PLSPM) Graph that will describe the relationship and the value of w (regression value) between variables and correlation analysis. The main parameter observed was the gonadosomatic index, nutrients such as plankton abundance, substrate, and water quality include temperature, dissolved oxygen (DO), salinity, pH, and currents.

RESULTS AND DISCUSSION

Ecological status

Ecological status is a field of study that studies the relationship of biotic and abiotic factors in an ecosystem. In this case, the ecological status studied is water quality and habitat, which includes the substrate and nutrients (plankton abundance) at the study station. The affecting water quality consists of physical and chemical parameters, where the physical and chemical parameters of the environment of the Sedati waters analyzed consist of DO, pH, temperature, salinity, and current. The results of measurements of water quality, substrate and plankton abundance can be seen in Figure 2, 3, 4 and 5.

Gonadosomatic index

Gonadosomatic index is a percentage ratio of gonad weight to a bodyweight of clams (Effendie, 2002). Gonadal somatic index will increase

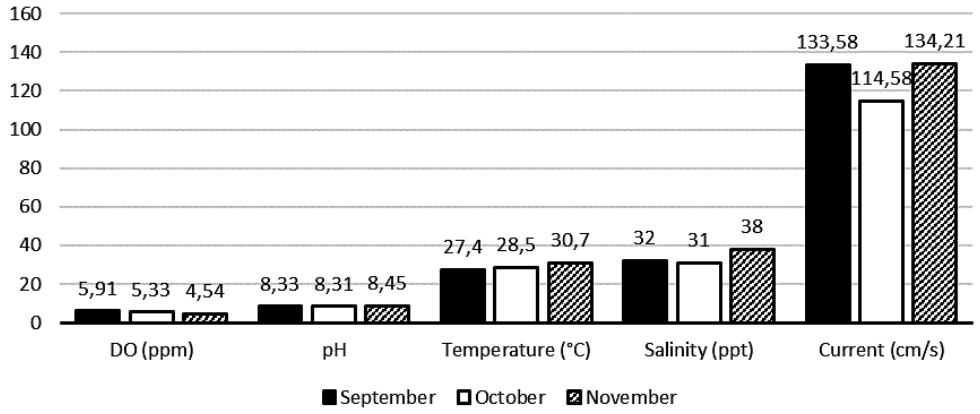

Figure 2. Water quality parameters of Sedati Waters during the study

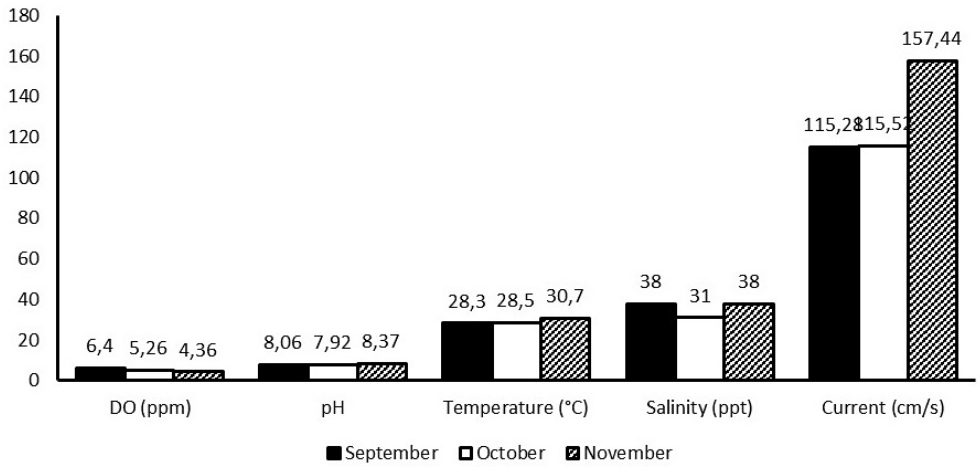

Figure 3. The condition of substrate and plankton abundance of the Sedati Waters during the study

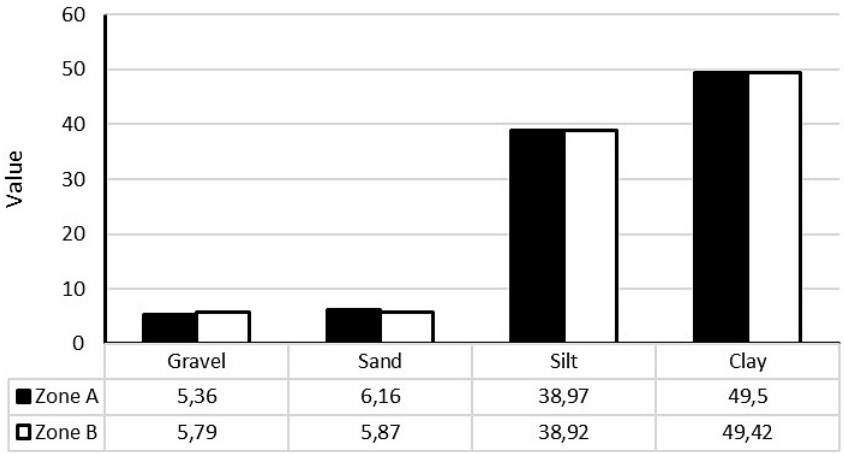

Figure 4. Substrate structure

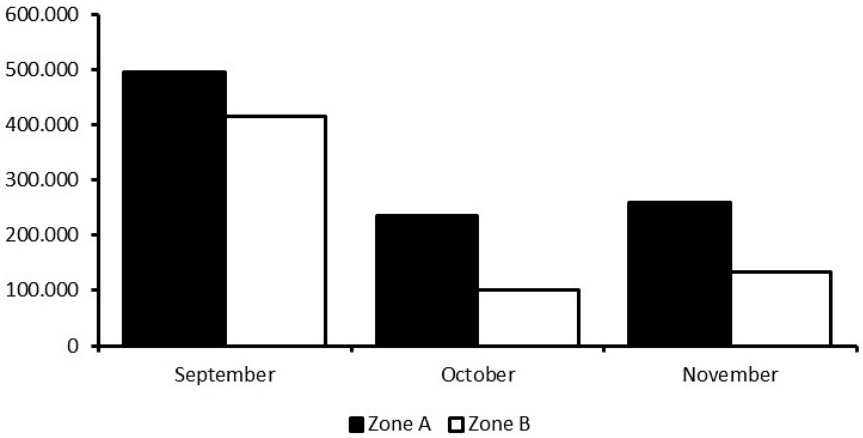

Figure 5. Plankton abundance (cell/L)

in value and will reach the maximum limit when spawning occurs (Afiati, 2007).

In the gonad area that affects the gonad maturity level (GML) short-necked clam can be seen as a Gonadosomatic index where the higher GSI obtained from the gonad weight (gonad width) divided by the total weight. The gonad maturity level short-necked clam will also be high and shows that the quantity of gonad that covers the visceral mass wall is directly proportional to GML. This is due to the development that occurs in the gonads, including the diameter of the ovum, causing the area of the gonad that covers the visceral mass wall to increase (Nurohman, 2012).

Regression analysis

Regression analysis between the ecological status of Sedati waters (water quality, substrate, and plankton abundance) was perform using the Partial Least Square Path Modeling (PLSPM) Graph, which would illustrate the relationship and value of w (regression values) between variables. Light blue indicates the dependent variable, while yellow indicates the dependent variable and independent variables of the study. The results of data analysis using PLSPM Graph between the ecological status of Sedati Waters, Sidoarjo, East Java, and the gonadosomatic index can be seen in Figure 6.

The results of data analysis using PLSPM Graph (Figure 7) show that the ecological status of Sedati waters has a relation (regression) to the gonadosomatic index of short-necked clam. In Figure 6 it can be seen that the water quality has a relation to the gonadosomatic index of short-necked clam both directly with a value of -12.78% and through nutrients that are worth 68.13%. While the nutrient has a relationship to the gonadosomatic index of -95.83% and the substrate has a relation to the gonadosomatic index of 25.25%. The negative value (-) in the regression shows the value inversely proportional. The smaller the amount of factors (independent variable) the value of the GSI (the dependent variable) will be even higher.

The value of the coefficient of determination (R2) of regression calculations between water quality, nutrients, and substrate as the ecological

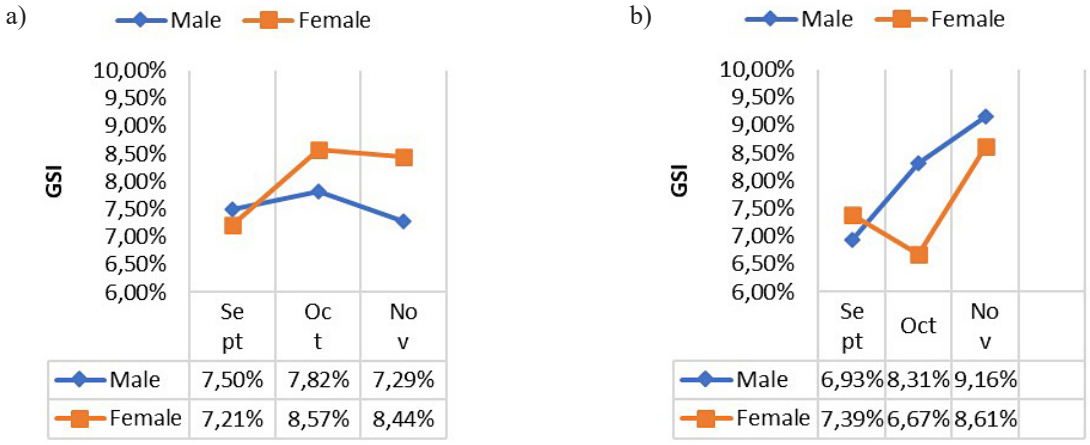

Figure 6. The gonadosomatic index of P. *undulatus* collected from station A and station B Sedati Waters from September–November 2019

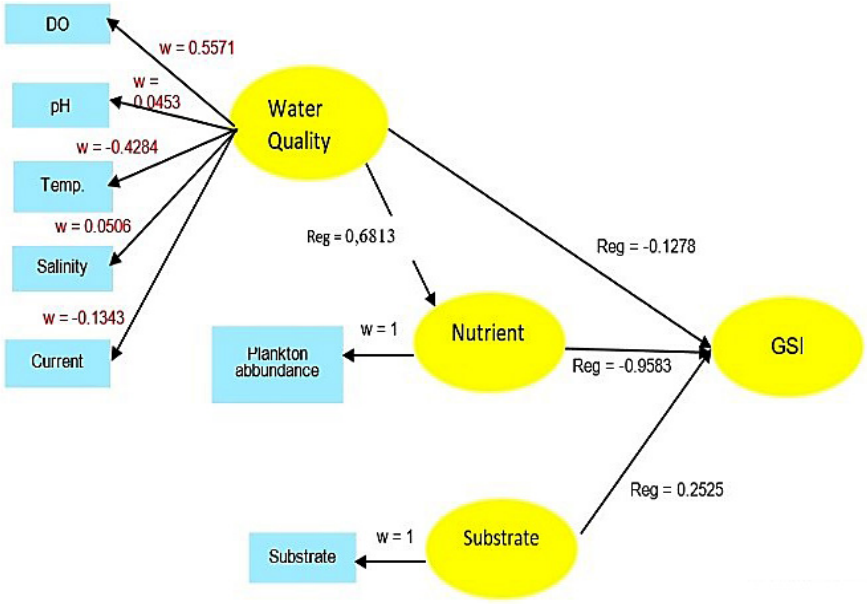

Figure 7. The results of the regression analysis of the ecological status of Sedati Waters on the gonadosomatic index of short-necked clam using Partial Least Square Path Modeling graph

status to gonadosomatic index based on the results of the regression analysis modeling above are as follows:

$$\text{GSI} = -0.12780 \cdot \text{water quality} - -0.95826 \cdot \text{nutrients} + 0.25246 \cdot \text{substrates} \quad (2)$$

While in the water quality itself, the effect of each parameter is different. In Figure 2 and 3 it can be seen that dissolve oxygen has the greatest effect on water quality that is equal to 55.57%, pH influences only 4.53% on water quality, temperature has an inversely proportional value of – 42.84% on water quality, salinity 5.06% effect on the water quality and currents have an effect of -13.43% on water quality with inversely proportional value. besides having a direct effect on GSI, it also has an effect through nutrients of 68.13%. The value of the coefficient of determination (R2) regression calculation between water quality to nutrient with the modeling equation is as follows:

$$\text{Nutrients} = 0.68127 \cdot \text{water quality} \quad (3)$$

Correlation analysis

Table 1 shows that the correlation analysis obtained the results of ecological status that affect the gonadosomatic index of short-necked clam are dissolve oxygen (DO), temperature, and plankton abundance. According to Sugiyono (2012), it can be said that the variable has a strong correlation

when the correlation interval is more than 0.60–0.799 and is very strong when the correlation interval value is 0.80–1,000. If the value is below the interval, it means that the correlation is very low or moderate. In contrast, while the negative (-) or positive (+) value indicates the correlation that is directly proportional or inversely proportional. The highest correlation value is shown by the plankton abundance of -0.9439, which means the value of plankton abundance with gonadosomatic index is 94.39% or very strong. Gonadosomatic index also has a very strong correlation with dissolve oxygen of 0.8392 or 83.92%, with a temperature of 0.6298 or 62.98% (strong). While with other ecological status variables, the gonadosomatic index has a moderate correlation or even very low because the value of the correlation interval is less than 0.60.

Gonadosomatic index is closely related to gonad maturity level because the gonad maturity level is directly proportional to GSI. In line with the gonad development phase, the gonad area will increase in size and weight to reach its maximum size when the clam enter the spawning process (Atmadja, 2007).

The temperature will affect the metabolic process and the dissolved oxygen in the water. If the metabolic process is disrupted, the reproduction process will also be inhibited. In the regression analysis, temperature has a negative value through the water quality of -44,28% but positive value of 62.98% in correlation analysis with the gonadosomatic index (GSI) where the higher the temperature the gonadosomtic index will be higher. This is because high temperatures can result in an increase of metabolic processes so that the gonads can develop faster. However, temperatures that are too high or too low can inhibit the process of egg fertilization, even temperatures that are extreme or change suddenly can cause failures in the fertilization process (Affandi and Tang, 2002). From the results of the study, the temperature obtained was extreme because the monthly differences were quite significant. This will cause the clams not to grow optimally and make the size of the clans small with a high gonadosomatic index because the size of the mature gonads is too early (Yan et al., 2014; Loboichenko et al., 2021).

Dissolve oxygen has the largest correlation coefficient value of water quality factors that is equal to -83,92% with negative value where the lower the DO value then the GSI value will be higher, this can be seen in Table 1. Dissolve oxygen values obtained at the two stations, according to the research of Nabuab et al. (2010) who found optimal dissolved oxygen for short-necked clam, was 4.1–6.87 ppm. While the pH value, salinity, and the current have a very weak correlation to the gonadosomatic index. These results are in following with research conducted by Hamli et al., (2015); Melati et al., (2021), where salinity, DO, pH, and currents do not correlate with the gonad maturity index of the short-necked clam.

When viewed from the habitat factor in the form of substrate and nutrient (plankton abundance) with Gonadosomatic index which has a very strong correlation is plankton abundance (nutrient) of -94.39% which means that the higher the value of plankton abundance, the value of gonadosomatic index the lower. These results are consistent with research by Yan et al. (2014) where GSI is negatively correlated with chlorophyll an on plankton.

The higher gonadosomatic index, the level of nutrient consumption will decrease because the available energy is only used to release eggs, while at the growth stage, nutrients are needed more because nutrients are needed for development and reproduction. This is consistent with the statement of Perez Camacho et al. (2003) and Serdar et al. (2010) which states that chlorophyll a in plankton is a form of nutrition needed by clam to get successful gonad development (gametogenesis).

Table 1. Correlation analysis of the ecological status of Sedati waters on the gonadosomatic index of short-necked clam

Var	DO	pH	Temperature	Salinity	Current	Plankton	GSI	Substrate
DO	1.0000	-0.5141	-0.8888	-0.2507	-0.6491	0.7244	-0.8392	-0.0561
pH	-0.5141	1.0000	0.4908	0.3227	0.6346	0.1651	0.0257	0.6611
Temperature	-0.8688	0.4908	1.0000	0.6757	0.6356	-0.5747	0.6298	-0.1203
Salinity	-0.2507	0.3227	0.6757	1.0000	0.5039	0.0506	-0.0895	-0.2885
Current	-0.6491	0.6346	0.6356	0.5039	1.0000	-0.1598	0.2155	-0.0633
Plankton	0.7244	0.1651	-0.5747	0.0506	-0.1598	1.0000	-0.9439	0.4019
GSI	0.8392	0.0257	0.6298	-0.0895	0.2155	-0.9439	1.0000	-0.1382
Substrate	-0.0561	0.6611	-0.1203	-0.2985	-0.633	0.4019	-0.1382	1.0000

While the substrate has a low correlation with the value of the gonadosomatic index of -13.82%.

The substrate texture in Sedati waters based on observations has a mud composition, with a particle size of less than 0.05 mm. These results are in accordance with the statement of Leethochavalit et al. (2004) which states that short-necked clam live in muddy or sandy soils with a distance of 3 to 7 km from the coast. This type of substrate in Sedati Waters supports the life of short-necked clam.

CONCLUSIONS

Ecological status affecting the gonadosomatic index of short-necked clam included water quality, nutrients, and substrates, was modeling by the mathematical equation. It correlates strongly with gonadosomatic index – the abundance of plankton (nutrient) reaches 94.39%, DO reaches 83.92%, and temperature reaches 62.98%.

REFERENCES

1. Affandi, R., Tang M.U. 2002. Fisiologi hewan air. Unri Press, Pekan Baru.
2. Afiati, N. 2007. Hermaphroditsm in *Anadara granosa* (L.) and *Anadara antiquate* (L.) (Bivalvia : Arcidae) from Central Java. Journal of coastal development, 10(3), 171–179.
3. Ambarwati, R., Trijoko. 2010. Morfologi fungsional kerang batik *Paphia* sp. (Bivalvia: Veneridae). Berkas penelitian hayati, 16, 83–87.
4. Atmadja, S.B. 2007. Beberapa catatan mengenai fekunditas relatif ikan japuh (*Dussumieria acuta*), tanjan (*Sardinella gibbosa*) dan banyar (*Rasstrelligger kanuraga*) di Laut Jawa. Jurnal penelitian perikanan laut, 73, 97–102.
5. Del Norte-Campos, A.K. Villarta. 2010. Use of population paramters in examing changes in the status of short-necked clam *Paphia undulata* Born, 1778 (Mollusca, Pelecypoda: Veneridae) in coastal waters of Southern Negros Occidental. Science Diliman, 21(1), 53–60.
6. DKP Jawa Timur. 2014. Laporan tahunan statistik perikanan tangkap di Jawa Timur tahun 2014. Dinas Perikanan dan Kelautan Provinsi Jawa Timur, Surabaya.
7. Effendie, M.I. 1997. Biologi perikanan. Yayasan Pustaka Nusatama, Bogor.
8. Effendie, M.I. 2002. Biologi perikanan. Yayasan Pustaka Nusatama, Yogyakarta.
9. FAO species identification guide for fishery purposes. 1998. Carpenter, K.E. and V.H. Niem (eds.). The living marine resources of the western central Pacific. Vol. 1. Seaweeds, corals, bivalves and gastropods. FAO, Rome.
10. Hamli, H., Idris, M.H., Abu Hena, M.K., Amy, H.R. 2015. Reproductive cycle of hard clam, *Meretrix lyrata* Sowerby, 1851 (Bivalvia: Veneridae) from Sarawak, Malaysia. Tropical life sciences research, 26(2), 59–72.
11. KKP Republik Indonesia. 2016. Laporan kinerja kementerian kelautan dan perikanan tahun 2015. Kementerian Kelautan dan Perikanan, Jakarta.
12. Leethochavalit, S., Chalermwat, K., Upatham, E.S. 2004. Occurrence of *Perkinsus* sp. in undulated surf clams *Paphia undulata* from the Gulf of Thailand. Dis Aquat Org., 60, 165–171.
13. Loboichenko, V., Leonova, N., Shevchenko, R., Strelets, V., Morozov, A., Pruskyi, A., Avramenko, O., Bondarenko, S. 2021. Spatio-Temporal Study of the Ecological State of Water Bodies Located within the Detached Objects of the Urbanized Territory of Ukraine. Ecological Engineering & Environmental Technology, 22(6), 36–44.
14. Melati, V.H., Sari, L.A., Cahyoko, Y., Arsad, S., Pursetyo, K.T., Dewi, N.N., Idris, M. 2021. Gastropod community structure as environmental change signals for tropical status in Sedati Waters, Indonesia. Ecological Engineering & Environmental Technology, 22(3), 82–90.
15. Nabuab, F.M., Ledesma-Fernandez, L., del Norte-Campos, A. 2010. Reproductive biology of the short-necked clam, *Paphia undulata* (Born 1778) from Southern Negros Occidental, Central Philippines. Science Diliman, 22(2), 31–40.
16. Nurohman. 2012. Laju eksploitasi dan keragaan reproduksi kerang darah (*Anadara granosa*) di Perairan Bondet dan Mundu, Cirebon, Jawa Barat. Bachelor Thesis, Departemen Manajemen Sumberdaya Perairan, Fakultas Perikanan dan Ilmu Kelautan, Institut Pertanian Bogor, Bogor.
17. Perez Camacho, A., Delgado, M., Fernandez-Reiriz, M.J., Labarta, U. 2003. Energy balance, gonad development and biochemical composition in the clam *Ruditapes decussatus*. Marine ecology progress series, 258, 133–145.
18. Saputra, R.F., Masithah, E.D., Wulansari, P.D. 2019. The Analysis of Cockle (Anadara inaequivalvis) Gonad Maturity Level in the Estuary of Banjar Kemuning River, Sedati, Sidoarjo. IOP Conf. Ser.: Earth Environ. Sci., 236 012061.
19. Serdar, S., Lok, A., Kirtik, A., Acarh, S., Kucukdermenci, A., Guller, M., Yigitkurt, S. 2010. Comparison of gonadal development of carpet shell clam (*Tapes decussatus*, Linnaeus 1758) in inside and outside of Çakalburnu Lagoon, Izmir Bay. Turkish journal of fisheries and aquatic sciences, 10, 395–401.
20. Sugiyono. 2012. Memahami penelitihan kualitatif. Alfabeta, Bandung.
21. Yan, L., Schone B.R., Li, S., Yan, Y. 2014. Shells of *Paphia undulata* (Bivalvia) from the South China Sea as potential proxy archives of the East Asian summer monsoon – a sclerochronological calibration study. Journal of Oceanography, 70, 35–44.