Contribution of Environmental Parameter on Stability Ecosystem of Habitat of Molluscs

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Abstract  This research was carried out from May to September 2013, located around Tallo River estuary, District of Tallo, Municipality of Makassar, Indonesia. The aim of this research was to determine the contribution of environmental parameters on the stability of ecological mollusks, using a quantitative method of sampling with a Principal Component Analysis Approach (PCA). The results of this research are expected to provide an overview and information for further research and as consideration for stockholders to ascertain the suitability of ecological habitats for the survival of molluscs.

The abundance and percentage of Molluscs were found in three classes, i.e., 285 ind/m² of Pelecypods or 61%, 95 ind/m² 95 of gastropods or 20%, 90 ind/m² of Bivalves or 19%. The contributions of environmental parameters as an identifier in management of habitat of mollusc are that salinity is +0.1571 in the range of 20 to 31%. The contribution of the depth is 0.5284 with a value of 1-4 meters. pH value is +0.5834 with a value of 7.7 to 8.2. Dissolved organic matter with a contribution is 0.0083 with a value of 21.98 to 22.74 ppm. Turbidity with a contribution is 0.1730 with a value of 2.8 to 7.25 NTU. The range is an optimal range for the growth and survival of molluscs at the research location.

Keywords Environmental Parameters; Habitat; Molluscs; Indonesia

Introduction

Life of aquatic organisms is strongly influenced by environmental conditions both organisms living in the water column and on the bottom of water. The organisms that live in the water column are called pelagic organisms being able to move freely, while organisms that live on the bottom of water are called benthic organisms, where they are always associated in the water either temporary or permanent. If condition of water has optimal stability in supporting the survival of the organisms, it is found the existence of various types of organisms in the water that reproduce perfectly and do every aspect of life such as behavior, role of ecology, and pattern of distribution will last well.

Benthic organisms are all kinds of the organisms living and associated with sediments on the bottom of waters, including basic plants (benthic plants) also called as fitobentos and basic animals (benthic animals) are called as zoobentos (Hutabarat and Evans, 1984).

One of the benthic animals is molluscs or soft animals that generally have an outer frame or shell composed of several classes. The large species are a part of the marine, freshwater and terrestrial ecosystems. Some of the organisms can be consumed by humans, which are pests, or even very deadly poison predators.

According to Odum (1971), molluscs are benthic organisms that holds a crucial role in the water community, particularly in the processes of mineralization and recycling of organic matter so that they are key components of the food chain. This relationship is based on the food chain of detritus commenced from dead organisms that are then untied by microorganisms. These microorganisms consumed by detritivores. Moreover, the researcher further asserts that macrozoobenthos has a vital role in determining the secondary productivity that can render the availability of food for other organisms and as an indication of the potential suitability of the water quality, especially as an indicator of the pollution.
Tallo River estuary helps to control flood of the northern city of Makassar, and waste water emanating from the societies and agriculture on the upstream areas. The drainage will carry sediment and organic materials originating from the local agriculture, the residential area, and the industrial area. The condition occurs all the years. As a result, it can lead to the changes of the water quality greatly affecting the conditions of the habitat of mollusc. Based on the above description, it is necessary to conduct a research to look at the contribution of the environmental parameters on the management of the mollusk habitat in Tallo River estuary.

Research methodology
This research was conducted in May until September 2011. The selected location was Tallo River estuary, District of Tallo, Municipality of Makassar. The analysis of the data was carried out in Marine Ecology Laboratorium, Marine Science Department, Faculty of Marine Science and Fishery, Hasanuddin University. The equipment utilized in the research was as follows: boat, global position system, bottom grab sampler, labeled sample bags, 0.5 mm sieve nets, base maps, writing tools, thermometers, Hand-held refractometers, kite currents, pole scales, and pH meters. Materials used were molluscs, alcohol and identification books.

Observation stations were divided into 20 sampling points. The stations were determined purposively using the GPS with the predetermined coordinates. Each of the stations was placed at a distance of 200 to 300 meters vertical to the sea and horizontal coastline with zigzag models. The mollusc sampling and water quality were conducted on each station that had been determined simultaneously according to the procedures as follows: (1) Molluscs, searching the position of the station or the sampling points using the GPS, lowering the bottom grab sampler until the sample touching the bottom of water, writing the depth record, releasing the weight so that the mouth of the grab sample closed. The grab samples containing sediment-mixed molluscs were pulled slowly until on the surface of the water. Those molluscs were separated from the sediment, and preserved in alcohol, alcohol and then identified in the laboratory. The sampling was done five times repeatedly in each of the stations. Data collected of the supporting variables such as temperature, salinity, pH, brightness, and the content of organic material was done equally with the main variables in each station, while the measurement of the other supporting variables such as the stream was done on stations representing the research area. (2) Analysis of mollusc samples was identified based on the guide book: Colin and Arneson (1995), Dharma (1988), Dharma (1992), Gem (1984), Mapstone (1990), Sabelli (1982).

Sample Analysis:
The abundance of macrozoobenthos was calculated applying an analysis proposed by Odum (1971) with the following equation:

\[ K = \frac{10000}{n \times a} \times X_i \]

Where: \( K \) = the abundance of the organisms (macrozoobenthos), \( \Sigma X_i \) = Individual Total in 5 subplots (tail), \( n \) = number of recurrence of subplots (5 times); and \( A \) = width of the subplots / width of mouth of Grab Sampler (20 x 20 = 400 cm2);

Diversity index (\( H' \)) is calculated using Shannon-Wiener diversity index (Odum, 1971):

\[ H' = -\sum \frac{n_i}{N} \ln \frac{n_i}{N} \]

With: \( H' \) = diversity index, \( n_i \) = the number of individuals of species, and \( N \) = the total number of individuals of all species; diversity index was calculated by the formula (Odum, 1971):

\[ E = \sum \frac{H'^2}{\ln s} \]

With: \( E \) = Equitability Index; \( H' \) = diversity index, \( s \) = Total number of types of organisms. Dominance index (\( D \)) was calculated using the formula (Magurran, 1988) as cited in Suryadi (2004)

\[ D = 1 - C \Rightarrow C = \sum_{n=1}^{s} \left( \frac{n_i}{N} \right)^2 \]

With: \( D \) = Simpson’s dominance index, \( N_i \) = number of individuals of species, \( N \) = number of individuals of all species, \( s \) = number of types of species

Data Analysis:
To determine the contribution of environmental parameters as an identifier of the management of the mollusc’ habitat was used the method of Principal Component Analysis (Begen, 2000).
Results and Discussion

The abundance of molluscs

Molluscs that are found comprise Phylum Molluscs are divided into three classes, i.e., Bivalvia, Gastropoda, and Pelecypod, which consist of 13 genera and 14 species and 52 individuals. The class bivalvia consists of four genera and five dominant species such as *Anomalodiscus squamosus*, *Donax vettatus*, and *Timoclea fabula*. The class gastropod consists of six genera; the six dominant species are such as *Clupeomorus coralium*, *Nassarius pollus*, *Telebraria palusris* and *Anadara Granosa*. The pelecypod consists of three genera and three species in which the three dominant species are such as *Hiatula clinrisis* and *Tellina timorsni*. The compositions of molluscs found during the research in Tallo River estuary are shown in the following Table 1 and Figure 1.

Table 1 Classification of the types of molluscs found in Tallo River estuary

| Phylum  | Class   | Genus   | Species                  | Total | Abundance (Ind/m²) |
|---------|---------|---------|--------------------------|-------|--------------------|
| Mollusc | Bivalvia| Anomalodiscus| *Anomalodiscus squamosus* | 13    | 65                 |
|         |         | Arca    | *Arcapectunculoides*     | 1     | 5                  |
|         |         | Donax   | *Donax vettatus*         | 2     | 10                 |
|         |         | Timoclea| *Timoclea ovata*         | 1     | 5                  |
|         |         |         | *T. fabula*              | 1     | 5                  |
|         | Gastropod| Anadara| *Anadara granosa*        | 2     | 10                 |
|         |         | Aneatome| *Aneatome helena*        | 1     | 5                  |
|         |         | Clypeomorus| *Clupeomorus coralium* | 5     | 25                 |
|         |         | Nassarius| *Nassarius pollus*     | 5     | 25                 |
|         |         | Strombus| *Strombus ureus ureus*  | 1     | 5                  |
|         |         | Telebraria| *Telebraria palusris* | 5     | 25                 |
|         | Pelecypod| Anadara| *Anadara antiquata*     | 1     | 5                  |
|         |         | Hiatula  | *Hiatula clinensis*      | 52    | 260                |
|         |         | Tellina  | *Tellina timorensis*    | 4     | 20                 |
|         | Total   |         |                          | 94    | 470                |

Figure 1 The physical shape of the molluscs found in Tallo River estuaries
The abundance indicates that the Phylum Mollusc from the class pelecypod shows that the value of the abundance is 285 ind/m² or 61%, 95 ind/m² of gastropods or 20%, 90 ind/m² of bivalves or 19% (Table 2 and Figure 2). Organisms found during the research show that Palaeocyod is the highest abundance due to Tallo River estuaries containing high organic materials. In addition, the other environmental parameters also support the existence of several species of macrozoobenthos. This case is in consonance with White’s opinion (1984) that some of the Phylum Molluscs like the water containing the high organic materials due to being stored large food. Furthermore, the researcher also states that the organic matters are commonly produced by the activity of agricultural societies and of settlements.

Table 2 Data of the results of organism observations and environmental parameters

| Station | Bivalvia (ind/m²) | Gastropoda (ind/m²) | Pelecypoda (ind/m²) | Temp (°C) | Sal (%sal) | pH | BOT | NTU | Depth (m) | Stream (m/det) |
|---------|------------------|---------------------|---------------------|-----------|-----------|-----|-----|-----|-----------|----------------|
| ST1     | 0                | 0                   | 53                  | 30        | 20        | 7.9 | 36.45 | 6.56 | 3.5       | 0.125          |
| ST2     | 0                | 7                   | 0                   | 30        | 29.5      | 8.2 | 32   | 6.56 | 1.1       | 0.142          |
| ST3     | 0                | 2                   | 1                   | 30        | 31        | 8.2 | 32   | 6.56 | 1.2       | 0.2            |
| ST4     | 0                | 1                   | 1                   | 30        | 30        | 7.8 | 36.59 | 7.25 | 1.6       | 0.5            |
| ST5     | 0                | 1                   | 0                   | 29        | 30        | 7.8 | 36.59 | 7.25 | 1.75      | 0.5            |
| ST6     | 0                | 0                   | 0                   | 31        | 27        | 7.8 | 36.59 | 7.25 | 1.5       | 0.1            |
| ST7     | 2                | 0                   | 0                   | 31        | 29        | 7.8 | 36.59 | 5.21 | 2.6       | 0.086          |
| ST8     | 0                | 0                   | 1                   | 30.5      | 30        | 7.8 | 36.59 | 5.21 | 3         | 0.416          |
| ST9     | 0                | 0                   | 1                   | 30.5      | 29.5      | 7.9 | 35.13 | 4.4  | 3.1       | 0.086          |
| ST10    | 0                | 0                   | 0                   | 31        | 30        | 7.9 | 35.13 | 4.4  | 3.2       | 0.111          |
| ST11    | 0                | 0                   | 0                   | 31        | 27        | 7.9 | 52.74 | 4.4  | 4.2       | 0.166          |
| ST12    | 0                | 0                   | 0                   | 30        | 21        | 7.9 | 52.74 | 4.4  | 4.4       | 0.217          |
| ST13    | 1                | 3                   | 0                   | 29.5      | 21        | 7.9 | 52.74 | 4.4  | 4.4       | 0.17           |
| ST14    | 0                | 1                   | 0                   | 30        | 30        | 7.9 | 46.73 | 4.4  | 1.6       | 0.111          |
| ST15    | 0                | 2                   | 0                   | 30        | 30        | 8.1 | 48.12 | 5.88 | 1.6       | 0.2            |
| ST16    | 2                | 1                   | 0                   | 29.5      | 30        | 8   | 48.12 | 5.88 | 1.7       | 0.2            |
| ST17    | 0                | 0                   | 0                   | 30        | 25        | 8   | 48.12 | 5.88 | 1.2       | 0.227          |
| ST18    | 0                | 0                   | 0                   | 30        | 27        | 8   | 21.98 | 5.88 | 2.1       | 0.25           |
| ST19    | 1                | 0                   | 0                   | 30        | 30.5      | 7.7 | 21.98 | 5.88 | 3.1       | 0.125          |
| ST20    | 12               | 1                   | 0                   | 29.5      | 30        | 7.7 | 31.2  | 2.81 | 4.1       | 0.156          |

Figure 2 The Abundance of molluscs in each different class

When linked to the abundance of macrozoobenthos in Tallo River estuaries and observation stations, the research indicates that *Hiatula clirinsis* of the class pelecypod is the highest abundance. It is found abundantly at stations 1, 3, 4, 9, and 10. *Perineries brevis* of the class polychaeta is a class that has the second highest abundance found at stations 1, 3, 4, 5, 6, 7, 8, 11, 15, 16, and 17. *Chyocomorua coralium, Nassarius pollus,* and *Telebraria sp* of the class gastropod have the third highest abundance found more at station 2, 3, 4, 5, 13, 14, 15, 16, and 20. *Anomalodiscus squamosus* and *Donax ventatus* of the bivalvia have the less abundance, and they are found at station 7, 13, 16, and 19. The fact indicates that macrozoobenthos found during the research in Tallo River estuary has uneven spreading. Similarly, pelecypod, which has the highest abundance, is only found at a specific station and dominated at station 1, while polychaeta and gastropoda are found more diffusely at some stations. It can be categorized there is a tendency for the molluscs to dominate a particular station in Tallo River estuary due to the effects of environmental degradation as the result of industrial
waste, household and agriculture in the upstream. Nevertheless, the effect has not shown a real change on the distribution of the molluscs; they are only found at one station that has a very high abundance of pelecypoda, where the location of the station is in the mouth of the river. Hence, it is assumed that the area occurs accumulation of the very high pollutants characterized by high rate of some environmental parameter values such as multiple BOT with a range from 21.98 to 52.78, low brightness with a range from 12.78% to 22.17%, the high turbidity with a range from 2.81 NTU to 7.25 NTU. However, some of the other environmental parameters are still under optimal conditions such as temperature with a range of 29.5 °C to 31 °C, salinity with a range from 20 ‰ to 31 ‰, pH with a range from 7.7 to 8.2, and oceanographic parameters (Table 2).

The management of the habitat molluscs
Principal Component Analysis (PCA) of the three classes of molluscs and seven environmental parameters having an impact on the habitat of the molluscs diffuses in 20 stations. It points out that the factorial axis is on four sides of the two factorial axes, i.e., axis 1 and 2 (F1, F2), where each axis describes the probative value based on the level of percentage, the axis F1 illustrates the probative value of 37% and the axis F2 explains 28% of the probative value of the total variance. Thus, the total percentage of the probative value is 65% (Figure 2). Principal Component Analysis chart shows that the three groups of molluscs based on each class are characterized by the different environmental parameters.

Bivalves are characterized with a contribution of +0.1571, which mean the habitat conditions for Bivalves’ growth are very limited by salinity fluctuations on the habitat. The range of the salinity in the location of the observations is approximately 29-31 ‰. The range is a decent range for the growth and survival of molluscs. In addition, the environmental parameter, an identifier of molluscs’ survival, is the depth with contribution value is +0.5284 with a range of 1.7 to 4.1 m. The other environmental parameters such as temperature, pH, BOT, turbidity, and stream show the contribution with negative correlation in the range of -0.1460 to -0.5357. The gastropods are characterized by a contribution of +0.1084, which mean the habitat conditions of gastropods’ growth are very restricted by salinity fluctuations of the habitat. The range of the salinity in the location of observations is approximately 29.5 to 30 o/oo. The gastropods are also individualized by pH with a contribution of +0.5834, which signify that the habitat conditions of the gastropods’ growth ranged from 7.7 to 8.2. The organisms are also identified by dissolved organic materials in the high contribution of +0.0083 with a range of 31.2 to 52.1. Furthermore, the environmental parameters that become the identifier are turbidity with a contribution of +0.1730. In other words, Gastropods’ life are limited in the turbidity ranged of 2.81 to 7.25 NTU. The range is a proper range for the growth and survival of molluscs, while the other environmental parameters such as the temperature, pH, and stream show a contribution with negative correlation in range of -0.0128 to 0.3313. Pelecypods are characterized by turbidity of 4.4 to 7.25 NTU with a contribution of +0.2069. It denotes that the habitat conditions for the growth of Pelecypods are limited by fluctuations of the turbidity. Moreover, the depth gives a contributes of +0.3627 or of 1.2 to 3.5 meters, which mean the habitat conditions for the growth of Pelecypods is a decent range for the growth and survival of mollusks. The other environmental parameters such as temperature, pH, and stream indicate that the contribution of the negative correlation is in the range of -0.0148 to -0.5271 (Table 3 and Figure 3).

Table 3 Results of the principal component analysis on the correlation matrix and the contribution of environmental parameters on the habitat of the molluscs

| Environmental parameters | Bivalvia   | Gastropoda | Pelecypoda |
|--------------------------|-----------|------------|------------|
| temperature              | -0.2709   | -0.3313    | -0.0488    |
| Salinity                 | +0.1571   | +0.1084    | -0.5271    |
| pH                       | -0.3852   | +0.5834    | -0.0148    |
| BOT                      | -0.1700   | +0.0083    | -0.0690    |
| NTU                      | -0.5357   | +0.1730    | +0.2069    |
| depth                    | +0.5284   | -0.3811    | +0.3627    |
| Stream                   | -0.1460   | -0.0128    | -0.1389    |
Figure 3 Circle of correlation showing the identifiers contributions of environmental parameters on the habitat of the molluscs

**Conclusion**

The environmental parameters such as pH, BOT, turbidity, and depth render real contributions as the identifiers of the management of the molluscs’ habitat.

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