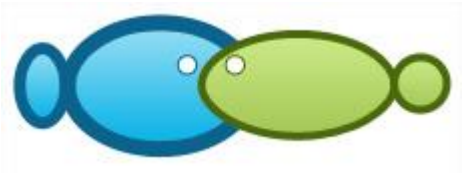

Diversity index, similarity index and dominance index of macrozoobenthos in Pangkajene River estuary, Pangkep Regency, Indonesia

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Abstract. The macrozoobenthos community serves as one of the indicators of the balance of aquatic quality in terms of its biological aspects. In the present study, the diversity index, similarity index and dominance index of macrozoobenthos in the estuary of Pangkajene River, Tekolabbua Village, Pangkajene District, Pangkep Regency, Indonesia, were determined. This study took on a survey research using samples from 5 stations with 3 substations each. Each station was sampled 4 times. Samples were collected from each sampling station and stored in sample containers. Based on the sampling results of macrozoobenthos, 5 different species of macrozoobenthos from 5 different genera were identified, i.e., *Balanus* sp., *Tereblaria* sp., *Pagurus* sp., *Tellina* sp., and *Nereis* sp. Results showed that: (1) the diversity index (H') at each sampling station was 1.011, indicating a moderate level of diversity; (2) the evenness or similarity index (E) ranged between 0.002 and 0.023, with an average of 0.01 at each sampling station, indicating a suppressed criterion; and (3) the dominance index ranged from 0.275to0.516with an average of 0.399, indicating a moderate index. The results showed a good condition of Pangkajene River in terms of its biological parameters.
Key Words: biological parameter, community structure, water quality.

Introduction. The estuary ecosystem is one of the ecosystems created by the Pangkajene River in Pangkajene City (Pangkajene Regency), Pangkep Island, Indonesia. The river expands through residential areas, ponds, agricultural land and traditional markets. Pangkajene River also serves as a key transportation link between islands using boats. The operation of transportation and the activities surrounding the river can lead to a strong potential of pollution due to waste discharge. The waste may include agricultural waste, domestic waste, pond waste, oil waste from boats and others. Waste that enters the body of water will cause the alteration of physical, chemical and biological properties of the water (Dauer 1993; Dauer et al 2000; Cleary et al 2005). Water quality is of utmost concern in biology landscapes and, hence, has been a common topic of interest in various studies in a number of locations (Brown et al 2000; Oktarina & Syamsudin 2015; Alfin 2014).

Measuring the abundance index, similarity or evenness index and diversity index of plankton, benthos (which consists of phytobenthos and zoobenthos) and nekton can be used to assess the quality of aquatic environments (Pearson & Rosenberg 1978). Macrozoobenthos will relatively remain in one area throughout its life and is, therefore, frequently used as a bioindicator for monitoring water quality (Tarwotjo et al 2018). The occurrence of pollution at the water floor, most notably in mud substrates, can ultimately alter the structure of benthic communities in the water (Yuniarti et al 2018).

The present work aims to determine the diversity index, similarity or evenness index and dominance index of macrozoobenthos in the estuary of Pangkajene River situated in Pangkajene Regency, Indonesia.

Material and Method. The study took place from May to July 2018. Sampling was located in the estuary of Pangkajene River situated in Tekolabbua Village, Pangkajene District, Pangkep Regency. Samples from each station were composited for identification. Following the identification, each sample collection required 5 sample containers, totaling 25 sample containers. Station 1 was situated in the middle of the estuary, extending 200 m from the shore. Station 2 was situated near mangroves, which are flooded during high tide and dry at the lowest tide. Station 3 was located at the estuary mouth. Station 4 was placed about 300 m from the estuary on the side of the river. Station 5 was located on the side of the river stretching for 100 m from the estuary.

Samples were delivered to the Water Quality Laboratory of Hasanuddin University for identification. The major variables of the study were macrozoobenthos and the number of individuals of each species found in the research site. The supporting variables were physico-chemical properties of the water, such as depth, temperature, brightness, type of substrate, and acidity.

The equipment used in the study included an Ekman dredge, microscope, soil tester, Secchi disk, stick thermometer, scale stick, 1-centimeter accuracy, plastic tray, mesh filter with a diameter of 0,55 cm, sample containers, micro wrinkler kit, magnifier, boat, and a 5 L bucket. 4% formalin and aquades were also used.

Determination of stations and sample collecting. Sample collection was conducted at 5 stations with 3 sub-stations each. The sample collection was repeated 4 times. Sampling stations were designated during the survey of the research sites. The stations each represented the condition of the estuary of Pangkajene River in Pangkep Regency. The sample collection was carried out as detailed below.

Samples were collected from each sub-station using an Ekman dredge that covered a sample area of 232 cm^2 and were placed in a container with river water. The soil was diluted and then filtered using a 0.5 mm mesh filter. After careful filtering, the materials and benthic species were manually separated. The filtered benthos was placed into 10 L containers and preserved using 20% alcohol. The samples were transported for identification at the Water Quality Laboratory of the Faculty of Maritime Affairs and Fisheries, Hasanuddin University, Makassar. The concentrations of dissolved oxygen and CO_2 were determined *in situ*, using the Wrinkler method that involved filling 10 L containers with river water and 60 mL of samples (Royce 1996). The measurement of pH, depth and temperature was also subject to *in situ* approach. The pH measurement involved a digital pH meter within a range between 1 and 14. Depth was determined from measurements with a Secchi disk, and temperature was measured using a rod or dip thermometer.

Data analysis. Macrozoobenthos identification was observed using standard macrozoobenthos identification methods (Campbell 1976; Dharma 1988; Dharma 1993). The diversity index was calculated using the following equation (Odum 1971):

$$H' = -\sum \left(\frac{ni}{N}\right) log \left(\frac{ni}{N}\right)$$

Where: H' - diversity index; ni - the number of individuals of each species; N - the total number of individuals. The determination of species diversity takes into classification the following criteria. If H'>3, the species diversity is extremely high. If H' is between 1.6 and 3, the species diversity is high. If H' is between 1 and 1.5, the species diversity is moderate. If H'<1, the species diversity is low.

The similarity index fits into the equation of the evenness index (E) (Odum 1971):

$$E = \frac{H'}{\log s}$$

Where: E - evenness index; H' - diversity index; Log s - the number of species in the zone defined by E that ranged from 0 to 1.

The dominance index of benthic species was formulated in the following equation (Odum 1971):

$$C = \Sigma\left(\frac{ni}{N}\right)^2$$

Where: ni- the number of individuals of each species; N - the total number of individuals.

Results and Discussion. The results of macrozoobenthos species identification is presented in Table 1.

Table 1

Benthic types, abundance, similarity index, diversity index, and dominance index of macrozoobenthos in the estuary of Pangkajene River, Pangkep Regency, Indonesia

Organism		*Samplecode*									
		Identification					*Abundance (ind m^{-2})*				
Genus	Species	1	2	3	4	5	1	2	3	4	5
Balanus	*Balanus* sp.	4	3	0	3	0	178	133	0	133	0
Terebralia	*Terebralia* sp.	11	8	1	2	2	489	356	44	89	89
Pagurus	*Pagurus* sp.	3	1	0	2	1	133	44	0	89	44
Tellina	*Tellina* sp.	0	2	1	1	0	0	89	44	44	0
Nereis	*Nereis* sp.	0	0	2	0	0	0	0	89	0	0
Total (N)							801	624	181	359	138
Diversity index (H')							0.933	1.116	1.038	1.317	0.649
Similarity or evenness index (E)							0.001	0.003	0.023	0.014	0.007
Dominance index (D)							0.449	0.395	0.362	0.275	0.516

The results of sample identification showed 5 species of macrozoobenthos from 5 different genera. *Balanus* sp. of *Balanus* genus was found at Station 1, Station 2 and Station 4. *Tereblaria* sp. of *Tereblaria* genus was found at Station 1, Station 2, Station 3, Station 4 and Station 5. *Pagurus* sp. of *Pagarus* genus was found at Station 1, Station 2, Station 4 and Station 5 (excluding Station 3). *Tellina* sp. of *Tellina* genus was found at Station 2, Station 3 and Station 4, and *Nereis* sp. of *Nereis* genus at Station 3.

The number of individuals at Station 1 was the highest of all stations (801 individuals). Station 2 comes second with 624 individuals, followed by Station 4 with 359 individuals, Station 3 with 180 individuals and Station 5 with 138 individuals.

In terms of abundance, *Tereblaria* sp. peaked with 489 ind m^{-2} in Station 1 and 356 ind m^{-2} in Station 2. The lowest abundance value was 44 ind m^{-2} for the following species: *Tereblaria* sp. in Station 3, *Pagurus* sp. in Stations 2 and 5, *Tellina* sp. in Stations 3 and 4.

The highest diversity index (H') was observed in Station 4 with 1.317, followed by Station 2 with 1.116, Station 3 with 1.039, Station 1 with 0.394 and Station 5 with 0.649. The highest similarity or evenness index (E) was 0.023 in Station 3, 0.015 in Station 4, 0.007 in Station 5, 0.003 in Station 2 and 0.002 in Station 1. As for the dominance index, Station 5 had the highest value (0.516), followed by Station 1 (0.449), Station 2 (0.395), Station 3 (0.363), and Station 4 (0.275).

The environmental parameters included depth, ranging between 0 and 110 cm, temperature between 27°C and 31°C, brightness between 25 cm and 35 cm, acidity (pH) between 6.3 and 7.8, and sandy-clay substrates.

The diversity indexes at Stations 4, 2 and 1 were moderate, while those at Stations 3 and 5 were low. The average diversity index of all stations was 1.011, which is moderate. The observed average was lower than the average diversity index of Arang-Arang Lake and Kumpeh River, which ranged between 1 and 1.5 (Asra 2009). It was lower than the diversity index from the coastal area of Panggung Village, Kedung District, Jepara Regency, which ranged between 1.47 and 1.52 (Izzah & Roziaty 2016). The average of the diversity index in this study was also lower than that of Lubuk Kertang Mangrove in

North Sumatera Utara (2.39) (Basyuni et al 2018), Situ Pamulang (1.48), and Suhuyon river (2.45) (Nangin et al 2015).

Based on the criteria adopted by Rappe (2010), all stations were in suppressed condition given the range of the evenness index (E), between 0.002 and 0.023, with an average range of 0.01.

In terms of dominance indexes, according to Rappe (2010), Station 5 had moderate dominance, with the remaining stations demonstrating low dominance. The average dominance index of all stations was 0.399. This average was moderately lower than that of Lubuk Kertang mangrove forest (0.54) (Basyuni et al 2018). The diversity index, similarity or evenness index and dominance index of macrozoobenthos in the water are attributed to a large number of factors, including substrate, season, salinity and sampling method (Boesch et al 1976; Barros et al 2008; Pinto et al 2009; Basyuni et al 2018).

Conclusions. The diversity index of all stations observed in the estuary of Pangkajene River, Tekolabbuan Village, Pangkep Regency, Indonesia, was 1.011 in average, indicating a moderate diversity category. The similarity or evenness index ranged between 0.002 and 0.023, with an average of 0.01, indicating a suppressed criterion. The dominance index of all stations was moderate, ranging from 0.275 to 0.516, with an average of 0.399.

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References

Alfin E., 2014 [Macrozoobenthos abundance in the Pamulang Lake waters]. Alkauniah Biology Journal 1(2):69-73. [In Indonesian].

Asra, 2009 [Macrozoobenthos as biological indicators of water quality in the Kumpeh River and Lake Arang-Arang in Muaro Jambi district, Jambi]. Biospecies 2(1):23-25. [In Indonesian].

Barros F., Hatje V., Figueiredo M. B., Magalhaes W. F., Dorea H. S., Emídio E. S., 2008 The structure of the benthic macrofaunal assemblages and sediments characteristics of the Paraguaçu estuarine system, NE, Brazil. Estuarine, Coastal and Shelf Science 78(4):753-762.

Basyuni M., Gultom K., Fitri A., Susetya I. E., Wati R., Slamet B., Sulistiyono N., Yusriani E., Balke T., Bunting P., 2018 Diversity and habitat characteristics of macrozoobenthos in the mangrove forest of Lubuk Kertang Village, North Sumatra. Biodiversitas 19(1):311-317.

Boesch D. F., Wass M. L., Virnstein R. W., 1976 The dynamics of estuarine benthic communities. Estuarine Processes, Uses Stresses, and Adaptation to the Estuary 1976:177-196.

Brown S. S., Gaston G. R., Rakocinski C. F., Heard R. W., 2000 Effects of sediment contaminants and environmental gradients on macrobenthic community trophic structure in Gulf of Mexico estuaries. Estuaries 23(3):411-424.

Campbell A. C., 1976 The Hamlyn guide to the seashore and shallow seas of Britain and Europe. Hamlyn, 320 p.

Cleary D. F. R., Becking L. E., de Voogd N. J., Renema W., de Beer M., van Soest R. W. M., Hoeksema B. W., 2005 Variation in the diversity and composition of benthic taxa as a function of distance offshore, depth and exposure in the Spermonde Archipelago, Indonesia. Estuarine, Coastal and Shelf Science 65(3):557-570.

Dauer D. M., 1993 Biological criteria, environmental health and estuarine macrobenthic community structure. Marine Pollution Bulletin 26(5):249-257.

Dauer D. M., Ranasinghe J. A., Weisberg S. B., 2000 Relationships between benthic community condition, water quality, sediment quality, nutrient loads, and land use patterns in Chesapeake Bay. Estuaries 23(1):80-96.

Dharma B., 1988 [Indonesian shells. Volume 1]. PT Sarana Graha, Jakarta, 111 p. [In Indonesian].
Dharma B., 1993 [Indonesian shells. Volume 2]. PT Sarana Graha, Jakarta, 135 p. [In Indonesian].
Izzah N. A., Roziaty E., 2016 [Macrozoobentos diversity on the coast of Panggung village Kedung District, Jepara Regency]. Bioeksperimen 2(2):140-147. [In Indonesian].
Nangin S. R., Langoy M. L., Katili D. Y., 2015 [Macrozoobenthos as a biological indicator in determining the North Sulawesi Sahuyon River water quality]. Jurnal MIPA 4:165-168. [In Indonesian].
Odum E. P., 1971 Fundamentals of ecology (3rd Edition). WB Soundress Co., 574 p.
Oktarina A., Syamsudin T. S., 2015 [Diversity and distribution of macrozoobenthos in the lotic and tapic waters of the Bandung Institute of Technology Campus Area, Jatinangor Sumedang, West Java]. Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia 1(2):227-235. [In Indonesian].
Pearson T. H., Rosenberg R., 1978 Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology: An Annual Review 16:229-311.
Pinto R., Patrício J., Baeta A., Fath B. D., Neto J. M., Marques J. C., 2009 Review and evaluation of estuarine biotic indices to assess benthic condition. Ecological indicators *9*(1):1-25.
Rappe R. A., 2010 [Fish community structures on different seagrass fields in Barang Lompo Island]. Jurnal Ilmu dan Teknologi Kelautan Tropis 2(2):62-73. [In Indonesian].
Royce W. F., 1996 Introduction to the practice of fishery science, revised edition. Academic Press, San Diego, 448 p.
Setyono H., 1996 [Oceanographic dictionary]. UGM Press, Yogyakarta, 211 p. [In Indonesian].
Tarwotjo U., Rahadian R., Hadi M., 2018 Community structure of macrozoobenthos as bioindicator of Pepe river quality, Mojosongo, Boyolali. Journal of Physics: Conference Series 1025:012039, 8 p.
Yuniarti, Ihsan Y. N., Asdak C., Dhahiyat Y., Kamarudin M. K. A., Gasim M. B., Ireana Yusra A. F., Juahir H., 2018 Impact sedimentation to community structure makrozoobenthos in Sagara Anakan Lagoon. Journal of Fundamental and Applied Sciences 10(1S):565-579.

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