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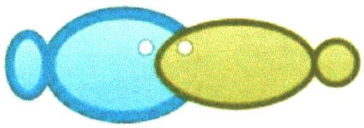

Bio-physicochemical analysis of mangrove area of Kayeli Bay, Buru Regency, Maluku Province, Indonesia for the development of mud crab *Scylla* sp. culture with silvofishery system

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Abstract. Silvofishery is an integrated type of aquaculture between mangrove plant culture and brackish-water pond. This study was aimed to assess several factors such us Important Value Index of mangrove, macrozoobenthos abundance and biophysical-chemistry of water quality for the development of mud crab culture with silvofishery pattern in Kayeli Bay, Buru Regency, Maluku Province, Indonesia. This study was conducted through direct observation of mangrove area by applying survey method using transects of 10x10 m and 5x5 m for the mother tree and seedling of mangrove, respectively, and 1x1 m for macrozoobenthos. Measurements of water biophysical-chemistry was performed directly (in situ) and through laboratory analysis. Result of the present study showed that five types of mangrove were found to grow in mangrove area of Kayeli Bay, namely *Rhizophora* sp., *Avicennia* sp., *Sonneratia* sp., *Bruguiera* sp. and *Ceriops* sp. Importance Value Index of mangrove ranged from 45.36 to 136.7 and was dominated by the type of *Rhizophora* sp., while macrozoobenthos abundance in mangrove area ranged between 4 and 64 ind/m^2. Parameter of water biophysical-chemistry in Kayeli Bay was in the optimum range for the development of mud crab culture with silvofishery pattern.

Key Words: coastal, fishery development, integrated farming, water quality, important value index.

Introduction. Mangrove is one of the coastal ecosystems (Sambu et al 2014). Mangrove has high productivity in the ecosystem with diversity of flora and fauna in intertidal zone on the shoreline in tropical and subtropical region (Awn et al 2016). Mangrove ecosystem has been known to have important role in preserving water ecosystem. They are theoretically have great ecological importance in shoreline stabilization, coastal erosion prevention, sediment retention, alleviation, nutrient retention, storm protection, and serve as bio-filter, besides their economic benefit through diverse forest products (Awn et al 2016). Area of mangrove forest shows positive correlation with annual catch from adjacent offshore fishing grounds in Philippines (Bagarinao 1998).

In many cases, intensive aquaculture is not environmentally friendly (Karim et al 2016), thus causing ecosystem degradation including in mangrove ecosystems. If we would like to obtain benefits from mangroves, both economically and environmentally proper management is required. Implementation of a system which is able to ensure commercial interest and environmental sustainability such as aquaculture with silvofishery system is just one example.

Several species with high economic value which is possible to be cultured in mangrove area with silvofishery system, one of them is the mud crab (*Scylla* sp.). Mud crab lives in mangrove forest area (David 2009) and is one of the commercial commodities in Indonesia (Yusuf et al 2016; Tahya 2016; Tahya et al 2016; Karim et al 2017). Mud crab is highly demanded both in domestic and international market for its tasty and high nutritious meat (Millamena & Quinito 2000; Catacutan 2002).

In term of concerning sustainable management of mangrove area in Kayeli Bay, concrete and constructive steps are necessary. It is required as one of the appropriate steps to preserve the sustainability of mangrove which ecologically plays role in maintaining coastal habitat and ensuring fishery products with important economic value, particularly mud crab. To obtain the description about the development of mud crab culture technology with silvofishery pattern in Kayeli Bay, Buru Regency, a study about this issue is needed.

Material and Method

Location. This study was conducted in mangrove area of Kayeli Bay, Buru Regency, Maluku Province, from August 2017 to January 2018.

Research design. This research was performed by observing the importance value index of mangrove vegetation, macrozoobenthos abundance, and water quality parameters in four locations, namely, Siahoni, Sanleko, Kayeli, and Masarete villages.

Importance value index of mangrove. Observation on mangrove vegetation was done by performing direct survey in four research locations. The result obtained was further processed to determine the importance value index following the equation:

$$IVI = RDi+RFi+Rci$$

Where:
IVI = Importance Value Index
RDi = Individual Relative Density (per unit of area)
RFi = Relative Frequency of species
RCi = Individual relative cover of species
The IVI is defined as a description on the effect or role of a mangrove species in mangrove community.

Macrozoobenthos abundance. Observation of macrozoobenthos abundance was performed through transect method covering 1 x 1 m in four observation areas (villages). Each area consisted of three stations and each station consisted of three sub-stations.

Water quality. Measurement was carried out in the Laboratory of Water Quality, Faculty of Marine Science and Fisheries, University of Hasanuddin Makassar, South Sulawesi. Measurements were performed twice a day, at 6:00 AM and 6:00 PM, concerning salinity, CO_2, pH, DO, temperature, and turbidity. Biological oxygen demand (BOD), ammonia, nitrate, nitrite, phosphate, TSS were measured at the end of the study. Current and tidal were measured daily.

Results

Importance value index of mangrove (IVI). There were five species of mangrove found in Kayeli Bay, namely *Rhizophora* sp., *Avicennia* sp., *Sonneratia* sp., *Bruguiera* sp. and *Ceriops* sp. (Table 1).

Based on the observation result, the species *Rhizopora* sp. was found to dominate Kayeli Bay for its distribution in all research locations. Mangrove forest at four research locations was dominated by *Rhizophora* sp. The IVI value of *Rhizophora* sp. in Siahoni area was 112.41%, slightly lower than *Ceriops* sp. which reached 112.77%, while *Bruguiera* sp. obtained a value of 64.78%. At Sanleko area was grown four types of mangrove which was dominated by *Rhizophora* sp. with INP value of 101.94%, followed by *Bruguiera* sp. of 77.69%, *Avicennia* sp. of 68.99%, and *Sonneratia* sp. of 49.16% in the last position. Similar to Sanleko area, Kayeli area was also grown by four types of mangrove dominated by *Rhizophora* sp. of 136.7%, followed by *Bruguiera* sp. of 78.37%, *Avicennia* sp. of 45.36% and *Sonneratia* sp. of 39.54%. Moreover, there were only three

types of mangrove found in Masarete area which was also dominated by *Rhizophora* sp. of 94.34%, followed by *Avicennia* sp. of 71.05% and *Sonneratia* sp. of 59.59%. The value obtained showed that mangrove *Rhizophora* sp. has an importance in terms of ecological position in mangrove area of Kayeli Bay. Domination of *Rhizophora* sp. species in all observation locations is expected due to its ability to adapt to the environment and the growth rate of this plant which is relatively faster than of other species (Sambu et al 2014).

Table 1

Result of the importance value index of mangrove vegetation

Location	*Results*				
	Mangroves	*RDi*	*RFi*	*RCi*	*IVI (%)*
Siahoni	*Rhizophora* sp.	44.65	33.33	34.43	112.41
	Avicennia sp.	0	0	0	0
	Sonneratia sp.	0	0	0	0
	Bruguiera sp.	4.25	33.33	27.20	64.78
	Ceriops sp.	51.08	33.33	38.36	112.77
Sanleko	*Rhizophora* sp.	56.66	25	20.28	101.94
	Avicennia sp.	20.47	25	23.52	68.99
	Sonneratia sp.	6.90	25	17.26	49.16
	Bruguiera sp.	13.80	25	38.89	77.6
	Ceriops sp.	0	0	0	0
Kayeli	*Rhizophora* sp.	80.12	25	31.58	136.7
	Avicennia sp.	4.63	25	15.73	45.36
	Sonneratia sp.	1.32	25	13.22	39.54
	Bruguiera sp.	13.92	25	39.45	78.37
	Ceriops sp.	0	0	0	0
Masarete	*Rhizophora* sp.	46.87	25	22.47	94.34
	Avicennia sp.	20.48	25	25.57	71.05
	Sonneratia sp.	9.02	25	25.57	59.59
	Bruguiera sp.	0	0	0	0
	Ceriops sp.	0	0	0	0

Source: Primary data processed.

Macrozoobenthos abundance. The observation results showed that three types of macrozoobenthos were found in the research location, namely gastropods, bivalve, and crustaceans (Table 2).

Gastropoda was the dominant (178 individuals) macrozoobenthos at all the four locations, followed by bivalve (43 individuals), and crustaceans (22 individuals) which were found on the surface and inside the substrate of mangrove.

Table 2

Macrozoobenthos abundance

Location	*Macrozoobenthos abundance (ind/m^2)*		
	Gastropod	*Bivalve*	*Crustacea*
Siahoni	64	8	5
Sanleko	59	16	8
Kayeli	20	5	4
Masarete	35	14	5

Source: Primary data processed.

Water quality parameters. Physico-chemical parameters of the water recorded in the research locations are presented in Table 3.

Table 3

Result of the water physico-chemical parameters

Parameter	Location			
	Siahoni	*Sanleko*	*Kayeli*	*Masarete*
Salinity (ppt)	20.16±0.28	20.16±0.28	6.53±0.07	6.83±0.05
Temp. (°C)	30.13±0.05	29.03±0.05	29.7±1.97	28.7±0.97
CO_2 (ppm)	23.60±0.55	23.60±0.55	31.87±0.07	31.87±0.07
pH	6.86±0.05	6.86±0.05	6.46±0.05	6.34±0.05
DO (ppm)	4.59±0.02	4.59±0.01	5.04±0.70	5.24±0.70
BOD (ppm)	0.34±0.29	1.88±0.02	0.58±0.70	0.54±0.70
Ammonia (ppm)	0.04±0.02	0.04±0.02	0.02±0.02	0.02±0.02
Nitrate (ppm)	0.21±0.03	0.11±0.02	0.02±0.01	0.02±0.01
Nitrite (ppm)	0.01±0.03	0.01±0.03	0.002±0.02	0.002±0.01
Phosphate (ppm)	0.28±0.02	0.21±0.02	0.17±0.03	0.16±0.02
Turbidity (NTU)	20.33±0.57	15.33±0.57	0.85±0.01	0.77±0.01
TSS (ppm)	14.50±0.28	0.01±0.028	2.03±69.93	2.01±59.91
Current (m/second)	0.03±0.01	0.02±0.01	0.09±0.03	0.04±0.01
Tides (m)	1.16±0.04	1.20±0.03	1.50±0.03	0.8±0.01

Source: Primary data processed.

Based on the results presented in Table 3, it is found that the range of water quality parameters obtained in theresearch location of Kayeli Bay was as follows: salinity 6.5-20.1 ppt, temperature 28.7–30.1°C, pH 6.3–6.8, and DO 4.5–5.2 ppm.

Concentration of ammonia in the research location was found to have a range of 0.02–0.04 ppm, nitrate concentration a range of 0.02–0.21 ppm, concentration of phosphate of 0.16–0.28. Turbidity level in the research location ranged from 0.7–20.3 NTU. Water turbidity is a reflection of the amount of phytoplankton exists in maintenance media and the amount of suspended solid accumulates in maintenance media. Furthermore, water current in research location was between 0.02–0.09 m/second with tidal height of 0.8–1.5 m.

Discussion. Importance value index ranged from 224.98 to 299.97. Importance value index of mangrove vegetation ranges from 100 to 300 (Sambu et al 2014). Importance value index will be the first step to see the effect or role of plants in mangrove ecosystem (Awn et al 2016). Composition of mangrove vegetation in Kayeli Bay was heterogeneous, yet still in the low level. This resu indicated that mangrove vegetation in Kayeli Bay was in good and healthy condition. One of the indicators which showing that mangrove ecosystem is in healthy condition is the heterogeneous component of plant indicating high biodiversity (Awn et al 2016). Beside the plant indicators, various macrozoobenthos was also found in this mangrove area. Chemical and physical factors in water (Nursidi et al 2017), and macro-micronutrient determined the growth of organism (Aslamyah et al 2016).

Ammonia is a compound of nitrogen waste, the main product in waters produced by aquatic organism (Neil et al 2005). According to Wang et al (2002), ammonia accumulation in body fluid will hamper biosynthesis function of protein in hepatopancreas.

The presence of nitrite in water is a result of ammonia nitrification by *Nitrosomonas* bacteria and nitrate denitrification by *Nitrobacter*. Positive effect occurs particularly for nitrification bacteria since nitrite is used as energy source in aerobic condition, and in anaerobic condition, nitrite is used as acceptor of electron to replace the position of oxygen which does not exist in waters. For aquatic organisms including crabs, nitrite is directly toxic and commonly formed in intensive culture or in polluted waters (Tsai & Chen 2002; Jansen 2003).

The results of water quality also showed good condition despite the salinity in Kayeli and Masarete area which was low, that was in the range of 6 ppt during raining

season. However, in general, the condition of water quality in Kayeli Bay has already met the needs of mud crab.

Conclusions. Study result provides a general description on the condition of mangrove in Kayeli Bay. The importance value index obtained showed that the condition of mangrove ecosystem was still in good and healthy condition. This result was confirmed by the existence of macrozoobenthos in Kayeli Bay. Measurement of water quality parameters indicated that the value was still able to be tolerated for the growth of mud crab, thus it is concluded that mangrove area in Kayeli Bay is highly feasible or appropriate to be developed as mud crab development area with sylvofishery system.

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