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The fish diversity of mangrove waters in Lombok Island, West Nusa Tenggara, Indonesia

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Abstract. *Wahyudewantoro G. 2018. The fish diversity of mangrove waters in Lombok Island, West Nusa Tenggara, Indonesia. Biodiversitas 19: 71-76.* Lombok Island's waters are the main gateway of the mass water flow from the Pacific and Indian Oceans. Therefore, it is suspected the fish species that inhabit them is very diverse. The aim of the research was to reveal the diversity of mangrove fish species, with a case study in West Lombok and Central Lombok. Fishes were caught using cast net with mesh sizes of 1.5 cm and 2.5 cm, gill net with mesh sizes of ¾ inch, 1.5 inch and 2 inches. This research found 38 species belonging to 28 genera and 20 families. *Oryzias javanicus* and *Periopthalmus argentilineatus* were distributed at all research stations.Species diversity index (H) of fish was in the range of 2.618 to 3.072, evenness index (E) 0.803 to 0.950 and species richness index (d) from 4.328 to 6.206. Based on the similarity of fish species that exist in each station, the species of fish in station IV were different from those of other stations.

Keyword: Fish, Lombok, mangrove, *Oryzias javanicus, Periopthalmus argentilineatus*

INTRODUCTION

Mangrove is a unique and complexed ecosystem, because there are associations between flora and fauna closely related to local environmental factors. Mangrove areas can be described as areas or wetland ecosystems which are very productive due to high nutrient productivity, because it obtains energy in the form of food substances brought by tidal sea water, to coastal areas and surrounding estuaries (Mukherjee et al. 2014; Das 2017; Osland et al. 2017). Therefore, in addition to protecting coastal areas and storing carbon, mangroves also support the diversity of flora, marine and coastal fauna (Hwanhlem et al. 2014; Lee et al. 2014). The mangrove ecosystem also serves as a breeding and feeding ground of various species of fish, shrimp, birds, mammals, and reptiles. In the mangrove ecosystem, there are dominant marine animal groups, namely mollusks, crustaceans and fish, and the mangrove trees act as a food chain that accommodate the lives of the tree fauna species (Hutchison et al. 2014; Nanjo et al. 2014b). In addition, mangrove is known to support ecosystem goods and services up to USD 194,000 • ha^{-1} • yr^{-1}, and significantly contributes to 10 to 30 percent of total fisheries worldwide, excluding small islands (Aburto-Oropeza et al. 2008; Costanza et al. 2014; Anneboina and Kumar 2017).

Fish is a potential inhabitant of mangrove ecosystem. In India between 2013 to 2014 marine fish production reached 3,443 thousand tons, and about 29 percent of it was exported abroad, most of which was largely a highly dependent on commercial marine fish species of mangroves (Anneboina and Kumar 2017). Within the mangrove ecosystem there are food chains that either directly or indirectly contribute significantly to the recruitment of adult marine fish, and 80% of commercial fish caught in coastal water around it (Harahab 2009; Camp et al. 2011; Sandilyan and Katherisan 2012).

Lombok is one of several small islands in the series the Great Sunda Islands, and its water becomes the main gate of water mass flow from the Pacific to the Indian Ocean. In Lombok coastal areas there are mangrove, seagrass, coral reefs, and estuaries. Large mangrove forests reach approximately 1340.1 ha, distributed in East Lombok district 1081.80 ha, West Lombok 229.23 ha and Central Lombok 29.07 ha. However, approximately 906.31 ha of it was damaged (Budhiman et al. 2001). Some of the damage was the result of the conversion of mangrove area into ponds and farmland. According to Aburto-Oropeza et al. (2008), the current mangrove decline is largely due to the ever-increasing coastal development, tourism, and aquaculture.

There is a concern that the damage of mangrove can have a negative impact on species diversity of fish and populations of fish species. So far, there has been little information of fish species of mangrove water in Lombok Island. Therefore, this study was conducted to reveal the fish diversity of mangrove in West and Central Lombok, in Lombok Island. The results are expected to be used as reference for the local policy makers to protect fish community.

MATERIALS AND METHODS

Study area

The research was conducted in mangrove waters of Lombok island, West Nusa Tenggara, Indonesia from 8 to 19 April 2013. Fish sampling was done in five stations

Figure 1. Fish sampling stations in Lombok island, West Nusa Tenggara, Indonesia

which covered Cemare Estuary (station I, West Lombok District), Rasu Bay (station II, West Lombok District), Sepi Bay (station III, West Lombok District) and Aan Cape (station IV, Central Lombok District) (Figure 1).

Procedures

The sampling of fishes in each station was done using certain gears, namely cast net with mesh sizes of 1.5 cm and 2.5 cm, gill net with mesh sizes of ¾ inch, 1.5 inch and 2 inches. Fish specimens were preserved in 10 % formalin. Then, the fish specimens were taken to fish laboratory in Bogor Zoological Museum, located in Cibinong. In the laboratory, the fish specimens were preserved using alcohol 70-75% as a permanent preservation. All samples were identified according to the identification keys from Weber and de Beaufort (1916), Allen and Swainston (1988), Kottelat et al. (1993) and Peristiwady (2006).

Data analysis

The data were analyzed (with program past 2.1.4) to determine the fish composition that inhabit the region, using some indexes, namely species diversity index (Shannon and Weaver *in* Odum 1971), species richness index (Margalef *in* Odum 1971) and the fish composition similarities among the stations were analyzed using Sorensen similarity index (with program past 2.1.4).

RESULTS AND DISCUSSION

Characteristics of sampling locations

Generally, mangrove trees found in sampling location were *Rhizophora* spp., *Bruguiera* sp., *Avicennia* sp., *Excoecaria* sp., *Sonneratia alba* and *Aegiceras* sp. The first location was Cemare River located in the Puyahan village, Lembar Subdistrict. In this location, the mangrove canopy was relatively moderate to dense. The next location was Rasu Bay in the Labuan Tereng Village, Lembar Subdistrict, whose mangrove was relatively open, the edges are sloping and muddy, and a lot of trash, such as plastic waste, was trapped in in some mangrove roots. The third location was Sepi Bay at the Sangap Village and Sekotong Subdistrict. As the name implies, this location was relatively quiet, dominated by coastal sand and rocks, and the mangrove forest was relatively dense. The fourth location was Aan Cape located in Sengkol Village, Rujut Subdistrict in Central Lombok, which is a gently sloping beach and has open mangrove forest.

The water around the Cemare River was relatively clear. Some fish anglers and wooden-ships of fishermen were occasionaly seen in this water. The water was relatively turbid at the Rasu Bay, while in Sepi Bay and Aan Cape the water was relatively clear. Aan Cape is visited by tourists for recreation and surfing.

Fish composition

The fish composition consisted of 38 species belonging to 28 genera and 20 families (Table 1). The results showed that the number of fish species in the mangrove water was relatively high in West Lombok. While the observations in each station revealed that station I was by dominated *Oreochromis niloticus* (34 individuals) and *Ambassis* sp. (20 individuals), station II by *Ostorhinchus lateralis* (5 individuals) and *Oryzias javanicus* (4 individuals), station III by *Chelon subviridis* (9 individuals) and *Ambassis* sp. (7 individuals), and station IV by *Chanos chanos* (5 individuals) and *Ambassis urotaenia* (4 individuals).

Rice fish *O.javanicus* and belodok *P.argentilineatus* were collected in all research stations (100%). The family of Gobiidae was represented by 7 species, and Chandidae by 4 species (Table 1).

Table 1. Fish diversity in the mangrove waters at Lombok island, West Nusa Tenggara, Indonesia

Family	Species	Location	Amount (ind.)	Distribution (%)
Chanidae	*Chanos chanos*	4	5	25.00
Oryziidae	*Oryzias javanicus*	1,2,3,4	21	100.00
Hemirhamphidae	*Hyporhamphus quoyi*	2,3	3	50.00
	Zenarchopterus dispar	1,2,3	13	75.00
Chandidae	*Ambassis buruensis*	1,3,4	12	75.00
	Ambassis interrupta	1,2,3	18	75.00
	Ambassis urotaenia	2,3,4	9	75.00
	Ambassis sp.	1,2,3	29	75.00
Apogonidae	*Apogon amboinensis*	1,2	8	50.00
	Ostorhinchus lateralis	2,3,4	8	75.00
	Sphaeramia orbicularis	2,3	3	50.00
Carangidae	*Caranx ignobilis*	1,3,4	5	75.00
	Caranx sexfasciatus	3,4	3	50.00
Leiognathidae	*Eubleekeria splendens*	1,2,3	7	75.00
Lutjanidae	*Lutjanus argentimaculatus*	1,3,4	4	75.00
	Lutjanus fulvus	1,3	2	50.00
	Lutjanus sp.	1	1	25.00
Gerreidae	*Gerres kapas*	4	3	25.00
	Gerres oyena	1,3,4	9	75.00
Monodactylidae	*Monodactylus argenteus*	1,3	4	50.00
Scatophagidae	*Scatophagus argus*	1,2,3	6	75.00
Cichlidae	*Oreochromis niloticus*	1,4	35	50.00
Siganidae	*Siganus guttatus*	1,3	3	50.00
Mugillidae	*Chelon subviridis*	2,3,4	15	75.00
Sphyraenidae	*Sphyraena barracuda*	1	1	25.00
	Sphyraena sp.	3	1	25.00
Eleotrididae	*Butis gymnopomus*	1	1	25.00
	Oxyeleotris uropthalmoides	1,3	4	50.00
Gobiidae	*Acentrogobius viridipunctatus*	2,3	5	50.00
	Acentrogobius sp.	1	1	25.00
	Glossobius aureus	1,2,3,4	6	100.00
	Glossogobius giuris	1,2,3	2	75.00
	Papillogobius reichei	1,3	9	50.00
	Periophthalmus argentilineatus	1,2,3,4	11	100.00
	Redigobius sp.	1,2,3	4	75.00
Anabantidae	*Anabas testudineus*	1	4	25.00
Monacanthidae	*Amanses scopas*	4	1	25.00
Mullidae	*Upeneus sulphureus*	4	1	25.00

Note: 1. Cemare Estuary (West Lombok); 2. Rasu Bay (West Lombok); 3. Sepi Bay (West Lombok); 4.Aan Cape (Central Lombok)

The occurence and comparison of fish species in each station

Station III had the highest number of species, which was 27, followed by station I with 26 species, station IV with 17 species, and Station II with 16 species.

The species diversity index (H′) at each station ranged between 2.618 and 3.072, the evenness index (E) 0.803-0.950 and the richness index (d) 4.328-6.206 (Table 3). Sepi Bay had the highest diversity of fish species i.e. with H′= 3.072, evenness index, E= 0.932 and species richness index, d= 6.206.

Ecosystem-based grouping of fish species diversity shows that Cemare Estuary (station I) had almost similar fish species composition with Sepi Bay (station III), with the degree of similarity 0.72, while Rasu Bay (station II) had the similarity level of fish species of 0.59 with stations I and III. Aan Cape (station IV) had different fish species composition from the other three stations, with similarity index of 0.44 (Figure 2).

Table 2. The presence or absence of fish in each station

Family	Species	Station			
		I	II	III	IV
Chanidae	*Chanos chanos*	0*	0	0	1*
Oryziidae	*Oryzias javanicus*	1	1	1	1
Hemirhamphidae	*Hyporhamphus quoyi*	0	1	1	0
	Zenarchopterus dispar	1	1	1	0
Chandidae	*Ambassis buruensis*	1	0	1`	1
	Ambassis interrupta	1	1	1	0
	Ambassis urotaenia	0	1	1	1
	Ambassis sp.	1	1	1	0
Apogonidae	*Apogon amboinensis*	1	1	0	0
	Ostorhinchus lateralis	0	1	1	1
	Sphaeramia orbicularis	0	1	1	0
Carangidae	*Caranx ignobilis*	1	0	1	1
	Caranx sexfasciatus	0	0	1	1
Leiognathidae	*Eubleekeria splendens*	1	1	1	0
Lutjanidae	*Lutjanus argentimaculatus*	1	0	1	1
	Lutjanus fulvus	1	0	1	0
	Lutjanus sp.	1	0	0	0
Gerreidae	*Gerres kapas*	0	0	0	1
	Gerres oyena	1	0	1	1
Monodactylidae	*Monodactylus argenteus*	1	0	1	0
Scatophagidae	*Scatophagus argus*	1	1	1	0
Cichlidae	*Oreochromis niloticus*	1	0	0	1
Siganidae	*Siganus guttatus*	1	0	1	0
Mugillidae	*Chelon subviridis*	0	1	1	1
Sphyraenidae	*Sphyraena barracuda*	1	0	0	0
	Sphyraena sp.	0	0	1	0
Eleotrididae	*Butis gymnopomus*	1	0	0	0
	Oxyeleotris uropthalmoides	1	0	1	0
Gobiidae	*Acentrogobius viridipunctatus*	0	1	1	0
	Acentrogobius sp.	1	0	0	0
	Glossobius aureus	1	1	1	1
	Glossogobius giuris	1	0	1	1
	Papillogobius reichei	1	0	1	0
	Periophthalmus argentilineatus	1	1	1	1
	Redigobius sp.	1	1	1	0
Anabantidae	*Anabas testudineus*	1	0	0	0
Monachantidae	*Amanses scopas*	0	0	0	1
Mullidae	*Upeneus sulphureus*	0	0	0	1
	Number of species	26	16	27	17

Note: * 1: present, 0: absent

Table 3. The indexes of species diversity (H′), Evenness (E) and Species Richness (d) at each sampling station

Station / Index	Cemare Estuary	Rasu Bay	Sepi Bay	Aan Cape
Species diversity index (H)	2.618	2.635	3.072	2.667
Evenness index (E)	0.803	0.950	0.932	0.941
Species Richness index (d)	5.045	4.328	6.206	4.431

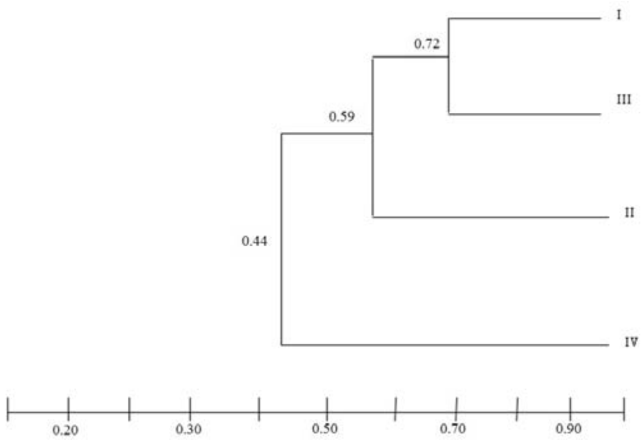

Figure 2. Grouping the mangrove ecosystem based on common fish species in each station

Discussion

Various fish species were collected in the mangrove waters allegedly because the ecosystem conditions and general physical waters were relatively good. Mangrove plants with good conditions were found at the edge of water, with various substrate characteristics, sandy, rocky and muddy. Similarly at Ujung Kulon National Park (TNUK) Pandeglang, Banten, where the mangrove ecosystem was in good condition, 43fish species, belonging to 33 genera and 24 families were found (Wahyudewantoro 2009). While in Guimaras mangrove waters, the Philippines, 50 species of fish were found. The condition of the mangrove vegetation there was quite good, consisting of several species, i.e *Avicennia* sp., *Bruguiera* sp., *Ceriops* sp., *Excoecaria agallocha*, *Heritiera littoralis*, *Nypa fruticans*, *Rhizophora* sp. and *Sonneratia* sp., with varying extents. The rivers were located 50 to 150 meters from the coastline with sandy to muddy substrate (Abroguena et al. 2012).

Each of research stations had dominant fish, whose number of individuals was relatively more abundant than the other species. This is consistent with the statement Nip and Wong (2010) that the fish community in a mangrove waters will be dominated only by a few species of fish, although the number of individual catches was relatively abundant. As in the Sikao Creek mangrove estuary, Southwest Thailand from 455 individuals, after identification, only 19 species were found dominant (Zagars et al. 2013). In the mangrove areas in the Egyptian Red Sea, 269 juvenile fishes represented 21 species (El-Regal and Ibrahim 2014).

The fish species caught in all locations were common fish species found in the mangrove ecosystem. These fishes allegedly exploited the mangrove area as feeding ground or nursery ground, as indicated by the fish catch, which ranged from juvenile to almost adult. Some studies suggest that mangroves are thought to provide more food for juvenile fish than other ecosystems, and there are about 70% -90% of juvenile-sized fish located within the mangroves (MacDonald et al. 2009; Mwandya et al. 2009). This hypothesis was reinforced by Nip and Wong (2010), showing that in the waters of the mangrove East of Hongkong half of the number of fish caught was still in juvenile size.

Rice-fish *O.javanicus* and belodok *P.argentilineatus* had high adaptability to all stations. The group of fish *Oryzias* spp. which belong Adrianichthyidae family generally live in freshwater. Kottelat et al. (1993) state that *O. javanicus* is often found in brackish and mangrove waters. According to research conducted by Yusof et al. (2013), *O.javanicus* was widely distributed in mangrove waters on the west coast of Peninsular Malaysia. While on the Saddang river in Tana Toraja Regency, South Sulawesi, *O. javanicus* could be found swimming in groups in the downstream and estuaries (Pratama et al. 2015). Belodok is the other mangrove species resident, because mangrove ecosystems provide abundant food and appropriate nutritional requirements (Gosal et al. 2013). Belodok also utilizes of the pneumatophores of *Sonneratia alba* as shelter from predators (Burhanuddin and Martosewojo, 1978 *in* Wahyudewantoro 2009). Magel et al. (2017) and Nanjo et al. (2014a) added that mangrove trees and roots could reduce the threat to juvenile fish both from some predators, as well as from extreme changes in environmental conditions.

Gobiidae and Chandidae families had the highest number of species throughout the research stations. It is suspected that species of these families are permanent or temporal residents in mangrove waters. Pramudji (2008) reported that in coastal area of Mahakam Delta, fish species of Gobiidae were found from the larval stage to adult. Gobiidae juvenile was also abundant in mangrove in Eastern Hong Kong, which may serve as feeding and nursery place (Nip and Wong 2010). Species members of Chandidae also have a wide spread of habitat, but some *Ambassis* spp. are more common in marine areas, estuaries and mangrove. Similarly, in the Sikao Creek, Southwest Thailand, where the species of *Ambassis interruptus* and *A. vachellii* are dominant, it is believed that the these species eat the microbenthos which is abundant in these waters (Zagars et al. 2013).

Table 2 shows that more fish species visited the Sepi Bay than the other stations. Accordingly, the species diversity index and species richness index in Sepi Bay (station III) were higher than those in Cemare Estuary (station I), Rasu Bay (station II), and Aan Cape (station IV). The high diversity in Sepi Bay might be caused by the high production of litter, which was 9.9 ton/ha/year (Zamrony and Rohyani, 2008). Day et al. (2012) argue that the leaves are a source of nutrients for the surrounding organisms. Falling leaves or litter, will then be broken down by microorganisms into detritus, which in turn will be utilized by various juvenile fish, shrimp and crab and shell as a source of food. The results of research conducted by Zagars et al. (2013) showed that mangrove trees can provide 70% primary nutrients for various species of fish. Sepi Bay mangrove water was better, because it is supported by a substrate of sand and rocks, so it is likely to attract fish species other than the resident fishes in the region. Habitat variations in mangroves such as substrate base, physical and environmental conditions can affect the diversity of existing fish species, and influence to structural heterogeneity of mangroves which attract much attention of juvenile fish (Nanjo et al. 2014a; Nip and Wong 2010).

The evenness index of each research stations was relatively not much different. Odum (1971) says that if there is no concentration of individuals of a specific species, the value of the evenness index will be high. The species richness index of the Rasu Bay (station II) was the lowest. This situation may be due to the the poor mangrove conditions in the Rasu Bay because of the amount of garbage either floating or caught in the mangrove trees and residual oil from motor boat combustion polluting the water. Fragmentation of habitat caused by poor environmental quality, allegedly contributes to the wealth of existing fish species (Abroguena et al. 2012).

Cemare Estuary (station I) and Sepi Bay (station III), had the highest similarity index, with 19 common fish species. The Rasu Bay (station II), had the 9 common fish species with the Sepi Bay and Cemare Estuary. Aan Cape had very different species composition, having only one common fish species with the other stations.

At the stations I and III, the mangrove vegetation cover was relatively moderate to dense, with sandy and muddy substrate, whereas at station II, the mangrove cover was relatively open, with young seedlings of mangrove plants, and with muddy substrate. Station IV had very open mangrove covering, sandy substrate, and was visited by many local people and tourists. Existing habitat conditions are suspected to be one of the causes of the species composition difference. Generally, the composition of fauna species in another location is influenced by similarity of habitat type or abiotic condition factors (Capenberg 2011).

In conclusion, a total of 38 species of fish were collected from four research stations in Lombok Island. *Oryzias javanicus* and *Periopthalmus argentilineatus* had 100% local distribution or were found in all research stations. Gobiidae was the dominant family with 7 species, higher than the other familes. Sepi Bay (station III) had the highest diversity index (H′=3.072) and species richness index (d=6.206), and the third highest of evenness index (E = 0.932). The highest number of fish species was found in station III (27 species), followed by station I (26 species), station IV (17 species), and station II (16 species).

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