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Original Article

Crab communities (Decapoda: Brachyura) in mangrove and estuaries in the Eastern Part of Lombok Island

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Abstract

Mangroves and estuary ecosystem in East Lombok which are appointed as Local Marine Conservation Areas (Kawasan Konservasi Laut Daerah/KKLD) are Gili Lawang, Gili Sulat, Sambelia and Jerowaru districts. Inventory of aquatic fauna in mangroves and estuaries is one of the important components of the marine conservation program. The objective of this study is to determine crab species composition in mangroves and estuaries of eastern Lombok during the East Lombok KKLD program. Targeted area for this study includes Gili Lawang, Gili Sulat in southern Lombok Island, Sugian in Sambelia, Ekas Beach, Tanjung Luar and Seriwe in Jerowaru, and Kidang in western Jerowaru. The crab was collected at 0 m to 100 m of seashore by digging the burrow. The crab community recorded was analyzed for resulting the Diversity, Evenness and Similarity Index. Ten families with 35 species of crab were found from two ecosystem types, mangrove and estuary. Each location has different diversity of ecosystem and habitat. The highest diversity is recorded in Kidang and Seriwe, while the lowest diversity in Gili Sulat. Species diversity is associated with ecosystem and habitat type diversity. Kidang and Seriwe has the highest ecosystem and habitat diversity, while Gili Sulat has the lowest diversity. In addition, the population of Ocypodidae is accounted as the dominant crab family for which *Austruca perplexa* is the dominant species.

Keywords: crab, diversity, Gili, KKLD, Lombok Island

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Introduction

Mangroves and estuaries are unique and complex ecosystems because of their position in between freshwater and marine. The faunal composition inhabits these ecosystems also has unique characteristics associated with their activities in tide fluctuations. One of the typical fauna is crab. Crab is not only known as a protein source, but also as sediment nutrient stabilizer, decomposer, deposit feeder and even shorebird existence decisive (Allen, 2010; Botto *et al*., 2000; Cardoni *et al*., 2010; Ólafsson and Ndaro 1997; Takagi *et al*., 2010). Since 2006, mangroves in Lombok have been managed as Local Marine Conservation Areas (Kawasan Konservasi Laut Daerah: KKLD) and divided into northern and southern areas. The northern area consists of Sambelia district, Gili Lawang Island and Gili Sulat Island, while the southern area consists of Jerowaru district (data from Dodokan Moyosari Land Rehabilitation and Conservation Agency, 2006; Kasasiah *et al.*, 2006). From 1999 to 2006 the mangrove forest area had increased to 78.3%, then another 7.2% addition in 2006 to 2009 (Nandini and Narendra, 2011).

Inventory of aquatic fauna in mangroves and estuaries is one of the important components of the marine conservation program. Unfortunately, data of the crab community that support the program in Lombok Island is very limited. A few earlier studies, before the KKLD program, were focused on West Lombok and Central Lombok Regencies. A study by Matsuura *et al.* (2000) has identified 35 species from Kuta, Central Lombok.

The objective of this study is to determine crab species composition in the mangroves and estuaries of eastern Lombok. On the other hand, the diversity of each study site is compared to assess the association of habitat with species richness. The whole information from this study can be used as one of references in determining the effectiveness of the conservation program. Furthermore, it can give illustration to the local community about the role and potential sources.

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Method

The seven study locations in East Lombok were Gili Lawang (S08º18'8.5" E116º42'10.01"), Gili Sulat (S08º19'41.86" E116º42'59.71"), Sugian Village-Sambelia District (S08º20'14.18" E116º41'46.97"), Tanjung Luar Beach-Keruak District (S08º46'526"), Seriwe Village-Jerowaru District (ordinate unavailable), Eka's Beach-Jerowaru District. The other location in Central Lombok is Batu Libak Beach and Jebak River-Kidang Village-East Praya District (S08º51'59.37" E116º41'46.97"). Jerowaru District is nominated as KKLD. Kidang Village is under different municipality, but the location is directly bordered Jerowaru on the western side (Fig.1). Therefore, this village becomes the support area of the KKLD.

The crab was collected in 2011–2015, for 7 to 21 days for each year. First sampling was conducted on June 21 2011 in Eka's Beach, second sampling was from on April 25 to 30 2014 in Seriwe Village, the third on April 24 2014 in Tanjung Luar and the fourth was conducted from 23 April until 5thMay 2015 at Gili Lawang, Gili Sulat, Sugian Village, and Kidang Village.

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The sampling point was chosen randomly and without plot. There was only one uptake for each sampling point, so there was no repeating for each point. Crabs were sampled quantitatively by sweeping the area from 0 m to 100 m horizontal distance of the sea shore at low tide. As many crabs were caught as possible by hand using a trowel and some plastic jar. Some crabs were caught by digging holes using a small trowel, while others only by hand.

The crab then preserved with ascending ethanol concentration. The living crab was immersed in 40% ethanol concentration to prevent autotomy. In an unconscious yet live condition, the crab then immersed in 70% concentration, to preserve the whole part of the body including the inner organs. Preserved crabs were put into labeled resealable plastic bags and carefully transported to the laboratory in Museum Zoologicum Bogoriense (MZB) in Cibinong, West Java.

Specimens were identified according to Crane (1975), FAO (1998), Matsuura *et al.* (2000), Poore (2004), Rahayu and Setyadi (2009) and Naderloo *et al.* (2010). Crabs were described using the measurement of species abundance, number of species, Shannnon-Wiener diversity index calculated using Ln, Alatalo species evenness index, and Simpson location similarity index. All index equations were referred to Odum (1971).

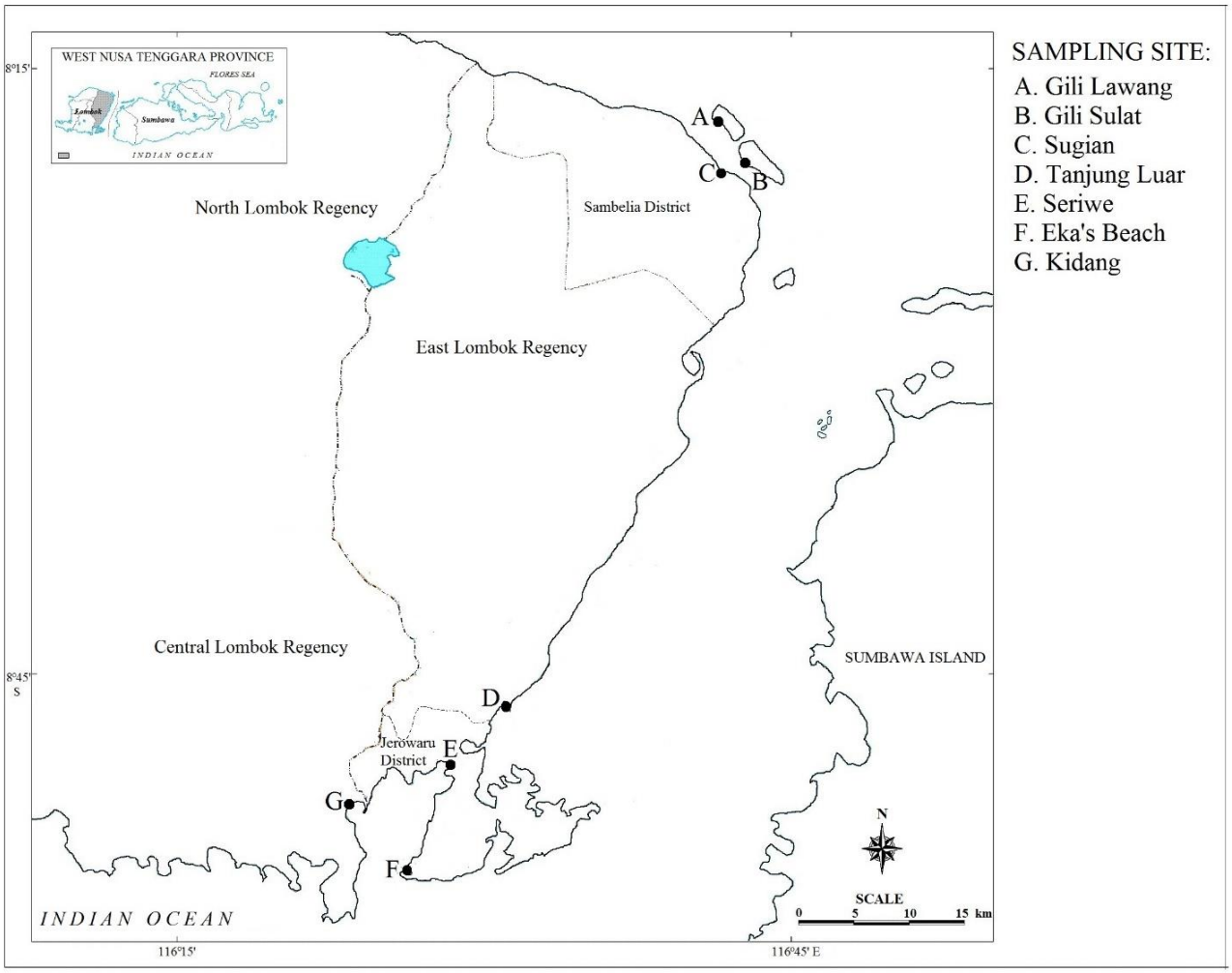


Figure 1. Sampling sites at the eastern part of Lombok Island

Results

The collected crab comprised of 35 species that belongs to ten families (Fig.2-8). Each location has a different species composition (Table 1). The highest family member belongs to Ocypodidae. The highest number of family, species and individual were found in Kidang, while the lowest in Gili Sulat.

Diversity index shows the species number for each location. Each location has a different number of species that results in different diversity index. The diversity index in Kidang was the highest, while the lowest was in Gili Sulat (Fig.9A). The highest proportion of diversity was found in Kidang Village, with 25.5% or 13 species from the total of 35 species, while Gili Sulat with 5.9% or 3 species from that total (Fig.9B). Crab collecting for Gili Sulat was conducted only in 2015.

Table 1. Diversity of crab species

No.	Family	Species	Location							Total
			GL	GS	SG	TL	SR	EB	KD	
1	Dotillidae	*Mictyris brevidactylus*	0	0	0	13	0	0	0	13
2	Eriphiidae	*Eriphia sebana*	0	0	0	0	0	1	1	2
3	Gecarcinidae	*Cardisoma carnifex*	0	0	6	0	0	0	0	6
4	Grapsidae	*Grapsus albolineatus*	0	0	0	0	3	3	14	20
5	Grapsidae	*Metopograpsus thukuhar*	0	0	0	0	0	0	5	5
6	Macrophthalmidae	*Macrophthalmus convexus*	0	0	0	0	0	3	0	3
7	Macrophthalmidae	*M. definitus*	0	0	0	0	0	0	2	2
8	Macrophthalmidae	*M. milloti*	0	0	0	0	0	100	0	100
9	Ocypodidae	*Ocypode ceratophthalma*	0	0	4	0	0	0	0	4
10	Ocypodidae	*Austruca annulipes*	75	0	0	0	0	0	0	75
11	Ocypodidae	*A. perplexa*	41	0	5	7	8	35	38	134
12	Ocypodidae	*A. triangularis*	14	0	5	0	16	0	0	35
13	Ocypodidae	*Thalassuca bellator*	0	0	0	3	0	0	8	11
14	Ocypodidae	*T. coarctata*	0	0	0	0	0	0	27	27
15	Ocypodidae	*T. dussumieri*	13	0	0	1	1	0	0	15
16	Ocypodidae	*T. vocans*	0	0	0	26	23	0	28	77
17	Ocypodidae	*T. forcipata*	0	0	0	3	0	0	0	3
18	Ocypodidae	*Paraleptuca crassipes*	25	0	0	0	0	0	0	25
19	Oziidae	*Epixanthus dentatus*	0	2	0	0	0	0	0	2
20	Oziidae	*Ozius guttatus*	0	0	0	0	0	0	1	1
21	Oziidae	*O. tuberculosus*	0	0	0	0	1	0	1	2
22	Portunidae	*Charybdis affinis*	0	0	0	0	1	0	0	1
23	Portunidae	*C. annulata*	0	0	0	0	1	0	1	2
24	Portunidae	*Portunus pelagicus*	0	0	0	0	1	0	0	1
25	Portunidae	*Thalamita spinimana*	0	0	0	0	1	0	0	1
26	Portunidae	*Thalamitha* sp.	0	0	0	0	1	0	0	1
27	Sesarmidae	*Episesarma lafondi*	0	0	5	0	0	0	0	5
28	Sesarmidae	*Neosermatium inermis*	1	0	0	0	0	0	0	1
29	Sesarmidae	*Haberma* sp.	4	0	0	0	0	0	0	4
30	Sesarmidae	*Parasesarma pangauranensis*	4	0	0	0	0	0	0	4
31	Sesarmidae	*P. sigillatum*	0	0	0	0	0	0	51	51
32	Sesarmidae	*Perisesarma semperi*	0	8	0	0	0	0	0	8
33	Sesarmidae	*Perisesarma* sp.	0	10	0	0	0	0	0	10
35	Varunidae	*Metaplax distinctus*	0	0	0	0	0	0	6	6
Number of individu			**177**	**20**	**25**	**53**	**57**	**142**	**183**	**657**
Number of species			**8**	**3**	**5**	**6**	**11**	**5**	**13**	**35**
Number of families			**2**	**2**	**3**	**2**	**4**	**4**	**8**	**10**

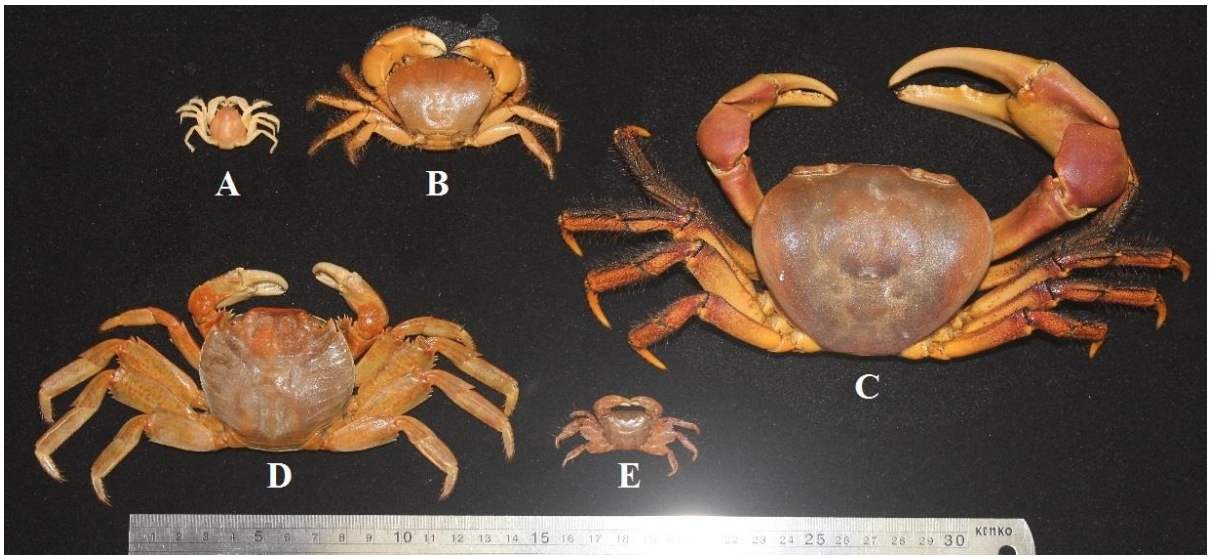
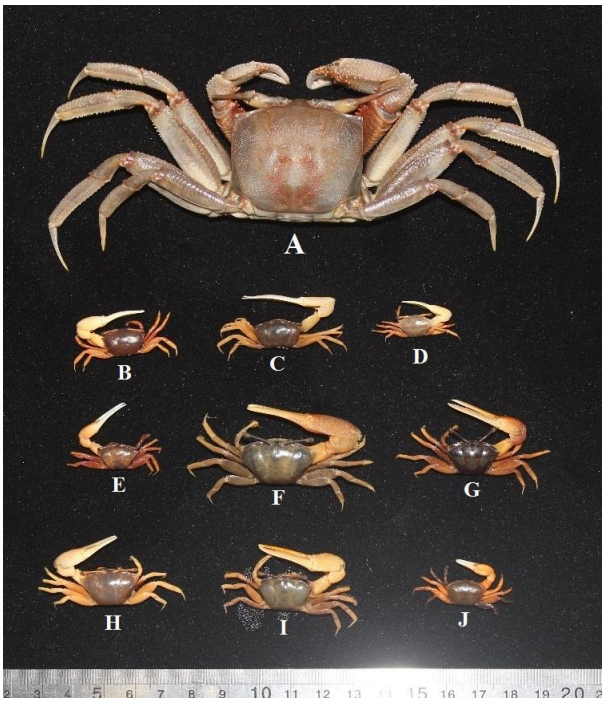


Figure 2. Dotillidae (A) *Mictyris brevidactylus*, Eriphiidae (B) *Eriphia sebana*, Gecarcinidae (C) *Cardisoma cernifex*, and Grapsidae (D) *Grapsus albolineatus*, (E) *Metopograpsus thukuhar*.

Figure 3. Macrophthalmidae (A) *Macrophthalmus convexus*, (B) *M. definitus*, (C) *M. milloti*.



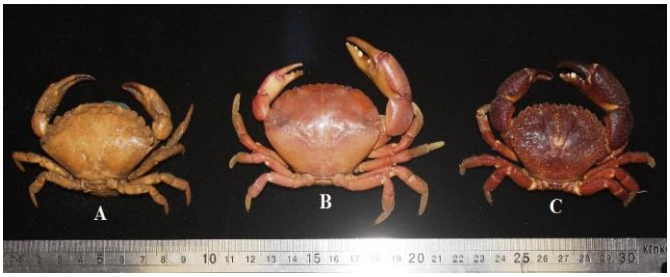


Figure 5. Oziidae. (A) *Epixanthus dentatus*, (B) *Ozius guttatus*, (C) *O. tuberculosus.*

Figure 4. Ocypodidae. (A) *Ocypode ceratophthalma*, (B) *Austruca annulipes*, (C) *A. perplexa*, (D) *A. triangularis*, (E) *Thalassuca bellator*, (F) *T. coarctata*, (G) *T. dussumieri*, (H) *T. forcipata*, (I) *T. vocans*, (J) *Paraleptuca crassipes*.

Figure 6. Portunidae. (A) *Charybdis affinis*, (B) *C. annulata*, (C) *Portunus pelagicus*, (D) *Thalamita spinima*, (E) *Thalamita* sp.

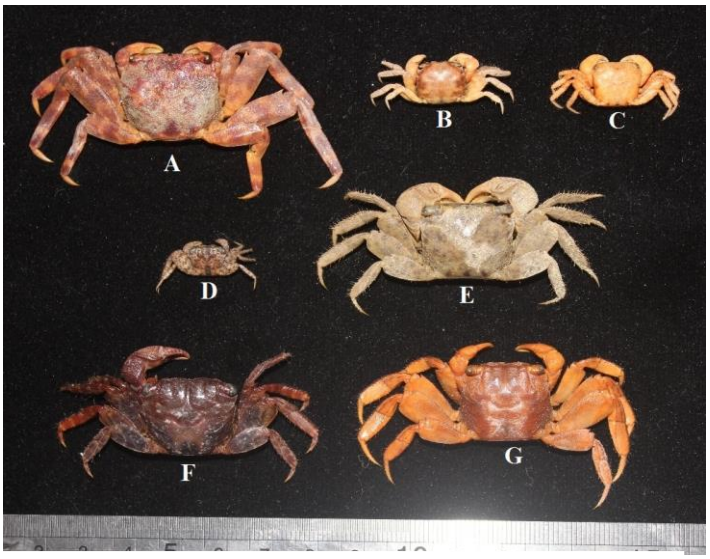


Figure 7. Sesarmidae. (A) *Episesarma lafondi*, (B) *Neosermatium inermis*, (C) *Haberma* sp., (D) *Parasesarma pangauranensis*, (E) *P. sigillatum*, (F) *Perisesarma semperi*, (G) *Perisesarma* sp.

Figure 8. Varunidae, *Metaplax distinctus*.

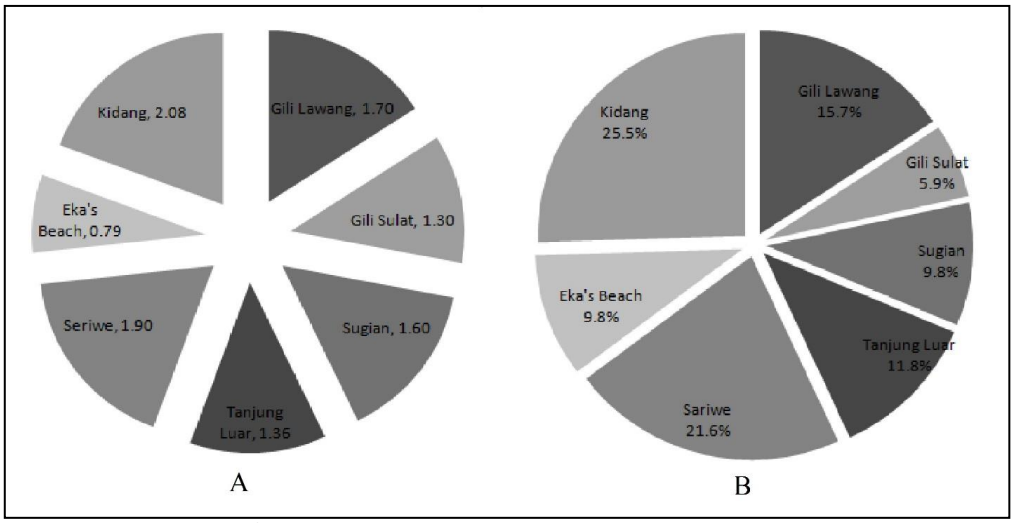


Figure 9. Species diversity of each location, (A) Diversity index; (B) Percentage

In general, sampling locations have different characteristics. Kidang has the most diverse ecosystem and habitat types, while Gili Sulat has the lowest (Table 2). There is a mangrove ecosystem with mud and sand substrate and an estuary ecosystem with sand and rock substrates. Sampling in Kidang was conducted in two ecosystems, mangrove and estuary. The mangrove has sand and mud substrate, while the estuary has sand and rock substrate.

The highest diversity index was found in Kidang Village and it is categorized as moderate. Meanwhile, the lowest indces were found in Gili Sulat and Seriwe, with low category (Table 3). The evenness index was highest in Kidang Village, while in Gili Sulat at the lowest.

Different diversity of each location leads to a variation of similarity index. The Simpson similarity index among locations shown that the crab species composition in Seriwe was more similar to Kidang (Fig.10). While the similarity index for Gili Sulat shows that there are no similarities with other locations, so that the score is 0.00.

Table 2. Characteristic of sampling location

Location	Characteristic
Gili Lawang	A small island which consists of mangrove and estuary ecosystems. Mangrove forests located in the inner part of the island and consist of sand and mud substrate. There is no river, so the mangrove only supplied by salt water. Estuary surrounding the island and consists of sand substrate.
Gili Sulat	A small island covered by mangrove ecosystem with mud substrate. The island is always submerged even at low tide.
Sugian	Village in southeast of Lombok Island, consists of mangrove and estuary ecosystem with sand, mud and rock. The mangrove supplied with fresh water from river and salt water from the sea.
Tanjung Luar	A village in north side of Lombok Island, consists of mangrove and estuary ecosystem with sand and mud. The mangrove supplied by fresh water from river and salt water from sea.
Seriwe	A village in north side of Lombok Island, consists of mangrove and estuary ecosystem with sand and mud. The mangrove supplied with fresh water from river and salt water from sea.
Eka's Beach	Located in a village in north side of Lombok Island. Estuary ecosystem with sand substrate.
Kidang	A village in north side of Lombok Island, consists of mangrove and estuary ecosystem with sand, mud and rock. The mangrove supplied with fresh water from river and salt water from sea.

Table 3. Diversity and Evenness indices of crab species in the study areas

Index	Locality						
	GL	GS	SG	TL	SR	EB	KD
H'	1,70	1,30	1,60	1,36	1,90	0,79	2,08
E	0,48	0,37	0,45	0,38	0,53	0,22	0,58

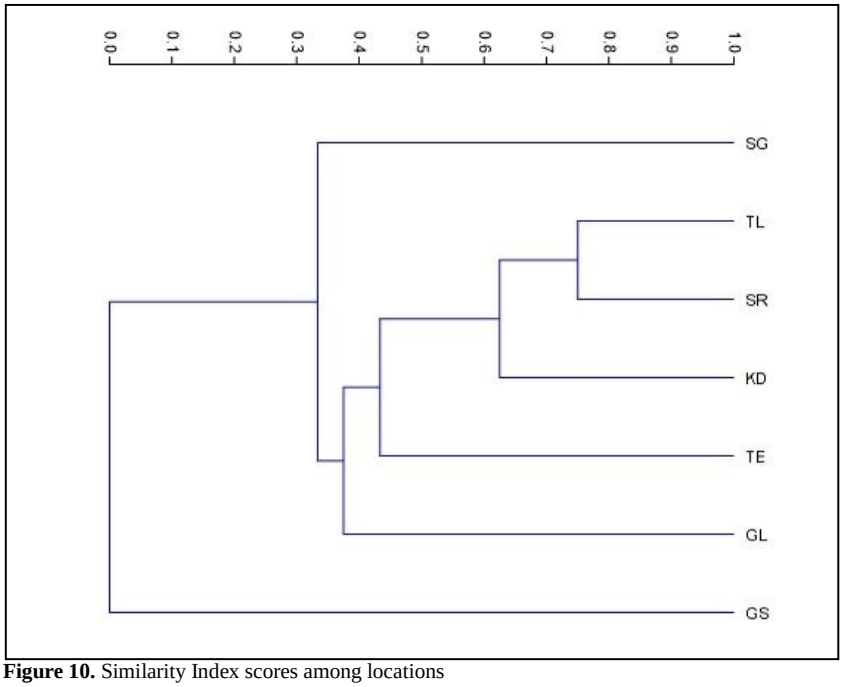


Figure 10. Similarity Index scores among locations

There were significant differences in population numbers among 35 species within the locality. *Austruca perplexa* is the dominant species with a total number of 134 individuals, while Ocypodidae population with a total number of 406 individuals dominated the other 10 families (Table 4).

Table 4. Index of dominanceof crab species and family

No.	Family	Species	Number of individual		Dominance	
			Species	Family	Species	Family
1	Dotillidae	*Mictyris brevidactylus*	13	13	0.000	0.000
2	Eriphiidae	*Eriphia sebana*	2	2	0.000	0.000
3	Gecarcinidae	*Cardisoma carnifex*	6	16	0.000	0.000
4	Grapsidae	*Grapsus albolineatus*	20		0.001	
5	Grapsidae	*Metopograpsus thukuhar*	5	25	0.000	0.001
6	Macrophthalmidae	*Macrophthalmus convexus*	3		0.000	
7	Macrophthalmidae	*M. definitus*	2		0.000	
8	Macrophthalmidae	*M. milloti*	100	105	0.023	0.026
9	Ocypodidae	*Ocypode ceratophthalma*	4		0.000	
10	Ocypodidae	*Austruca annulipes*	75		0.013	
11	Ocypodidae	*A. perplexa*	134		0.042	
12	Ocypodidae	*A. triangularis*	35		0.003	
13	Ocypodidae	*Thalassuca bellator*	11		0.000	
14	Ocypodidae	*T. coarctata*	27		0.002	
15	Ocypodidae	*T. dussumieri*	15		0.001	
	Ocypodidae	*T. forcipata*	3		0.000	
16	Ocypodidae	*T. vocans*	77		0.014	
17	Ocypodidae	*Paraleptuca crassipes*	25	406	0.001	0.382
19	Oziidae	*Epixanthus dentatus*	2		0.000	
20	Oziidae	*Ozius guttatus*	1		0.000	
21	Oziidae	*O. tuberculosus*	2	5	0.000	0.000
22	Portunidae	*Charybdis affinis*	1		0.000	
23	Portunidae	*C. annulata*	2		0.000	
24	Portunidae	*Portunus pelagicus*	1		0.000	
25	Portunidae	*Thalamita spinimana*	1		0.000	
26	Portunidae	*Thalamitha* sp.	1	6	0.000	0.000
27	Sesarmidae	*Episesarma lafondi*	5		0.000	
28	Sesarmidae	*Neosermatium inermis*	1		0.000	
29	Sesarmidae	*Haberma* sp.	4		0.000	
30	Sesarmidae	*Parasesarma pangauranensis*	4		0.000	
31	Sesarmidae	*P. sigillatum*	51		0.006	
32	Sesarmidae	*Perisesarma semperi*	8		0.000	
33	Sesarmidae	*Perisesarma* sp.	10	83	0.000	0.016
35	Varunidae	*Metaplax distinctus*	6	6	0.000	0.000

Discussions

Crab is one of the important group of animal in the aquatic environment. Most of the species play a role as a keystone species in accordance to its burrowing behavior. The burrowing activity supports the substrate in aeration, mineral circulation and material decomposition. The healthy substrate will in turn, support the vegetation growth. Dotillidae, Macrophthalmidae, Ocypodidae,

Sesarmidae and Grapsidae play this role (Botto *et al*., 2000; Cardoni *et al*., 2010; Ólafsson and Ndaro 1997; Takagi *et al*., 2010)

Species of *Austruca*, *Paraleptuca*, *Thalassuca*, *Metaplax*, *Epixanthus* and members of the family Sesarmidae inhabit the mangrove ecosystem. Meanwhile, *Macrophthalmus*, *Ocypode*, *Charybdis*, *Portunus*, and *Thalamita* live in estuary ecosystem. Each species lives in special habitats and microhabitats. For example, in Ocypodidae, genus *Ocypode* inhabit sandy beaches while the others inhabit mud and sand in the mangrove. Members of Ocypodidae, excluding Genus Ocypode, live in the same habitat, but different microhabitat. Microhabitat is a specific habitat of species in an ecosystem (Crane, 1975; Kim *et al.*, 2004; Lim, 2005). Present study found that *Paraleptuca crassipes* and *Thalassuca dussumieri* lives in the same mud substrate in Gili Lawang. However, each population of Ocypodidae able to form their own population boundaries, so they are not mixed to each other (Bezerra *et al*., 2006; Lim *et al*., 2005). The aspect that built the boundaries is still unknown.

The diversity that were found in each location cannot be used to reflect the environmental condition. However, the species diversity concludes the ecosystem diversity, climate, tide and sampling method. Sampling method is depend on the tide. At high tide, the crabs are collected by grabbing and filtering the substrat, while at low tide crabs are collected by hand. The lowest diversity is found in Gili Sulat due to the island inundation to 0.5 m even at low tide. The collected crab from that location is dominated by *Perisesarma* which has arboreal behavior during high tide.

Total number of species in Gili Sulat are contradictive to Gili Lawang, this perhaps due to the contrasted characteristics. Gili Lawang has a wider land area which is always exposed even at high tide. The area consists of mud and sand substrate. Ocypodidae that inhabit mud and sandy substrate dominated the collected crab. In this small island, *Paraleptuca crassipes*, *Thalassuca dussumieri* and *Austruca. triangularis* are the species that live in mud substrate, while *Austruca annulipes* and *A. perplexa* in sand substrate.

As a whole, KidangVillage has the highest diversity shown by the highest score of diversity index, even though it is in the moderate category (H'<1 = low, H':1-2 = moderate, H'>2 = high). The other three locations that are categorized as moderate are Gili Lawang, Seriwe and Sugian. Those four locations have moderate diversity as a result of different type of ecosystem and habitat. They consist of mangrove and estuary, with three different substrates, *i.e.*, mud, sand and rock. The conclusion of the resulting data is similar to Rosenzwerg (1995) who stated that the higher the habitat variation, the higher the diversity.

The other three have the low category for diversity index. It was caused by the sampling that has been conducted only in one ecosystem. Sampling in Gili Sulat and Tanjung Luar were undertaken in a mangrove ecosystem with mud substrate, while at Eka's Beach it was held in an estuarine with mud and sand substrate.

The evenness index of Eka's Beach is low because there is only *Macrophthalmus milloti* that was collected as an abundant population compared to *Eriphia sebana* and *Grapsus albolineatus*. *Macrophthalmus milloti* is a deposit feeder crab which lives as a colony in mud substrate. This species digs shallow burrows that make large numbers of this species collected easily. On the other hand, *Eriphia sebana* and *Grapsus albolineatus* are solitary and very active species. The remaining six locations have a moderate score of evenness indices (Table 3), which conclude that the number of population for each species is distributed equally.

The highest similarity index between two locations accounted from Seriwe and Kidang, showing that crab species composition in Seriwe is most similar to Kidang. Higher index scores of those locations are associated with similar characteristics of two ecosystem types (Fig.10). There are mangrove and estuarine ecosystems which have three habitat types, mud, sand and rock. In addition, Seriwe and Kidang are classified as the same forest type called wet forest (Nandini and Narendra, 2011).

Sea current affects larval spread from sea to land. The current divided into bottom and surface current. The larva spread depends on the direction and velocity of the surface current which resulted by wind direction and velocity (Harms, 1986; Yanicelli *et al.*, 2006). The larva can reach the different island from the mother's if the distance is narrow and the surface current velocity is high. Very wide distance leads to larva death since there is a high risk of temperature fluctuation and predation in the sea (Bezerra *et al*. 2006; Soedibjo and Aswandi, 2007; Sorrea and Uieda, 2008). Accordingly, Sugian and Gili Lawang, categorized as wet forest, has a high similarity index for having similar ecosystem and habitat. The narrow distance between both has help crab larva to spread from one land to others easily (Fig.1). Tanjung Luar as rain forest (Nandini and Narendra, 2011) has a high similarity index to Seriwe in accordance to the narrow space between them. Eka's Beach has a high similarity index to Kidang with the same reason as the previous case. Eka's Beach, Seriwe and Kidang are situated in Eka's Bay (also called Awang Bay). This bay became the major access for crab-larval spread among those areas. This condition leads to high index similarities between those areas.

Among the total ten families, Ocypodidae dominate the species diversity and population number. One species of Ocypodidae, *Austruca perplexa*, dominated not only within the family, but also among the 35 collected species. This crab was found in all sampling sites except in Gili Sulat. Even within the group, this species has the widest distribution in Indonesian coasts (Murniati, 2012). In particular, it is so far only known for its ecological role in the ecosystem as keystone species. The crab that has important ecological and economic role is family Portunidae. Other collected crab families such as Gecarcinidae, Grapsidae and Oziidae have economical potencies but less exposed (FAO, 1998).

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