

Diversity of gastropods in mangrove ecosystem of western coast of Aceh Besar District, Indonesia

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Abstract. The objective of the present study was to evaluate the diversity of gastropods in mangrove ecosystems of the western coast of Aceh Besar District, Indonesia. The sampling was done during March to April 2014 at four sampling locations and covered four villages namely Alue Naga, Kajhu, Neuheun and Ujung Batee. Three transects were determined at every sampling location and each transect had three plots (1 m x 1 m) and the gastropods were collected at the plots randomly by filtering the sediment using two level sieve. The study showed that *Terebralia sulcata* was the predominant species and this species was found at all of sampling locations. The Shannon-Wiener diversity index of gastropods was ranged between of 1.549 to 2.036, with an average value of 1.834. It was concluded that the diversity index of gastropods in western coast of Aceh Besar District was at low category.

Key Words: mollusk, *Terebralia sulcata*, sediment, *Rhizophora*, frequency of incidence.

Introduction. Approximately 15,652 ha of mangrove forest are located in Aceh Besar district, Indonesia (DKP Aceh Besar 2011). Most of these mangroves are situated along the western coast of Aceh Besar which covers two sub districts of Baitussalam and Mesjid Raya. The mangrove ecosystem along the western coast of Aceh Besar is bordered and affected by the tidal regime of the Malacca Strait with semi diurnal tidal type and less water input from adjacent rivers (Rizal 2000; Rizal et al 2010). Consequently, the western coastal region of Aceh Besar is highly dynamic and has specific characteristic of habitats, for example the variations in type of sediment.

The sediment determines the diversity of coastal flora and fauna. The coastal flora are generally dominated by mangroves as important habitats for feeding, spawning and nursery grounds of most aquatic animals, for example mollusks, shrimps, fishes and water birds (Biswas et al 2009; Raharja et al 2014; Sukardjo 1986). Gastropods are one of the predominant organisms within the mollusks group and are frequently found in mangrove ecosystems of western coast areas of Aceh Besar (Fadli et al 2012). These organisms live at the bottom of the water with types of sediment loam, sandy loam and sandy (Rizky et al 2012).

Gastropods have an important role in the food web of coastal ecosystems; they feed detritus and leaf litter (Leitte & Turra 2003), and they serve as prey (food) for shorebirds. In addition several species of gastropod have economic value for human consumption (Octavina et al 2014). Study on gastropods from northern coast of Aceh Besar district has been reported by Dewiyanti & Karina (2012) and Andayani (2006). However, no study was done on the diversity of gastropods in mangrove ecosystems along the western coast of Aceh Besar district. On the other hand, the development of coastal zone for settlement, agriculture and aquaculture industries continuously occurs. Therefore, information on biodiversity of gastropods is crucial in relation to providing comprehensive data on the gastropods in Aceh Besar District, Indonesia in relation to

arranging a better conservation strategy of coastal ecosystems of Aceh Besar district. Hence, the objective of the present study was to examine the diversity of gastropods along the western coast of Aceh Besar District, Indonesia.

Material and Method

Time and study site. The study was conducted along the western coast of Aceh Besar District, Indonesia covering two subdistricts of Baitussalam and Mesjid Raya at four sampling locations: Muara Krueng Cut, Kajhu Village, Neuheun Village and Ujoeng Batee Village (Figure 1). The descriptions of every sampling site are presented in Table 1. Samplings were done during March to April 2014.

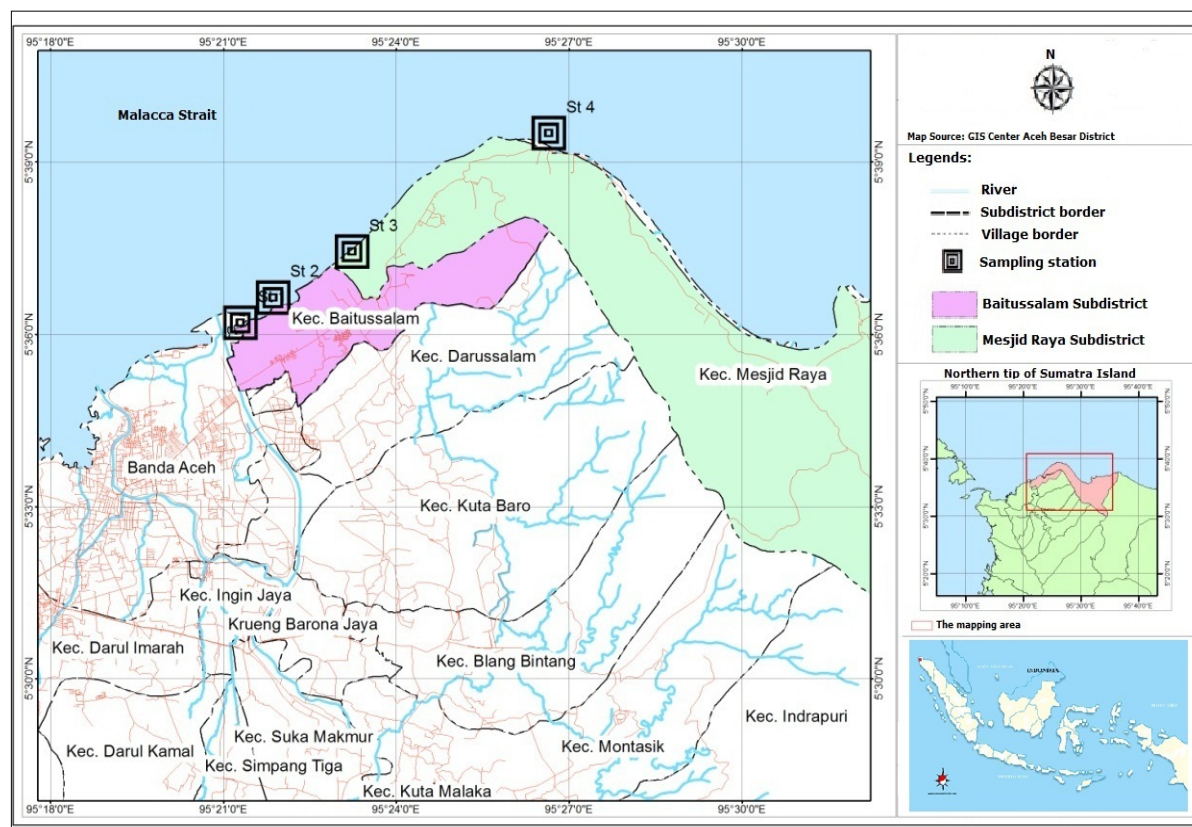


Figure 1. The map of western coast of Aceh Besar District showing sampling areas. The black squares are sampling sites.

Table 1
Sampling locations along of western coast of Aceh Besar District and its characteristics

Location	Coordinates	Characteristics
Cut River Mount (Baitussalam subdistrict)	5°36'0"N, 95°21'0"E	Mangrove forest area, Lamnyong and Cut River mounts, aquaculture pond areas
Kajhu Village (Baitussalam subdistrict)	5°37'0"N, 95°22'0"E	Mangrove forest, Neuheun River mouth
Neuheun Village (Mesjid Raya subdistrict)	5°38'0"N, 95°22'0"E	Mangrove forest, Kuala Gigieng estuary areas
Ujung Batee Village (Mesjid Raya subdistrict)	5°40'0"N, 95°27'0"E	Mangrove forest

Gastropods sampling. Transect method was used in this study. A total of three transects were determined randomly. The transect was 20 m in length and 10 m width perpendicular to the shoreline. The distance between transects were 2 m interval and every transect has three plots (1 m x 1 m) as representative of tidal conditions; first plot was inundated at high and low tides, the second plot was inundated at high tide and dry

at low tide, and the third plot was always dry during both high and low tides (nine plots totally at every transect).

The sediment at every plot was taken into 30 cm depth then filtered with two levels sieve (0.25 mm and 1.00 mm) to collect the gastropods. Collected gastropods were washed and preserved in 70% alcohol then transported to Laboratory of Zoology, Syiah Kuala University, Banda Aceh for further analysis. Gastropods were identified based on Dance (1992) and Dharma (1992). The species and density of mangrove were also recorded at the same time at every sampling location and the species of mangrove was identified based on Bengen (2000).

Data analysis

Frequency of incidence. The frequency of incidence (Fol) of each species was estimated according to Muchlisin & Siti-Azizah (2009) as follows: $Fol = N_{i.St} / N.St \times 100\%$, where, $N_{i.St}$ = the total number of locations where the species *i* was found, $N.St$ = the total number of sampling locations.

Diversity index. The Shannon-Wiener diversity of gastropod was calculated as follow:

$$H' = - \sum_{i=1}^S P_i \ln P_i$$

where: H' = Shannon-Wiener diversity, n_i = total individuals of species-*i*, N = total number of individuals of all species, $P_i = n_i/N$. According to Odum & Barret (2004) the Shannon-Wiener diversity index is classified into three levels: low ($H < 2$), moderate ($2 < H < 4$), and high ($H > 4$).

Dominance index. The Simpson dominance index was calculated based on Odum & Barret (2004) as follow:

$$D = \sum_{i=1}^S (p_i)^2 = \sum_{i=1}^S \left(\frac{n_i}{N}\right)^2$$

where: C = Simpson dominance index, S = total species, n_i = total individual of species-*i*, N = total number of individual of all species, $P_i = n_i/N$. The categories were, $0 < C \leq 0.5$ is low dominance; $0.5 < C \leq 0.75$ is moderate dominance; $0.75 < C \leq 1.00$ is high dominance.

Type of sediment and C-organic. Samples of sediment were collected at every sampling location with 30 cm depth from the surface to inside. The composition of sediment particles were analyzed using shieve shaker based on Baron & Clavier (1992), while the C-organic were determined using gravimetry method based on Suin (2002).

Results and Discussion. A total of 15 species of gastropods belonging to 7 families were recorded during the study. *Terebralia sulcata* (Potamididae) was the predominant gastropod along the western coast of Aceh Besar district. This species was found in all of sampling locations, while the lower abundance was *Nerita maxima* (Neritidae). This species was only found in station IV (Ujung Batee village). Based on genera, *Terebralia* was also predominant with three species members, followed by *Cerithidea* (2 species), *Cerithium* (2 species) and *Nerita* (2 species). In general the Fol of gastropods was higher because most of the species were found in all of the sampling locations except for *Nerita nigrita* and *N. maxima*, where these species were only found at one station (station IV). Based on the sampling station, the study revealed that station IV has high species richness, while low species richness was found in station III (Neuheun village); however, the higher total at individual gastropods was found at station I (Alue Naga Village) where *Rhinoclavis aspera* and *T. sulcata* were predominant at this station (Table 2).

The study also recorded 12 species of mangroves which belonged to 9 families where *Rhizophora* was the predominant in species and genera; it occurred in all of the sampling locations. Fol of mangroves was 100%, which indicates that all species occurred at all sampling locations; however higher total individual was found at station IV in Ujung Batee Village (Table 3).

Table 2

Abundance of gastropods in western coast of Aceh Besar District, Indonesia according to sampling station

Species	Family	Stations (Ind/m ²)				Σ Individual	Fol (%)
		I	II	III	IV		
<i>Pseudovertagus aluco</i>	Cerithiidae	143	12	4	6	165	100
<i>Cerithidea alata</i>	Cerithiidae	21	6	298	57	382	100
<i>Cerithidea cingulata</i>	Cerithiidae	120	260	8	67	455	100
<i>Cerithium columna</i>	Cerithiidae	5	189	6	67	267	100
<i>Cerithium nodulosum</i>	Cerithiidae	81	10	14	104	209	100
<i>Rhinoclavis aspera</i>	Cerithiidae	396	12	4	40	452	100
<i>Conus striatellus</i>	Conidae	2	11	5	6	24	100
<i>Cymbiola nobilis</i>	Volutidae	0	1	0	3	4	60
<i>Cypraea interrupta</i>	Cypraeidae	5	4	4	9	22	100
<i>Nerita maxima</i>	Neritidae	0	0	0	3	3	25
<i>Nerita nigrita</i>	Neritidae	8	11	5	6	30	100
<i>Papuina translucida</i>	Camaenidae	0	0	0	9	9	25
<i>Telescopium telescopium</i>	Potamididae	130	96	44	298	568	100
<i>Terebralia</i> sp.	Potamididae	286	26	11	9	332	100
<i>Terebralia palustris</i>	Potamididae	32	310	167	37	546	100
<i>Terebralia sulcata</i>	Potamididae	395	279	398	289	1361	100
Total individual		1624	1227	968	1010	4829	
Total species		13	14	13	16		

I = Alue Naga Village, II = Kajhu Village, III = Neuheun Village, IV = Ujoeng Batee Village, Fol = Frequency of incidence.

Table 3

Abundance of mangrove in western coast of Aceh Besar District, Indonesia according to sampling station

Species	Family	Stations (Ind/m ²)				Σ Individual	Fol (%)
		I	II	III	IV		
<i>Avicennia marina</i>	Avicenniaceae	17	15	10	10	52	100
<i>Bruguiera gynorrhiza</i>	Rhizophoraceae	13	10	18	22	63	100
<i>Ceriops tagal</i>	Rhizophoraceae	12	10	6	1	29	100
<i>Rhizophora apiculata</i>	Rhizophoraceae	14	18	23	15	70	100
<i>Rhizophora mucronata</i>	Rhizophoraceae	20	22	24	24	90	100
<i>Nypa fruticans</i>	Arecaceae	1	1	5	9	16	100
<i>Sonneratia alba</i>	Lythraceae	2	2	2	13	19	100
<i>Xylocarpus granatum</i>	Meliaceae	2	1	1	1	5	100
<i>Ipomea pes-caprae</i>	Convolvulaceae	12	18	15	26	71	100
<i>Calotropis gigantea</i>	Asclepiadaceae	2	12	16	17	47	100
<i>Melastoma candidum</i>	Melastomataceae	2	4	13	13	32	100
<i>Pandanus tectorius</i>	Pandanaceae	10	6	3	6	25	100
Total individual		107	119	136	157	519	100
Total species		12	12	12	12		

I = Alue Naga Village, II = Kajhu Village, III = Neuheun Village, IV = Ujoeng Batee Village, Fol = Frequency of incidence.

The Shannon-Wiener diversity index of gastropods ranged between 1.549 to 2.036, where the highest diversity was found at station IV (Ujung Batee Village) and the lowest diversity was found at station III (Neuheun Village). In general the average diversity of gastropods along the western coast of Aceh Besar District was 1.834, which indicates low category. The dominance index of gastropods ranged between 0.177 to 0.288, with an average value of 0.224, and indicates low dominance (Table 4). The analysis of sediment showed that one station has sandy loam (dominant clay) and three stations have characteristics of argillaceous sand (dominant sand) where the sandy loam sediment had a higher rate of C-organic compared to argillaceous sand sediment (Table 5).

The study revealed that station I has a higher number of individual (abundance) gastropods while the total number of species (species richness) was highest at station IV (Ujung Batee Village). However, in general the diversity indices of gastropods along

western coast of Aceh Besar District were of a low category. This study indicates that the abundance of gastropods was dependent on the sediment type in relation to food availability as shown in station I (Alue Naga Village). The predominant species of gastropods of western coast of Aceh Besar District was *T. sulcata*. It was probably due to this species having high adaptation on the variability of environmental conditions such as type of sediment and salinity.

Table 4

The Shannon-Wiener diversity index (H') and dominance index (C) of gastropoda and mangrove according to sampling locations

Sampling locations	Shannon-Wiener diversity index (H')	Dominance index (C)
Alue Naga Village	1.943	0.177
Kajhu Village	1.810	0.233
Neuheun Village	1.549	0.288
Ujong Batee Village	2.036	0.197
Average	1.8345	0.224

Table 5

Type of sediment and C-organic contents according to sampling location of western coast of Aceh Besar District

Sampling locations	Soil textures			Sediment type	C-organic content (%)
	Sand	Silt	Clay		
Alue Naga Village	152.89	54.89	32.66	Sandy loam	2.006
Kajhu Village	191.22	24.33	33.11	Argillaceous sand	1.296
Neuheun Village	195.44	22.22	16.66	Argillaceous sand	1.163
Ujong Batee Village	184.89	28.89	19.22	Argillaceous sand	1.486

In general the gastropods are detritus feeders; they grow well in substrate with high organic matters as recorded in station I. According to Georgiev et al (2009) the abundance of gastropods is subject to the availability of food such as detritus and macro-algae, and they prefer habitats which are protected from currents, waves and direct sunlight (Zamprognio et al 2013; Davie & Sumardja 1997; Gilman et al 2006). In addition, types of sediment and size of sediment particles strongly affects the total abundance of gastropods (Ahn & Choi 1998; Thorin et al 2001). In general the grain size of sediments is affected by current and waves, where small particles were mostly settled on waters with weak currents (Purnawan et al 2012).

The higher abundance was found at station I. This station has sediment type of sandy loam with high C-organic content, which indicates this station has higher organic matter which is needed by gastropods for food. According to Barnes (1987) muddy areas are an ideal habitat for gastropods, because the availability of abundant food. The predominant species of gastropods was *T. sulcata*, this species being found at all of the sampling locations in nearly the same abundance. It indicates that *T. sulcata* can live and grow well in sandy loam and argillaceous sand sediments.

N. nigrita and *N. maxima* have low abundance and are only found at station IV (Ujung Batee Village); this station has characteristics of higher density of mangrove resulting in more shade and shelter. We suspect both species have difficulties to adapt to extreme environmental conditions, therefore they prefer the location that has dense mangrove canopies as recorded in station IV. High density mangroves are an ideal shelter for aquatic animals, because it provides shelters that protect them from interference by physical and biological parameters such as predation, competition, light intensity and hydrodynamics.

This study indicates that the gastropods communities along the western coast of Aceh Besar District were in threatened condition. This is due to decrease of mangrove areas in this region. Our field observation showed most of the mangrove areas have been converted to aquaculture ponds and settlement areas as is the case in other places in Indonesia (Raharja et al 2014). The expansion of aquaculture pond intensively occurred

during 1970a to 1980a (Muchlisin 2012), unfortunately at the expense of existing mangrove forests. Therefore, it is very necessary to plan a conservation strategy to conserve the coastal ecosystem of Aceh Besar, Indonesia.

Conclusions. The diversity index of gastropods in western coast of Aceh Besar District was at low category, where *T. sulcata* was the predominant species in this region. The abundance of gastropods along the western coast of Aceh Besar District was affected by type of sediment where sandy loam sediment with high C-organic content had higher abundance; however the species richness was not affected by type of sediment.

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