Benthic Molluscs Communities in the Intertidal Coast of Tanimbar Islands, West Southeast Mollucas
(Komunitas Moluska di Pantai Pasang Surut Kepulauan Tanimbar, Maluku Tenggara Barat)

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ABSTRACT

This paper presents the results of a survey on intertidal molluscs in 3 habitats (Seagrass bed, coral reef, and sandflat) in Tanimbar Islands of West South-east Moluccas, Indonesia. Six relatively large and two small islands were attained to perform 125 plots of 34 stations. Molluscs' diversity in each habitat were calculated using Shannon-Wiener formulation whereas Mann-Whitney formulation for comparing between habitats. Multivariate analyses for clustering of PAST 2.17 was utilized to further the analyses. A number of 101 species gastropods (26 families) and 51 species of bivalves (19 families) were recorded. Seagrass bed was inhabited by 100 species, followed by coral reef by 85 and sandflat by 44 species. Shannon-Wiener indexes for molluscs' diversity range in seagrass was 0.39 to 1.29, in coral was 0.27 to 1.14 and in sandflat was 0.52 to 0.99. Clustering analyses for stations revealed that three stations in seagrass were the most dissimilar, followed by one station in coral due to habitat. Clustering analyses for species found four dissimilar groups of molluscs, whereas a group has many consimilar members.

Keywords: Seagrass, coral, sandflat, diversity, clustering

ABSTRAK

Makalah ini menyajikan hasil survei moluska intertidal di 3 habitat (padang lamun, terumbu karang, dan rataan pasir) di Kepulauan Tanimbar, Maluku Tenggara Barat, Indonesia. Survey dilakukan di enam pulau yang relatif besar dan dua pulau kecil dengan jumlah 125 plot dari 34 transek. Keragaman moluska di masing-masing habitat dihitung dengan menggunakan formulasi Shannon-Wiener sedangkan formulasi Mann-Whitney untuk membandingkan antara habitat. Analisis pengelompokkan dari PAST 2.17 digunakan untuk analisis lebih lanjut. Survey telah mencatat 101 spesies gastropoda (26 famili) dan 51 spesies bivalvia (19 famili). Padang lamun didiami oleh 100 spesies, diikuti oleh terumbu karang sebesar 85 dan rataan pasir oleh 44 spesies. Indeks Shannon-Wiener untuk keragaman moluska di padang lamun sebesar 0,39-1,29, di karang sebesar 0,27-1,14 dan di rataan pasir 0,52-0,99. Analisis pengelompokkan menunjukkan bahwa akibat perbedaan habitat, tiga stasiun di padang lamun adalah yang paling berbeda, diikuti oleh satu stasiun di terumbu karang. Analisis kluster untuk spesies menemukan empat kelompok moluska yang berbeda, sedangkan kelompok memiliki banyak anggota yang serupa

Kata Kunci: lamun, karang, pasir, keanekaragaman, pengelompokkan

INTRODUCTION

Moluccas Province of Indonesia (now Moluccas and North Mollucas Provinces) is largely consist of marine area, approximately 90% of it is seawaters. Correspondingly, the province has at least 6.000 mile (11.000 km) of coastal area. That lengthy area is mostly contributed by thousands of islands, mostly small islands. Accordingly, West Southeast Mollucas is in not different situation with the rest of area. It consists of vast area of seawaters dotted by small islands. Consequently it also has an extensive coastal area with extended coastline. Four main types of the tidal environment in the area are coral reef, sea-grass bed, mangrove, and sandflat. They occur patchy in the surveyed areas

Tanimbar Islands is a part of West Southeast Mollucas. The Islands, consists of 66 islands, is run NNE to SSW occupy an of 120 Km length to 60 Km breadth (Kaye 1989) or similar with 5,440 sq km Banda Sea. The survey was

conducted in six relatively large islands namely Larat I., Fordate I., Wuliaru I., Selu I., Seira I., and Selaru I (Figure 1). All of the islands are relatively flat by average elevation is 50 m with some low hills in the central part. Tanimbar Islands is influenced by two seasons, east dry season (April-October), and west rainy season (November-March). The total rainfall for the Islands in 1985-1991 ranged from 1,499-3,310 mm with the mean annual temperature is 27°C and variation between monthly means is less than 1-2 °C (Purwanto 2002)

The interior of island is overgrown by virgin lowland deciduous forest. Towards the coast, freshwater swamp dominated by oncosperma forms the transition zone to extensive areas of mangrove forests fringed by tidal mudflats. Mangrove of *Rhizophora stylosa*, *Ceriops tagal*, *Bruguiera gymnorrhiza* and *Avicennia alba* composed the coastline of Tanimbar. Some of the islands are surrounding by sandflat with seagrass bed on it.

The complex environments in the area are home of many marine organism communities with their mutual connection. It is not doubted the circumstance is interesting to be understood. However, our understanding on the communities has been severely handicapped by the lengthy coastline and the scarcity of marine biologist in the area. As a start for obtaining the knowledge about marine coastal communities of the area, the Division for Marine resources of Center of Oceanology Research and Development (now the Research Center for Deep Sea)-LIPI Ambon in conjuction with the Research Center for Geotechnology)-LIPI Bandung, the Research Center for Biology-LIPI Bogor, the Research Center for Population - LIPI Jakarta, the Marine Geological Institute of Indonesia Bandung conducted an expedition to Tanimbar Islands by using RV Baruna Jaya VII for 25 days (9 Oct. - 2 Nov. 1998). The teams has many interest such as geology, marine geology, botany, inhabitant demography, and marine biology. This paper only presented the result for the marine mollusc study during the expedition.

MATERIALS AND METHODS

Snails were sampled in three different habitat types i.e seagrass, coral, and sandflat, no attempt was made to classify the substrate. The seagrass is an intertidal area grown by seagrass which is mostly dominated by *Enhalus accoroides* in association with *Thalasia* sp. and *Siringodium* sp. Landward, the seagrass is often in circumference with mangrove dominated by *Rhizophora stylosa* (Pulumahuny 2003). The coral is refer to sandy area which occur patchy in coral reef area. Small seagrass such as *Thalasia* can be found sparse and irregular on the sand. Most of the area are relatively small approximately 2-5 m^2. the sandflat, on the other hand, is a fast area in the intertidal area. This area is grown by no plant.

A number of 34 stations were deployed in this research. In each station, a line transects that perpendicular to the general coastline were established in this research. All the lines were put to use in and below the intertidal area down to a 1.2m depth, a workable depth. In each transect, 3-7 plots of 10 m distant to were established. Plots of 0,5 m x 0,5 m iron frame was laid at every 10 m along the transects. Researchers dug the sediment layer in the frame of approximately 30-cm depth by using shovel and transfered the materials into a 500 µm sieve in order to separate the snails from the sediments. Snail samples were picked up and

Figure 1. Map of Tanimbar Islands in Indonesia. Red dots were research stations

stored in plastics bags. All specimen were preserved in a 10% formalin solution. Bags of snail samples were transferred to laboratory in Division for Marine Resources R&D of Indonesian Institute of Sciences (LIPI) in Ambon.

In the laboratory, all specimen were washed, sorted, counted, and identified to species level manually. All specimens have been catalogued and are housed in reference collection of the Division for Marine Resources R&D of Indonesian Institute of Sciences (LIPI) in Ambon.

A matrix of species composition was built to analyse the molluscs comunities in 3 habitat types and the pooled snail numbers were transfered to Shannon-Wiener indexes (Odum 1971) calculated manually by using of Microsoft Excell 2010. Comparison between habitats was done by applying Mann-Whitney. A PCA and a cluster for plots (Euclidian distance) were performed using PAST 2.17 (PAleontological STatistics, Norway) to advance the analyses.

RESULTS

Mollusc assemblages

We recorded 152 species of intertidal molluscs in the 125 plots sampled, consisted of 101 species gastropods (26 families) and 51 species of bivalves (19 families). Table 1 gives a list of mollusc species collected from all locations with their numbers. Most of the molluscs were live in seagrass bed environment (100 species), whereas in coral and sandflat were inhabited by 85 and 44 species respectively. The molluscs inividual number is in the same order as seagrass bed (886 individu), coral reef (538 individu) and sandflat (154 individu).

The 10 largest densities of the mollusc in each type of habitat were shown by table 2 below. *Tellina* sp. 1 is represented in all habitat types.

Calculation of Shannon-Wiener indexes on each station in seagrass, coral, and sandflat habitats are range from 0.39 to 1.29 (average 0.89, std 0.30), 0.27 to 1.14 (average 0.74, std 0.32), and 0.52 to 0.99 (average 0.81, std 0.17) respectively. Furthermore, comparison the indexes among habitat tipes for similarity, revealed in the Table 3 below, stated that only seagrass and coral significantly similar at 5% level of confidence. The others are unsignificant.

The results of stasion cluster analysis shown in Figure 2. A number of 4 grouping habitat at a similarity level of 110 point were generated. The most distant or dissimilar is Larat4L, followed by Larat6L and Seira14L. All of them are seagrass meadows. Wotap 16C as the last one is a coral habitat. The rest group consists of a mixture of various habitats in all the islands. Larat4L occupied by 164 individuals, whereas Larat6L inhabited by 155 individuals, Seira14L by 106 individuals, and Wotap 16C by 74 individuals.

The results of species cluster analysis shown in Figure 3, reveals 5 groups of species; two of them are single species i.e. *Cerithium celebrasum* and *Tellina* sp1. in group 1 and 2. Groups 3 consists of two species specifically *Cerithium traillii* and *Clypeomorus bifasciata*. A cluster of many species constitutes group 4. Group 5 contains six species members namely *Rhinoclavis vertagus*, *Smaragdia rangiana*, *Cerithium munilum*, *Mitrella puella*, *Euchithara arenivaga*, and *Eucithara* sp.

DISCUSSION

Mollusc assemblages

The largest number of species is closely related to the magnitude of the sub-ecosystem where they were inhabit. In seagrass habitat,

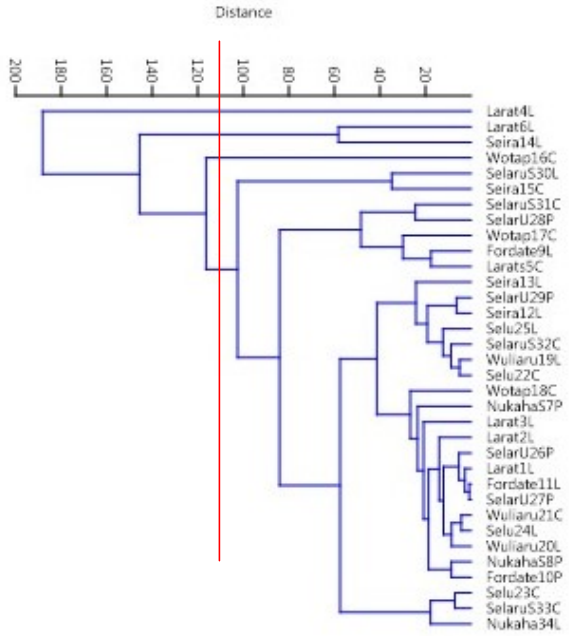

Figure 2. Dendrogram of station cluster analysis using Euclidean distance for molluscs species that found in Tanimbar Islands. Red vertical line = 110 similarity point

Table 1. Species composition and its number in each habitat type

No.	Species	Sg	Cr	Sf	Total	No.	Species	Sg	Cr	Sf
1	*Smaragdia rengiana*	91	63	2	156	76	*Vexillum rugosum*	2	1	
2	*Attactodea striata*	21	120	4	145	77	*Drupella ochrostoma*	3		
3	*Tellina sp1*	92	12	22	126	78	*Morula margariticola*		3	
4	*Cerithium celebrasum*	120			120	79	*Hebra corticata*		3	
5	*Clypeomorus bifasciata*	13	42		55	80	*Nassarius arcularius*	1		2
6	*Euchitara celebensis*	42	13		55	81	*Strombus luhuanus*		3	
7	*Vexillum cruentatum*	36	17		53	82	*Anadara antiquata*	2		
8	*Euchitara arenivaga*	37	10		47	83	*Barbatia amigdalustomum*			2
9	*Anadontia edentula*	12	27	6	45	84	*Glycymeris pedunculus*		2	
10	*Tellina staurella*	14	23	8	45	85	*Lutraria sp.*	2		
11	*Nassarius globosus*	3	38	4	45	86	*Semele sp.*	2		
12	*Cerithium traili*	38	1		39	87	*Gafrarium tumidum*		2	
13	*Donax faba*	19	8	4	31	88	*Tapes litteratus*		2	
14	*Mitrella puelia*	29	2		31	89	*Timoclea marica*	1	1	
15	*Rhinoclavis vertagus*	5	3	22	30	90	*Clypeomorus moniliferus*		2	
16	*Cerithium zonatum*	22	2	1	25	91	*Pyrene ocellata*		2	
17	*Pyrene versicolor*	19	3		22	92	*Peristernia nasatula*			2
18	*Anadara scapha*	19	1		20	93	*Mitra bacillum*	2		
19	*Fragum unedo*	9	8		17	94	*Mitra retusa*			2
20	*Tellina sp3*	15			15	95	*Nassarius margaritiferus*	2		
21	*Cyprea annulus*	4	5	5	14	96	*Natica uezona*	2		
22	*Phasianella aethiopica*	9	5		14	97	*Natica undulata*	2		
23	*Cerithium rostratum*	11	2		13	98	*Pyramidella sp.*		2	
24	*Cerithium munilum*	11			11	99	*Barbatia decussata*	1		
25	*Strombus labiatus*	6	5		11	100	*Chama refexa*	1		
26	*Cathalotia sp.*	11			11	101	*Fimbria fimbriata*	1		
27	*Codackia tigerina*	6	4		10	102	*Gari sp.*	1		
28	*Modiolus micropterus*	6	2	1	9	103	*Meropesta sp.*	1		
29	*Athys cylindricus*	4	5		9	104	*Davila plana*			1
30	*Strombus urceus*	9			9	105	*Pinna muricata*	1		
31	*Mactra grandis*	5	3		8	106	*Spondilus versicolor*	1		
32	*Tellina gargadia*	6	2		8	107	*Tellina parvitas*	1		
33	*Tellina sp2*	3	4	1	8	108	*Tellina radians*		1	
34	*Tellina virgata*	4	3	1	8	109	*Marcia hiantica*		1	
35	*Bulla ampulla*	6	2		8	110	*Pitar subpellucidus*	1		
36	*Nasarius pullus*			8	8	111	*Casmaria erinaclus*	1		
37	*Nerita violacea*	3		5	8	112	*Cerithium aluco*		1	
38	*Trachycardium rugosum*	3	4		7	113	*Cerithium moniliferus*	1		
39	*Cerithium columna*		6	1	7	114	*Rhinoclavis aspera*	1		
40	*Mitra cucumerina*			7	7	115	*Pyrene testudinaria*			1
41	*Clavus unizonalis*	1	5	1	7	116	*Conus capitaneus*			1
42	*Ctena bela*	1	4	1	6	117	*Conus magus*			1
43	*Pinctada margaritifera*	4	1	1	6	118	*Conus marmoreus*		1	
44	*Gafrarium pectinatum*	3		3	6	119	*Conus virgo*		1	
45	*Engina alveolata*	4	2		6	120	*Conus sp.*		1	
46	*Engina zonalis*			6	6	121	*Vexillum leucodesmum*		1	
47	*Cyprea errones*	6			6	122	*Vexillum plicarium*	1		
48	*Nassarius*	2	2	2	6	123	*Vexillum vulpecula*		1	
49	*Pyramidella sulcata*	2		4	6	124	*Vexillum sp.*		1	
50	*Euchitara sp.*	4	2		6	125	*Cymatium pileare*	1		
51	*Trachycardium subrugo*	3	2		5	126	*Haliotis varia*			1
52	*Maleus maleus*	5			5	127	*Pteryaya undulata*		1	
53	*Pitar manillae*	5			5	128	*Drupa glossularia*	1		
54	*Pitar pellucidus*	3	2		5	129	*Maculotriton seriala*		1	
55	*Cerithium sp2*		5		5	130	*Morula funiculus*	1		
56	*Nassarius calospira*	5			5	131	*nassarius crenoliratus*	1		
57	*Nassarius subspinora*			5	5	132	*Nassarius horridus*		1	
58	*Polinices sebae*	1	4		5	133	*Natica qualteriana*			1
59	*Umbonium guamensis*	2		3	5	134	*Natica fasciata*			1
60	*Gari squamosa*	3	1		4	135	*Natica onca*			1
61	*Leptomya psicatus*	2	2		4	136	*Natica vittelus*		1	
62	*Tellina crucigera*	4			4	137	*Eunaticina papilla*	1		
63	*Tellina linguafelis*	4			4	138	*Nerita albicilla*		1	
64	*Engina mendicaria*		4		4	139	*Oliva tesselata*		1	
65	*Conus coronatus*		2	2	4	140	*Oliva oliva*		1	
66	*Conus sponsalis*			4	4	141	*Milda ventricosa*		1	
67	*Cyprea moneta*	1	3		4	142	*Terebra sp.*	1		
68	*Nassarius coronatus*	4			4	143	*Hastula hetica*	1		
69	*Polinices pyriformis*	2	2		4	144	*Tectus fenestratus*			1
70	*Vasum turbinellum*		4		4	145	*Euchellus atratus*		1	
71	*Atrina vexillum*	2	1		3	146	*Trochus maculatus*	1		
72	*Tellina capsoides*	2	1		3	147	*Turris crispa*		1	
73	*Tellina palatam*	2	1		3	148	*Vanikoro cancellata*	1		
74	*Cerithium sp1*			3	3	149	*Cymbiola vespertillio*	1		
75	*Vexillum exasperatum*	2	1		3		Total	886	538	154

Remarks: Sg= Seagrass, Cr= Coral reef, Sf= Sand flat

Table 2. The ten species reach the highest density in each habitat type

Habitat types					
Seagrass		**Coral**		**Sandflat**	
Species	**Den.**	**Species**	**Den.**	**Species**	**Den.**
Cerithium celebrasum	7.50	*Atactodea striata*	14.70	*Rhinoclavis vertagus*	3.14
Tellina sp1.	5.75	*Smaragdia rengiana*	5.73	*Tellina sp1.*	3.00
Smaragdia rengiana	5.69	*Clypeomorus bifasciata*	3.82	*Tellina staurella*	1.14
Euchitara celebensis	2.69	*Nassarius globosus*	3.45	*Nassarius pullus*	1.14
Euchitara arenivaga	2.44	*Anodontia edentula*	2.45	*Mitra cucumerina*	1.00
Cerithium trali	2.38	*Tellina staurella*	2.09	*Anodontia edentula*	0.86
Vexillum cruentatum	2.25	*Euchitara celebensis*	1.18	*Engina zonalis*	0.86
Mitrella puella	1.81	*Tellina sp1.*	1.09	*Cyprea annulus*	0.71
Cerithium zonatum	1.44	*Euchitara arenivaga*	0.91	*Nassarius subspinora*	0.71
Atactodea striata	1.31	*Donax faba*	0.82	*Nerita violacea*	0.71

Tabel 3. Comparicon for biodiversity indexes in each habitat type using Mann-Whitney test

	Seagrass	**Coral**	**Sandflat**
Seagrass	-	significant	unsignificant
Coral	153	-	unsignificant
Sandflat	67	40	-

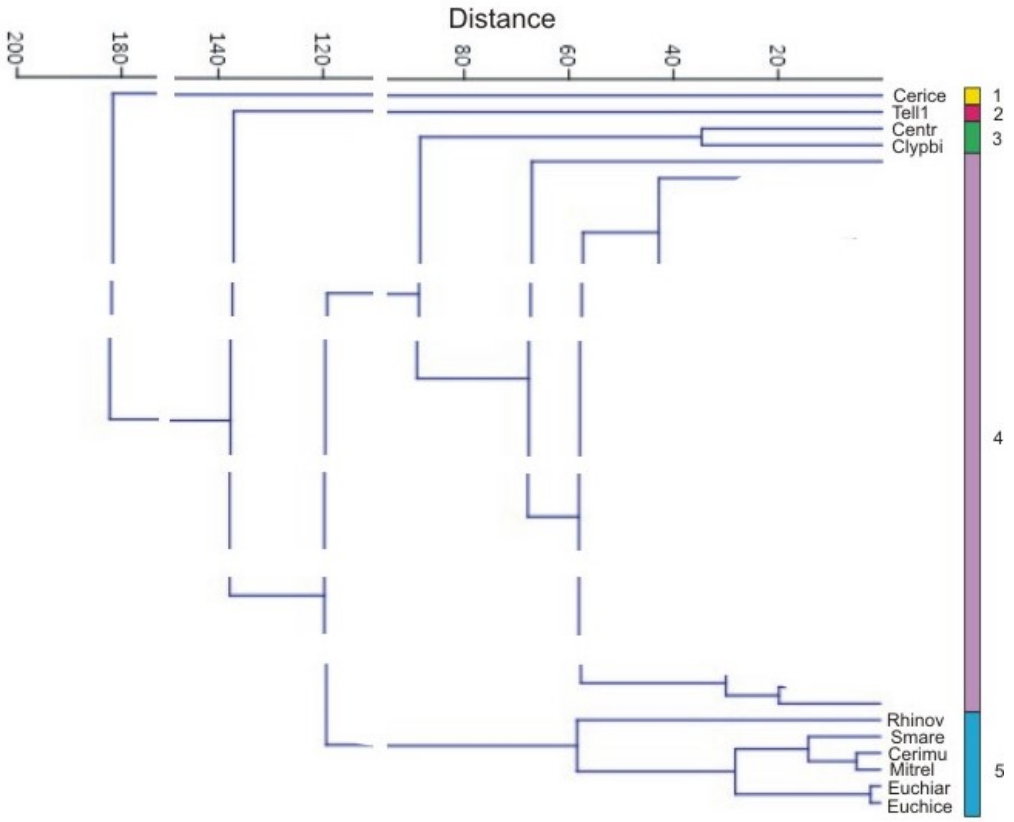

Figure 3. Dendrogram of species cluster analysis using Euclidean distance for molluscs that found in Tanimbar Islands. Red vertical line = 80 similarity point. In the interest of conspicuousness the members of groups 4 were erased

molluscs were found alive clinging on seagrass leaf surface, on the sidelines of seagrass leaf armpit, above the base surface waters and in the bottom of the water itself. While in other habitats, they are located just above the surface of the base or in bottom waters. Since they live in different places or different niche that serve the different necessities, the competition between inhabitants can be reduced as low as possible. Even farther, more species can be accommodate in the very same places. This was also confirmed by Frith (1977) who studied in mainland Thailand mangrove forest with small islands in the vicinity.

Only a few species have high individual number, among which are *Smargdia rengiana*, *Atactodea striata*, and *Telina* sp. 1 and *Cerithium selebrasum* (Table 2). *S. rengiana* is a small-sized snail (± 5 mm) and live attached on the leaves of seagrass. The space on seagrass leaves for *rengiana* is very large because the leaf can be occupied on both sides at once. Therefore, space is not a limiting factor for this species. In addition, the vertical seagrass leaves in the water column made the oxygen-bringing seawater pass freely, therefore the supply of oxygen to the snails are actually unlimited. This is coupled with the oxygen produced by photosynthesis of seagrass itself. The leaves itself is a good protector for the snails from predation. Wave factors by itself can be eliminated because generally seagrass growth in calm water or slightly wavy. Moreover, snail nourishment in the form of epiphytic diatoms, filamentous and calcareous algae encrusting on the leaf surface of the plant available in abundance.

Atactodea striata is a shellfish that live buried themselves in the sand at the sea surface boundary. These mussels were able to migrate to follow the rise and fall of the water level. When the water reaches it, these shells will emerge upwards out of place and move with the water. Shortly before the water recedes they will soon bury himself again in such a manner that these shells ensures the availability of water, which means the availability of oxygen to him. Wave in this case is not a limiting factor for these types of shellfish. The oxygen content is always abundant in water where shellfish live because of the agitation of the water when the tide occurs. When the waters swept the sand surface, also carried by microorganisms contained in the surface of the sand so as a "filter feeder", these shells also get food in abundance. The movement in the same way is also dedicated to finding a partner and shelter. Therefore, for animals with high motion ability, movement activities for exploration, food, spawn, escape, and the shelter is a daily activity (Creutzberg 1975) and ultimately affect the abundance and distribution of species (Underwood 1977). Of the two examples, it can be concluded that when oxygen and food as necesities is abundant, life quality will increase and it is reflected in the species number or individual number.

Molluscs diversity

Shannon's highest index is found in station 3 of Larat Island. This station is located in the seagrass meadow area in front of the mangrove forest. The dense seagrass in this area consists of 3 types of *Enhalus acoroides*, *Thalassia*, and *Siringodium*. Such areas are highly productive (Odum 1971) since sufficient oxygen is supplied by seagrasses, while the food is also supplied by mangrove plants behind it in the form of litter beside from the meadows itself. It is an ordinary thing about an exchange of mangrove-derived productivity to other areas in the estuary (Bouillon *et al*. 2008). This condition created the areas occupied by many molluscs species and in the long run constructed an advanced molluscs biodiversity area. There is no dominance species in this area even though many species have close kinship as the result of adaptive radiation since they occur in different niche.

Molluscs' diversity (represented by the Shannon Index) in sandflat is significantly opposite with what found in seagrass and coral environment even it is not unussual that sandflats in Tanimbar Islands were populated by a few species molluscs. Heryanto & Radjab (2014) found a single species of bivalve in a fast area of sandflat of Yamdena Island, whereas this survey I found 154 molluscs' species in sandflat , 886 and 538 species in seagrass and coral respectively. A similar founding also

stated by Barnes & Barnes (2012) and Barnes (2017) in seagrass and sandflat. Also, disturbance on sandflat inhabitants lead to less variable faunal assemblages (Corte *et al*. 2017 and Thrush *et al*. 1991).

With the assumption that the seawater of adjacent stasion positions were almost the same, chemically and physically, it is most likely that vegetations were determinant of molluscs occurence even in the same sandflat as it is also found by Barnes (2017), Reich (2014), and Vonk *et al*. (2010). Only certain molluscs are able to live and survive on sand because of the harsh environment of the solid substrate, usually without vegetation (open), and large waves. At the water and beach border can be found *Donax faba* capable of moving following the swash. Beneath it, in a constantly submerged environment, found *Barbatia amigdalustostum*, *Engina zonalis*, *Pyrene punctata*, *P. testudinaria*, *Natica gualteriana*, *N. fasciata*, and *N. onca*.

Base on station' cluster analysis, it was obvious that stations in seagrass meadow were the most dissimilar (Figure 2.) since they sustain enormous number of molluscs species. It is acknowledged previously, seagrass meadow has more spaces could be occupied by molluscs by reason of supply food and stabilized shelter (Barnes 2017). On the other hand, stations in coral reef were less dissimilar due to the molluscs in the assemblages were more rely on coral substrats.

By cluster analysis, snail *Cerithium celebrasum* is the most dissimilar at >180 point since it packs 120 speciments in only one station of seagrass meadows. This snail lives in the sand and scavenge remnant of everything for its life. The second most dissimilar of *Tellina* sp1. most probably it adheres in 10 stations with 117 specimen. This bivalve lives in the sand and as a filter feeder it feed on suspended matter and food particles in the water. From the six members of group 5, only *S. rangiana* lives attach on seagrass leaves, whereas the others are dwell in the muddy sandy bottom of seagrass meadows. Wheresoever the molluscs live in seagrass meadows, the meadows is "the most diverse and highly productive coastal ecosystems in the world" .

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