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Community structure of fish in inner Ambon bay, Maluku, Indonesia

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Abstract
Research to study community structure of fish was carried out during April/May 2014 represented first transition period and during January/February 2015 represented west monsoon at Lateri waters, Inner Ambon bay. Fish samples were collected by using beach seine operating during the night. A total of 31 families that consist of 50 species of fishes were collected during the study in which 27 were pelagic fishes and 23 were demersal species. The most abundant species was represented by *Stolephorus indicus* (>50%) followed by *Leiognathus leuciscus* and *Encrasicholina hetroloba* (pooled > 25%). The highest occurrences of frequency were represented by *Caranx sexfasciatus, Leiognathus equulus* and *S. indicus* (presence=100%), while the lowest were represented by 14 species (12.5%). Shannon diversity indexes (H') for first transition, west monsoon and pooled were 1.57, 1.84 and 1.83, respectively with the Simpson dominance indexes were 0.37, 0.24 and 0.30, respectively. Shannon evenness indexes for first transition, west monsoon and pooled were 0.43, 0.52 and 0.47, respectively. Based on those three indexes it could be concluded that fish community in Inner Ambon bay have moderate diversity with low dominance but in unsteady state. This unsteady state of fish community could be due to high fishing intensity or might be due to environmental degradation of Inner Ambon bay.

Keywords: Fish community structure, abundance, diversity, Ambon bay

1. Introduction
Ambon bay located in Ambon Island, Maluku province is famous not only for its beauty but also for its potential of fishery resources such as fish, crustacean, mollusk and echinoderms [16, 18-20, 26, 27]. This fishery potential occurs because it is supported by three ecosystems i.e. mangrove, seagrass and coral reef which are used as habitat for a number of marine organism including important economical species [7, 12, 21, 26, 27]. Those three ecosystems are used by various marine biotas as spawning area, feeding ground and sanctuary area.
Ambon bay is divided into two parts namely Inner Ambon bay and Outer Ambon bay. Inner Ambon bay or locally known as Teluk Ambon Dalam (TAD) for long time is known as fishing ground for variety of fishes. Some researchers [9, 13, 14, 18, 19, 22-25, 29] have used TAD to study fish resources.
Development due to population increase in Ambon Island will affect environment of Ambon bay, especially TAD which is a semi-closed waters, with an almost round shape and shallow [18]. In fact, degradation has occurred in some part of ecosystem which supports fish resources in TAD as reported by Tuhumury (2008) [28] and Bakarbessy (2014) [4]. Ecosystems degradation could cause some adverse change in community structure of fishes that is associated with them resulting in fish decrease, migrate to other place or extinct [7, 26].
Temporal changes in the associated fish community in TAD have not been well documented. Therefore, this research was conducted to get some recent information on fish resource in TAD by focusing in studying community structure of fish in first transition period and west monsoon.

2. Materials and Methods
2.1. Sampling site
This research was conducted at Lateri waters (3º38' S; 128º14' E) to study community structure of fish in Teluk Dalam Ambon (TAD), Maluku Province, Indonesia (Figure 1).

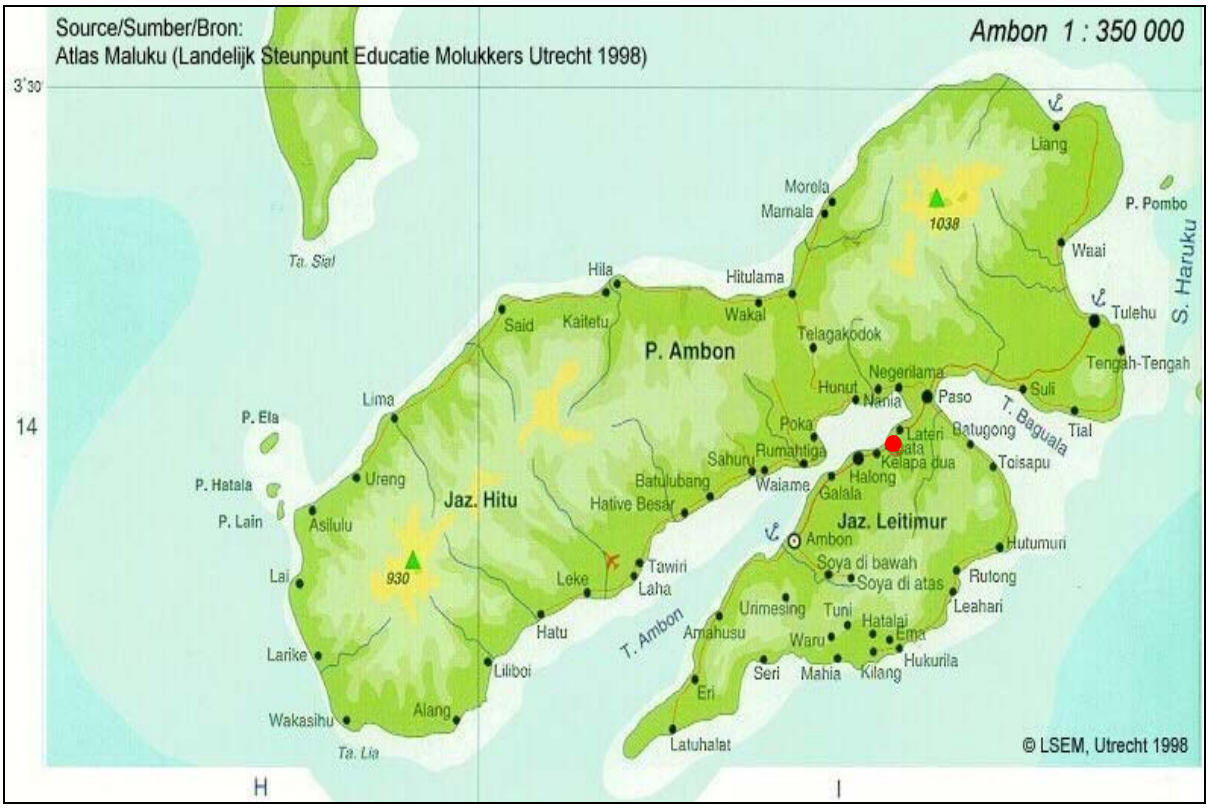

Fig 1: Map showing sampling site (red circle)

2.2. Sample collection and analysis

Sample of fish was collected every two weeks during the night by using beach seine at Lateri waters on April to May 2014 represented first transition period and on January to February 2015 represented west monsoon. Fish samples were identified based on Carpenter and Niem (1999) [5], Allen (2000) [1], Allen *et al*. (2003) [3], Kuiter and Debelius (2006) [8] and Allen and Erdmann (2012) [2]. Subsequently, identified fishes were measured by using a portable digital balance to the nearest gram and then counted individually.

Data were processed with Microsoft Excell program and PAST (Palaentological Statistic) software [6]. T-student test was used to compare fish caught between first transition period and west monsoon. Diversity comparison of fish community for those two periods was also analised by using t-student test proposed by Magurran (1991) [11].

3. Results and Discussion

3.1. Fish biomass

A total of 113.5 kg (mean=14.19 kg; SD=6.94) of fish caught during eight times sampling for first transition period and west monsoon (Table 1). It can be seen in Table 1 that biomass of fish caught in west monsoon is higher than in first transition period. However, t-student test showed that there is no significant difference ($t_{calc.} = 0.37 < t_{table(p=0.05;\ df=3)} = 3.18$) in biomass of fish caught between those two periods.

Table 1: Biomass of fish caught during the study

Season	Biomass (kg)						
	1	2	3	4	Total	Mean	SD
First transition	16.0	18.9	7.0	9.3	51.2	12.80	5.58
West monsoon	7.5	7.0	24.8	23.0	62.3	15.58	9.64
Pooled					113.5	14.19	6.96

3.2. Species composition and number of fish caught

Fifty species of fish which are consist of 27 pelagic species and 23 demersal species belonging to 31 families are caught during fishing operation (Table 2). Based on season, number of species caught in first transition period (23 families, 39 species) > number of species caught in wet season (18 families, 35 species). However, t-student test showed that there is no significant difference in number of species caught between seasons ($t_{calc.} = 0.05 < t_{table\ (p=0.05;\ df=3)} = 3.18$).

Number of species found in first transition period during the study is similar to the number of species found by Syahailatua (2010) [26] in the period of April-May in Inner Ambon bay i.e. 40 species from 16 families.

Table 2: Species composition and number of individual fish caught during the study

No.	Family/Species	Season				Pooled	
		First Transition		West Monsoon			
		Ind.	%	Ind.	%	Ind.	%
I	Acanthuridae						
1	*Acanthurus* sp	0	0.00	3	0.20	3	0.06
II	Apogonidae						
2	*Apogon* sp	37	1.09	8	0.54	45	0.92
III	Atherinidae						
3	*Atherinomorus* sp	45	1.33	8	0.54	53	1.09
IV	Belonidae						
4	*Strongylura* sp	1	0.03	0	0.00	1	0.02
V	Carangidae						
5	*Caranx sexfasciatus*	7	0.21	6	0.40	13	0.27
6	*Selar crumenothalmus*	14	0.41	1	0.07	15	0.31
7	*Atule mate*	2	0.06	3	0.20	5	0.10
8	*Megalaspis cordyla*	1	0.03	0	0.00	1	0.02
9	*Selaroides leptolepis*	0	0.00	4	0.27	4	0.08
VI	Centropomidae						
10	*Lates calcarifer*	1	0.03	0	0.00	1	0.02
VII	Chaetodontidae						
11	*Chaetodon* sp	1	0.03	0	0.00	1	0.02
VIII	Channidae						
12	*Channa striatus*	1	0.03	1	0.07	2	0.04
IX	Clupidae						
13	*Anodontostoma chacunda*	1	0.03	0	0.00	1	0.02
14	*Dussumieria acuta*	55	1.62	0	0.00	55	1.13
15	*Encrasicholina heteroloba*	579	17.05	0	0.00	579	11.86
16	*Herklotsichthys quadrimaculatus*	198	5.83	30	2.02	228	4.67
17	*Stolephorus commersonii*	90	2.65	33	2.22	123	2.52
18	*S. indicus*	1950	57.42	549	36.94	2499	51.19
19	*Thryssa* sp	6	0.18	105	7.07	111	2.27
X	Fistularidae						
20	*Fistularia commersonii*	0	0.00	3	0.20	3	0.06
XI	GERIDAE						
21	*Gerres oyena*	2	0.06	3	0.20	5	0.10
XII	Haemulidae						
22	*Plectorhinchus* sp	0	0.00	1	0.07	1	0.02
XIII	Leiognathidae						
23	*Leiognathus equulus*	14	0.41	190	12.79	204	4.18
24	*L. leuciscus*	231	6.80	417	28.06	648	13.27
25	*Leiognathus* sp	70	2.06	7	0.47	77	1.58
XIV	Lethrinidae						
26	*Lethrinus* sp	0	0.00	2	0.13	2	0.04
X	Lutjanidae						
27	*Lutjanus malabaricus*	1	0.03	0	0.00	1	0.02
28	*L. sanguineus*	2	0.06	3	0.20	5	0.10
29	*L. vita*	6	0.18	2	0.13	8	0.16
XVI	Mullidae						
30	*Upeneus tragula*	2	0.06	0	0.00	2	0.04
31	*U. vittatus*	4	0.12	9	0.61	13	0.27
XVII	Mugilidae						
32	*Valamugil speigleri*	8	0.24	1	0.07	9	0.18
XVIII	Nemipteridae						
33	*Nemipterus* sp	21	0.62	3	0.20	24	0.49
34	*Scolopsis ciliates*	27	0.80	4	0.27	31	0.63
XIX	Plotosidae						
35	*Plotosus lepturus*	1	0.03	0	0.00	1	0.02
XX	Psettodidae						
36	*Pseudorhombus* sp	1	0.03	0	0.00	1	0.02
XXI	Scatophagidae						
37	*Scatophagus argus*	1	0.03	2	0.13	3	0.06
XXII	Scombridae						
38	*Rastrelliger* sp	0	0.00	74	4.98	74	1.52
39	*Scomberomorus commersoni*	2	0.06	0	0.00	2	0.04
40	*Scomberoides tala*	0	0.00	1	0.07	1	0.02
XXIII	Scorpaenidae						
41	*Pterois* sp	1	0.03	0	0.00	1	0.02

XXIV	Serranidae						
42	*Epinephelus tauvina*	3	0.09	0	0.00	3	0.06
XXV	Siganidae						
43	*Siganus vermiculatus*	2	0.06	2	0.13	4	0.08
XXVI	Sphyraenidae						
44	*Sphyraena* sp	5	0.15	1	0.07	6	0.12
XXVII	Synodontidae						
45	*Saurida gracilis*	0	0.00	1	0.07	1	0.02
46	*Saurida tumbil*	2	0.06	0	0.00	2	0.04
XXVIII	Tetraodontidae						
47	*Arothron* sp	1	0.03	2	0.13	3	0.06
XXIX	Theraponidae						
48	*Therapon jarbua*	0	0.00	3	0.20	3	0.06
XXX	Trichiuridae						
49	*Trichiurus* sp	0	0.00	2	0.13	2	0.04
XXXI	Hemiramphidae						
50	*Zenarchopterus* sp	0	0.00	2	0.13	2	0.04
Total		3396	100	1486	100	4882	100

Notes: I - XXXI = number of families; 1 - 50 = number of species

Eventhough number of individual fish caught in first transition period is two times was higher than the number of fish caught in west monsoon, t-student test showed that there is no significant difference between those two periods ((t_{calc}.= 1.23 < $t_{table(p=0.05;\ df=49)}$= 2.01). It can be seen in Table 2 that *Stolephorus indicus* is the most abundant species (51.19%) during the study, followed by *Leiognathus leuciscus* and *Encrasicholina heteroloba* (pooled > 25%). On the contrary, Syahailatua (1997) [25] has found *Rastrelliger kanagurta* as the most abundant species, while *S. indicus* and *E. heteroloba* at 3rd and 7th, respectively. Most of *S. indicus* caught by beach seine fishers in TAD is sold alive to skipjack fishers to be used as life bait fish to catch skipjack tuna (*Katsuwonus pelamis*) [24, 25, 29].

3.3. Occurrence frequency

Occurrence frequency of fishes during two periods of fishing operation is presented in Table 3. Occurrence frequency of fishes in TAD varies ranging from 1 (only found in one fishing operation) to 8 (caught in every fishing operation). The lowest frequency represented by 14 species while the highest represented by three species i.e. *Caranx sexfasciatus, Leiognathus equulus* and *S. indicus.* One of the lowest occurrence species i.e. *E. heteroloba* occurs with high number of individuals. Previous study by Ongkers (2012) [18] has also found high number of *E. heteroloba* but it occurred in all year round of sampling periods.

Frequent occurrence of *S. indicus* is not surprising because TAD is well known for a long time as fishing ground for this species [29] and it become a target species for beach seine fishers of Lateri. Furthermore, Syahailatua (1997) [25] also found *S. indicus* as one of the most frequent species caught by fishers in TAD.

Tabel 3: Occurrence frequency of fish during the study

No	Species	First Transition				West monsoon				Occurence	
		1	2	3	4	1	2	3	4	Total	%
1	*Acanthurus* sp	0	0	0	0	1	0	1	1	3	37.5
2	*Apogon* sp	1	1	1	0	0	1	1	1	6	75.0
3	*Atherinomorus* sp	1	1	1	0	0	0	1	1	5	62.5
4	*Strongylura* sp	1	1	0	0	0	0	0	0	2	25.0
5	*Caranx sexfasciatus*	1	1	1	1	1	1	1	1	8	100.0
6	*Selar crumenopthalmus*	0	0	0	0	1	1	1	1	4	50.0
7	*Atule mate*	0	1	0	0	1	0	1	1	4	50.0
8	*Megalaspis cordyla*	0	0	0	1	0	0	0	0	1	12.5
9	*Selaroides leptolepis*	0	1	0	0	0	0	0	1	2	25.0
10	*Lates calcarifer*	0	0	1	0	0	0	0	0	1	12.5
11	*Chaetodon* sp	0	1	0	0	0	0	0	0	1	12.5
12	*Channa striatus*	0	1	0	1	1	0	0	0	3	37.5
13	*Anodontostoma chacunda*	1	0	0	0	0	0	0	0	1	12.5
14	*Dussumieria accuta*	1	1	1	0	0	0	0	0	3	37.5
15	*Encrasicholina heteroloba*	0	0	0	1	0	0	0	0	1	12.5
16	*Herklotsichthys quadrimaculatus*	0	0	0	1	1	1	0	1	4	50.0
17	*Stolephorus commersonii*	1	1	1	1	1	0	0	0	5	62.5
18	*S. indicus*	1	1	1	1	1	1	1	1	8	100.0
19	*Thryssa* sp	1	1	0	0	0	1	1	1	5	62.5
20	*Fistularia commersonii*	0	0	0	0	0	1	1	1	3	37.5
21	*Gerres oyena*	1	1	0	1	1	1	0	1	6	75.0
22	*Plectorhinchus* sp	0	0	0	0	0	0	1	0	1	12.5
23	*Leiognathus equulus*	1	1	1	1	1	1	1	1	8	100.0
24	*L. leuciscus*	0	1	1	0	1	1	1	1	6	62.5
25	*Leiognathus* sp	1	1	1	1	0	1	1	0	6	62.5
26	*Lethrinus* sp	0	0	0	0	0	0	1	1	2	25.0

27	*Lutjanus malabaricus*	0	1	0	0	0	0	0	0	1	12.5
28	*L. sanguineus*	0	1	1	1	1	0	1	1	6	75.0
29	*L. vita*	1	1	0	0	0	0	1	1	4	50.0
30	*Upeneus tragula*	1	1	1	1	0	0	0	0	4	50.0
31	*U. vittatus*	0	1	0	0	1	0	1	1	4	50.0
32	*Valamugil spieigleri*	1	1	0	0	0	1	0	0	3	37.5
33	*Nemipterus* sp	1	1	1	1	1	1	1	0	7	87.5
34	*Scolopsis ciliatus*	1	1	0	0	1	1	1	1	6	75.0
35	*Plotosus* sp	0	0	0	1	0	0	0	0	1	12.5
36	*Pseudorhombus* sp	1	0	0	0	0	0	0	0	1	12.5
37	*Scatophagus argus*	1	1	1	0	0	0	1	1	5	62.5
38	*Rastrelliger* sp	0	0	0	0	0	0	1	1	2	25.0
39	*Scomberomorus commersoni*	0	0	1	0	0	0	0	0	1	12.5
40	*Scomberoides tala*	0	0	0	0	1	0	0	0	1	12.5
41	*Pterois* sp	1	0	0	0	0	0	0	0	1	12.5
42	*Epinephelus tauvina*	0	0	0	1	0	0	0	0	1	12.5
43	*Siganus vermiculatus*	1	0	1	1	0	0	1	1	5	62.5
44	*Sphyraena* sp	1	1	1	1	0	0	1	0	5	62.5
45	*Saurida gracilis*	0	0	0	0	0	0	1	0	1	12.5
46	*S. tumbil*	1	1	1	0	0	0	0	0	3	37.5
47	*Arothron* sp	0	0	0	1	1	0	1	0	3	37.5
48	*Therapon jarbua*	0	0	0	0	0	1	1	1	3	37.5
49	*Trichiurus* sp	0	0	0	0	1	0	1	0	2	25.0
50	*Zenarchopterus* sp	0	0	0	0	0	0	1	1	2	25.0

Notes: 1 = presence 0 = absence

3.4. Community structure

Community structure of fishes in this study was analised by using three indexes namely diversity index of Shannon, dominance index of Simpson and evenness index of Pielou. Those indexes are presented in Table 4.

Table 4: Community structure indexes of fish during the study in TAD waters

Index	Season		
	First transition	West monsoon	Pooled
Diversity (H')	1.57	1.84	1.83
Dominance (D)	0.37	0.24	0.30
Evenness (E)	0.43	0.52	0.47
1/D	2.71	4.17	3.34

Eventhough fishes in wet season (35 species) is less compare to the fishes in first transition period (39 species), Shannon diversity index for wet season (H'=1.84) is higher than in first transition period (H'=1.57). Subsequent analysis by using t-student test shows that there is highly significant difference of fish diversity between those two seasons ($t_{calc.}=6.53 > t_{table}$ (p=0.001; df=3204)=3.29. Low diversity of fish in first transition period because there is one species i.e. *S. indicus* (57%) dominate fish caught. According to Mason (1981) [15], diversity based on Shannon index can be categorized into three namely low (H' < 1), moderate (1 ≤ H' ≤ 3) and high (H' > 3). Based on those criteria, fish diversity in TAD can be categorized as moderate.

Dominance index of fish community in TAD for first transition period is slightly higher than dominance index at wet season and pooled (Table 4). Simpson dominance index can be catagorised into three level i.e. low (D < 0.4), moderate (0.4 < D < 0.6) and high (D > 0.6) [10]. Based on those, dominance of fish community in TAD can be categorized as low. It also can be seen in Table 4 that reciprocal value of dominance index (1/D) for wet season is 1.5 times higher than its value for first transition period. This higher reciprocal value indicated that fish community at wet monson period is more diverse compare to fish community at first transition period [11].

Evenness index of fish community at first transition period, wet monsoon and pooled were 0.43, 0.52 and 0.47, respectively. Evenness index ranging from 0 to 1, in which E = 1 indicating equal number of individual for every species in the community [11]. Furthermore, Odum (1975) [16] stated that a community is in stable condition if the value of E ≥ 0.6. Based on this criterion, it seems that fish community in TAD is in unsteady state. This unsteady state of fish community could be due to high fishing intensity or might be due to environmental degradation of Inner Ambon bay as suspected by Tuhumury (2008) [28] and Bakarbessy (2014) [4].

4. Conclusion

A total of 50 species from 31 families of fish are captured during the study in TAD with the most abundant species is represented by *S. indicus* while the most frequent species are represented by *C. sexfasciatus, L. equulus* and *S. indicus.* Fish at wet season is more diverse than fish at first transition period. Based on diversity, dominance and evenness indexes, it could be concluded that fish community in TAD have moderate diversity with low dominance but in unstable condition.

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