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Coral reef fishes of Tuhaha Bay, Saparua Island, Maluku province, Indonesia

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Abstract

Research on reef fishes of coral reefs of Tuhaha Bay Waters, Saparua Island was conducted on January 2016. Eleven stations of coral reef habitat were chosen randomly for this study and were observed by using underwater visual census method. The transect area of 250 m² (50 m length, 5 m width) was established at each station and reef fish found in each transect was identified to the species level using reference literature. At least 35 families of reef fish which consist of 105 genera and 243 species were found during the study. Those reef fish species found can be categorized into target species (77 species), major species (143 species) and indicator species (23 species). Coral Fish Diversity Index (CFDI) determined based on six main families indicate that relative diversity of reef fish in the study area can be classified into very poor to poor categories. Based on CFDI value, estimated number of reef fish in the coral reef habitat of Tuhaha Bay waters of Saparua Island was 434 species.

Keywords: reef fish, taxa composition, coral fish diversity index, Tuhaha Bay

1. Introduction

Two things that make Maluku Province has an important role in fisheries sector can be seen from two aspects, *firstly*, its position at the center of coral reef triangle and between flow of Pacific and Indian Ocean water mass current, and *secondly*, its position in Fisheries Management Area (FMA) of Indonesia where three FMA *i.e.* 714 (Banda Sea), 715 (Seram Sea) and 718 (Arafura Sea) out of 11 FMA situated in Maluku Province with the potency of 1.6 million ton per year^[1]. Saparua Island is one of an island among 1340 islands belong to Maluku Province. This island is classified as small island according to island size classification^[2, 3, 4] with size of 207 km² situated at Lease Islands, Central Maluku District. This island has three bays *i.e.* Haria Bay, Saparua Bay and Tuhaha Bay. With the size of 51.19 km², Tuhaha Bay which situated at northern part of the island has great fish resources potency such as molluscs, echinoderms, some pelagic fish, crustacean of economic and non economic value as well as three most important ecosystem namely mangrove, seagrass bed and coral reefs^[5, 6, 7, 8, 9, 10, 11]. Among these three ecosystems, coral reefs is the largest ecosystem (389.70 ha), followed by mangrove (154.23 ha) and seagrass (12.60 ha). Many coral reef fishes are found to live within coral reef ecosystem^[11]. Many scientist have visited Saparua Island to study reef fishes like expedition conducted by V.G Springer and M. Gomon in 1973 and 1974^[13], 2nd Rumphius Expedition in 1975 and Tuhaha Bay is one of their study site^[14]. There is a probability that the number of reef fishes will certainly increase with additional collections and continuation of investigation^[2, 14]. Consider the need for sustainable biodiversity of reef fishes, data on reef fish diversity and its status become an important matter. This research was carried out with the main objectives to study taxa composition and relative diversity of reef fishes in the coral reef habitat of Tuhaha Bay waters, Saparua Island.

2. Materials and Methods

The research was conducted on January 2016 at 11 coral reef stations in the coral reef habitat of Tuhaha Bay waters, Saparua Island (Fig. 1). Data of reef fishes were collected by using Underwater Visual Census (UVC) according to English *et al* (1994)^[15] at 250 m² transect area (50 m length and 5 m width). Reef fishes found inside the transect area were identified to the species level based on Kuitert (1992)^[16], Allen (2000)^[18], Kuitert and Tonzuka (2001)^[17] and Allen *et al* (2003)^[18]. Identified species was then categorized into target species, major species and indicator species according to English *et al.* (1994)^[15].

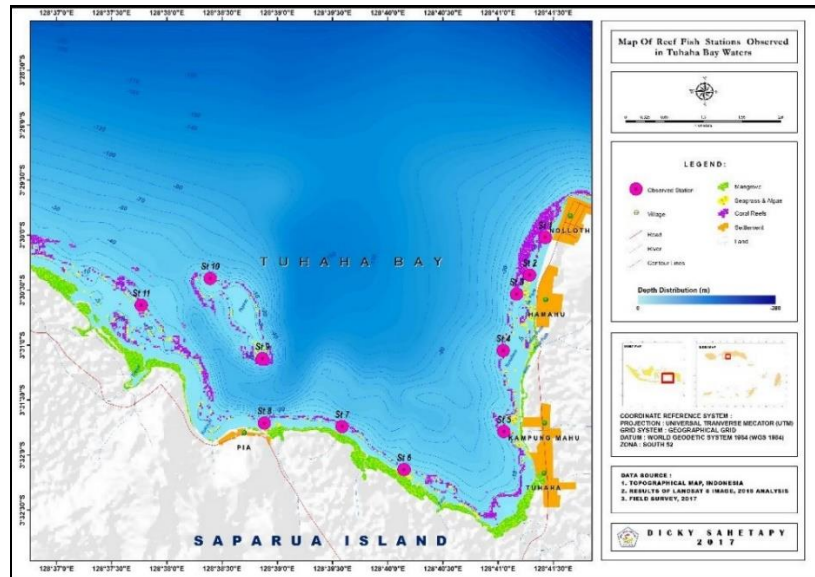


Fig 1: Map of Tuhaha Bay showing sampling sites

Total species of reef fish in the area was estimated by using Coral Fish Diversity Index (CFDI) for restricted small areas (< 2,000 km²) as proposed by Allen (1998) [20] and Allen& Erdmann (2012) [21] using the following formula:

$$\text{Estimated total species (< 2,000 km}^2\text{)} = (3.39 \times \text{CFDI}) - 20.595.$$

CFDI values was also used to classify relative diversity of reef fish [20] in the coral reef habitat of Tuhaha Bay waters of Saparua Island, and criteria used for classification presented in Table 1.

Table 1: Relative diversity of reef fish based on CFDI

Category	CFDI Value		
	Sampling site	Local region	National region
Extraordinary	> 150	> 330	> 400
Excellent	130-149	60-329	330-339
Good	100-129	200-259	220-329
Moderate	70-99	140-199	160-219
Poor	40-69	50-139	80-159
Very poor	< 40	< 50	< 80

3. Results and Discussion

3.1 Taxa composition of reef fish

There are 243 species of reef fishes belong to 105 genera and 35 families found during this study at coral reefs area of Tuhaha Bay of Saparua Island (Table 2). Those reef fishes can be categorized into target species (77 species), major species (143 species) and indicator species (23 species). From 34 fish family found, eight families with highest number of species, in decreasing order, are Labridae, Pomacentridae, Chaetodontidae, Serranidae, Scaridae, Acanthuridae, Pomacanthidae and Luntjanidae, with respectively number of species as follows: 39, 36, 23, 19, 13, 12, 11 and 10 species (Figure 2). Total number of species from those eight families collectively contributes approximately 67.08% of the total coral reefs fishes found in Tuhaha Bay. On the other hand, nine out of 34 families found *i.e.* Aulostomidae, Carangidae, Carcharhinidae, Cirrhitidae, Dasyatidae, Ptereleotridae, Sphyrnidae, Synodontidae and Zanclidae, each has one species only. Among families with highest species number, Labridae and Pomacentridae have the highest species number (Fig. 2). These two coral reef fish families usually have highest species number with wide habitat distribution and even can be found at area with poor coral reef [21]. These two families were also found to have high number of species at coral reef of Banda Island [22] and coastal area of southern Ambon Island of Maluku Province [23].

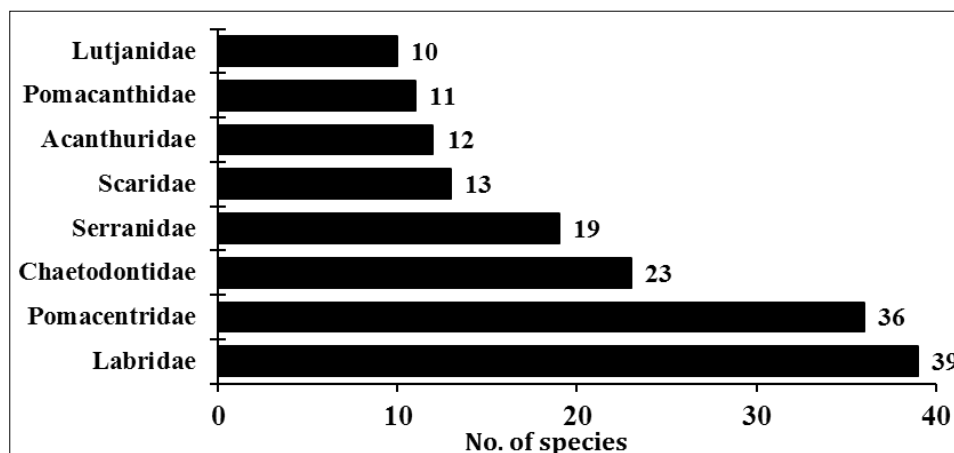


Fig 2: Eight of the most frequently found reef fish families in the Tuhaha Bay waters

Number of species found at each sampling station range between 56 to 104 species with the average of 80 species. Coral reef area with highest variety of species are station 10 with 104 species and station 9 with 101 reef fish species, as well as station 1 and 3 with 99 species each (Table 2). This table also shows that, station with higher number of species tend to have higher number of genera and family like station 1, 9 and 10. Number of species found in this study is higher than previous study conducted in this area [13] This difference could be due to different in station number sampled. In present study 11 stations were observed, whilst in previous study only 3 stations were observed. Number of coral reef fishes found at coastal area of southern Ambon Island [19] and at Banda Islands [22, 23] is much higher than what was found in this study. Number of coral reef fishes found in southern Ambon Island amounted for 293 species whilst in Banda Islands amounted to 500 species. Number of sampling site of southern Ambon Island was 19 sites whilst in Banda Islands were 20 sites. All these studies shows that differences in number of species found could be affected by study sites, sampling method as well as number of sampling station.

Table 2: Taxa composition of reef fish in Tuhaha Bay, Saparua Island.

Station	Taxa					
	Species				Genera	Family
	TS	MS	IS	Sub-Total		
1	30	54	15	99	61	22
2	15	32	9	56	35	18
3	30	59	10	99	54	18
4	32	39	10	81	52	21
5	20	31	5	56	40	17
6	18	54	5	77	49	19
7	22	39	6	67	47	18
8	18	54	9	81	50	21
9	30	62	9	101	60	25
10	30	65	9	104	61	26
11	16	37	7	60	40	17
Total ^{*)}	77	143	23	243	105	35

Notes: TS = target species MS = major species IS = indicator species. ^{*)}Total number found in all sites

Until recently, the highest number of reef fishes found in Indonesia was recorded at Bird’s Head Peninsula (Raja Ampat Island), Fakfak-Kaimana Coast and Cendrawasih Bay, West Papua, with species number amounted for 1,511 which belong to 451 genera and 111 families [19]. Area surveyed in Allen and Erdmann (2009; 2012) [18, 21] was 50,000 km² with free scuba diving UVC method with the depth down to 60 m, and number of species found was 1,320. Other factor that can contribute to number of species differences is repeated sampling. As reported by Allen and Erdmann (2012) [21],

Table 3: CFDI value, number of species and category of reef fishes

Station	CFDI	Observed species	Estimated species	Category
1	60	99	183	Poor
2	37	56	105	Very poor
3	68	99	210	Poor
4	46	81	135	Very poor
5	32	56	88	Very poor
6	49	77	146	Very poor
7	42	67	122	Very poor
8	52	81	156	Poor
9	57	101	173	Poor
10	63	104	193	Poor
11	38	60	108	Very poor
Total	134	243	434	Poor

number of reef fishes found in Raja Ampat in repeated surveyed between 2001, 2002, 2009 and 2012 are 236, 1,102, 1,320 and 1,437 respectively.

From those reef fish category, reef fish of major species is higher than target species and indicator species and target species is higher than indicator species (Table 2 and Figure 3.). In other word majority (58.85%) of reef fishes found in Tuhaha Bay belong to major species group. Higher number of major species group found in reef ecosystem seems to be a general pattern. In Banda Islands [22], southern coast of Ambon Island [23] and Cendrawasih Bay, West Papua [24], for example, number of major species group found in reef ecosystem is higher compared to two other species group.

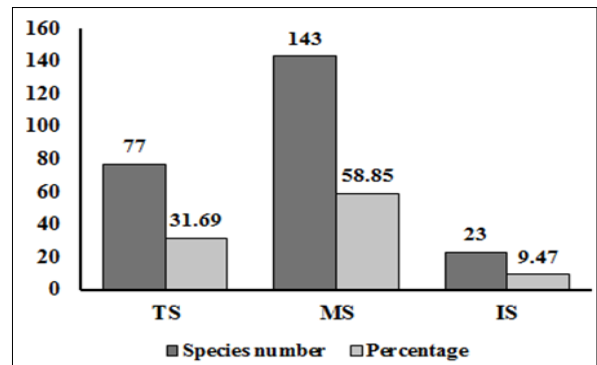


Fig 3: Distribution of target, major and indicator species of reef fishes at Tuhaha Bay, Saparua Island

From 8 reef fishes family found in this area, Serranidae is one of the target fish with high economy value. There are 19 species (11.73%) in this family commonly harvested by local fisher either for consumption and for commercial purpose. The number of species of this family found in Tuhaha Bay is lower than what was found in southern coast of Ambon Island [24] and in Banda Island [23]. Number of species difference was attributable to number of sampling station and sampling method.

3.2 Relative diversity of reef fish

Relative diversity of reef fish based on Coral Fish Diversity Index (CFDI) at Tuhaha Bay can be seen at Table 3. This table shows that over all CFDI of reef fish found in Tuhaha Bay is 134 which can be categorized as poor (see Table 1 for criteria). CFDI in this area ranges between 32 to 68 which means poor to very poor condition. CFDI is used to determine relative diversity of reef fish based on number of species observed that belong to 6 main family *i.e.* Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae, Scaridae, and Acanthuridae [20, 21].

Result displayed at Table 3 shows that number of reef fish found in this study is 243 species, whilst number of reef fish predicted based on CFDI from 6 key indicator families is 434 species. Estimated value shows that species number found

should be 70.8% more than observed number of species found in this area. This can be achieved when repeated sampling is conducted.

Table 4: CFDI value of reef fishes in several locations of Indonesia

No.	Location	CFDI	Number of species observed	Number of species estimated
1	Weh Island, Sumatera	196	533	644
2	Bintan Island, Riau, Sumatera	97	304	305
3	Bali and Nusa Penida	377	977	1312
4	Togean and Banggai Islands, Sulawesi	308	819	1190
5	Maumere Bay, Flores	333	1111	1108
6	Komodo Island, Flores	280	750	928
7	Raja Ampat Islands, West Papua	373	1437	1465
8	Fak Fak-Triton Bay, West Papua	322	1005	1249
9	Cenderawasih Bay, West Papua	302	965	1165
10	Banda Islands, Maluku, 2015	284	592	942
11	Central Maluku	167	272	546
12	Buru Island, Maluku	158	261	515
13	Western Seram Island, Maluku	93	170	295
14	Southern coastal waters of Ambon Island	165	293	539
15	Tuhaha Bay, Saparua Island, Maluku	134	243	434

Source: No. 1-9 = Allen & Erdmann (2012); No. 10 - 13 = Rijoly (2015); No.14 = Limmon *et al* (2017)

Table 4 shows CFDI value of several reef fishes in Indonesia, and it explains that there is a variation in CFDI between sites. CFDI of reef fish from Tuhaha Bay is smaller than all sites listed at Table 4 except from Bintan Island of Riau ^[21] and from Western Seram Island ^[27].

4. Conclusions

A total of 243 reef fish species which belong to 105 genera and 35 families were identified during the study in Tuhaha Bay waters. Most of the reef fish are belong to major species category (143 species) while the remaining are target species (83 species) and indicator species (27 species). Generally, relative diversity of reef fish in Tuhaha Bay waters can be categorized as poor based on coral fish diversity index, whilst at some stations they are categorized as very poor. Based on coral fish diversity index of six main families of reef fish (134), then an approximately 434 species of reef fish are estimated can be found in the coral reefs habitat of Tuhaha Bay waters, Saparua Island.

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