

# Fish larval composition and distribution assessment in the northern waters of Ambon Island

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**Abstract.** The Banda Sea ecosystem has been highlighted in the past decade for its potential role in providing economically important fish stock for human consumption. However, literature studies indicated lack of references regarding fish larvae abundance and composition in coastal areas of islands impacted directly by the Banda Sea. The study covers fish larval survey carried out at the northern waters of Ambon Island in April 2017. The composition, distribution, and abundance of fish larvae were described based on five horizontal and one vertical sampling stations. Twenty-eight families were identified and two of them were the most abundant: Atherinidae (23% of the total larvae) and Apogonidae (21% of the total larvae). Most of the other families were known to be neritic and in particular were fishes commonly found to be associated with coral reef ecosystems. This finding indicated the profile of the northern waters area, which has extensive coral reef coverage, as well as estuary and mangrove area.

**Keywords:** Banda Sea, ichthyoplankton, coral reef

## 1. Introduction

The Banda Sea is known as one of Indonesian important fishing grounds of commercial fishes, such as yellowfin tuna, skipjack, and small pelagic fishes. Administratively, it is a part of Maluku Province of Indonesia. It is included in the Fisheries Management Area (FMA) 714 together with the Tolo Bay waters. The Maximum Sustainable Yield of small pelagic, demersal and reef fishes' of the Banda Sea is recently estimated at 124 477 tons per year [1]. Coastal waters of small islands in the Banda Sea were reported as fishing grounds for the aforementioned groups of fishes. However, catching activities vary according to the monsoon periods. Maluku Province Fisheries and Marine Office reported in 2007 that the local fishermen of the Ambon Island northern coastal area will carry out these activities during the southeastern monsoon season (May-September) [2].

Studies on fish larvae in this area were few and were carried out mostly in the oceanic area of the Banda Sea ecosystem (c.f [3,4]). However, there is not much information, if any, available regarding fish larvae abundance and composition in coastal areas of islands impacted directly by the Banda Sea, such as the Ambon Island. This is due to the difficulties encountered when identifying fish larvae collected directly from the sea, as specimens are prone to degradation due to handling during sampling and pre-treatment prior to identification. Whereas it is possible that larvae of commercial fishes such



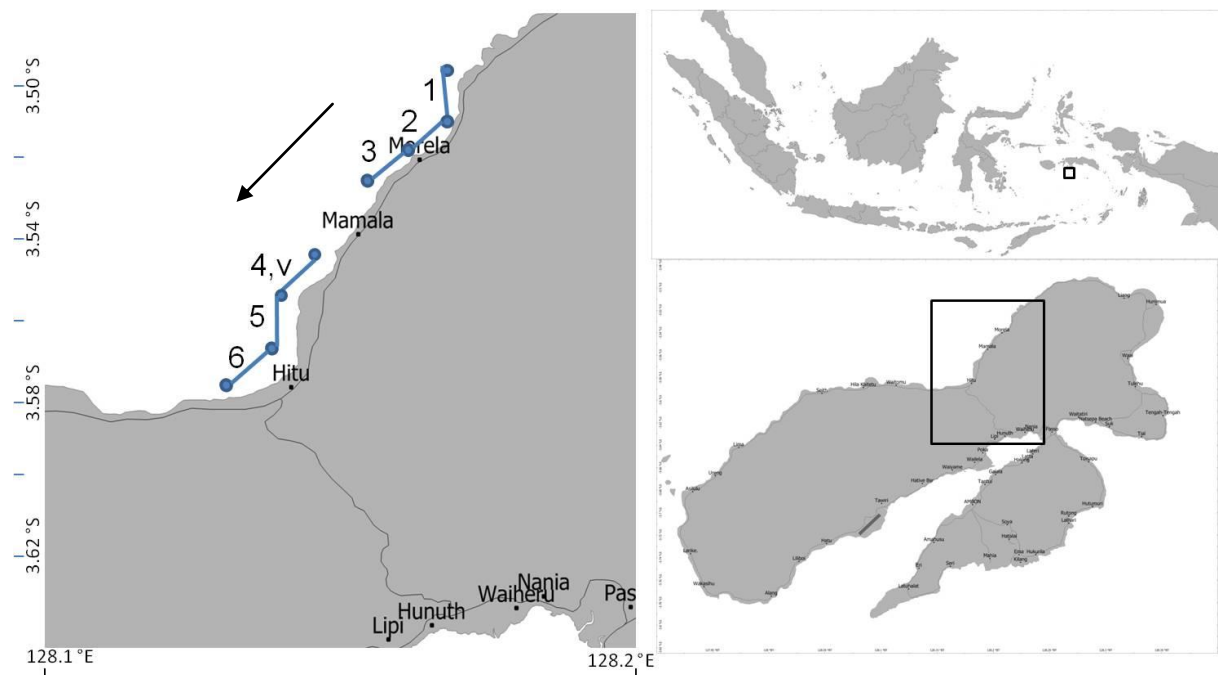
as yellowfin tuna could be found in the coastal area [2]. For this reason, it is necessary to have the initial information to confirm its presence in the northern coastal area of Ambon Island and to study the relationship between the yellowfin tuna larvae and its adult in the Banda Sea if possible.

The objective of this study was thus to provide updated information regarding fish larvae in this area. This information can be used by the Maluku Province government to sustainably plan the management of fisheries resources of the area.

## 2. Material and Methods

### 2.1. Sample collection

Samples were collected from the northern coastal area of Ambon Island (figure 1) at April 10-11, 2017. The sampling site was chosen because it was known locally for long time to be fishing grounds, notably for small pelagic and coral reef fishes. Sampling was carried out during the low tide period. As a consequence, the sampling was carried out approximately 20 to 50 meters seaward from the shoreline. A single bongo net with 500  $\mu$ m mesh was used for this purpose. The diameter of the net opening was 1.5 m, and the length was 2.5 m. It was equipped with 5 kg weight. Sampling was carried out during the night (19.00-20.00 local time), with the net towed horizontally at the speed of 2 knots for about 15 minutes. At one of the stations (Station 4), the net was also towed vertically (nylon rope length 20 m). A traditional light emitting device was used to attract larvae to the net. Samples collected were obtained from the net by spraying and rinsing, and subsequently stored in plastic bottles filled with 10% formalin until transfer to the fish laboratory.



**Figure 1.** Map of Indonesia (inset, upper right), Ambon Island (inset, lower right) and sampling location (main, left). Blue dots indicate the starting and end points where sampling net was towed (2 knots, 20 minutes). Black arrow indicates the towing direction. Numbers (1-6) denote horizontal towing stations and v denote the location where the net larva was towed vertically.

### 2.2. Sample preservation and sorting

Samples obtained were diluted with tap water to reduce the preservative (formalin) concentration and sorted according to their family based on their morphology. Sorting was carried out manually. Small samples were sorted using a dissecting microscope (Nikon SMZ-645). Fish larvae were separated from

the rest of the samples. Other organisms (copepods, phytoplankton, molluscs, and crustacean) were also sorted out and counted but not identified.

### *2.3. Sample counting, measurement, documentation, and identification*

Samples were counted manually either visually or by using the dissecting microscope when their sizes were too small to be counted directly. Millimetre block paper was used to measure the total length (TL) of samples obtained as there was no ocular micrometer objective lens available. The pictures of fish larvae to be identified were taken manually using iPhone 6sPlus camera. High resolution pictures obtained were pooled according to stations and used as supporting data for identification. Samples were identified using several guidelines and identification books [5-8]. All samples were preserved after identification in 75% alcohol. Developmental stage of fish larvae was determined according to Kendall et al. [9] by examining the morphology of larvae collected during sampling, especially pigment pattern, larval body shape, absence or presence of armature on head bones and fin shape.

### *2.4. Calculation of fish larvae population density*

Fish larvae population density was defined as the amount of larvae sampled per sampling area, using the following equation [10]:

$$T = 1000 t / V \quad (1)$$

with T is population density, expressed in number of fish per 1000 m<sup>3</sup>; t is number of fish counted and V is volume of water filtered by net (1000 m<sup>3</sup>). Due to the absence of flowmeter during the sampling period, the volume of water filtered by net was calculated by multiplying the area of net opening with the distance it was towed.

## **3. Results and Discussions**

### *3.1. Sampling locations profile*

The seabed in this coastal area is a shallow shelf from the intertidal area to about 50 meters seaward, and a steep slope is observed afterward. The sampling site was known as a fishing ground, notably for small pelagic and coral reef fishes. As has been described elsewhere in this proceeding [11], local fishermen used homemade bombs in the sampling area to fish (ca. 2005). Local authorities have intervened by educating them on the importance of keeping the coral reef ecosystem unharmed. This intervention resulted on the discontinuation of the blast fishing method in recent years. Tanjung Setan was popular locally as a recreational site, notably for swimming, snorkelling and diving. Fragments of branched coral found were mostly due to anchoring and tourism activities. Overall Morela coral reef ecosystem is in better condition compared to those in Mamala and Waipokol. Morela station was closed to the shore, where houses were built over the shoreline. Waitomu station was close to the river mouth where there was slight mangrove coverage at the shore.

The coral reef condition of this area in general was relatively good visually during the day on the sampling period. The depth was between 4 to 6 meters (table 1).

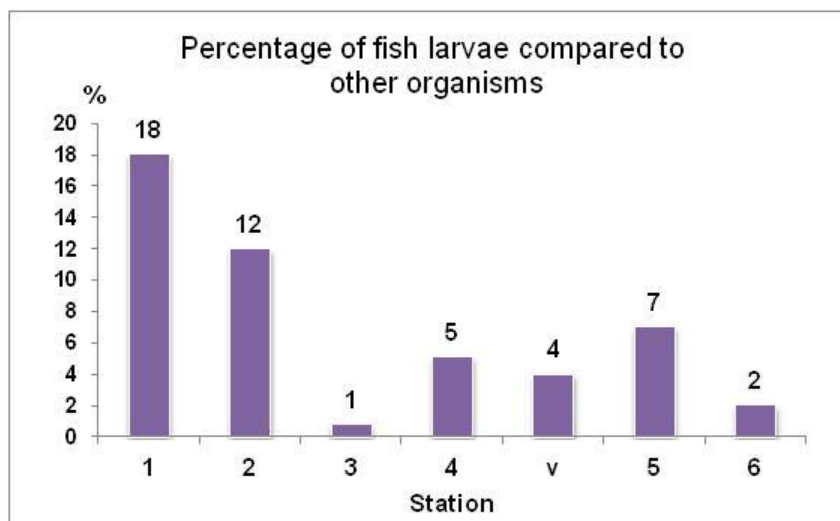
### *3.2. Total numbers of fish larvae obtained*

Fish larvae were obtained in all stations, both horizontal and vertical. The number of larvae per collection ranged from 4 to 94, averaging 23 larvae (actual counts) per sampling station. They were largely outnumbered by other organisms (copepods, phytoplankton, mollusc and crustaceans) total count (5 072 samples) (figure 2). The highest percentage (18% of total sample obtained in the station) of fish larvae number compared with the other organisms was observed in Station 1 (Tanjung Setan). Nevertheless, in terms of actual count, the number of fish larvae obtained in station 1 was second the least (7 specimens only) compared to all the other stations.

**Table 1.** Sampling locations profiles.

Stations	Location	Position coordinates (Latitude, Longitude)	Approximate depth (m)	Dominant substrate
1	Tanjung Setan	3°31'00.0" S, 128°13'23.4" E	6	Coral reef
2	Morela	3°33'16.5" S, 128°11'26.1" E	6	Coral reef
3	Mamala	3°33'13.1" S, 128°11'27.8" E	4	Coral reef
4	Waitomu	3°35'08" S, 128°06'44.0" E	4	Rocky
v	Waitomu-vertical			
5	Wakal	3°35'14.9" S, 128°09'16.8" E	6	Sand
6	Waipokol	3°34'56.7" S, 128°10'20.4" E	6	Sand

The total number of fish larvae sampled was 230 (actual counts), including larvae that were too poorly preserved (disintegrated) to be identified (20 larvae). However, the highest count of sample (94 fish larvae) was found on station 4 (Waitomu). This station was situated at the river mouth that goes directly to the coastal area, and heavily impacted by household wastes. Station 4 also had the total highest count (1 827) of other organisms –predominantly molluscs (63%) - compared to all the other stations. It seems that the river mouth was rich of nutrients due to the dumped household wastes, which explain the high abundance of organisms obtained during net towing.



**Figure 2.** Percentage of fish larvae compared to other organisms in total samples obtained in each stations, horizontal (1-6) and vertical.

### 3.3. Larval fish composition

Larval fish composition obtained in this survey is summarized by family in Table 2. Larvae of more than 20 families were listed, but those of six families contributed to 66% of the total population density. Most of the larvae obtained were on the pre-flexion to flexion phases of larval development. The discussion here will be focussed on these six families.

The Atherinids (Silversides) larvae (22% of the total) were the dominant group with 84% occurrence of the total stations. They were found in all horizontal stations but none on the vertical one. This confirms their particular features of small, silvery schooling fishes that are closely associated with surface waters during all stages of life. Some species have larvae with dorsal pigment on the midbrain, short snout and terminal small mouth with large, round to ovoid, eyes [6]. Atherinids sampled were mostly between pre-flexion to flexion stage, as observed from their morphological features, particularly the incomplete growth of fins (see for ex. Fig. 3a). Their TLs were between 1 to 4.5 mm. About 46% of this family (from Atherinids population density) was found in station 4. This was explained by the high availability of their food (phytoplankton) in station 4, which reached 27% of total phytoplankton obtained from all stations.

**Tabel 2.** Population density, range of TL and larval stage of fish larvae obtained per station based on family. 1-6: horizontal towing, v: vertical towing at station 4. NR: Not relevant

No	Family	Population density (ind.1000 m <sup>-3</sup> )							TL range (mm)	Larval stage	
		per station						Total			
		1	2	3	4	v	5				6
1	Ambassidae	0	1	0	1	0	0	0	2	2.5-3.5	Flexion
2	Apogonidae	1	1	0	9	10	6	3	27	2.5-14	Pre-flexion to juvenile
3	Atherinidae	2	2	2	15	0	9	2	30	1-4.5	Pre-flexion to flexion
4	Aulostomidae	0	0	0	0	0	0	1	0	6	Pre-flexion
5	Berycidae	1	0	1	0	0	0	0	2	2-3	Pre-flexion
6	Callionymidae	0	0	0	0	0	1	0	1	4	Pre-flexion
7	Carangidae	0	0	0	1	0	0	0	1	3	Pre-flexion
8	Clupeidae	1	10	0	4	0	0	0	15	2.5-27	Pre-flexion
9	Dactylopteridae	0	0	0	1	0	0	0	1	3	Pre-flexion
10	Diodontidae	0	0	0	0	0	1	0	1	1	Flexion
11	Engraulidae	0	0	0	1	0	2	4	7	1.5-4	Pre-flexion
12	Exotidae	0	0	0	0	0	1	0	1	3	Pre-flexion
13	Gerreidae	0	0	0	1	1	2	0	4	3-18	Pre-flexion to juvenile
14	Gobiidae	0	0	0	0	0	1	0	1	6	Pre-flexion
15	Holocentridae	0	0	0	5	0	0	0	5	3	Pre-flexion
16	Labridae	0	0	0	1	0	1	0	2	2.5-5	Pre-flexion
17	Lutjanidae	0	0	0	3	0	2	0	5	3-5	Pre-flexion
18	Leiognathidae	0	2	0	2	0	0	0	4	3-4	Pre-flexion
19	Monacanthidae	0	0	0	1	0	0	0	1	4	Pre-flexion
20	Mullidae	0	1	0	1	0	1	0	3	2.4-5	Pre-flexion
21	Mugilidae	0	0	0	1	0	0	0	1	2.5	Pre-flexion
22	Plesiopidae	0	0	0	2	0	1	0	3	3	Pre-flexion
23	Pomacentridae	0	1	0	0	0	1	0	2	2.5-4	Pre-flexion
24	Serranidae	0	1	0	1	0	0	0	2	2.5-5	Pre-flexion
25	Sillagonidae	0	0	0	1	0	2	1	3	3-4	Pre-flexion
26	Synodontidae	0	1	0	0	0	1	0	2	2.5-5	Pre-flexion
27	Triodontidae	0	1	0	0	0	0	0	1	17-27	Pre-flexion
28	Triacanthidae	0	0	0	1	0	1	0	2	2-4	Pre-flexion
29	Disintegrated larvae	0	0	0	9	0	1	3	10	NR	NR
Total fish larvae (ind. 1000 m <sup>-3</sup> )		5	21	3	61	11	34	5	135		

The Apogonids (Cardinal fishes) were the second to have the highest population density (20% of total larvae). Fishes in this family are small, usually reddish, carnivorous and nocturnal living around coral reefs and other habitat, with larvae characterised by spotted lines on cheek bones and caudal fin, wide jaw bones and separated dorsal fins [6]. Most of them were already on the juvenile phase, indicated by their size (13-19 mm) that exceeded the other familial group. Its occurrence in large number at the vertical station could due to its nocturnal life style, as the sampling was carried out at night. They had about 84% occurrence of the total stations. However, contrary to the Atherinids ones, the Apogonids were found in all stations but in station 3. Despite the characteristic of this station (coral reef environment), samples from this station were the lowest in numbers, compared to the other stations.

Fish larvae belonging to the family Clupeidae ranked third in abundance with 9% of the total larvae taken in about 43% of the stations. They are small to moderate, silvery, planktivorous, schooling fishes of great commercial importance, with members such as herrings, sardinellas and sardines fishes [6]. About 69% of total Clupeids larvae were mostly found in station 2, an area predominantly covered by coral reefs, with many floating nets on site. Their TLs were the most varied, ranging from 2.5 to 27 mm.



Engraulidae (anchovies) larvae ranked fourth and exceeded 5% of the total population density, with 43% occurrence of the total stations. They are silvery, marine planktivores, schooling fishes of small to moderate size [6] (larvae sampled TL range: 1.5-4.5 mm). Commonly used as baits for big-pelagic fishing activities in Ambon waters and surrounding areas, their larvae are characterized by its very elongated body form [6] (figure 3d).



**Figure 3.** Representative of six families with highest occurrence during sampling: a. Atherinidae, b. Apogonidae, c. Clupeidae, d. Engraulidae, e. Holocentridae and f. Lutjanidae. Scale bar: 1 mm.

Holocentridae (Squirrelfishes) and Lutjanidae (Snappers and Fusiliers) larvae ranked fifth and each exceeded 3% of the population density with occurrences of 14% (Holocentridae) and 28% (Lutjanidae) of the total stations. Holocentrids are small to moderate in size, nocturnal, large-eyed, usually red fishes that shelter in the recesses of coral reefs during the day, with some species are known to be commercially important food fishes [6]. In contrast, Lutjanids are medium to large, carnivorous fishes found in various habitats such as coral reefs, mangroves, sandy bottoms and deep, rocky reefs, with many economically important fishes [6].

One third of the larvae obtained belong to the other 22 families, with occurrence of more than 50% of these families in station 4, compared to other stations. Their total counts ranging from 1 (e.g. Aulostomidae, Callyionimidae, Dactyloptiridae) to 6 (Gerreidae, Leiognathidae) samples only.

Some of the larvae sampled belonged to the families of ornamental tropical fishes reported previously to be found in Ambon Island coral reef ecosystem [12], such as Pomacentridae, Labridae, Serranidae, Monacanthidae and Gobiidae. However, the identification carried out in this study was only to family level, and it was thus inconclusive, whether the larvae obtained were indeed from specific species that are known to be commercially traded as ornamental fishes or not.

Almost 9% of larvae obtained were too poorly preserved (disintegrated) to be identified, and some others did not even have intact gas bladder, which made the identification work difficult. However this is the common problem faced when sampling fish larvae from the sea, as the degradation due to pre-treatment and/or preservation phase were prone to happen and thus might damage the samples. This

was comparable to the damaged specimens obtained during the EASTROPAC I cruise, for example, that reached 11% of the total specimens collected [13].

No scombrid larva was found on this sampling site. This was possibly because the sampling site is not a breeding and/or nursing ground for this family. Fishes may be constrained in the location of spawning sites by their physiology, especially during early life-history stages ([14] and references therein). Other than that, it could also due to the environmental parameters such as sea surface temperature that was not conducive for Scombridae fishes breeding. Scombrid fishes such as yellowfin tuna breed on specific temperature (25-29°C), whereas the sampling took place in the middle of transition period from west monsoon to east monsoon, where average sea surface temperatures range from 30-31°C. Unfortunately no temperature measurement was carried out during the sampling period to justify this explanation. Other than that, it was also probably due to the distance from the coastal area, as well as the period when the sampling was carried out. An ichthyoplankton survey carried out in the off-coast area of the Savu Sea, for instance, collected some tuna larvae. The sampling was carried out in October and November 2016 using the oblique tow approach, at a location where the depth was at 80-120 m (Simanjuntak C, personal communication). Sampling on east monsoon period at nearby location but on deeper water column is thus deemed necessary to confirm these hypotheses of scombrid larvae absence.

In regard with the local fisheries management, ornamental and/or fishes caught for food are prone to overfishing by local fishermen. It is thus highly recommended that the fishing activity should be followed up closely by the relevant authorities to ensure the sustainability of the fisheries resources in this area.

#### 4. Conclusion

Samples identified in this study indicated the profile of Ambon Island northern coastal waters, which are dominated by coral reef, mangrove and estuary ecosystems. Larval groups with the highest occurrence belonged to Atherinidae and Apogonidae, two coastal associated fishes with different features. The other families found during this study were mainly associated with coral reefs ecosystem. No scombrid larva was found, and this could due to the lack of supporting environmental parameters for its spawning on the sampling period and/or the sampling locations that were not typical of this larval group spawning and/or nursery ground.

#### Acknowledgment

This research was supported financially by LIPI's internal funding for research and development, as a part of the research project on sustainable utilization of marine bioresources in Ambon Island northern coastal waters. The authors wish to thank two anonymous reviewers who have helped on the improvement of this manuscript substantially. We also want to thank Abdul Wahab Radjab, the coordinator of the project, to facilitate the sampling trip, and La Pay, Jance Hehuwat and Tamara Ginzel for their assistance during sampling, preservation and identification of the samples. This is contribution number 0009 from Marine Microbiology and Biotechnology Laboratory, Center for Deep-Sea Research LIPI.

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