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Temporal Spread of Gonad Maturation Level and Food Habits of Halfbeak fish (*Hemiramphus* sp.) Caught in Kayoa Waters,South Halmahera

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Abstract

Halfbeak fish (*Hemiramphus* sp.) is intensively caught using fishing gear “giob” (mini purse seine), so that it is potential threat of sustainability of the fish resources. Until now, there is no available information on biological aspects of halfbeak fish in study. The study aimed to analyze the temporal spread of gonad maturity level (GML) and the food habits of halfbeak fish. The data collection method used to collect the fish samples was survey. The data of halfbeak fish’s length and GML were derived from observation result made to provide fish samples which were collected once per month for one year (n = 1.546). The data of halfbeak fish food habits were obtained from fish stomach contents of 37 fish. GML temporal spread analysis was done descriptively, based on GML IV in which the fish was in condition of ready to spawn. Analysis of the fish food habits was done using preponderance index (Ii).

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The results showed that the halfbeak fish had the maximum length and average length as follows, females: 21.4 cm (18.72 ± 1.37) and males: 21.6 cm (17.67 ± 1.53). Temporal spread of GML IV takes place every month, and the most spread is divided in two phases, namely the first phase on January, February, March, and the second phase on September, October, and November. Type of fish food for the first sequence of the Ii, namely: phytoplankton (52.79%), debris (31.36%), crustaceans (12.04%), zooplankton (3.73%), and fish scales (0.08%).

Keywords:Halfbeak fish (*Hemiramphus* sp.); Gonad Maturation Level; food habits.

1. Introduction

The halfbeak fish is one kind of small pelagic fish resources in South Halmahera which has an important economic value. Particularly in Kayoa waters,fish is caught by using fishing gear “giob” (mini purse seine) and performed in the business scale. The catching is very intensively done in the coastal waters of bay and strait. The caught fish is processed into dried smoked fish. Fumigation is done with the use of wood from mangrove trunk. The uncontrolled catching fish and the use of mangrove wood as firewood in the fumigation process potentially threats to the sustainability of fish resources [1]. Fishing gear“giob” (mini purse seine) is a tool used specifically by fishermen to catch halfbeak fish [2, 3]. The main materials of this fishing gear consist of nets, rigging ropes, floats and weights. Giob is divided into three parts namely wings, shoulders and pockets. The principle of catching fish is spreading nets around the band to form a functional barrier to prevent fish not to get out of the net [4].

Fishing halfbeak fish using giob is done at any time. The catching operation follows the pattern of daily migration of halfbeak fish. The halfbeak fish migrates into coastal waters in the afternoon and will leave the waters by night. The presence of the ban of halfbeakfish to the coastal waters is alleged to feed and spawn [2]. Research related to the food of halfbeak fish (*Hyporhamphus melanochir*) has ever done in South Australian waters, where the results of the analysis of the stomach contents found that Halfbeak fish main food was seagrass (*Zosteraceae*) and hyperbenthic crustaceans, especially amphipods [5]. Other research indicated that the presence of halfbeak fish in the coastal waters is to spawn [3]. Spawning habitat of Halfbeak fish is similar to that of scadsmackerel (*Decapterus macarellus*), which migrates into the shallow waters of the reef to spawn [6]. The spawning place of halfbeak fish of *Hemiramphus brasiliensis* is along coral reefs [7].The research was conducted to analyze the temporal spread of gonad maturation level (GML) and the food habits of halfbeak fish. The result was expected to be a valuable input for planning and management strategies for sustainability and conservation of halfbeak fish resources in the waters of Kayoa, South Halmahera.

2. Materials and Methods

The collecting halfbeak fish for samples was done in Kayoa Islands, which is the basis of giob fisheries in South Halmahera District (Fig.1).

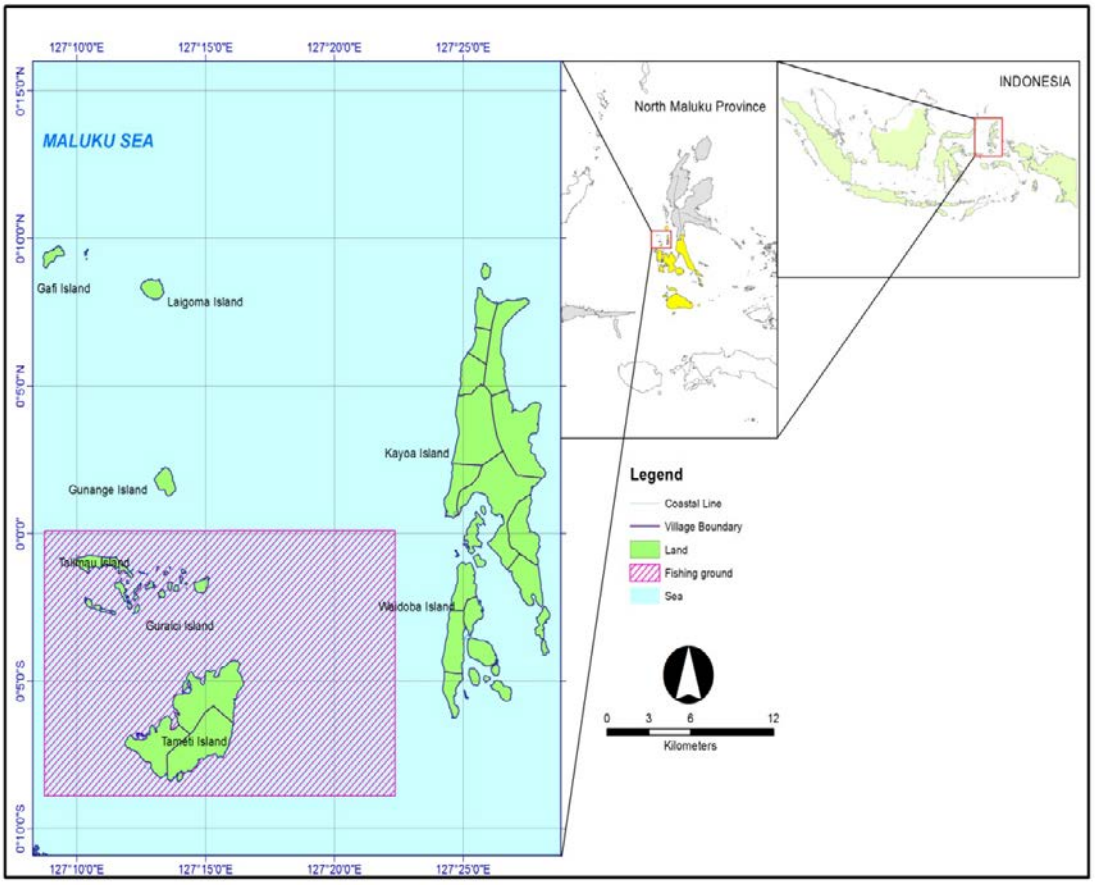

Fig. 1. Locations of sample collection of halfbeak fish.

Samples used to analyze the temporal spread of halfbeak fish GML were collected once per month for a year with total samples of 1.546 fish. Fish samples used for analyzing of gastric contents were taken once in the number of 37 fish. The samples were measured their fork length (FL) at the nearest millimeter from the tip of the upper jaw to the fork-tailed [7]. The halfbeak fish samples were then separated by sex, and only females were used for the analysis of GML. Observation of fish GML was done using Cassie criteria [8, 9]. GML observation criteria are presented in Table 1.

Analysis of the temporal spreadof GML was done descriptively to predict the Halfbeak fish spawning period. The prediction of spawning period was based on temporal spreadof GML IV, where fish condition was ready to spawn [10].

The analysis of food habits of the fish used the preponderance index analysis (Ii) [11] with the calculation formula as follows:

$$I_i = \frac{VixOi}{\sum VixOi} \times 100$$

Ii = index of preponderance of food group in i^{th}

Vi = volume percentage of a type of food

Oi = percentage of occurrence frequency of a variety of food

$\sum ViOi$ = the number of Vi x Oi of all kinds of food

Table 1. Criteria of GML observation

GML	Females (♀)	Males (♂)
I	Ovaria is like yarn.Body cavity to the fore is long with clearcolor, and smooth surface.	Testicle is like yarn, Body cavity is shorter (limited) and it is seenthe end in a body cavity with clear color.
II	Ovaria becomes larger size.The color is darker yellowish. Eggs have not been clearly seen.	The testicular size is bigger. The color is milky white. The form is clearer than its form in the level I.
III	Ovaria is yellow. The morphology of eggs begins to be able to be seen.	Surface of testes appear jagged. The color is alarmingly white, and the testes look bigger. In preservation, it is easily broken.
IV	Ovaria looks bigger and bigger, and the egg is yellow and it is easily separated. The oil is not visible, and it fills 1/2-2/3 of abdominal cavity.The intestinal is desperated.	As in level III, it appears more clearly. Testicle is solid.
V	Ovaria is frown, and its wall is thick.The residual eggs are near rectum.	The back section of testicular is flat and its section near rectum still contains.

Source: Cassie (1954) and Effendie (1979)

3. Results

3.1. Temporal Distribution of Halfbeak Fish Length Size

The total sample number of halfbeak fish collected during November 2011 to October 2012 was 1.546 fish, ranging from the female and male of 618 fish and 928 fish respectively. The maximum length of female Halfbeak fish temporal spread ranged from 15 to 20.6 cmand the minimum length of it ranged from 10.2 to 17.5 cm. The male halfbeak fish maximum length ranged from 20 to 21.6 cm, and its minimum length ranged from 13.9 to 16.5 cm. The average length shows that the male and female

Halfbeak fish achieved the greatest length in January. The length of the largest female was 21.4 cm (18.72 ± 1.39) and that of the largest male was 21.6 cm (17.67 ± 1.52) (Table 2).

Table 2. Temporal spread of length size (cm) based on sex of halfbeak fish caught in the Kayoa waters, South Halmahera

Month	Length FL (cm) male			Length FL (cm) female		
	Maximum	Minimum	Mean+SD	Maximum	Minimum	Mean +SD
November*	20.0	16.5	18.08±0.90	19.5	16.0	17.82 ±0.82
December*	20.5	16.0	18.48±1.20	21.0	14.5	17.88±1.52
January**	21.4	16.2	18.72±1.39	21.6	14.3	17.67±1.53
February**	20.6	15.2	17.6 ±1.26	21.6	14,3	17.33±1.27
March**	15.6	10.2	12.89±1.31	20.0	13.9	16.89±1.06
April**	20.0	16.0	18.10±0.93	20.0	16.5	18.17±0.75
May**	19.5	16.0	17.88±0.79	19.5	15.5	17.28±0.71
June**	20.0	16.0	18.07±0.89	19.5	15.5	17.52±0.73
July**	21.0	17.0	18.63±0.85	19.5	15.5	17.52±0.73
August**	20.0	17.0	18.35±0.78	19.0	16.0	17.61±0.67
September**	21.0	17.5	18.91±0.60	20.0	16.0	18.00±0.71
October**	21,0	16.0	19.00 ±0.92	21.0	16.0	18.23±0.88

Description: * 2011; **2012

3.2. Temporal Spread of Female Halfbeak fish GML

The GML of halfbeak fish caught from November 2011 to October 2012 was varied. To predict the fish spawning period was used the GML of female halfbeak fish. If GML IV is used as a basis to infer spawning period, it will be seen that the halfbeak fish has two phases of breeding namely the first phase in January, February, March and the second phase in September, October, and November (Fig. 2).

3.3 Food Habits of Halfbeak Fish

The analysis of the stomach contents of halfbeak fish showed five food groups namely phytoplankton, zooplankton, crustaceans, debris, and fish scales. Phytoplankton group consisted of 16 species which are dominated by species of *Rhizosolenia* sp. (12.69%), *Trichodesmium* sp. (20.33%), and *Nitzschia* sp. (14.34) (Table 3). Zooplankton are the food group which consists of 16 species with total proportion of 3.73%, while crustaceans (12.04%), debris (31.36%), and fish scales (0.08%) (Table 4).

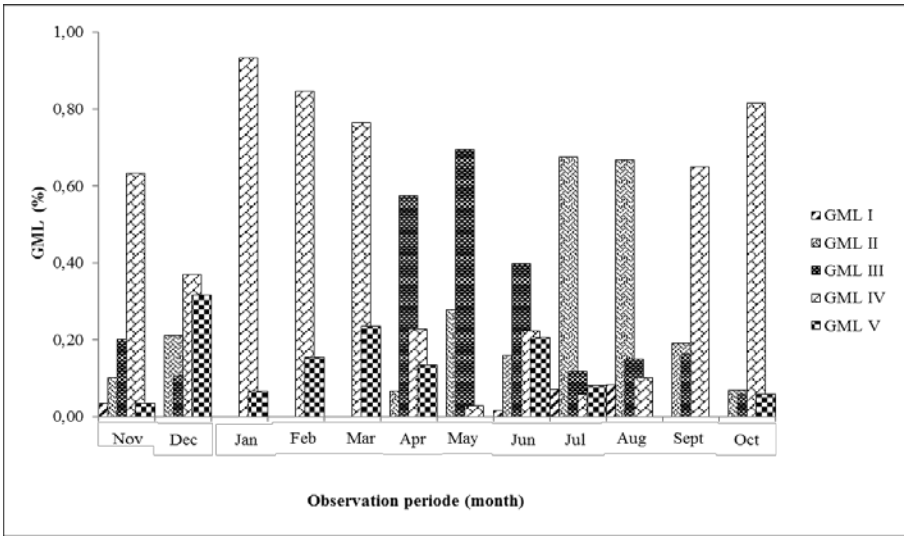

Fig. 2. The temporal spread of GML of halfbeak fish caught in the Kayoa waters, South Halmahera, (n = 618 fish).

Table 3. Index of preponderance of halfbeak fish group food of phytoplankton

No	Group food	Vi (%)	Oi (%)	Vi*Oi	∑VI*Oi	IP (%)
I	Phytoplankton					
1	*Eucampia* sp.	0.37	70.33	25.70	2.656.89	0.97
2	*Coscinodiscus* sp.	0.63	173.33	109.29		4.11
3	*Rhizosolenia* sp.	0.93	363.33	337.07		12.69
4	*Chaetoceros* sp.	0.08	8.67	0.66		0.02
5	*Guinardia* sp.	0.07	13.33	0.96		0.04
6	*Ceratium* sp.	0.06	10.00	0.64		0.02
7	*Gyrodinium* sp.	0.01	10.00	0.08		0.00
8	*Surirella* sp.	0.18	33.00	5.96		0.22
9	*Thalasionema* sp.	0.03	1.33	0.04		0.00
10	*Trichodesmium* sp.	0.95	570.00	540.24		20.33
11	*Thalassiotrix* sp.	0.25	39.67	9.88		0.37
12	*Coconeis* sp.	0.02	6.67	0.16		0.01
13	*Nitzschia* sp.	0.89	427.34	381.00		14.34
14	*Hemiaulus* sp.	0.12	8.67	1.04		0.04
15	*Richelia* sp.	0.05	3.33	0.16		0.01
16	*Gonyodoma* sp.	0.05	3.33	0.16		0.01
17	*Protoceratium* sp.	0.05	1.67	0.08		0.00
18	*Peridinium* sp.	0.06	5.00	0.32		0.01

19	*Navicula* sp.	0.21	29.33	6.24		0.23
20	*Melosira* sp.	0.27	47.67	12.63		0.48
21	*Pleurosigma* sp.	0.04	7.67	0.34		0.01
22	*Bacillaria* sp.	0.02	6.67	0.13		0.01
23	*Thalassiosira* sp.	0.05	5.33	0.26		0.01
24	*Leptocylindrus* sp.	0.22	33.33	7.36		0.28
25	*Climacodium* sp.	0.02	3.33	0.07		0.00
26	*Amphora* sp.	0.06	10.00	0.56		0.02
27	*Dactyliosolen* sp.	0.03	3.33	0.11		0.00
28	*Asterionella* sp.	0.06	8.33	0.47		0.02
29	*Streptotheca* sp.	0.21	38.00	7.94		0.30
30	*Dinophysis* sp.	0.09	12.00	1.06		0.04
31	*Diatoma* sp.	0.15	21.33	3.26		0.12
32	*Climacospheina* sp.	0.08	5.00	0.40		0.02
33	*Halosphaera* sp.	0.05	10.00	0.48		0.02
34	*Gomphonema* sp.	0.02	3.33	0.08		0.00
35	*Fragilaria* sp.	0.05	20.00	0.96		0.04
36	*Limcophora* sp.	0.03	3.33	0.11		0.00
	Number					52.80

Table 4. Index of preponderance of halfbeak fish group food of zooplankton, crustaceans, debris, and fish scales

No	Group food	Vi (%)	Oi (%)	Vi*Oi	∑VI*Oi	IP (%)
II	Zooplankton					
1	*Calanus* sp.	0.13	12.67	1.68	2.656.89	0.06
2	*Branchionus* sp.	0.38	73.00	27.56		1.04
3	*Synchaeta* sp.	0.17	23.33	3.94		0.15
4	*Favella* sp.	0.05	9.67	0.47		0.02
5	*Clamydodon* sp.	0.08	10.33	0.83		0.03
6	*Leptrotintinus* sp.	0.48	65.66	31.64		1.19
7	*Evadne* sp.	0.10	31.00	3.24		0.12
8	*Tintinnopsis* sp.	0.35	56.00	19.79		0.74
9	*Xystonella* sp.	0.21	28.67	5.99		0.23
10	*Sagitella* sp.	0.04	3.33	0.13		0.01
11	*Agalma* sp.	0.03	6.67	0.21		0.01
12	*Helicostomella* sp.	0.19	29.67	5.72		0.22
13	*Parafavella* sp.	0.03	18.67	0.60		0.02

14	*Rhabdonella* sp.	0.03	6.67	0.21	0.01
15	*Eucalanus* sp.	0.04	3.33	0.13	0.01
16	*Tintinnidium* sp.	0.07	9.67	0.70	0.03
	Number				3.73
III	Crustaceans	0.86	388.00	331.90	12.04
IV	Debris	0.98	886.00	864.65	31.36
V	Scales	0.11	20.67	2.24	0.08

4. Discussion

The temporal spread of maximum length of halfbeak fish caught in Kayoa waters, South Halmahera was 21.4 cm in female and 21.6 cmin male. This length is not much different from the length of the Halfbeak fish species of *Hemiramphus marginatus* which spreads in Western Indian Ocean, and it was restricted to the Red Sea and the Persian Gulf, the halfbeak fish had maximum length of 26 cm [12]. *Hemiramphus marginatus* caught in Philippine waters had total maximum length of 30 cm [13]. The size difference is only caused by the method of measurement, where the fish mouth snout length is measured in range of 5-8 cm. The length of the halfbeak fish available in the research location was very different when it was compared to the halfbeak fish species (*Hemiramphus balao*) caught in the Gulf of Florida that had maximum length of 40 cm [14]. Allegedly, the different sizes were due to different species.

Based on the temporal spread of GML, the GML IV spreads almost every month. GML IV as a level where the fish is ready to spawnused as a basis to infer spawning period, so it can be determined that the halfbeak fish spawns throughout the year. Spawning patterns in a span of one year showed that the halfbeak fish of Kayoa waters forms two phases of spawning namely the first phase of which spawning peaks on January, February, March and the second phase of which spawning peaks on September, October, November. This is different from the halfbeak fish (*Hemirhamphus marginatus*) spawning pattern in the Gulf Mandapan India which has short spawning period namely November- December and does not lay eggs more than once a year [15]. Spawning period of *Hemiramphus brasiliensis* and *H. Balao* species in South Florida waters lasts from March-June with it spawning peak during April-June [16].

The spawning peak of halfbeak fish in second phase on September, October, November in this study, is in accordance with [1] the peak of catching season of halfbeak fish, namely August to October. The peak of catching halfbeak fish which coincides with the spawning season can be interpreted that the presence of abundant halfbeak fish in coastal waters which is alleged to perform spawning, and at the same time, fishermen can use this condition to catch halfbeak fish. This scenario indicates that in these months, fishing activity should be managed to provide opportunities for halfbeak fish to spawn in

advance before caught so this does not interfere the process of recruitment of new individuals in the catching area.

The composition of fish food will help explain the possibility of habitats visited [17, 18]. The halfbeak fish food of phytoplankton and debris groups which has the largest proportion, namely 52.80% and 31.36% respectively, becomes the main food. While, crustaceans and zooplankton in proportion of 12.04% and 3.73% respectively are supposed to be supplement food. The same type of food is available in hemiramphids caught in southern Victoria [19, 20]. Based on the type of food, it can be assured that the basis of food forming is debris. Condition of research area shows that halfbeak fish catching area is the coastal waters of small islands, with the region characteristic of having an availability of mangrove and seagrass resource. The presence of halfbeak fish in these waters can be assured to feed and spawn. Efforts should be made to maintain the sustainability of halfbeak fish namely the management of coastal physical environment resources such as mangrove and seagrass beds.

5. Conclusion

The maximum and average lengths of halfbeak fish caught in the Kayoa waters, South Halmahera were 21.4 cm (18.72 ± 1.37) for females and 21.6 cm (17.67 ± 1.53) for males. Spread of female halfbeak fish GML had two peak periods namely on January-March and September-November. The composition of halfbeak fish food consists of phytoplankton (52.80%), debris (31.36%),and crustaceans (12.04%) as main food, zooplankton (3.73%), and fish scales (0.08%) as supplement food.

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