BIODIVERSITAS
Volume 24, Number 12, December 2023
Pages: 6574-6583

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d241219

Length-weight relationship, condition factor, and reproductive aspects of Lutke's halfbeak *Hemiramphus lutkei* (Valenciennes, 1847) from Seram Sea, Maluku, Indonesia

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Manuscript received: 7 August 2023. Revision accepted: 21 December 2023.

Abstract. *Talakua M, Suadi, Djumanto, Setyobudi E. 2023. Length-weight relationship, condition factor, and reproductive aspects of Lutke's halfbeak* Hemiramphus lutkei *(Valenciennes, 1847) from Seram Sea, Maluku, Indonesia. Biodiversitas 24: 6574-6583.* Lutke's halfbeak is one of the Seram Sea's most commercially important fish species, providing food resources and community livelihood for an extended duration. Data and information on fish biology are important for responsible fisheries management. This research aimed to determine Luke's halfbeak's length-weight relationship, condition factor, and reproductive aspects at Seram Sea, Maluku. Fish samples were collected monthly for seven months, from August 2021 to February 2022. Each sample was measured for its length and weight and then dissected for sex and gonad maturity stage determination. The data was analyzed to determine the length-weight relationship, the condition factor, the distribution of gonadal maturity stage, and fecundity. *Hemiramphus lutkei* (Valenciennes, 1847), originating from the Seram Sea, indicates a negative allometric growth pattern. The average relative condition factor (Kn) of *H. lutkei* in the Maluku Seram Sea was around 1 and did not show a significant difference between males and females. The condition factor varied during the observation period, ranging from 0.92 to 1.09. The fish are mostly (80%) in good or very good condition. *H. lutkei* has a high potential fecundity; spawning was predicted throughout the year, with individual fecundity ranging from 263 to 1893 eggs. Luke's halfbeak populations in the Seram Sea could be exploited sustainably; however, this should be conducted with proper management.

Keywords: Allometric, garfish, growth pattern, pelagic fish, Seram Sea

INTRODUCTION

The fish species of the genus *Hemiramphus* are found all over the world. Nowadays, 11 species are recognized as valid species of the genus *Hemiramphus* (FishBase 2023), with various distributions for each species. For example, the distribution of *Hemiramphus archipelagicus* Collette & Parin, 1978 includes the Indo-West Pacific, East Africa, Madagascar, the Cook Islands, and Taiwan. *Hemiramphus lutkei* (Valenciennes, 1847) is native to the northwest Pacific (Hata et al. 2018). However, this species was also found in the coastal waters of India (Mohanty et al. 2020), Rote Island, East Nusa Tenggara (Balukh et al. 2021), Seram Sea Maluku, Indonesia (Talakua et al. 2022), and Nain Island, North Minahasa District (Umasangadji et al. 2023). Halfbeak groups can be found in the coastal waters of islands and continental coastlines, particularly in regions with dense vegetation. The adult's halfbeak primarily consumes seagrass (Yousuf et al. 2013; Tabassum et al. 2017a), while juveniles ingest zooplankton, green algae, and diatoms (Akyol and Ertosluk 2019). Halfbeak has become a commercially important fish commodity in several regions. Lutke's halfbeak (*H. lutkei)* is an important fish target species in the Maluku Sea and surrounding area, caught mainly by a small mini purse seine called *giop* (Natan et al. 2019; Talakua et al. 2022). Halfbeak fisheries have become an important part of the local community, providing animal protein and trading commodities traded mainly in smoked fish processing, mostly operated by women.

Intensive halfbeak capture could deplete the fish population in the absence of suitable fisheries management. Effective management of fisheries resources requires the availability of information on various aspects of fishery biology. Quantitative data on fish species, such as the relationship between fish length and weight and condition factors, are important and required fisheries biology information for fish population management (Kumar et al. 2017; Furuichi et al. 2021; Narzary and Khangembam 2022). Length-weight relationship and condition factor are among the most valuable tools in fisheries science and management (Jisr et al. 2018; Abidin et al. 2019; Furuichi et al. 2021; Samsun and Erdoğan Saĝlam 2021). Regular assessment of condition factors is important to obtain information on the health condition and productivity of the fish population (Muzzalifah et al. 2015; Kumar et al. 2017). Lutke's halfbeak fishing capture must consider aspects of their reproductive biology. Fishermen in the Seram Sea, Maluku, have limited knowledge and understanding of the reproductive biology of this fish. Fish population development depends on the success of reproduction to produce offspring and ensure their survival. Besides being necessary for the growth of fish populations, fish reproduction is also important to maintaining the health of aquatic ecosystems. Lutke's halfbeak became entangled in the nets of fishers as fish schools made their way to

spawning grounds (Linggi et al. 2021). Therefore, most of the fish that were captured are a group of fish that are in the gonad maturity phase and ready to spawn. The Lutke's halfbeak exhibits a daily migration (temporal migration) to coastal regions abundant in coral reefs and seagrass beds (Behera et al. 2019; Akyol and Tosunoglu 2020). Until now, no information has been related to the length-weight relationship, condition factor and reproduction aspects of Lutke's halfbeak at Seram Sea, Maluku.

Therefore, this study aimed to (i) determine the length-weight relationship to predict the fish growth pattern, (ii) determine the condition factor to assess the habitat suitability for the growth of halfbeak, and (iii) determine the gonad maturity stage to estimate the spawning pattern, and (iv) assess the fecundity of the Lutke's halfbeak. This research will enhance the existing data and information to facilitate the implementation of suitable management and conservation strategies for halfbeak species.

MATERIAL AND METHODS

Fish sample and sampling location

The fish samples were obtained from the fishers who caught halfbeaks around Kayeli Bay in the Seram Sea (Ubung Village and Waelapia Village) (Figure 1). Around 100 fish were randomly selected from each location during each observation period from August 2021 to February 2022.

Measurement of total length and body weight

Measurement of the total length (TL) of fish was carried out with a digital caliper (accuracy of 0.01 mm), while measurement of fish weight (W) was carried out with a digital scale (accuracy of 1.0 g). The total length and body weight data were separated between male and female fish.

Sex determination

The abdomen was dissected using a dissecting set apparatus to determine the fish's sex. The gonads were removed, and then they were observed to confirm the sex of the fish based on the morphological characters.

The length-weight relationship

The calculation was conducted using the data analysis menu available in the Microsoft Excel program. The length-weight relationship was calculated using the following equation: $W=aL^b$, where W is the body weight (g), and L is the total length of the measurement results converted from mm to cm. Parameter a is the intercept, and b is the slope (referring to Muzzalifah et al. 2015; Kumar et al. 2017; Karna et al. 2018; Narzary and Khangembam 2022). The b value was used to predict the fish growth pattern: b = 3, indicating an isometric growth pattern; b<3, a negative allometric growth pattern; and b>3, a positive allometric growth pattern.

The condition factor

The condition factor of allometric fish growth was calculated in relative by the formula described previously (referring to Kumar et al. 2017; Jisr et al. 2018) as follows:

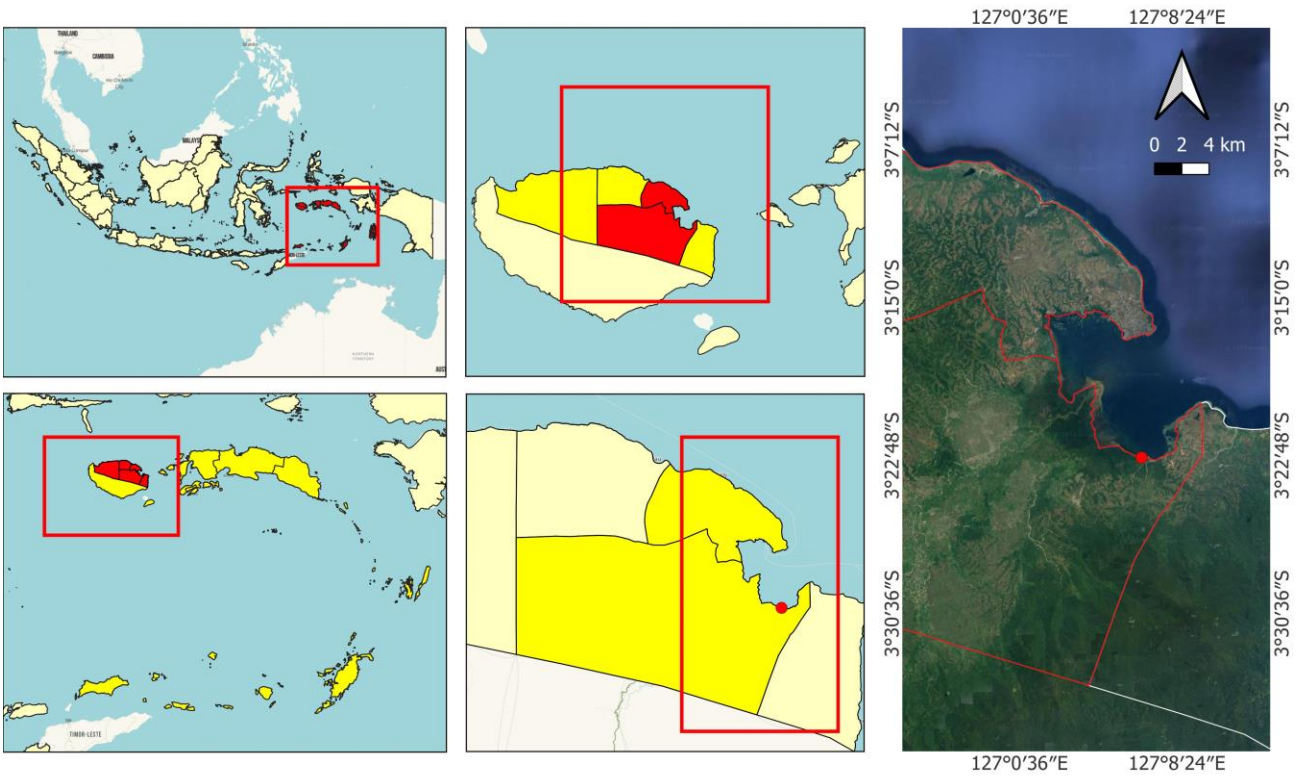

Figure 1. Sampling locations of halfbeak in the Seram Sea, Maluku, Indonesia

$$Kn = \frac{W}{aL^b}$$

Where:
Kn = relative condition factor
W = fish weight (g)
L = fish total length (cm)
a and b = constant

Gonad maturity stage determination

The gonads were weighed using digital balancing with an accuracy of 0.01 g. The male fish's left and right gonads are not separated but are weighed and determined by their gonad maturity stage (GMS). For the female fish, the left and right gonads were separated, then each gonad was weighed and then observed for gonadal maturity stage determination based on the prominent morphological characteristics. The determination of the gonad maturity stage was conducted referring to Tester and Takata (1953) (Table 1), with modifications adjusted to the results of the observations.

Fish fecundity

The fecundity was determined using the gravimetric method by taking eggs from the female fish with gonad maturity stages III to IV. As many as 10% of the samples of mature female fish (from the left and right gonads) were taken, and each was put into a sample bottle containing 4% formalin solution for preservation. The eggs were counted individually and then calculated for their relative fecundity, referring to Effendie (2002), as follows:

$$F = \frac{\sum eggs\ left\ gonad}{W\ left\ gonad} + \frac{\sum eggs\ right\ gonad}{W\ right\ gonad}$$

Where:
F = fecundity
W = weight (g)

RESULTS AND DISCUSSION

Sex ratio of *H. lutkei*

A total of 1,497 fish samples were observed, comprising 875 males and 622 females. The proportion of male fish was consistently higher than in each observation period, except for November. In November, female fish were higher (60.73%) than male fish (39.27%) (Figure 2). This period showed a unique pattern in November compared to other periods. The most significant sex ratio occurred in February, with a proportion of 74.06% males to 25.94% females. This indicates that February exhibited the highest male-to-female ratio compared to all other observation periods.

Length and weight distribution of *H. lutkei*

The distribution of total length and weight of the Lutke's halfbeak (*H. lutkei)*, both male and female, showed variations during the observation period. The total length of males ranged from 24.27-29.85 cm, while body weight ranged from 33.00-75.00 g (Table 2). The total length of female fish ranged from 25.20-31.66 cm, and body weight ranged from 39.00-89.00 g (Table 3).

Most male fish have a total length of 26.72-27.92 cm (68.69%), while the female fish is dominated by a total length of 28.10-29.50 cm (71.38%). The frequency distribution of the total length of the Lutke's halfbeak (*H. lutkei*) is shown in Figure 3.

Length-weight relationship of *H. lutkei*

The length-weight relationship of both male and female *H. lutkei* showed a negative allometric growth pattern, with values of b = 2.326-2.961 for males and b = 2.455-2.881 for females. (Tables 4 and 5). Overall, the length-weight relationship of male *H. lukei* follows the formula $W=0.004L^{2.886}$, while that of female *H. lutkei* follows the formula $W=0.003L^{2.962}$ (Figure 4).

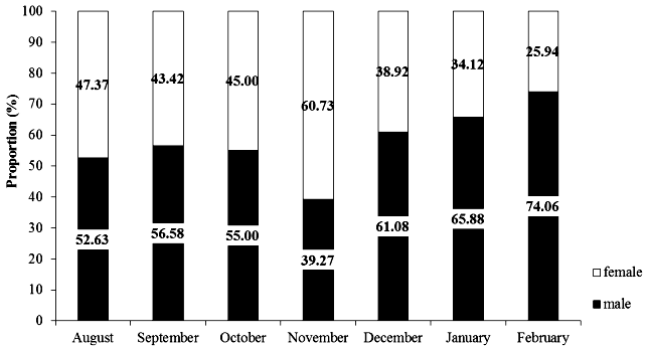

Figure 2. The proportion of male and female fish *Hemiramphus lutkei* from the Seram Sea, Maluku, Indonesia

Table 1. Classification of the gonad maturity stage by Tester and Takata (1953)

Gonad maturity stage	Female ♀	Male ♂
I. Immature	Very small like threads and transparent, round cross-section, reddish color	Very small like a thread and transparent, flat in cross-section, white in color
II. Maturing	Gonads fill ¼ of the body cavity, round, reddish, or yellow; eggs are not visible	Gonads fill ¼ of the body cavity and are flat and white
III. Mature	Gonads fill ½ of the body cavity, yellow in color, visible eggs	Gonads fill ½ of the body cavity, white
IV. Ripe	Gonads fill ¾ of the body cavity; the yellow color is almost clear or translucent, and eggs are clearly visible.	Gonads fill ¾ of the body cavity, white, filled with white fluid.
V. Spawning	Reddish in color, soft, and no eggs visible	White, sometimes with brown spots

Table 2. Length and weight distribution of male *Hemiramphus lutkei* from the Seram Sea, Maluku

Month	n (ind.)	Total length (cm)				Weight (g)			
		Min	Max	Average	SD	Min	Max	Average	SD
August	70	25.05	29.26	27.15	0.96	44.00	71.00	54.67	5.55
September	129	25.79	29.48	27.35	0.82	42.00	75.00	55.77	5.73
October	121	25.55	29.24	27.53	0.70	45.00	67.00	54.09	4.33
November	86	25.00	29.35	27.50	1.02	39.00	70.00	54.77	6.29
December	124	24.81	29.39	26.92	0.86	36.00	65.00	49.88	5.12
January	168	24.27	29.33	26.97	0.85	33.00	63.00	48.23	4.96
February	177	24.96	29.85	27.15	0.82	38.00	71.00	50.55	5.40
Total	875	24.27	29.85	27.20	0.88	33.00	75.00	52.01	5.98

Table 3. Length and weight distribution of female *Hemiramphus lutkei* from the Seram Sea, Maluku

Month	n (ind.)	Total length (cm)				Weight (g)			
		Min	Max	Average	SD	Min	Max	Average	SD
August	63	26.08	30.91	28.43	0.95	49.00	86.00	64.79	7.38
September	99	26.13	31.66	28.56	1.10	48.00	89.00	65.11	8.32
October	99	27.10	31.58	28.59	0.91	48.00	84.00	61.57	6.53
November	133	25.82	30.95	28.36	1.06	45.00	78.00	61.51	7.39
December	79	25.20	30.97	27.73	1.03	41.00	69.00	53.66	5.86
January	87	26.39	31.34	28.23	1.02	39.00	77.00	53.98	6.20
February	62	26.31	30.32	27.95	0.88	41.00	67.00	52.85	5.93
Total	622	25.20	31.66	28.30	1.04	39.00	89.00	59.51	8.38

Table 4. Length-weight relationship of male *Hemiramphus lutkei* from the Seram Sea, Maluku

Month	n (ind.)	Equation $W = a L^b$	r	R^2	Growth pattern
August	70	$W = 0.004 L^{2.397}$	0.843	0.711	Negative allometric
September	129	$W = 0.005 L^{2.829}$	0.838	0.703	Negative allometric
October	121	$W = 0.024 L^{2.326}$	0.747	0.558	Negative allometric
November	86	$W = 0.006 L^{2.750}$	0.870	0.757	Negative allometric
December	124	$W = 0.004 L^{2.884}$	0.885	0.783	Negative allometric
January	168	$W = 0.011 L^{2.544}$	0.786	0.618	Negative allometric
February	177	$W = 0.003 L^{2.961}$	0.835	0.697	Negative allometric
Total	875	$W = 0.004 L^{2.885}$	0.808	0.653	Negative allometric

Notes: r = coefficient of correlation; R^2 = coefficient of determination

Table 5. Length-weight relationship of female *Hemiramphus lutkei* from the Seram Sea, Maluku

Month	n (ind.)	Equation $W = a L^b$	r	R^2	Growth pattern
August	63	$W = 0.005 L^{2.808}$	0.819	0.670	Negative allometric
September	99	$W = 0.016 L^{2.471}$	0.749	0.561	Negative allometric
October	99	$W = 0.007 L^{2.728}$	0.837	0.701	Negative allometric
November	133	$W = 0.004 L^{2.852}$	0.881	0.776	Negative allometric
December	79	$W = 0.015 L^{2.455}$	0.833	0.693	Negative allometric
January	87	$W = 0.014 L^{2.473}$	0.792	0.627	Negative allometric
February	62	$W = 0.004 L^{2.881}$	0.810	0.656	Negative allometric
Total	622	$W = 0.003 L^{2.962}$	0.778	0.605	Negative allometric

Note: r = coefficient of correlation; R^2 = coefficient of determination

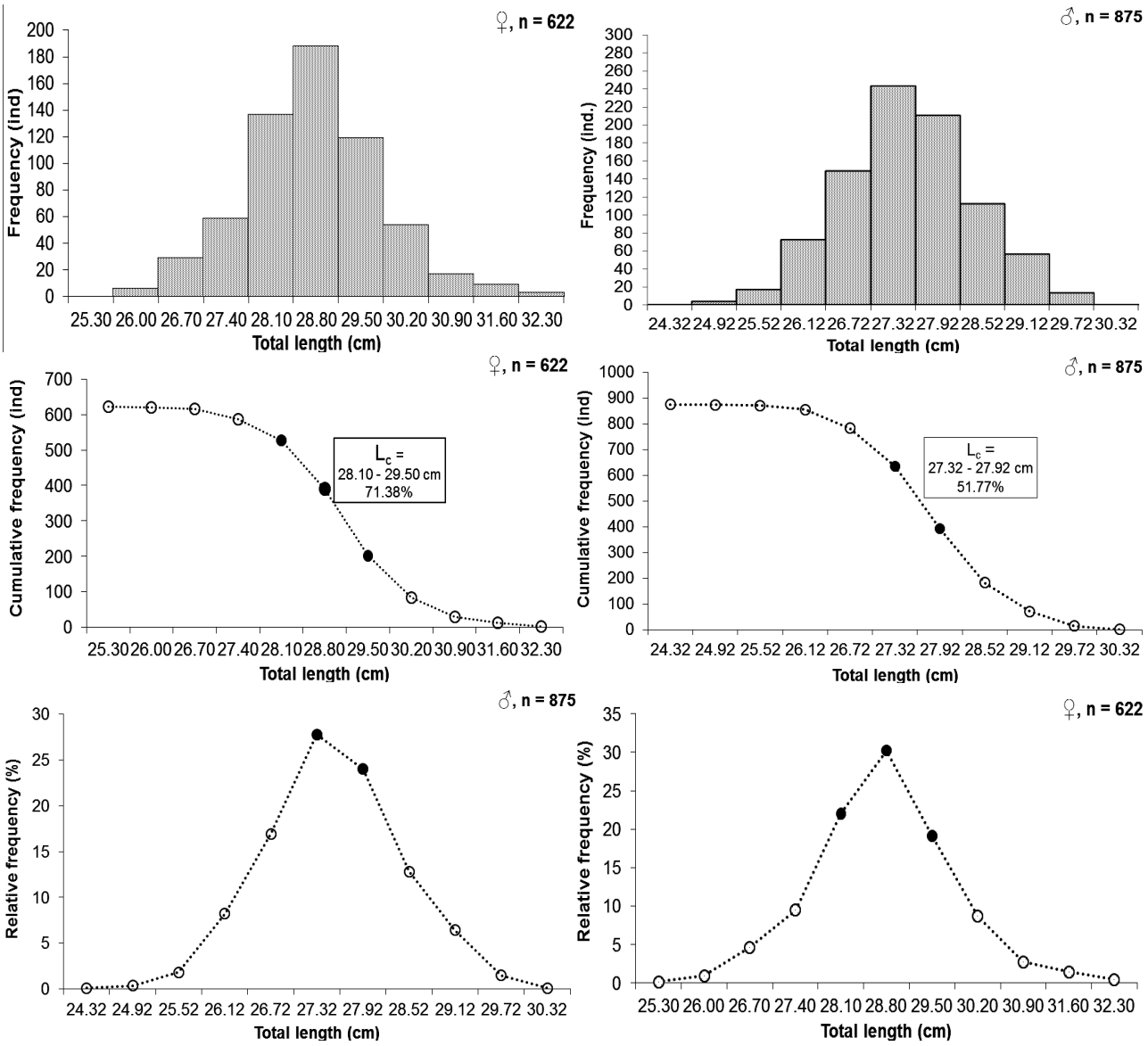

Figure 3. Length distribution, relative, and cumulative frequency of male (*left*) and female (*right*) of *Hemiramphus lutkei* from the Seram Sea, Maluku, Indonesia

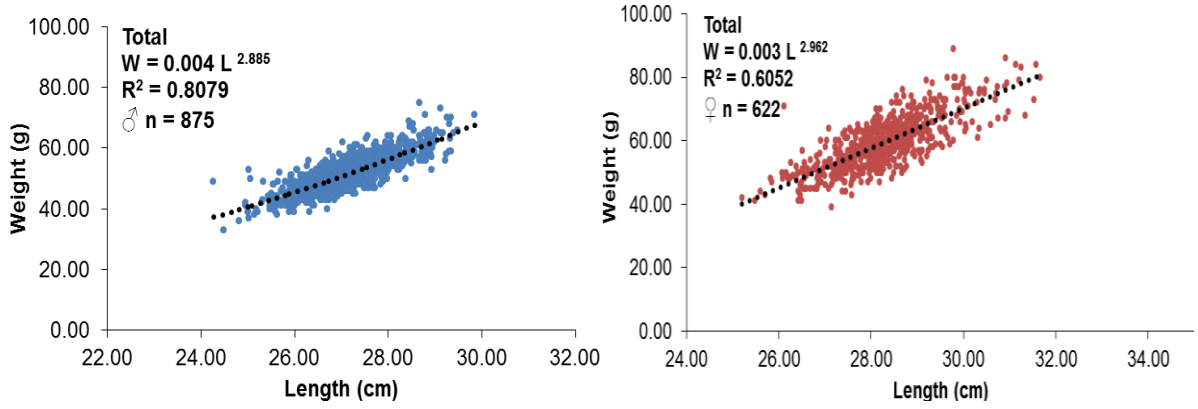

Figure 4. Length-weight relationship of male (*left*) and female (*right*) of *Hemiramphus lutkei* from the Seram Sea, Maluku

Ponderal index (Kn) of *H. lutkei*

The condition factor (Kn) value showed variation during the observation period for both male and female fish. The lowest Kn value for male fish was 0.94, found in November, January, and February, while the highest Kn value was 1.07 (January). The lowest (0.92) and the highest (1.09) Kn values of female fish were observed during the same period, namely September (Figure 5).

Kn values were categorized as fair (Kn≤0.95), good (Kn = 0.95-1.05), and very good (Kn≥1.05). Most fish were in good condition (Kn>0.95), which is more than 80% for males and more than 75% for females (Figure 6).

Distribution of gonad maturity stage of *H. lutkei*

There were five stages of gonad maturity found during the sampling period, from gonad maturity stages (GMS) 1 to 5, but in different proportions. The detailed classification and proportion of the gonad maturity stage of Lutke's halfbeak are shown in Table 6 and Figure 7.

Table 6. Classification of the gonad maturity stage of male and female *Hemiramphus lutkei* from the Seram Sea, Maluku

Gonads maturity stage	Female ♀	Male ♂
I. Immature	Pale-yellow, long and small	Transparent and small
II. Maturing	Pale-yellow, no visible egg dots, visible blood vessels	Milky-white, long and small
III. Mature	Yellow, visible many black dots, many blood vessels	Pale-brown, visible blood vessels
IV. Ripe	Yellow, very many eggs, full filling of the gonad sac, many and wide blood vessels	Brown, many blood vessels in the posterior gonad, testes 1.0 - 3.0 cm long, milky-white discharge visible
V. Spawning	Reddish-brown, flaccid, few eggs remaining in anterior or posterior (mostly posterior) gonads, many blood vessels, posterior part of gonad associated with genital track reddish-brown	Reddish-brown, small, many small blood vessels in the posterior part of the gonad, no visible testes

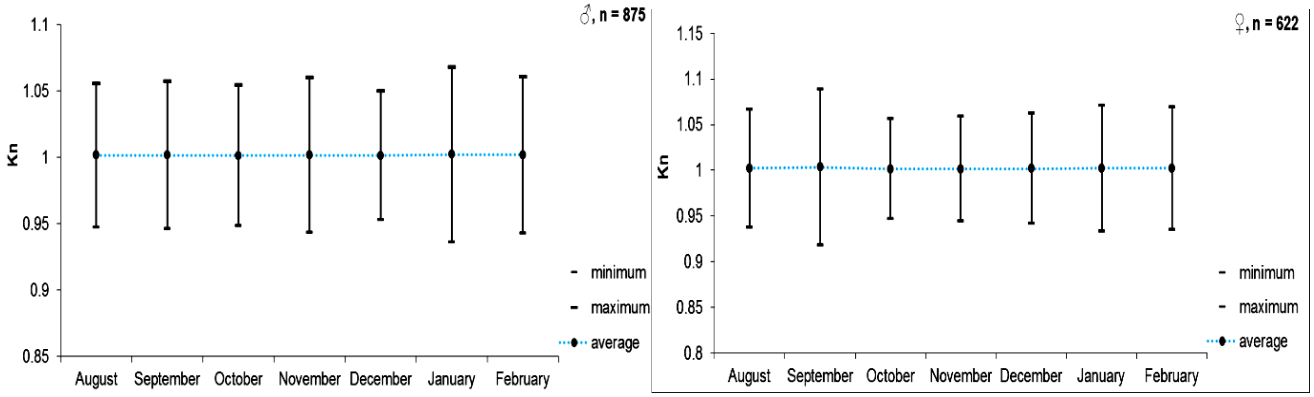

Figure 5. Ponderal index of male (*left*) and female (*right*) of *Hemiramphus lutkei* from the Seram Sea, Maluku

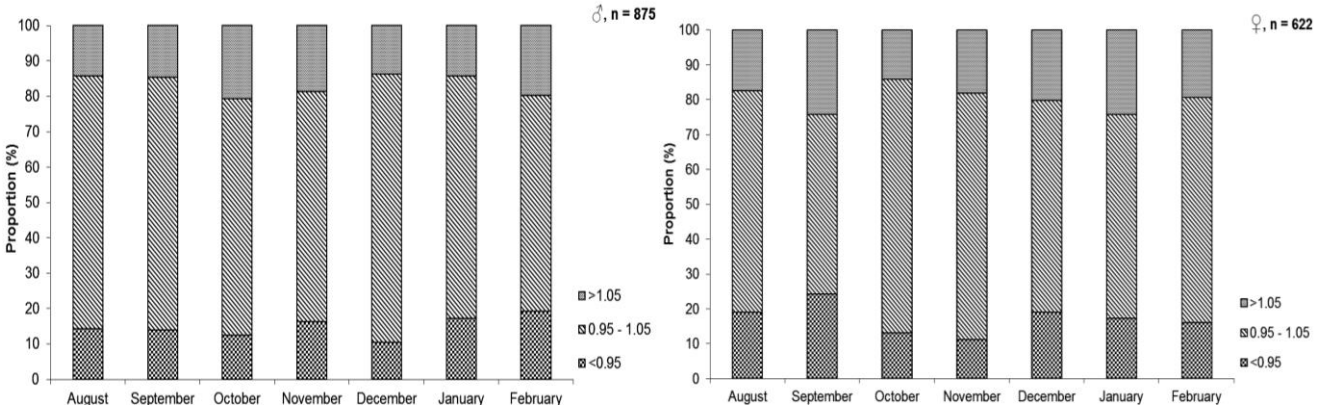

Figure 6. Proportion of Kn value of male (*left*) and female (*right*) of *Hemiramphus lutkei* from the Seram Sea, Maluku, Indonesia

Moreover, from August to October, most male fish were in GMS III: August 97.14%, September 84.50%, and October 92.56%. From November to February, most male fish had GMS IV, that is, November 89.53%, December 87.10%, January 38.69%, and February 44.63%. In the female fish, the GMS in August and September is mostly in GMS IV, with August 73.02% and September 65.66%, respectively. In October, mostly female fish were in GMS V with 62.63%, while in November, mostly female fish were in GMS IV with a percentage of 73.68%. From December to February, most female fish were in GMS V, that is, December at 65.82%, January at 59.77%, and February at 46.77%.

Fecundity

The fecundity of *H. lutkei* varies greatly, ranging from 263 to 1,893 eggs, with the lowest fecundity average found in September (263 eggs), while the highest fecundity was observed in November (1,893 eggs). The fecundity for each fish size group and monthly can be seen in Table 7 and Figure 9 in detail.

The monthly average fecundity of *H. lutkei* ranges between 497.86 and 838.43, as shown in Figure 9. February had the lowest fecundity at 497.86, while November had the maximum fecundity at 838.43.

Based on the gonad maturity stage, gonad development is grouped into the immature gonad group (Stages I and II), mature gonads (Stages III and IV), and spawn (Stage V). For males, the number of fish in the mature gonad category is 80%, while for females it is 59% (Figure 8).

Table 7. The fecundity distribution of *Hemiramphus lutkei* is based on the length size

Total Length (TL) (mm)	Number of samples (n)	Fecundity		
		Minimum	Maximum	Average±SD
<270	5	666	1,814	985.95±471.76
271-280	27	292	956	664.60±162.36
281-290	43	297	1,893	648.45±298.19
291-300	29	263	1,640	637.90±278.54
>300	7	360	1,2591	586.71±303.21

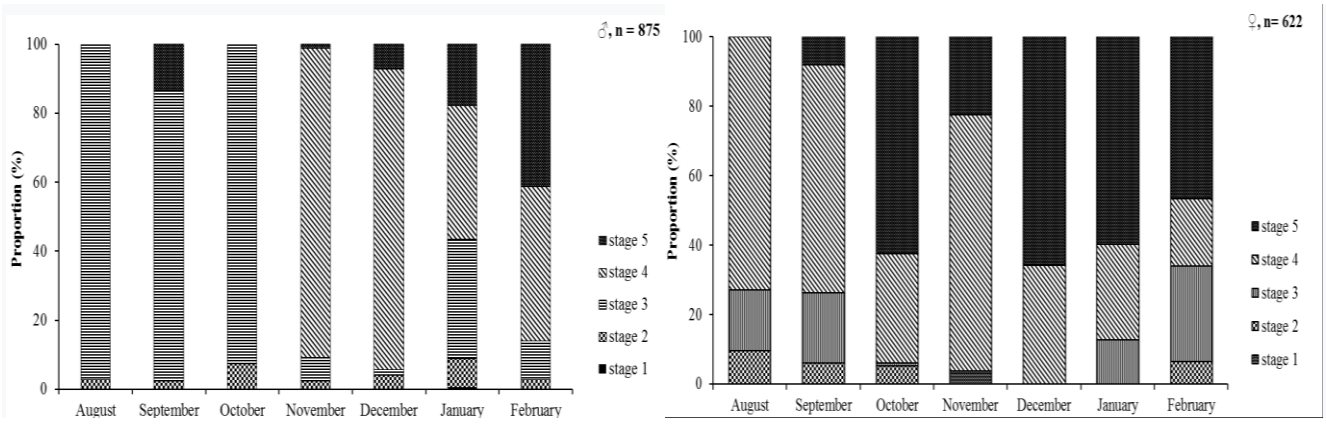

Figure 7. Proportion of gonads maturity stage of male (*left*) and female (*right*) of *Hemiramphus lutkei* from the Seram Sea, Maluku, Indonesia

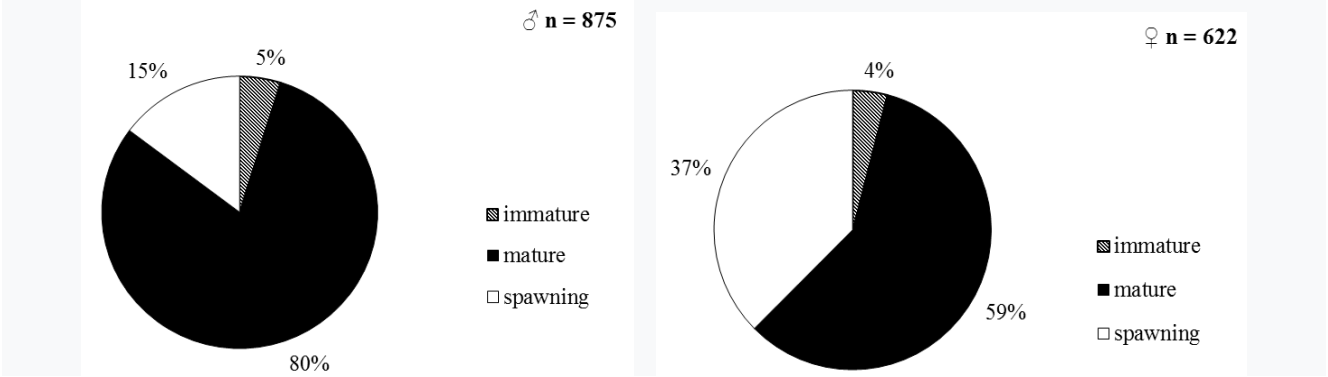

Figure 8. Percentage of gonad maturity of male (*left*) and female (*right*) of *Hemiramphus lutkei* from the Seram Sea, Maluku

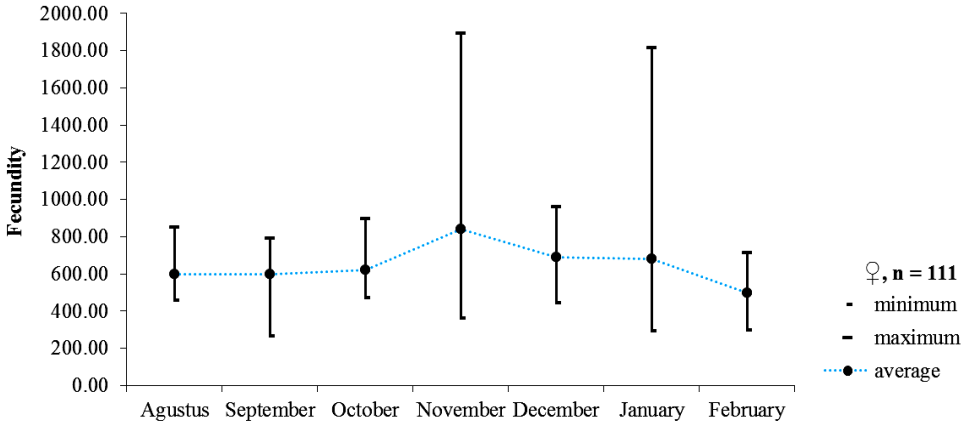

Figure 9. Fecundity of *Hemiramphus lutkei* from the Seram Sea, Maluku, Indonesia

Discussion

Hemiramphus lutkei, a member of the Hemiramphidae family, is a diminutive pelagic species that typically inhabits the continental shelf and surface waters no deeper than 200 meters (Emperua et al. 2018; Gaerlan et al. 2018; Sekadende et al. 2020). Halfbeak is a fish species that is commercially significant and ubiquitous throughout the Maluku Archipelago (Natan et al. 2019; Linggi et al. 2021). The male population of *H. lutkei* originated from the Seram Sea is larger than the female population every month except November. This month, the number of female *H. lutkei* was higher than male ones by as much as 60.73% (Figure 2). Overall, the proportion of males was 58.45% (n = 875), and that of females was 41.55% (n = 622); this shows a relatively balanced population in their habitat.

This study showed the average length of *H. lutkei* was 27.20 cm for males and 28.30 cm for females. As a comparison, *H. lutkei* caught in Gopalpur, India, has a standard length of 23.50 cm, while that caught in Boxipalli, India, has a standard length of 21.90-27.00 cm (Mohanty et al. 2020). There were also differences in total length between *H. lutkei* caught in Indonesian waters, namely 23.40-33.90 cm for fish caught off the coast of Rote Island, East Nusa Tenggara (Balukh et al. 2021), and 19.5-24.3 cm for fish caught off the coast of Nain Island, North Minahasa (Umasangadji et al. 2023). The difference in the average length in different regions of the world may be due to different physiochemical parameters and sampling periods. Aquatic habitat conditions such as food availability greatly influence fish growth apart from genetic factors (Lv et al. 2020; Canosa and Bertucci 2023; Menon et al. 2023).

The length-weight relationship for male *H. lutkei* follows the equation $W = 0.004\ L^{2.885}$, while for female *H. lutkei*, it follows the equation $W = 0.003\ L^{2.962}$. The b value of males and females is relatively the same, namely 3<b, which indicates a negative allometric growth pattern; that is, the increase in length of the fish is faster than the weight. *H. lutkei* has a greater total length ratio compared to body height and width (Talakua et al. 2022), so it has an elongated and slightly cylindrical body shape (Behera et al. 2019; Tiralongo et al. 2022). The growth pattern of male and female *H. lutkei* in the Seram Sea is similar to that of *H. lutkei* from several locations. Balukh et al. (2021) reported a negative allometric growth pattern on *H. lutkei* from Rote Island, East Nusa Tenggara. Umasangadji et al. (2023) also reported a negative allometric growth pattern on *H. lutkei* from Nain Island, North Minahasa, North Sulawesi, Indonesia.

The average relative condition factor (Kn) of *H. lutkei* in the Seram Sea, Maluku, was around 1 and relatively the same between males and females. The lowest Kn values for male fish (0.94) were observed in November, January, and February, while the lowest Kn values for female fish (0.92) occurred in September. *H. lutkei* from the Seram Sea Maluku has a slightly different Kn value from *H. lutkei* from the coast of Nain Island, North Minahasa male 0.98±0.06 and females 1.03±0.07, while *H. lutkei* from the Karachi Coast, Pakistan, Kn value between 0.844 and 1.250 (Tabassum et al. 2017b). Kn was classified into <0.95 for fair, 0.95-1.05 for good, and >1.05 for very good. Lloret-Lloret et al. (2022) explained that individuals with Kn values around 1.0 and more than 1.0 represent individuals in better conditions, while individuals with Kn values below 1.0 represent individuals in worse conditions. In general, the condition of *H. lutkei* in the Seram Sea was good. Both male and female fish are mostly in good and very good condition, with only about 20% in fair condition.

Brosset et al. (2015) state that the fish condition factor index is divided into three categories: the morphometric condition factor index, bioenergy index, and biochemical index. Determination of fish condition factors is very important for managing and utilizing fish populations, including understanding population dynamics, monitoring the status of fish stocks, and determining important variables in determining the plumpness or physiological status of fish (Brosset et al. 2015). The relative condition factor of *H. lutkei* from the Seram Sea shows the monthly variation, as well as the difference in Kn between males and females. Morphological changes in body weight more influenced the differences in Kn values between males and females. Variations in Kn values in adult females are

strongly influenced by gonadal development. Albo-Puigserver et al. (2021) mention a change in energy use during the reproductive period; in addition to body maintenance and growth, more stored energy is used for the reproductive process.

Interpretation of monthly variations in gonad maturity levels shows that adult male and female *H. lutkei* experience gonad maturity between August and February and indicates that female *H. lutkei* spawn more than once (multiple spawning). The first spawning is estimated to occur between September and November, and the second is between December and February. As a comparison, other species from the Hemiramphidae family, namely *H. brasilliensis*, are reported to spawn more than once based on microscopic analysis of gonad development in *H. brasilliensis* from the coast of Rio Grande do Norte, northeastern Brazil (Oliveira and Chellappa 2014).

The *Hemiramphus* species found in Indonesian waters exhibit similar patterns of gonad maturation and spawning periods. In their study, Balukh et al. (2021) documented the presence of *H. lutkei* along the seashore of Rote Island, East Nusa Tenggara. The researchers observed that the population of *H. lutkei* from September to November was primarily composed of fish with fully developed gonads, encompassing both male and female individuals. According to a study conducted by Ginanjar et al. (2019), *Hemiramphus robustus* Günther, 1866, a species found along the Boalemo Sea coast of Gorontalo, exhibits spawning behavior between December to January.

The fecundity of *H. lutkei* from the Seram Sea varies, ranging from 263 to 1,893 eggs. This differs greatly from the fecundity of *H. lutkei* on the Nain Island North Minahasa coast, ranging from 923 to 3,578 (Umasangadji et al. 2023). The fecundity of the *Hemiramphus* family shows variations depending on the species and environmental conditions. Differences in fecundity are considered part of the reproductive strategy and adjustment to the life cycle conditions of each type of fish in its habitat. Fish fecundity varies because of growth patterns, population density, body size, food availability, and mortality rates (Oliveira et al. 2015). In this study, the fecundity of *H. lutkei* was different at different total lengths. This is slightly different from that shown by Oliveira and Chellappa (2014), who stated that the fish fecundity increased as fish size increased.

It was predicted that 59% of the females died due to caught activities. This group of fish is easily entangled in nets because their movements are slow due to their increased relative body weight on the gonad development. *H. lutkei* makes its spawning journey to the coast of the Seram Sea to look for nesting places. The Seram Sea's surface temperature is relatively high during the southeastern and northern monsoons. However, the amount of *H. lutkei* caught by fishermen tends to fluctuate. Daily weather conditions may influence this in the coastal waters of the Seram Sea during the transition periods between the southeast season and the north season and vice versa. The Seram Sea and the other sea waters in the Maluku archipelago region, in general, are influenced by the monsoon patterns that occur in Indonesia (Suniada 2020), with various seasonal variations on each island.

The study shows that the *H. lutkei* stock has not been subjected to overexploitation; fishing operations continue to operate normally and have not surpassed the stock's available capacity. This condition allows the potential for increased exploitation of Lutke's halfbeak to meet direct consumption by the community or demand on raw materials for processing smoked fish in Buru Regency and its surroundings. According to the healthy condition of the fish during observations, Seram Island's coastal waters are relatively good ecologically and could support the growth of halfbeaks. However, management of *H. lutkei* needs to be carried out properly based on the best available fish biology data and information. Management actions by adjusting fishing gear are necessary, especially fitting the mesh size (Edwin 2019), which allows mature fish to escape from the net. This adjustment is expected to reduce the proportion of mature fish entangled in nets and allow these fish to spawn (Pratasik et al. 2020). Another management action is the consideration of closing seasons or areas, especially during the peak season for halfbeak spawning (Clarke et al. 2015; Edwin 2019).

ACKNOWLEDGEMENTS

Thanks to Universitas Gadjah Mada for the funding through RTA Scheme Number 3134/UN1.P.III/DIT-LIT/PT/2021. Thanks to the Ecology Laboratory Faculty of Mathematic and Natural Science UNPATTI for facilitating field research equipment.

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