

Reproductive biology of three reef fish species from Kei Islands, Southeast Maluku, Indonesia

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Abstract. Golden-lined spinefoot (*Siganus lineatus*), pink ear emperor (*Lethrinus lentjan*) and redbelly yellowtail fusilier (*Caesio cuning*) are three dominant species of reef fish were caught in Kei Islands, Southeast Maluku. The increasing number of fishermen catching reef fish in these waters, will threaten the resources if no management measures based on the biological aspects. The objective of this study was to analyze the sex ratio, length at first maturity, and spawning season period of these species based on the reproduction biology aspects. Sampling was carried out in 13 fish landing locations in the Kei Islands, Southeast Maluku from January to December 2016. A total of 744 fish samples were measured for the standard length, body weight, gonad maturity stage, and gonad weight. Sex ratio (male: female) of *S. lineatus*, *L. lentjan* and *C. cuning* are 1:1.08, 1:4.02 and 1:1.81, respectively in favour of females. Length at first maturity of these species were 32.3 cm, 25.1 cm and 22.3 cm for males, respectively and 21.9 cm, 25.3 cm and 21.6 cm for females, respectively. Spawning season prediction was analyzed by the distribution of monthly gonad maturity stage. The peak of spawning season for these fish species are predicted to occur from January to April and September to December.

1. Introduction

Uncontrolled fishing that takes continuously will cause a change in population structure, a decrease in stock and extinction. In the condition of fisheries resources that are still not exploited, the composition of the population provides proportionally large and old-age resources. As a result of fishing, the resources are declined and the population will be dominated by small and young-aged resources [1].

Golden-lined spinefoot (*Siganus lineatus* Valenciennes, 1835), pink ear emperor (*Lethrinus lentjan* Lacepede, 1802), and fusilier redbelly yellowtail (*Caesio cuning* Bloch, 1791) are three species of reef fish that are targeted by small-scale fishermen in Kei Islands, Southeast Maluku, Indonesia. These fish are caught mostly with gill nets and handlines. The local fisheries management authority does not yet have regulations related to the biological references points for the capture of these three species. On the other hand, the fishing trends tend to change the size and structure of the age of resources in a population, the body size and life span of the fish will decrease. This change will affect the other case of fish life. Egg production in a population will decrease because the size of the broodstock and fertility decreases. Other influences from overfishing are changes in the characteristics of fish life such as age, gonad maturity size, growth rate, and genetic-based reproductive [2].

Several studies on Siganidae have been conducted to determine morphometric and meristic characteristics, reproductive biology, growth and mortality, and food and feeding habits [3, 4, 5, 6, 7, 8, 9, 10]. While, studies on Lethrinidae include discussing biology, stock assessment, reproductive



biology, gonad maturity histology, age, growth and mortality parameters have been reported by several researchers [11, 12, 13, 14, 15, 16, 17]. In addition, research on Caesionidae include discussing growth, length distribution, gonad maturity, length-weight relationship, catch composition, fishing gear, and reproductive biology [18, 19, 20, 21, 22]. The study of aspects of reproductive biology is needed as a basis for the sustainable fish resources management. The reproductive biology aspects need to be studied are the peak of spawning season and the exploitation status based on the maturity distribution and length at first maturity. Therefore, the objective of the present study was to analyze the sex ratio, length at first maturity, and spawning season of *S. lineatus*, *L. lentjan* and *C. cuning* from Kei Islands, Southeast Maluku, Indonesia.

2. Materials and Methods

2.1. Site and Time

Sampling was carried out in 13 fish landing sites in Kei Islands, Southeast Maluku Regency from January-December 2016 (Figure 1).

2.2. Sampling and Measurement Procedures

Sampling of *S. lineatus*, *L. lentjan* and *C. cuning* biology was based on randomly sampled sampling, with each number of fish samples as many as 189, 256 and 312 fish, respectively. The fish samples were captured using gill nets with mesh size of 2 to 2.5 inch and handlines with hook size of number 9 to 12. The standard length of each individual fish was measured using a ruler with an accuracy of 1 mm and the body weight and gonad weight measured using a digital balance (Ozone Digital Kitchen Scale OX-315) with accuracy of 1 gram.

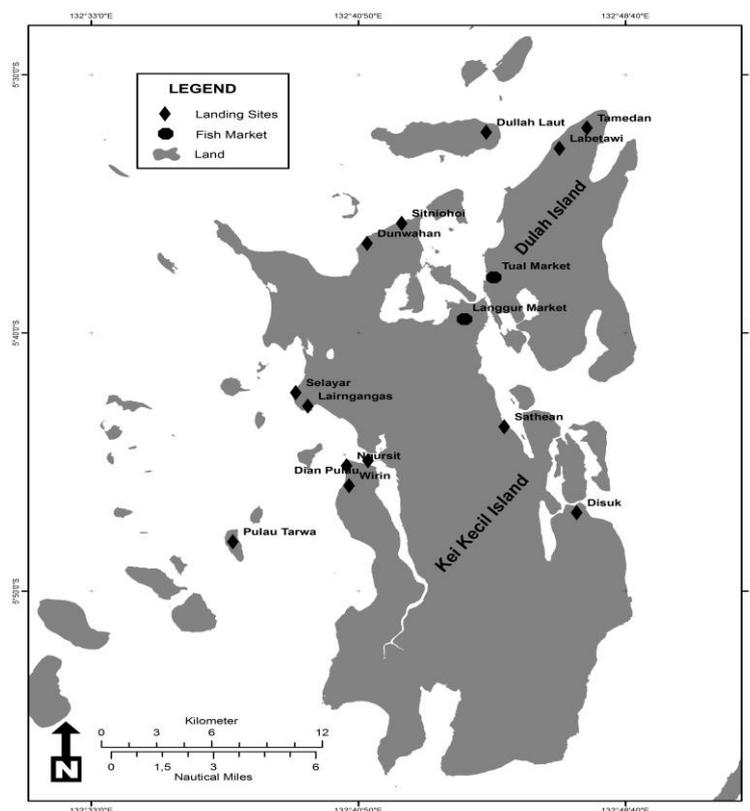


Figure 1. Research sites in Kei Islands, Southeast Maluku, Indonesia.

2.3. Data Analyses

The sex and level of gonad maturity were identified based on the gonad morphology [23]. Sex was determined to analyse the sex ratio and tested for significant divergence from the expected 1:1 ratio by using a Chi-square (X^2) goodness of fit test [24]. The gonad maturity classification was made where stages III and IV were considered to be mature for males and females respectively. For both males and females, the size at first maturity was determined by calculating the proportion of mature individuals in each size class (standard length). The size at which 50% of individuals were mature was taken as the size at which fish reach maturity for the first time [25].

The monthly gonad index (GI) was calculated with the equation [26]:

$$GI = \frac{Wg}{W} \times 100 \%$$

where:

Wg : gonad weight (g)
 W : total weight (g)

3. Results and Discussions

3.1. Sex Ratio

A total of 189 specimens of *S. lineatus* was sexed, of which 91 were male and 98 were female, giving a sex ratio of 1:1.08 in favour of females. A chi-square goodness of fit test was performed and the results showed that the ratio was not significantly different from a 1:1 ratio ($X^2 = 0.259$, $0.25 < p < 0.001$). This ratio is close to *S. canaliculatus* study in Arabian Gulf and Qatar coastal waters with a ratio of 1: 1.13 and 1: 1.09 [6, 9]. Research with the same species with different periods in the Arabian Gulf shows a ratio of 1.1: 1 [8].

L. lentjan had a total of 256 specimens that was sexed, of which 51 were male and 205 were female, giving a sex ratio of 1:4.02 in favour of females. A chi-square goodness of fit test was performed and the results showed that the ratio was significantly different from a 1:1 ratio ($X^2 = 92.641$, $0.01 < p < 0.025$). This ratio is very different from the ratio in other waters with the same species of 1: 1.11 [17]. The ratio of *L. harak* in Kenyan coastal waters of 1:1.10 is also very different from the results of this study [13].

Table 1. Chi-square values for sex ratio of each species.

Species	Numbers		F : M Ratio	X^2	Significance level
	M	F			
<i>Siganus lineatus</i>	91	98	1 : 1.08	0.259	-
<i>Lethrinus lentjan</i>	51	205	1 : 4.02	92.641	**
<i>Caesio cuning</i>	111	201	1 : 1.81	25.962	*

- = not significant; * $p = 0.025-0.05$; ** $p = 0.01-0.025$

C. cuning had a total of 312 specimens that was sexed, of which 111 were male and 201 were female, giving a sex ratio of 1:1.81 in favour of females. A chi-square goodness of fit test was performed and the results showed that the ratio was significantly different from a 1:1 ratio ($X^2 = 92.641$, $0.025 < p < 0.05$). This ratio close to the ratio of the same species in Seribu Islands by 1: 1.19 [20].

3.2. Length at first maturity

S. lineatus males attained first sexual maturity at 32.3 cm SL, and females became first sexually mature at 21.9 cm SL, with their percentage increasing thereafter (Fig. 2a). The percentage of mature females at 25 cm is greater than that of males, implying that females attained sexual maturity while slightly

smaller than males. Studies on *S. canaliculatus* show the first sexual maturity at 18 cm for males and 19 cm for females in Arabian Gulf and 17.7 cm for males and 17.2 cm for females in Qatar coastal waters [6, 9]. In *L. lentjan*, males attained first sexual maturity at 25.1 cm SL and females at 25.3 cm SL (Fig. 2b). The percentage of mature females at 25 cm is greater than that of males. Studies on the same species show the first sexual maturity at 28.4 cm in Tuwwal coastal waters and 33 cm in Red Sea [16, 15].

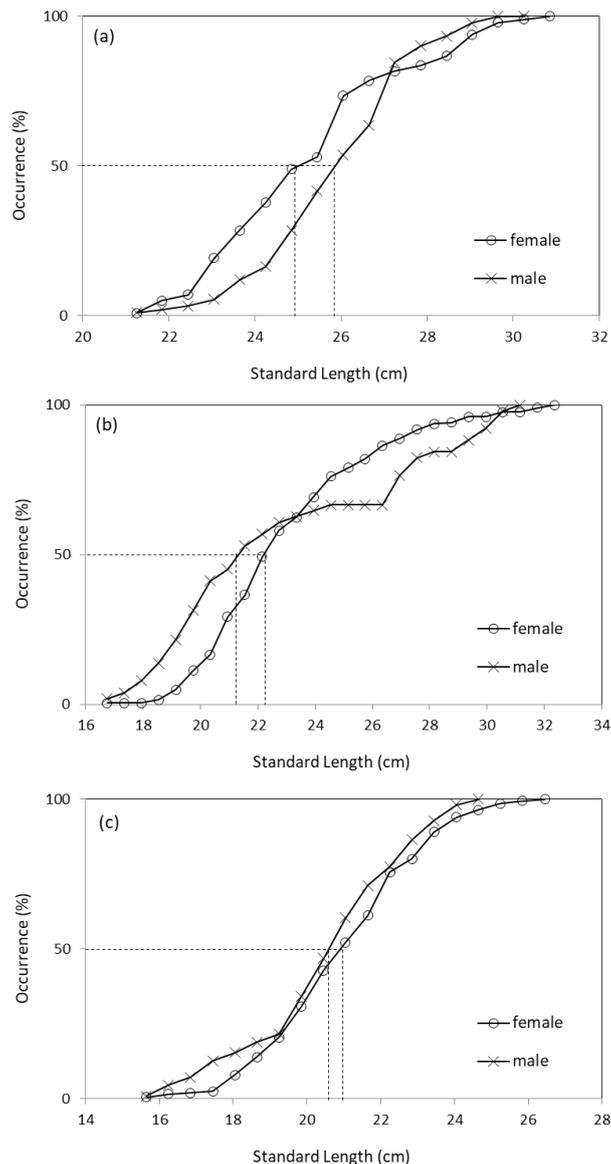


Figure 2. Percentage of sexually mature for each species: (a) *Siganus lineatus*, (b) *Lethrinus lentjan*, (c) *Caesio cuning*. Size at first maturity is the length at which 50% of all individuals are sexually mature.

C. cuning males attained first sexual maturity at 22.3 cm SL, and females became first sexually mature at 21.6 cm SL, with their percentage increasing thereafter (Fig. 2c). The percentage of mature females at 25 cm is greater than that of males, implying that females attained sexual maturity while slightly smaller than males. Study on the same species shows the first sexual maturity at 22.92 cm in

Seribu Islands, but study on *C. erythrogaster* shows the first sexual maturity at 27.8 cm in Banggai Kepulauan coastal waters [19, 22].

3.3. Gonad-Index

Gonad-index of *S. lineatus* (Fig. 3a and 3b), *L. lentjan* (Fig. 3c and 3d), and *C. cuning* (Fig. 3e and 3f) for females and males, respectively showed the variation montly, for example the GI increased in January to April, then decreased in the following months. GI increase in September to December again. These two periods are predicted as the spawning season of these species, where fish are ready to spawn.

The spawning season of *S. canaliculatus* in Arabian Gulf is predicted on April to June, has the same result in Qatar coastal waters [6, 9]. In the other studies of *L. lentjan*, the spawning season are predicted on April and May in Tuwwal coastal waters [16]. The spawning season of *C. cuning* in Seribu Islands is predicted on November to December [20].

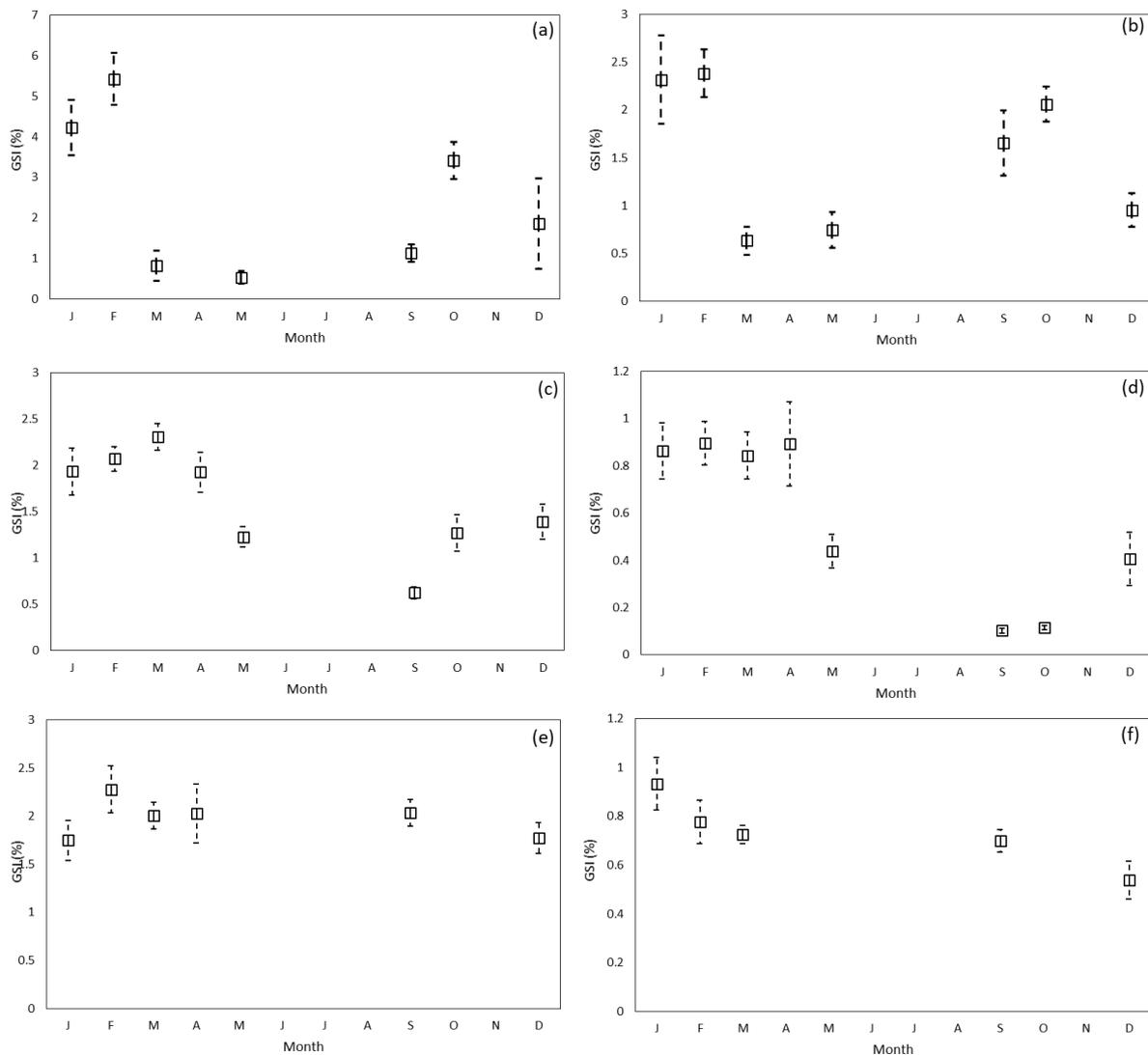


Figure 3. Monthly gonad-index (GI) percentage for each species: (a) *Siganus lineatus* females, (b) *Siganus lineatus* males, (c) *Lethrinus lentjan* females, (d) *Lethrinus lentjan* males, (e) *Caesio cuning* females, and (f) *Caesio cuning* males.

Acknowledgement

All authors appreciate and wish to thank to WWF-Indonesia who financially support the study. Also, we wish to thank to field enumerators: Ainun Silvia Jayanti, Thomas Sasmoyo Ardhi, Maria Fofid, and Paskalina Ohoiledwarin, who done field work and gathering the necessary data.

References

- [1] Ricker W E 1975 Bulletin of the Fisheries Research Board of Canada 1911-382
- [2] Jennings S, Kaiser M, Reynolds J D 2001 Marine Fisheries Ecology Alden Press Ltd Blackwell Publishing United Kingdom 417 pp
- [3] Wambiji N, Ohtomi J, Fulanda B, Kimani E, Kulundu N, Hossain M Y 2008 *South Pacific Studies* **29**(1) 1-15
- [4] Ramkumar B, Murugan A 2018 *Indian Journal of Geo Marine Sciences* **47**(2) 390-394
- [5] Gundermann N, Popper DM, Lichatowich T 1983 *Pacific Science* **37**(2) 165-180
- [6] Tharwat AA 2004 *International Journal of Plant, Animal and Environmental Sciences* **4**(4) 95-102
- [7] Wassef E A, Abdul Hady H A 1997 *Fisheries Research* **33** 159-166
- [8] El-Sayed A M, Bary K A 1994 *Oebalia* **20** 79-88
- [9] Nelson S G, Lock S A, Collins L A 1992 Growth of the rabbitfish *Siganus randalli* Woodland in relation to the feasibility of its culture on Guam Technical Report No 97 University of Guam Marine Laboratory 30 pp
- [10] Zaahkoug S A, Khalaf-Allah H M, Mehanna S F, El-Gammal F I, Makkey A F 2017 *Egyptian Journal of Aquatic Biology & Fisheries* **21**(1) 63-72
- [11] Muchlisin Z A, Fransiska V, Muhammadar A A, Fauzi M, Batubara A S 2017 *Croatian Journal of Fisheries* **75** 142-154
- [12] Prihatiningsih 2015 Estimasi parameter populasi ikan lencam (*Lethrinus lentjan*) di sekitar perairan Kotabaru (P. Laut) – Kalimantan Selatan *Prosiding Seminar Nasional Ikan Ke-8 Masyarakat Iktiologi Indonesia* 269-278
- [13] Kulmiye A J, Ntiba M J, Kisia S M 2002 *Western Indian Ocean Journal of Marine Science* **1**(2) 135-144
- [14] Ezzat A A, Wassef E A, Bawazeer F A 1994 *Journal of King Abdulaziz University – Marine Sciences* **7** 215-232
- [15] Wassef E A 1991 *Fisheries Research* **11** 75-92
- [16] Kedidi S M, Abu Susha T, Allam K 1984 Biology and stock assessment of the redspot emperor, *Lethrinus lentjan*, from waters adjacent to Tuwwal, Saudi Arabia. Project for Development of Fisheries in Areas of the Red Sea and Gulf of Aden, Food and Agriculture Organization of the United Nations 21 pp
- [17] Toor H S 1968 *Indian Journal of Fisheries* **11** 581-596
- [18] Dahlan M A, Jannah M, Najamuddin, Omar S B A, Nur M 2018 *AAFL Bioflux* **11**(1): 272-277
- [19] Indarsyah I J, Hartati S T, Wahyuni I S 2011 Pertumbuhan, sebaran ukuran panjang, dan kematangan gonad ikan ekor kuning (*Caesio cuning*) di perairan Kepulauan Seribu *Prosiding Seminar Nasional Ikan Ke-VI Masyarakat Iktiologi Indonesia* 293-298.
- [20] Hartati S T, Wagiyo K, Prihatiningsih 2011 *Jurnal Penelitian Perikanan Indonesia* **17**(2) 83-94
- [21] Mujiyanto, Satria H, Sugianti Y 2010 Hubungan panjang dan berat ekor kuning (*Caesio cuning*) hasil tangkapan bubu di perairan Teluk Saleh, Nusa Tenggara Barat *Prosiding Seminar Nasional Biologi Fakultas Biologi Universitas Gadjah Mada* 972-977
- [22] Subroto, Hadi I, Subani W 1994 *Jurnal Penelitian Perikanan Laut* **91** 22-23.
- [23] Holden M J, Raitt D F S 1974 Manual of Fisheries Science. FAO Rome Part 2-Methods of Resources Investigation and their Application 135
- [24] Zar J H 1999 Biostatistical analysis Fourth edition Prentice-Hall New Jersey 663 pp (Main text) + 212 pp (Appendices)
- [25] King M 1995 Fisheries Biology Assessment and Management. Blackwell Science Ltd (Fishing

News Books) Osney Mead Oxford 341 pp

[26] Effendie M I 2002 *Biologi Perikanan* Yayasan Pustaka Nusantara Yogyakarta 163 pp

[27] Muchlisin Z A, Musman M, Siti-Azizah M N 2010 *Reproductive Biology and Endocrinology* **8**
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