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Reproductive traits and spawning activity of striped eel catfish (Plotosidae) in Kolono Bay, Indonesia

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Abstract. *Asriyana A, Halili H. 2021. Reproductive traits and spawning activity of striped eel catfish (Plotosidae) in Kolono Bay, Indonesia. Biodiversitas 22: 3020-3028.* Reproduction is a natural process for a species to ensure its sustainability in nature. This study aimed to investigate the reproductive traits and spawning activity of the striped eel catfish in Kolono Bay, South Konawe District, Southeast Sulawesi, Indonesia. A total of 965 individuals were collected monthly from June 2020 to May 2021 by using bottom experimental gillnets. Spent/spawning stages of the male and female fish were found during the East season (June-August). The proportions of the spent/spawning stages of male and female fish were 60% and 55.56% and the values of the gonadal somatic index were 1.19 ± 0.53 and 2.19 ± 3.47, respectively during the East season, indicate occurring the peak spawning in this season. Females matured gonads more rapidly at 198.3 mm compared to males at 224.5 mm. Female fecundity was 1,730 ± 390 eggs, with an egg diameter of about 0.11-1.35 mm. Striped eel catfish is a total spawner fish that has one mode of egg distribution pattern. During the East season, it needs protection for spawning. The findings will help in designing effective management and developmental strategies to conserve the striped eel catfish population in the future.

Keywords: Conservation, fecundity, gonadal maturity, length at maturity, spawning period

INTRODUCTION

Striped eel catfish, *Plotosus lineatus* (Thunberg, 1787), known as marine catfish or *sembilang*, is a preferred catch. In Asia, local fishermen often capture the Plotosus genera because they have a higher commercial value as reported in several countries (Ahmed and Haque 2007; Usman et al. 2013a; Amornsakun et al. 2018; Thu et al. 2019). Typically, the striped eel catfish occupy the coral reefs, estuaries, intertidal areas, and open waters. This fish is widespread in the Western Indo-Pacific region: the west and south coasts of India and outside of Sri Lanka, eastward along the shores of Bangladesh and Myanmar, through the Indo-Australian Islands and the Philippines to Papua New Guinea (Gomon 1984). It also can be found in Rea Sea and East Africa to Samoa, Palau and Yap in Micronesia (Myers 1991); sometimes enters freshwaters of East Africa (Lake Malawi) and Madagascar (Taylor and Gomon 1986); in the Mediterranean (Doğdu et al. 2016).

The gray eel catfish, *Plotosus canius* (Hamilton, 1822), is a close relative of *P. lineatus*, which has gained a threatened status in several locations including India, Bangladesh, and Malaysia (Patra et al. 2005; IUCN Bangladesh 2000; Usman et al. 2013a), and this condition is potentially to occur in *P. lineatus.* To conserve the striped eel catfish population, there is an immediate need for practical data on its reproductive biology to design effective strategies.

The number of studies on striped eel catfish is lesser than that on gray eel catfish. Previous studies have focused on the growth (Ya et al. 2015); risk assessment (Galanidi et al. 2019); population dynamics (Asriyana et al. 2020a); and bycatch of Plotosidae (Asriyana and Halili 2021); whereas studies on reproductive biology are relatively limited (Vijayakumaran 1997; Heo et al. 2007). As part of reproductive traits and spawning activity, information on gonadal somatic index or maturity index (GSI), maturation age, fecundity, and spawning pattern is very important. Gonadal development can be quantitatively known through the GSI. Fluctuations of GSI values are closely related to the egg development stage, egg diameter, and ponderal index (Lizama and Ambrósio 2002; Tzikas et al. 2007; Asriyana and Halili 2020). This information is closely related to the management of fish as a water resource.

The response of aquatic biota to water bodies depends on the physical and chemical characteristics of the water bodies and is expected to give different responses to the reproductive biology of striped eel catfish in Kolono Bay. Many studies have reported that differences in fish responses are related to water conditions at different locations (Barbosa et al. 2018; Asriyana and Irawati 2019; Teixeira et al. 2019). This study investigated reproductive traits and spawning activity of striped eel catfish, *P. lineatus,* in Kolono Bay. The findings of this study could be beneficial in the conservation efforts of *P. lineatus* in different water bodies.

MATERIALS AND METHODS

Sampling sites

The Kolono Bay is located in South Konawe District, Southeast Sulawesi, Indonesia. The coordinates of the

Kolono Bay are 4°20'35"-4°27'30" S and 122°39'55"-122°47'49" E (Figure 1). The observation station is located horizontally. Station I, which is bordered by mangrove ecosystems and coral reefs, has substrate rock type and coral fragments and it is located adjacent to the river mouth. Station II and III, bordered by seagrass, mangrove, and coral reef ecosystems, have a different substrate, muddy sand substrate and rocky substrate type. Station III, located around the bay mouth. The selection of the station aims to ensure that the striped eel catfish samples caught represent the condition of the striped eel catfish population in the waters of Kolono Bay.

Sampling design

Sampling was conducted every month for 12 months in all stations from June 2020 to May 2021. The study is included four seasons: East season (June to August), East-West season (September to November), West season (December to February), and West-East season (March to May). Fish were caught using bottom experimental gillnets, with net meshes of 1.25, 1.5, 1.75, 2, and 3 inches. The length and height of the net used for each mesh are 80 and 1.5 m in the water. The nets are installed at high tide and removed at low tide.. During fishing, water quality parameters, such as turbidity, salinity, pH, and temperature were measured at each station. Turbidity, salinity, pH, and temperature were measured in-situ using a turbidity meter (WGZ-1B Portable Digital), hand refractometer (ATAGO), pH meter (Hanna Digital HI 98107), and Hg thermometer, respectively.

Fish were identified according to the method of Froese and Pauly (2020). The total length (mm) and weight (g) of the collected samples were measured and the gonads were collected after the opening of the abdominal cavity of the fish. The sex of fish was distinguished based on gonadal morphology and the presence of genital papillae in the abdomen (Figure 2). The gonads were weighed using a 0.01 g scale, followed by analyzing the gonadal somatic index (GSI) and fecundity.

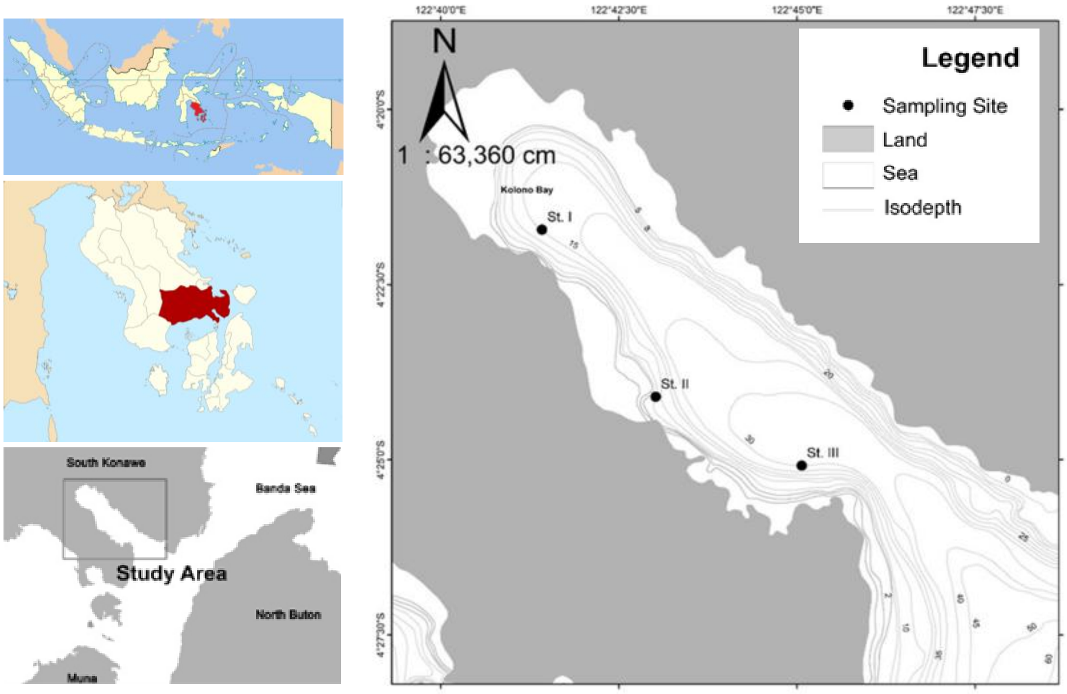

Figure 1. Location of the study in Kolono Bay, South Konawe District, Southeast Sulawesi, Indonesia from June 2020 to May 2021

Figure 2. Sexual dimorphism of striped eel catfish. A. Male; B. Female

The eel catfish sex ratio was determined by assessing the number of male and female fish, according to the methods of Usman et al. (2013a). Observation of gonads was carried out on fish that had undergone the stage of gonad maturity based on Heo et al. (2007). Gonadal fish development was determined based on the method of Heo et al. (2007), wherein the stages of gonad development of male and female fish are categorized into six stages: early growing, growing, early mature, mature, spent/spawning, degenerative and recovery stages. The GSI was determined by comparing the gonadal weight with the bodyweight of the fish (Adebiyi et al. 2011; Freitas and Montag 2019). Length at maturity was determined by plotting a graph of the percentage of mature gonad fish versus its total length. Minimum fish length of at least 50% of mature gonad fish (mature and spent/spawning stage) is stated as the size of the first mature gonad fish (King 1995; Khan et al. 2002). Striped eel catfish spawning time was determined based on variations in GSI values. Fecundity was analyzed using gravimetric methods (Khan et al. 2002; Trueman 2006; Ahmed and Haque 2007). The spawning patterns were determined according to female fish egg size distribution in the early mature, mature, and spawning stages. The diameters of the eggs were determined by using an ocular micrometer (Amornsakun et al. 2018).

Data analysis

Differences in body length and weight between sexes were analyzed using the non-parametric Mann-Whitney U test, at a confidence level of 95%. Differences in water quality parameters, sex ratio, GSI, and fecundity based on the season were analyzed using the non-parametric Kruskal-Wallis test, at a confidence level of 95% (Sokal and Rohl 1995). Data were analyzed with the SPSS ver. 26 software.

RESULTS AND DISCUSSION

Physical and chemical conditions of the water

At the time of this study, there were considerable variations in the physical and chemical conditions of the water (Figure 3). Temperature, salinity, and pH were significantly different between the seasons (p = 0.003; 0.012; 0.000, respectively; α = 5%), except for the turbidity (p = 0.142, α = 5%).

Sex ratio, gonadal development, and length at maturity

The total number of striped eel catfish caught in the water of the Kolono Bay was 965 individuals consisting of 713 males and 252 females. The length and weight of male fish ranged 40-325 mm and 0.3-218.2 g, respectively. Whereas the length and weight of female fish ranged 40-254 mm and 0.3-123.4 g, respectively. The male striped eel catfish were more in number than the female counterparts, with a ratio of 2.82:1 (Table 1). According to the Kruskal-Wallis test, the ratio of male-to-female fish did not differ in all seasons (p = 0.160, α = 5%).

The gonadal maturity stage is a certain stage of gonad development before and after the fish is spawning. The percentage of gonads that develop in striped eel catfish varies between seasons (Figure 4). In this study, gonad maturity stages were between early growing to spent/spawning stages, except for the degenerative and recovery stages. The spent/spawning stage in male and female fish populations was 60% and 55.56%, respectively which only detected in the East season.

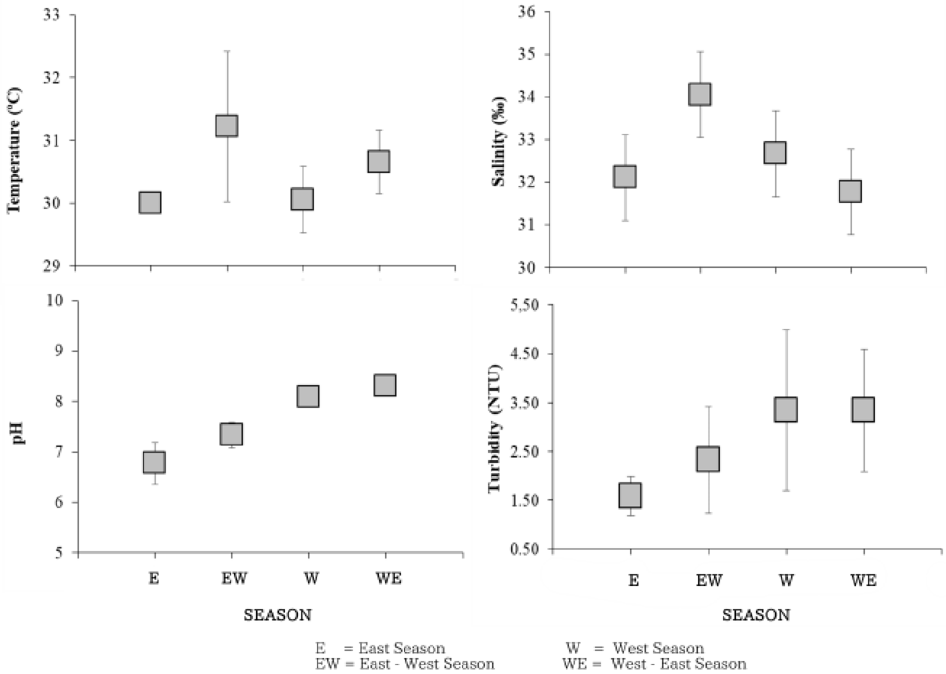

Figure 3. Seasonal physical and chemical variations in the waters of the Kolono Bay, South Konawe District, Southeast Sulawesi, Indonesia

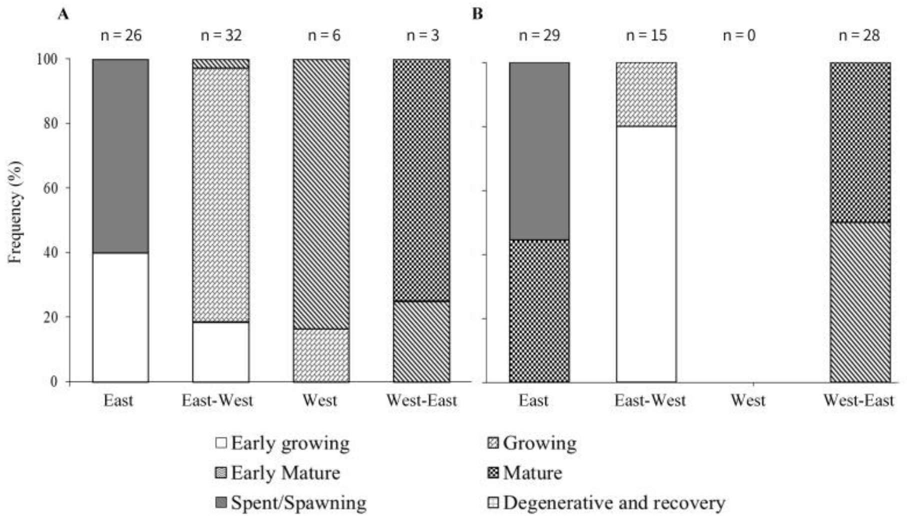

Figure 4. Seasonal variations of gonadal development of striped eel catfish in the Kolono Bay, South Konawe District, Southeast Sulawesi, Indonesia. A. Male; B. Female

Table 1. Seasonal variations in the sex ratio of the striped eel catfish in the Kolono Bay, Indonesia

Sex	Season				n
	East	East-West	West	West-East	
Male	387	279	6	41	713
Female	149	37	0	66	252
Sex ratio	2.62:1	7.34:1	1:0	1:1.62	2.82:1

Note: $p > 0.05$ ($\alpha = 5\%$, df = 3), the Kruskal-Wallis test

The high proportion of the male and female fish populations in the spent/spawning stage indicated that the spawning season for striped eel catfish occurs in the East season (June-August). During the West season, the number of striped eel catfish was limited. Only six male fish and no female fish were found in the West season.

The variations in the GSI values during the study period are presented in Table 2. The results indicated that the fish do not lay eggs simultaneously and, therefore, the gonadal development varies between the seasons ($p = 0.000$, $\alpha = 5\%$). An increase follows the higher development of gonad-striped eel catfish in the value of GSI (Figure 5).

The highest GSI values were found for both male and female fish in the East season (June-August), implying occurring of spawning in this season. Latter conditions showed no difference from the high proportion of male and female gonad development during the spent/spawning stage that occurring in the East season. At the first maturity, length was 224.5 and 198.3 mm in male and female fish, respectively (Figure 6), suggesting that female fish mature earlier than male fish.

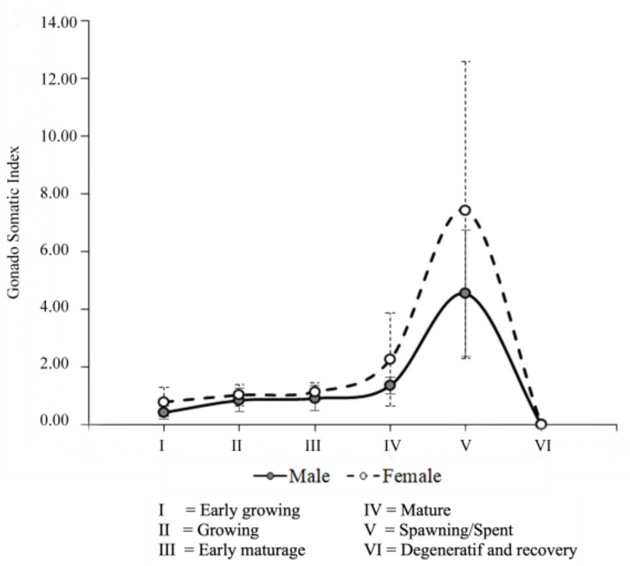

Figure 5. Correlation between gonadal development stage and gonadal somatic index of striped eel catfish in the Kolono Bay, South Konawe District, Southeast Sulawesi, Indonesia

Table 2. Seasonal variation of gonadal somatic index (GSI) of striped eel catfish in the Kolono Bay, South Konawe District, Southeast Sulawesi, Indonesia

Season	Male			Female		
	Range	Mean ± SD	n	Range	Mean ± SD	n
East	0.53-2.94	1.30 ± 0.38	26	1.32-2.12	1.55 ± 0.38	29
East-West	0.13-0.92	0.56 ± 0.17	32	0.53-1.37	1.01 ± 0.26	15
West	0.01-0.07	0.05 ± 0.03	6	0	0	0
West-East	0.14-1.40	0.58 ± 0.71	3	0.19-1.83	0.75 ± 0.47	28

Note: SD: standard deviation; n: number of individuals; $p < 0.05$ ($\alpha = 5\%$, df = 3), the Kruskal-Wallis test

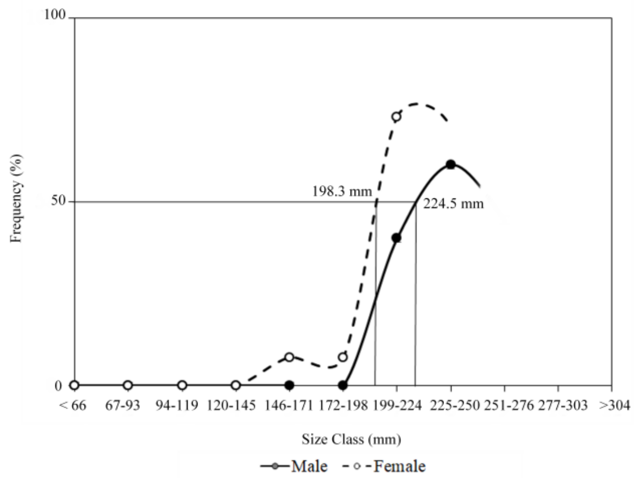

Figure 6. Length at first maturity (Lm50) of striped eel catfish in the Kolono Bay, South Konawe District, Southeast Sulawesi, Indonesia

Table 3. Seasonal variations in the fecundity of striped eel catfish in the Kolono Bay, South Konawe District, Southeast Sulawesi, Indonesia

Season	Fecundity		N
	Range	Mean ± SD	
East	1,415-2,194	1,730 ± 390	29
East-West	-	-	-
West	-	-	-
West-East	995-1,800	1,415 ± 310	12

Note: $p < 0.05$ ($\alpha = 5\%$, df = 3), the Kruskal-Wallis test

Fecundity

The total number of eggs produced by female fish during spawning (fecundity) is listed in Table 3. The amount of fecundity was significantly different between the seasons (p = 0.002, α = 5%), with the highest fecundity occurring from June to August, which was approximately 1,415-2,194 eggs. The relationship between the magnitude of fecundity and the total length and body weight of female fish are $F=0.36TL^{1.61}$ (R^2=0.61) and $F=14.43W + 915.72$ (R^2=0.33), respectively.

Spawning pattern (distribution of the egg diameter)

According to the size, egg diameters were categorized into nine groups (Figure 7). The shift in the distribution of the egg diameter to the right implies that the greater the gonad maturity stage, the greater is the diameter of the egg.

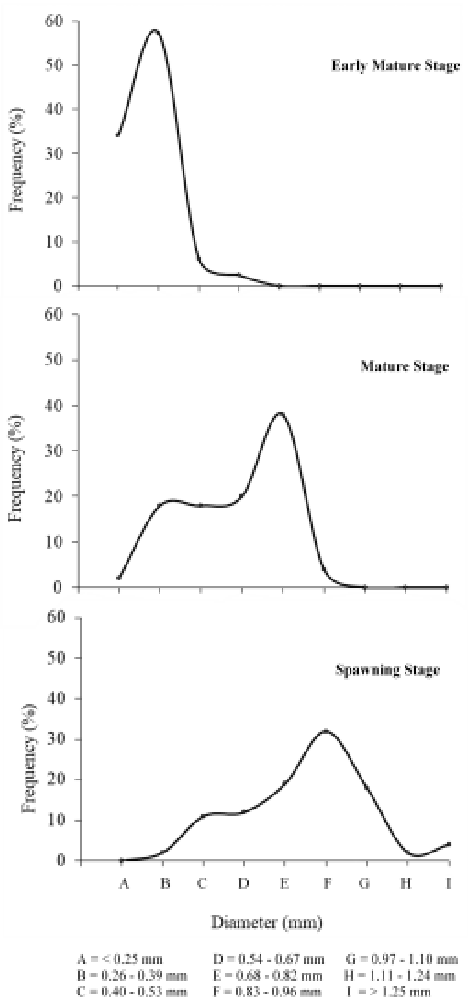

Figure 7. Egg diameter distribution of striped eel catfish in the Kolono Bay, South Konawe District, Southeast Sulawesi, Indonesia

Discussion

The Kolono Bay is a nursery ground by the juveniles of striped eel catfish male and female. The length and weight of the fish samples varied from 67 to 93 mm (43.25% to 47.62%) and <20.4 g (80.56% to 81.63%), respectively. The Kolono Bay has complex ecosystems, such as seagrass, mangrove, and coral reef ecosystems. The three ecosystems are a habitat for protection, food foraging, and growth of marine life, as reported by Asriyana et al. (2020a) to striped eel catfish and other authors who performed studies in different locations (Verweij et al. 2006; Asriyana et al. 2018; 2020b).

The striped eel catfish demonstrated primary and secondary sexual characteristics, such as sexual dimorphism between the male and female fish; for example, the presence of urogenital papillae in the abdomen (Figure 2) which has been also found in gray eel catfish, *P. canius* (Amornsakun et al. 2018). These signs enable easier determination of the sex ratio of the population in the waters. In our study, the sex ratio of striped eel catfish was not significantly different between the seasons, with the proportion of male fish being higher than female fish (2.82: 1).

At the beginning of life, the number of male fish was higher than female fish (East, East-West, and West seasons). However, toward the time of spawning, the number of females was higher than male individuals (Table 1). This difference might be related to the behavior of male fish. Just before the spawning season, adult male fish burrow and build nests under rocks and remain in the nests after spawning to deposit eggs (Thresher 1984). This behavior could be expected to cause an adult male for the captured in spawning time lower than adult females. Meanwhile, after laying eggs, more male individuals at the juvenile stage were found than adult males. The sex ratio information is important to know because it is related to the reproductive strategy developed by the eel catfish to support the success of the spawning process. The ideal sex ratio of male-to-female fish in a population is 1:1, that is, 50% male and 50% female fish (Ball and Rao 1984). Spawning migration can cause deviations from the ideal sex ratio (Ilhan and Togulga 2007), where the genital ratio in the period leading up to and during spawning can change regularly. In the beginning, the male fish dominate, and then the sex ratio can change to 1:1, and followed by female fish dominance. These deviations can also be caused by environmental factors, including temperature, light, salinity, and the social environment of fish life (Jobling 1995); differences in fish distribution, activity, and movement (Türkmen et al. 2002); childcare activities (Liang et al. 2005); fishing mortality (Offem et al. 2008) and predation (Alp and Kara 2007); sex differences in growth, death, or reproductive energy costs (Araújo et al. 2019); and response to food availability. If food availability is abundant, female fish predominate, and vice versa (Vicentini and Araújo 2003).

Reproductive activities can be determined qualitatively based on gonadal development and quantitatively based on fluctuations in the GSI value. An increase in the development of gonad-striped eel catfish is always followed by an increase in GSI value (Figure 5). The higher the stages of gonadal development of striped eel catfish, the more variations in the GSI obtained, and then the GSI value will decrease when the spawning ends. Therefore, the GSI value can be used to determine the spawning season of fish (Figure 4). The presence of male and female individuals that include in the spent/spawning stage from June to August (East season) indicates the spawning season for striped eel catfish. These findings are in line with the high values of male and female GSI (1.19 ± 0.532 and 19 ± 3.47, respectively). In addition to the phenomenon of male and female spawning fish (Figure 4), high GSI values (Table 2), peak spawning season of eel catfish are from the high value of the ponderal index in July (K = 1.27-1.29) and the presence of larvae in August (Asriyana et al. 2020a). Ponderal index is an index that represents fish fatness or the accumulation of fat and gonadal development if viewed from fish nutritional adequacy (Le Cren 1951; Asriyana et al. 2020a). Ponderal index value increases in the peak of the spawning season and decreases thereafter. During the spawning season, the gonads of the striped eel catfish are growing. Therefore, increases in the sperm size and egg diameter are reflected by elevated ponderal index and GSI values. After spawning, both values decrease because sperm and eggs decrease, further increasing the amount of energy expenditure for spawning (removing the eggs and sperm). This result is supported in the study by Heo et al. (2007) that was conducted in the waters of the Sungsan and Jocheon, Korea. According to histological observations and variations in the GSI values, *P. lineatus* seems to have a reproductive cycle consisting of several stages. These include male fish undergoing maturation during September-May and spent stage during April-July and female fish undergoing maturation during April-June and spawning stage during June-July. High GSI values have been reported during the spawning season for other catfish species, such as *P. canius* (Usman et al. 2013a) and *Phractocephalus hemioliopterusus* (Freitas and Montag 2019). Of the 965 individuals obtained during the study (713 males and 252 females), only 139 individuals (67 males and 72 females) could be analyzed for gonadal somatic index. This is related to the common gonadal development in fish, which includes two processes, namely the gonadal growth stage and the gonadal maturation stage as reported by Lagler et al. 1977; Harvey and Hoar 1979. The growth stage of fish gonads takes place from fish hatching to sexual maturity. While the gonad maturation stage takes place after the fish reaches adulthood and continues to develop as long as the fish's reproductive function is still running normally.

Some studies have demonstrated that fish from the family Plotosidae do not always have a spawning season from June to August (Table 4). Variations in environmental conditions cause changes in the spawning season, and the fish look for favorable conditions for the development of spawning yields. The temperature, salinity, and pH of the Kolono Bay water are different significantly in all seasons ($p < 0.05$, $\alpha = 5\%$), even during the East season (June-August). The physical and chemical conditions of the waters (temperature, 30.00 ± 00°C; salinity, 32.11 ± 2.08 ‰; and pH, 6.78 ± 0.32) were optimal to support the spawning activity of striped eel catfish. In several other fish species, the spawning season is influenced by the aquatic environment and food availability, migration tactics, and age structure (Yoneda and Wright 2015; Gallagher et al. 2018; Arula et al. 2019; Teixeira et al. 2019).

Table 4. Spawning season in several members of the family Plotosidae

Species	Spawning period	Location	References
P. canius	May-June	Hooghly-Matkah Estuary and Chilka Lake, India	Sinha (1984)
P. lineatus	October-January	North Andhra Pradesh coast, India	Vijayakumaran (1997)
P. canius	April-July	Coastal region of Khulna, Bangladesh	Khan et al. (2002)
P. canius	April-July	Bangladesh	Ahmed and Hague (2007)
P. lineatus (M)	September-May	Sungsan and Jocheon coast, Korea	Heo et al. (2007)
P. lineatus (F)	June-July		
P. canius	October, April	Semarang, Indonesia	Dewanti et al. (2012)
P. canius	July-October	Pattani Bay, Thailand	Amornsakun et al. (2018)
P. lineatus (M)	June-August	Kolono Bay, Indonesia	*This research* (2021)
P. lineatus (F)	June-August		

In striped eel catfish, the first mature gonad occurs more quickly in females than in male fish (Figure 6), suggesting that female fish gonads mature faster than male fish gonads, at 198.3 mm in size. In the Indian and Korean waters (Vijayakumaran 1997; Heo et al. 2007), the *P. lineatus* gonads have been reported to mature earlier, at 159 mm and >150 mm, respectively. The difference in size can be attributed to the differences in growth rates, food availability, and environmental conditions of the waters that support the growth of striped eel catfish. *P. lineatus* in the Kolono Bay had a lower growth coefficient of 0.27 per year. The maximum length (251.89 mm) of the fish was attained at 2.4 years of age (Asriyana et al. 2020a), whereas in Indian waters, the growth coefficient is more excellent at 1.37 per year and the fish reach a maximum length of up to 243.73 mm at 2.19 years of age (Vijayakumarn 1997). These findings demonstrate that *P. lineatus* in Indian waters has a higher growth rate and therefore reaches the gonadal stage at a faster pace than *P. lineatus* in the Kolono Bay waters. Several studies have indicated that many factors, such as the growth rate, water quality, and capture pressure of fishing activity influence the size of the early mature gonads (de Graaf et al. 2003; Moresco and Bemvenuti 2006; Laleye et al. 2006).

Female broodstock fecundity varies between species and within the same species as a result of adaptation to habitats. The striped eel catfish fecundity in the Kolono Bay ranges from 1,415 to 2,194 eggs, with an average of 1,730 ± 390 eggs. This number is higher than that in the striped eel catfish in the waters of the North Andhra Pradesh coast, India, which ranges from 913 to 2,298 eggs, with an average of 1.558 ± 349 eggs (Vijayakumaran 1997), and in the waters of the Sungsan and Jocheon coast, Korea, which ranges from 525 to 1,176 eggs (Heo et al. 2007). The variation might occurred due to the environmental conditions of *P. lineatus*. The variation in the amount of fecundity is the mechanism and strategy of fish to increase the number of eggs and fish growth rates (Duarte and Araújo 2002). Several factors can vary the fecundity, such as season, food, habitat and aquatic environment, the diameter of the eggs, and differences in fish age (Nikolsky 1963; Suzuki et al. 2000; Saliu and Fagade 2003). Even in population stock, fecundity varies and is comparable to fish size and condition. This condition happened in striped eel catfish, whose size is more extended, and have higher fecundity than smaller fish. The latter results appeared from the model of the relationship between fecundity and the total length of striped eel catfish (R^2 = 0.61). Such model can be used to predict the amount of fecundity generated in a population. A similar situation was reported for *P. canius* in the Khulna coast, Bangladesh (Khan et al. 2002) and *P. lineatus* in the waters of the Sungsan and Jocheon coast, Korea (Heo et al. 2007) and other catfish, such as *Mystus gulio* in the Khulna, Bangladesh (Islam et al. 2008) and *Pelteobagrus* spp. in the Gorges Reservoir, China (Liao et al. 2018). However, the association between fecundity and weight mass cannot be used as a prediction model. They are determining the amount of fecundity because it has a coefficient of determination <50% (R^2 = 0.33). The low coefficient of determination of the model was also found in species *P. canius* (Usman et al. 2013b).

Egg diameter varies between species and among individuals within the same species. The size of the egg diameter increases with the gonad maturity and GSI (Figure 5). Striped eel catfish eggs are about 0.11-1.35-mm which was smaller than the egg diameters of other catfish groups such as *Loricariichthys castaneus* (Gomes et al. 2011) and *P. canius* (Usman et al. 2013b; Amornsakun et al. 2018). The factor that possibly influences the variations in egg diameter is the nature of caregiving, population density, and environmental conditions (Shinkafi and Ipinjolu 2012; Usman et al. 2013b; Barneche et al. 2018). The distribution of egg diameters has one mode, indicating that striped eel catfish release their eggs simultaneously during the spawning season. This result is in line with the behavior of *P. lineatus* in the northern waters of the Andhra Pradesh coast, India (Vijayakumaran, 1997), and the Sungsan and Jocheon coast, Korea (Heo et al. 2007). Striped eel catfish were grouped as synchronous groups (Murua and Sabarido-Rey 2003) or known as spawners in unison (total spawner). Siluriformes (catfish) spawning patterns do not always spawn simultaneously, but there are partial spawners, such as *Loricariichthys platymetopon*, *Loricariichthys* sp., *Loricaria* sp. (Suzuki et al. 2000); and *P. canius* (Usman et al. 2013b; Amornsakun et al. 2018).

In present study, the highest proportion of gonad development was found during the spent/spawning stage (60% and 55.56%) and the GSI peak values for male and female fish (1.19 ± 0.532 and 19 ± 3.47, respectively) were noted during the East season (June-August), and such results can be used as a guide to predict the spawning time of striped eel catfish. This information can be used as one of the policy bases for spawning ground protection in Kolono Bay to provide these fish with the opportunity to spawn at least once before being caught. The size of the first mature gonad at 198.3 mm suggests that striped eel catfish above this size can be caught to ensure the sustainability of its population in nature. Regular observation of the size at first mature gonad can be an indicator of pressure on the population. Reproductive capacity produced in the striped eel catfish conservation had some factors. They are the value of fecundity (1,730 ± 390 eggs), the amount of fecundity based on total body length (R^2 = 0.61), and spawning patterns (total spawner). It is important to acquire data on their reproductive habits to manage resources and conserve striped eel catfish.

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