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Fecundity and Temporal Reproductive Cycle of Four Finger Threadfin (*Eleutheronema tetradactylum*) in Malaysian Coastal Water

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ABSTRACT

Several aspects of the reproductive biology of four finger threadfin, *Eleutheronema tetradactylum* collected from coastal waters of Sebatu, Malacca, Peninsular Malaysia between August 2009 and October 2010 were studied to describe the fecundity and temporal reproductive cycle. Temporal reproductive cycle was reviewed utilizing monthly changes in Gonadosomatic Index (GSI) and macroscopic observation of ovaries. Estimated fecundity of mature ovaries ranged from 341,358-1,114,757 eggs with a Total Length (TL) that range from 38.0-55.5 cm. The estimated average fecundity was 663,078±76,935. The relative fecundity ranged from 393-1202 eggs g^{-1} b.wt. with induced a 657±68 mean value. According to our findings; a linear correlation appeared between the estimated Fecundity (F), Ovary Weight (OW), Body Weight (BW) and Total Length (TL) show. Present results also indicate that four finger threadfin fish has a lengthy spawning season starting from March-September in Malacca coastal waters of Peninsular Malaysia.

Key words: Biology, four finger threadfin, *Eleutheronema tetradactylum*, reproduction, gonadosomatic index

INTRODUCTION

The studies on fish reproduction allow to quantify the reproductive prospective of individual fish such as by fecundity, spawning fraction, measurement size during maturity period, daily spawning actions and seasonal reproductive duration period. A study by Murua and Saborido-Rey (2003) demonstrates that colder water fish particularly demersal fishes reveal fecundity and oocyte development synchronous which is unlikely with pelagic species. For instance, the pelagic species which is typically temperate water fishes reveal oocyte development asynchronous and often have non fecundity characteristics. Therefore, the findings by Murua and Saborido-Rey (2003) indicate to improve knowledge on the existing assessments processes for the commercial fish species including effective management facilitate capacities. Further to improve the knowledge on the existing processes an extensive databases establishment on data on abiotic factors together with the stocks reproduction parameters database may enable to extract more research facts to find out the correlation between reproductive potential, the effects of fishing pressure and environmental variation (Murua *et al*., 2003). Resource managers then take this information, review the options and select the one that best fulfills the biological, economic and social constraints of that fishery (Iversen, 1996; Royce, 1996).

The fecundity of fish is described as seasonal spawning potential and alternatively is defined as the number of eggs ripening between current and next spawning period in a female (Bagenal and Tesch, 1978). However, the existing fecundity definition of description does not constantly associate the success of reproductive fertility but indicate a point of reproductive measurement (Moyle and Cech, 2000). Nikolsky (1969) indicated that the success on reproductive fertility of fecundity may very depending on the food supply nature and differences, temperature, environmental circumstances, stress condition, fish size and length or even due to density-dependent mechanisms which are authenticated by Treasurer (1981), Sztramko and Teleki (1977), Tsai and Gibson (1971) and Bagenal (1978). Moreover, smaller fish contains small visceral space and ovaries for eggs compared to large fish and therefore, some studies indicates that egg development and size related to fish body length and sometime on the environmental condition (Bagenal and Tesch, 1978; Hislop, 1988; Wright and Shoesmith, 1988; Moyle and Cech, 2000). Consequently, fisheries scientist generally uses the fecundity information to better understand the relation between the survival species and its environment (Iversen, 1996).

There are a good number of literature are available on the fish biology (Yousefian *et al*., 2012; Yuksel and Celayir, 2010; Duyar and Eke, 2009; Bayhan *et al*., 2008; AL-Sultan, 2007; Gbadamosi and Daramola, 2007; Sink *et al*., 2006; Karayucel *et al*., 2006; Bozkurt, 2006; Rema and Gouveia, 2005; Nguyen *et al*., 2005; Hossain *et al*., 2004; Sahinler and Can, 2003). However, several studies on fish reproduction show that most polynemids species exhibits hermaphrodites protandry which their sex changing from male to female with fish growth (Patnaik, 1970; Motomura, 2004; Pember, 2006). As part of the polynemids fish, *Eleutheronema tetradactylum* or known as four finger threadfin is one of very high commercial and important fisheries species for Kuwait, India, Thailand, Vietnam, Indonesia, Singapore, Bangladesh, Cambodia, Myanmar, northern Australia and Malaysia (Motomura, 2004). In spite of their commercial value and the long-standing interest displayed in four finger threadfin *E. tetradactylum*, basically very few life history works have been conducted in Malaysia or elsewhere. Therefore, our initiatives by this study is to act on the reproductive biology by adding the limited body knowledge of tropical four finger threadfin species emphasizing on fecundity and temporal reproductive cycle in *E. tetradactylum* collected from coastal waters of Sebatu Malacca, Malaysia.

MATERIALS AND METHODS

Collection of specimens: The sampling for our study was carried out on monthly basis in the coastal waters of Sebatu, Malacca (02°06.002' N; 102°28.004' E), Peninsular Malaysia (Fig. 1) from August 2009 to October 2010. A total of 162 specimens of *E. tetradactylum* were collected using gill net. The mess sizes of the gill nets were 7-12.5 cm and net lengths were 800-1200 m. Nets were set at depth ranging from 2-7 m at early morning between 5.00 and 7.00 h, then raised and the fish collected between 8.00 and 9.00 h. The identification of fish's specimen for our study was taken care of following on external markings together with meristic and morphometric features (Mohsin and Ambak, 1996; Motomura *et al*., 2002; Motomura, 2004). In addition, following on the standard procedure our fish's specimens were located in ice slurry and shifted to the laboratory same day.

Fig. 1: Map showing the study area (in box) where four finger threadfin was sampled at coastal water of Sebatu, Malacca, Malaysia

Laboratory procedures and data collection: All fish were measured to the nearest 1 mm in the Total Length (TL) and weighted to the nearest 1 g. Gonads of the fish were examined under a dissecting microscope for its external features such as turgidity and colour in order to determine a maturity stage. The sex ratio also calculated in this study (i.e., No. of males/No. of females (Simon *et al*., 2012). The female was determined by the macroscopic observation of matured ovary (Laevastu, 1965a).

Fecundity estimates and relative fecundity: Fecundity by definition is measured in an ovary of a female by the total number of nonprimary growth oocytes with determinate fecundity (Hunter *et al*., 1992). This standard measured of estimation was used in our study from 15 females *E. tetradactylum* captured during sampling period. To obtain the best result, the fresh ovarian tissue was carefully weighed to the nearest 0.01 g using the best practice, dissected cautiously and preserved in Gilson's fluid (Laevastu, 1965b; Sreenivasan, 1978). In addition, sub-samples were dissection in three different parts for of the each ovary; particularly apical regions, near the base, mid and weighed cautiously. Oocytes were counted and loosened from trabeculae using best practice. The total number of oocytes was estimated in the ovary and reported as well in our sample to find out the fecundity (Clavier, 1992; Simon *et al*., 2012). Total fecundity 'F' was considered as the number of vitellogenic oocytes at any time in ovary development (Hunter *et al*., 1992; Iversen, 1996; Simon *et al*., 2012; Salcedo-Bojorquez and Arreguin-Sanchez, 2011). Relative fecundity is the number of eggs per unit of body weight of female sample was also calculated (Simon *et al*., 2012). Finally, we utilized correlation analysis to find the relationships of Fecundity (F) of the sampling Body Length (BL), Body Weight (BW), Eviscerated Weight (EW) and Gonad Weight (GW) (Simon *et al*., 2009, 2012).

Temporal reproductive cycle: Paired gonads were weighed individually in our study to the nearest 0.01 g and the mean of Gonadosomatic Index (GSI) was determined monthly. GSI was calculated as:

$$GSI = \frac{GW}{SW} \times 100$$

where, GW is gonads weight and SW is somatic weight (represents the BW without GW) (Solomon and Ramnarine, 2007; Simon *et al*., 2009; Ozvarol *et al*., 2010). In this study, GSI of both male and female were combined as this species was identified as hermaphrodite protandry fish. Specimens with mature ovary were identified with maturity stages. Maturity classification of our study specimens is followed of seven macroscopic stages adapted from Laevastu (1965b), Patnaik (1970) and Selman and Wallace (1989). Stage I and II considered as immature, stage III and IV maturing or developing, stage V and VI mature/spawning and stage VII spent. Ova were measured from each stage to determine the average diameter.

RESULTS AND DISCUSSION

Sex ratio and size distribution: A total of 162 specimens of *E. tetradactylum* were collected during the study. Among the 162 samples, 147 were males and 15 were females with a sex ratio of 9.8 males/females (Fig. 2). Males ranged in TL from 14.8-39.0 cm and BW ranged from 26.3-644 g, conversely, in female TL ranged from 35.0-55.5 cm and BW ranged from 450.0-1700.0 g. It was observed in the present study that among the collected samples males were predominated in number compared to their female samples (Table 1). Overall the total catch of four

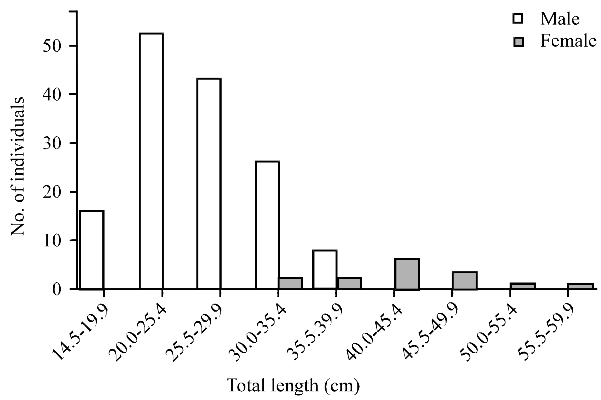

Fig. 2: *E. tetradactylum* male and female size distribution collected from Malacca coastal waters, Malaysia from August 2009-September 2010

Table 1: Monthly distribution of *E. tetradactylum* collected at study area from August 2009- October 2010

Year	Month	Male	Female	Sex ratio
2009	16 Aug.-15 Sep.	23	-	-
	16 Sep.-15 Oct.	9	-	-
	16 Oct.-15 Nov.	7	1	7.0
	16 Nov.-15 Dec.	14	1	14.0
	16 Dec.-15 Jan.	12	1	12.0
2010	16 Jan.-15 Feb.	10	-	-
	16 Feb.-15 Mar.	10	1	10.0
	16 Mar.-15 Apr.	19	1	19.0
	16 Apr.-15 May	9	-	-
	16 May-15 Jun.	11	-	-
	16 Jun.-15 July	1	3	0.3
	16 July-15 Aug.	15	3	5.0
	16 Aug.-15 Sep.	5	3	1.7
	16 Sep.-15 Oct.	2	1	2.0
Total		147	15	9.8

finger threadfin male population was highest round the year except in July. In month of September, the occurrences of males were highest whereas females were observed more frequently during June, July and August. This might be due to different timing of sexual maturity, habitat partitioning or sampling bias (Bagenal, 1978).

Fecundity estimates and relative fecundity: A total of 12 gravid females of four finger threadfin fish were examined for its fecundity. Based on 15 specimens of female fish, 12 fishes contained mature ovary to estimate the fecundity. Eggs from three parts of matured ovary exhibit homogenous in shape and size suggested that four finger threadfin fish is a total spawner (Fig. 3). The estimated mean fecundity ranged from 341,358-1,114,757 eggs with a mean value of 663,078±76,935. Relative fecundity was calculated as an index of the capability of production with the fish body weight. The relative fecundity ranged from 393-1202 eggs g^{-1} b.wt. with a mean value of 657±68.

The relationships between fecundity and total length revealed F = 25352 TL-541151 (r = 0.76; N = 12; p<0.001) (Fig. 4). This result means that fecundity increases with body length at a constant rate. The relationship of the Body Weight (BW), body Eviscerated Weight (EW) and Ovary Weight (OW) to fecundity also show the same results that fecundity increases with total Body Weight (BW) and Eviscerated Weight (EW) at a similar rate (Fig. 4).

E. tetradactylum at Malaysia coastal water seem to be highly fecund species, when consider that they have eggs which are dispersed by the coastal waters from the spawning ground. The results of this study agreed with the previous studies by Patnaik (1970) which reported estimate fecundity varied from 226,541-3,826,683 in Indian waters and Abdul Samad (1987) from 179,546-488,927 in Musi estuary, South Sumatra, Indonesia. The increase in fecundity with the weight and length is similar in nature by the observations done in two archer fishes *Toxotes jaculatrix* and *Toxotes chatareus* in Malaysian coastal waters (Simon *et al.*, 2012) and also reported elsewhere for Myctophidae fish (Gartner, 1993).

Temporal reproductive cycle: The mean GSI (MGSI) of fish shows three peaks throughout a year (Fig. 5). The first peak was in month of March (MGSI = 1.38±1.09) followed by June-July

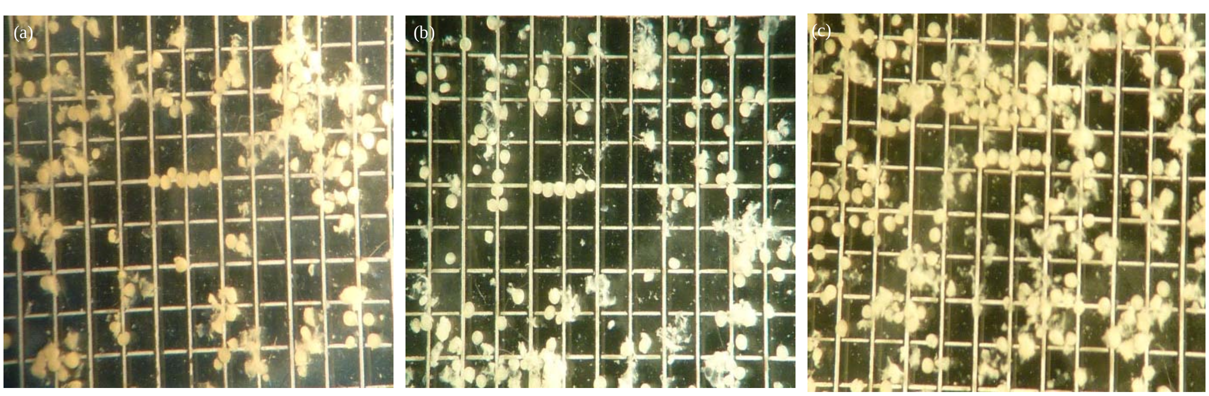

Fig. 3(a-c): Eggs of *E. tetradactylum* from three parts of ovary, (a) Base, (b) Mid and (c) Apical region, Total length = 39.5 cm, The area of quadrate is 1×1 mm

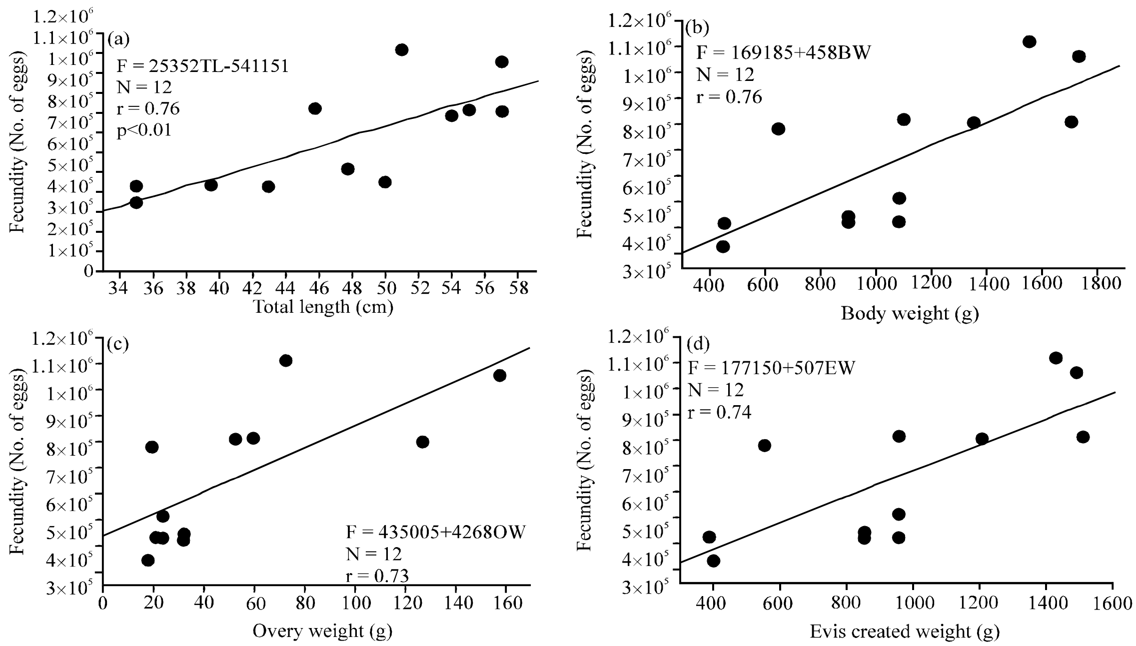

Fig. 4 (a-d): Relationship of fecundity with (a) Total length, (b) Body weight, (c) Ovary weight and (d) Eviscerated weight of *E. tetradactylum* females during August 2009-October 2010

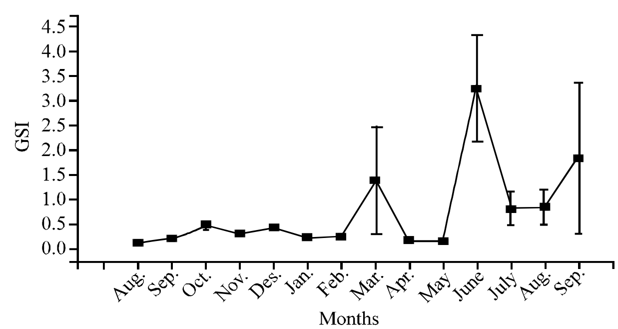

Fig. 5: Mean monthly gonadosomatic indices (GSI) ±SE of *E. tetradactylum* in Malacca coastal waters, Malaysia from August 2009-October 2010

(MGSI = 3.26±1.10) which the highest peak. Then the last peak which the second highest (MGSI = 1.85±2.68) was in September. This indicates the spawning season was began in March and continue until September which took about six months. Eight of nine female specimens collected during June to August were in spawning condition. In month of November, December, January and February, the mean GSI were decreased. This indicated that most female was released the eggs which undergone stage VI of maturity.

These study provides the first evidence that *E. tetradactylum* has a lengthy spawning period starting from March to September in Malacca coastal waters of Peninsular Malaysia. This lengthen period of spawning gives the opportunity of female fish to release all the eggs in one season. In west coast Peninsular Malaysia and Strait of Malacca area received maximum rainfall twice a year on April-May and October-November. Patnaik (1970) reported that *E. tetradactylum* at Chilka Lake, India spawns twice a year with the peak period in January and June, respectively. While Pember (2006) found that north-western Australia *E. tetradactylum* have the peak spawning season in October to December. This seasonal change in wind and rainfall affect the spawning season of the fish in terms of their higher fecundity.

Female reproductive maturity is commonly quantified base on GSI values, because using fish size is generally inaccurate and the size at maturity varies greatly not only within a species but even within populations (Lowe-McConnell, 1982). However, determination of reproductive maturity using only the GSI is not adequate because structures within the ovary that can be predictive, such as oocytes developmental stage and accumulation of yolk within the interstitial tissue, cannot be obtained from weight alone. Direct observation of histological architecture is the most accurate method to determine the stage of maturation of the ovary. The combined use of oocyte size distribution and GSI proved to be efficient to assess ovarian maturation in *E. tetradactylum*.

CONCLUSION

This study illustrates the reproductive biology of *E. tetradactylum* in Malacca coastal waters of Peninsular Malaysia. The analysis is done of our study such as GSI and maturity stages, define the spawning season of *E. tetradactylum* in the coastal water in Malacca. This study provides an insight of baseline knowledge of the reproductive biology of four finger threadfin for future studies of commercially important fish species. However, more in depth research is needed as histological observations of gonadal development are important to figure out the basic architecture of oocyte development and to elaborate the hermaphrodite protandrous phenomenon.

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