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Fecundity and Gonado-somatic Index of *Trichiurus lepturus* (Linnaeus, 1758) Along the Zamboanga del Norte Coast

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Abstract –

Gonado-somatic index and fecundity are tools for measuring the sexual maturity and ability of animals to reproduce. This study investigates the reproduction of Trichiurus lepturus. Specifically, this aimed to determine the sex ratio, the GSI, the relationship between fecundity and total length, fecundity and total weight, fecundity and ovary weight. The Descriptive Method of research was used. Percentage and chi-square was utilized in determining the percentage of occurrence and sex ratio respectively. Pearson r Product Moment Coefficient of Correlation was used to determine the relationships of the parameters. The study revealed that females outnumbered males and the sex ratio for different month showed significant difference. Spawning season was observed to occur in November and December as revealed in its GSI values and it synchronized with the full and new moon phases. Fecundity is positively correlated with body weight, body size, and ovary weight where ovary weight is observed to be the best index for fecundity. The results of this study could be used further for formal stock assessment of cutlassfish fishery.

Keywords*—****Gonado-somatic Index, fecundity, T. lepturus, moon phases, Zamboanga del Norte***

I. INTRODUCTION

The cutlassfish is a cosmopolitan species in tropical and sub-tropical waters. *Trichiurus lepturus* fishery has emerged as one of the most important commercial marine fisheries in China (Lou, 1991). These species are mostly caught in trawl catches in coastal waters east coast of India (Reuben et al., 1997, Chakravarty 2013). World harvests are approximately 750,000 tons annually. These species are mainly caught by bottom trawling (Lou, 1991) and in lower amounts by longline, handline, gill net, drift net and purse seine (Chen and Liu, 1982).

Population dynamics of trichiuridae are made possible through reproductive parameters such as sex composition, gonado-somatic index (GSI) and fecundity (Bal and Rao 1984). Fecundity data serve as a predictor of reproductive potential, vulnerability (Sadovy, 1996), egg calculation per unit area and spawning stock biomass (Paddack and Estes 2000). In many temperate and tropical fishes, annual fecundity is seasonally indeterminate and batch fecundity is the only useful measurement (Hunter J. et al., 1981). On the other hand gonado-somatic index quantifies the gonad weight and the fish somatic weight (Watton, 1991). The variation in GSI throughout an annual cycle usually indicates the beginning and end of the fish reproductive period, an important component of the fish's life history (Estrada, J. et al., 2000).

Comprehensive study on reproductive biology of trichiurus has been studied by Kwok and Ni (1999) in China Seas, Martins and Haimovici (2000) in the South-West Atlantic and Al-Nahdi et al.,(2009) in the Arabian sea coast of Oman. Spawning and reproductive cycle were studied by checking the temporal profile of the gonado-somatic index and by examining ovaries macroscopically and whole oocytes microscopically. However, similar research on fecundity and GSI of this species has not been extensively studied in marine waters of our country.

Hence, this study presents a comparative account of gonado-somatic index and fecundity of *Trichiurus lepturus* caught in the coastal waters of Zamboanga del Norte. This aimed to a) determine the population composition b) calculate the gonado-somatic index and c) determine the relationship between fecundity and total length, fecundity and total weight, fecundity and ovary weight. Understanding fecundity and GSI would serve as a tool for better management of this resource.

II. METHODS

The gathering of data commence in the second week of November 2013 until March 2014. The sampling sites identified were limited to the the coastal municipalities of Zamboanga del Norte particularly Dapitan City, Dipolog City, Katipunan, Manukan, Roxas, and Sindangan. One hundred sixty-four *Trichiurus lepturus* were collected from commercial catches within the identified landing sites. The freshly caught specimens were chilled and transported to the laboratory for analysis. The length and weight of individual sample were taken with accuracy of 1 mm and 1 mg respectively. Determination of sex was done by opening the body cavity of fish to expose the gonads. The dissected ovaries and testes were staged, blotted dry, weighed and treated with 10% formalin for gonado-somatic index and fecundity studies.

Table I. Macroscopic characteristics of ovaries and microscopic characteristics of whole oocytes of Trichiurius spp (Li 1982, Luo et al. 1983, Ni and Templeman (1985)

Stage	Classification	Ovary Appearance	Oocyte Microscopic Appearance
1	Immature	Ovarian wall transparent, no egg can be seen. Oocyte threadlike and short	Oocyte transparent and irregular or round shape. The nucleus occupies the bulk of the cell and the oocyte is surrounded by a thin follicle layer.
2	Developing	Ovary color cream to yellow, eggs, if present, hard to seen. Ovary about 50% length of ventral cavity.	Oocyte is round, multiple nucleoli appear; lipid bodies appear around the nucleus while yolk vesicles are observed in the peripheral region during the initial stage, yolk granules start to develop and are difficult to see.
3	Maturing	Ovary yellow to orange color, opaque oocytes visible through epithelium. Ovary about 60-70% length of ventral cavity	Vitellogenic oocyte yolk vesicles decrease in number while yolk granules increase in size and number follicular layers increase in thickness. Yolk globules start to fuse together and oocytes become more transparent.
4	Spawning (ripe)	Ovary swollen, filled with hydrated oocytes visible through epithelium. Eggs in the oviduct transparent, can be extruded with gentle pressure. Ovary about 80% .length of ventral cavity	Lipid bodies fuse with one another and become one large oil droplet. Nuclear envelope breaks down and (germinal vesicle breakdown) and oocyte increase in transparency. Hydrated oocyte reach the maximum size and ready to spawn.
5	Spent	Ovary translucent with pale violet color. Ovary shrunk and flaccid.	Empty follicles (Post-ovulatory follicle) are present.

The gonado-somatic index was calculated using the formula: GI = weight of gonad/ weight of fish x 100. The relationship between body weight and ovary weight was determined using Pearson r Product Moment Coefficient of Correlation. Chi-square test was carried out as per standard procedure (Snedecor 1961) in sex ratio analysis.

To estimate the fecundity the hydrated oocyte method was employed (Hunter et al., 1983) Twenty-two ripe ovaries were used from formalin preserved ovary of known weight, ovary subsamples were obtained from the anterior, middle and posterior regions of the ovary and weighed to the nearest 0.001 g using an electronic balance and all the mature eggs in the sample ovary were counted under binocular microscope using a counter chamber. The fecundity was estimated using the formula: Fecundity = no. of eggs in sub-sample/ wt. of the sub-sample x wt. of ovary. The relationship between fecundity and total length, fecundity and body weight and fecundity and ovary weight were worked out using Pearson r Product Moment Coefficient of Correlation after log transformation.

III. RESULTS AND DISCUSSION

Results

Sex ratio

A total of 164 *T. lepturus* were sampled, out of which 35 were juveniles. The percentage of occurrence in different size groups is shown in figure 1. The table revealed that 60% of the females belong to size group of 675-809 mm, 60% males belong to 540-674 mm and 50% males and females had a total length that range from 1215 -1349 mm. The figure also showed that four of the size groups had 100% occurrence of females, moreover, the rest of the size group constitute more than 50% of females. None of the fish samples had body length that range from 1080-1214 mm. On the other hand table 2 revealed the sex ratio of the population. Females were dominant in the month of November, December and March. Males were dominant in the month of January.

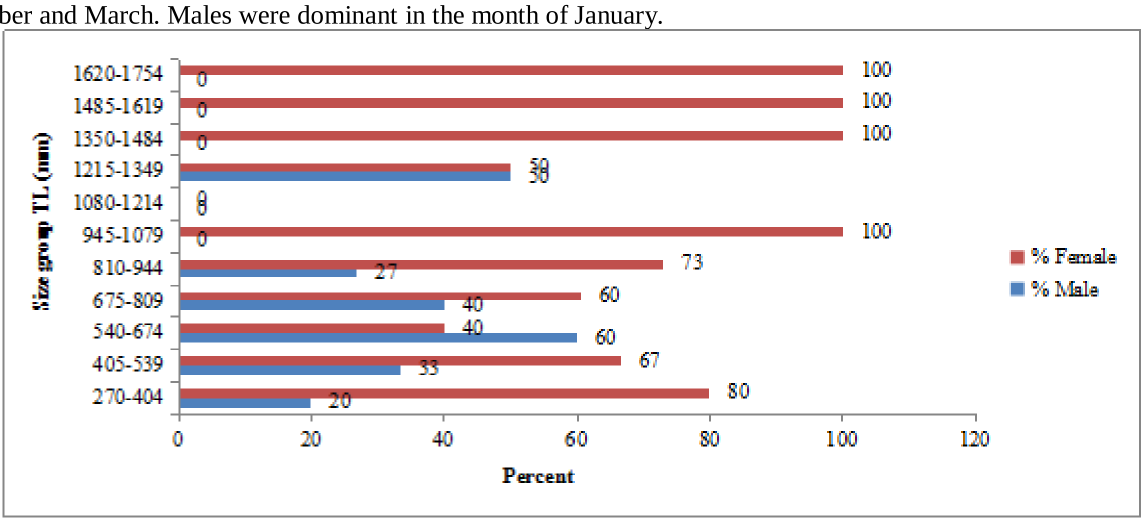

Fig. 1 Percentage of occurrence of males and females of *T. lepturus* in different size groups from Zambo. Del Norte marine waters.

Table II. Monthly variation in sex ratio

Month	No. of Females	No. of Males	F:M
Nov-13	19	6	3:01
Dec-13	14	8	1.75:1
Jan-14	9	17	0.5:1
Feb-14	12	13	0.92:1
Mar-14	20	16	1.25:1
Total	60	74	0.81:1

Gonado-somatic Index

The gonado-somatic index for females of *T. lepturus* (Fig. 1) was found to be very high during the months of November '13 (3.30 ±3.17) and December '13 (3.38 ±4.51) and slightly higher in February (2.70 ±4.31) indicating that the spawning activity takes place during these months. A fall in GSI values has been seen in the months of January '14 (2.70 ±4.31) and March 2014(1.63 ±1.31). The GSI for males of *T. lepturus* is relatively lower compared to the GSI for females although months of November'13 (0.96 ±0.64) and February '14(0.85 ±0.76) showed a slight increase of GSI values that coincides with the GSI of females. As shown in figure 3, spawning of *T. lepturus* occurred during the full and new moons. Ripe females were recorded in November (n = 3), December (n = 6) and February (n= 5). A linear relationship was observed on the body weight of fish and its ovary weight. As revealed in fig. 4, body weight of *T. lepturus* showed a strong positive correlation with ovary weight at $r^2 = 0.629$, $p < 0.05$.

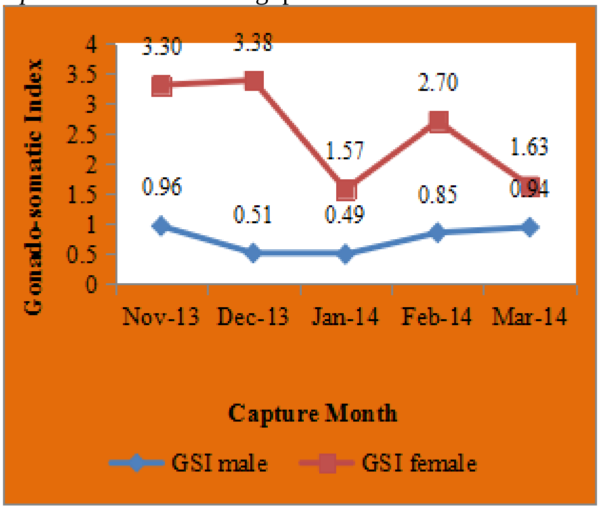

Fig.2 Monthly mean GSI values of *T. lepturus*

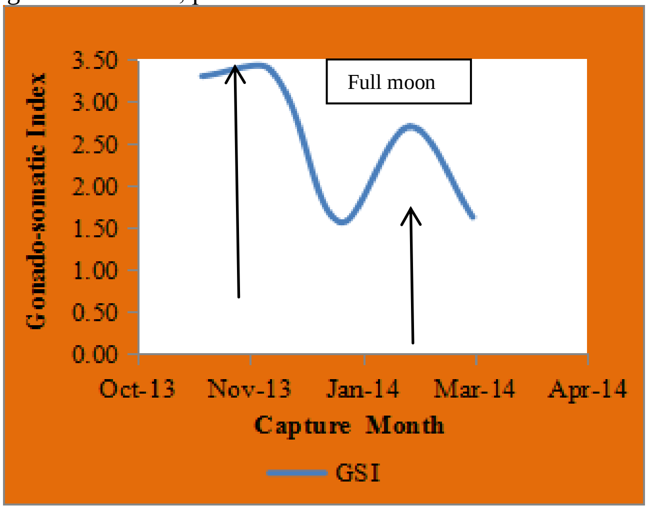

Fig. 3 GSI for female *T. lepturus* during the spawning season showing the timing of full and new moon

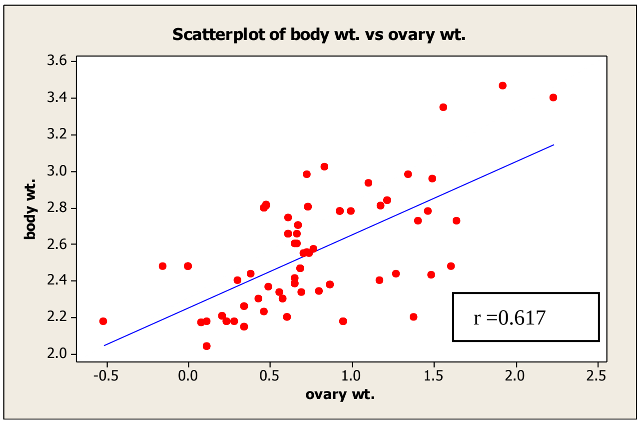

Fig. 4. Relationship between body weight and ovary weight

Fecundity

The relationship between fecundity and body length is shown in figure 5. According to it the number of ova varied from 87,597 for a fish length 600 mm to 1,373,378 in the fish measuring 1,595 mm. The regression equation is found to be linear hence the number of egg contained was more or less proportional to the length of the body. The strong positive correlation implies that the relationship between fecundity and body length is highly significant (r = 0.837).

Meanwhile shown in figure 6 is the relationship between fecundity and body weight. The number of ova varied from 22,568.45 for a fish of weight 240 g to 845,923.09 in the fish weighing 2,200 g. Fecundity increased as the body weight increased. The relationship between fecundity and total body weight is found to be linear and highly significant (r = 0.851).

There is a significant relationship between fecundity and ovary weight as shown in figure 7. The number of eggs per female increased with increasing ovary weight (r = 0.974). It is evidently shown in the figure that fecundity varied from 52,234 in an ovary of weight 4.1 g to 1,373,378 in the ovary weighing 171 g.

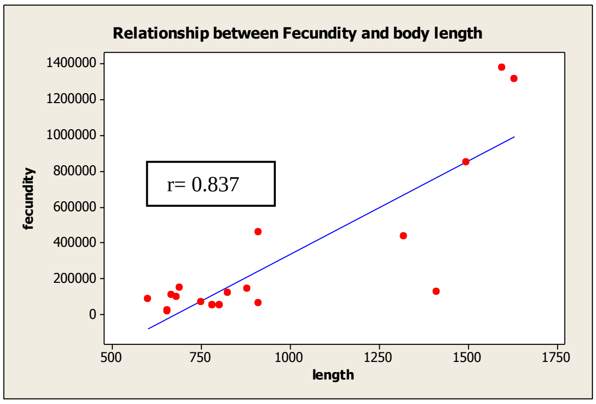

Fig. 5 Relationship between fecundity and body length

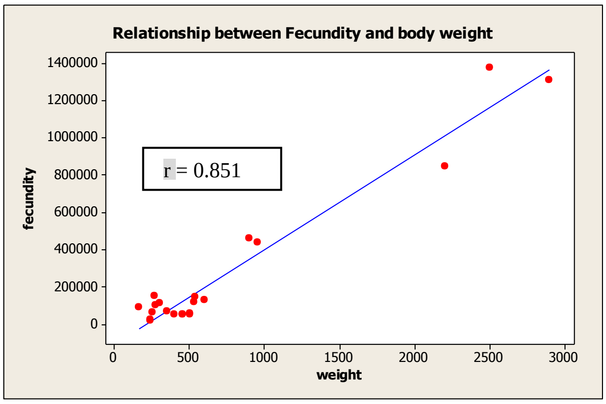

Fig. 6 Relationship between fecundity and body weight

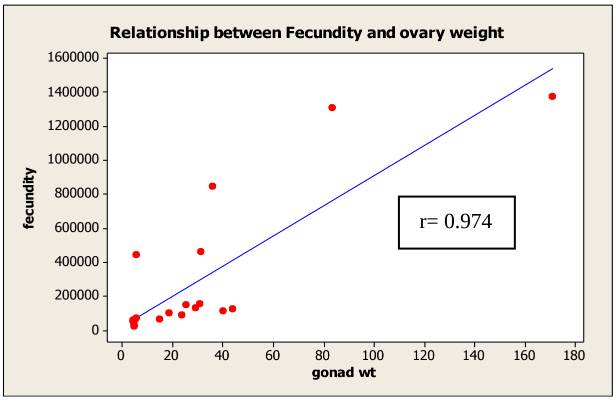

Fig. 7 Relationship between fecundity and ovary weight

Discussion

The females outnumbered males in general. Chi-square test on sex ratio for different months showed significant difference during November, December and March (x^2 = 5.86, p > 0.05, df= 4). Similarly, a significant dominance of female over males was observed in most of the months by James et al., (1986). The differences in sex ratio indicate a differential fishing due to the changes in the pattern of migration of sexes to and from the fishing grounds (Reuben et al., 1997).

Spawning season of females can be indicated based on the changes in gonad weight in relation to the body weight (Qasim, 1973). Prabhu (1955) reported that T. lepturus spawning takes place once in a year i.e., in June but the observations of Tampi et al., (1968) and Narasimham (1976) is similar to the results of this study, that spawning season were observed in November and December. Figure 3 revealed that GSI of *Trichiurus lepturus* was high during full moon and new moon phases. This is due to the fact that moon phases influence the strength of the tide, thus, many species of marine fish and shrimp spawn when tidal currents are the strongest. Marine fish synchronize their spawning with strong tide to transport larvae from offshore areas into shallow estuaries (Allen, M. 2010).

The variation of the relationship between the gonad weight and the fish somatic weight (Wootton, 1991) is usually attributed to high variability of the environmental parameters influencing the reproductive timing of spawning species (Kaya 1973, Burns, 1976). In this investigation, females of *T. lepturus* peak GSI was observed in November, December and February. This result coincides with the observation done by Ghosh, et al.,(2014) along the Arabian sea that the peak GSI were observed during December – January.

Abdussamad *et al*., (2006) have found the fecundity of *T. lepturus* in 630 – 820 mm size fish as 40,250 ova per fish from Kakinada waters. This study observed that fecundity of fish 600- 800 mm long is about 69,915 ova per fish thus indicating a higher fecundity values than the above mentioned study.

Numerous studies have been done on the relationship between fecundity and body parameters such as weight, length and gonad weight. A linear relationship between fecundity and the fish weight has been reported by Gupta (1968) and Singh *et al*., (1982), Somdutt and Kumar (2004). Sinha (1972) found out a linear relation between the fecundity and ovary weight. The values of correlation coefficient r in the present study indicate that among the parameters identified, it is the ovary weight that has the closest correlation with fecundity (r = 0.974) thus, ovary weight is the best index for fecundity followed by body length (r = 0.837) and body weight (r = 0.851). The present study conforms to that of Bahaguna and Khatri, 2009.

IV. CONCLUSIONS

The present observations illustrates the reproductive biology of *Trichiurus lepturus* in the coastal waters of Zamboanga del Norte, Philippines. This study provides information on gonado-somatic index and fecundity of *Trichiurus lepturus* which could be used further for formal stock assessment for establishing an ecologically sustainable cutlassfish fishery in the province.

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