BIOLOGICAL STUDIES ON THE THREADFIN BREAM NEMIPTERUS JAPONICAS (BLOCH, 1791) ALONG CHENNAI COAST OF INDIA

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Abstract: A study was carried out to understand the relative reproductive changes in the Japanese threadfin bream (*Nemipterus japonicus*) along Chennai coast ofIndia. *N. japonicus* (Nemipteridae) (vernacular name Sankara in Tamil) is a demersal species, abundant in coastal waters, found along muddy or sandy bottoms at 5 to 80 meters depth of sea regions and they are concentrated at depths of 100-200 meters. These fishes are one of the major demersal fishery resources, contributing 15.34% to the total demersal landings in India. Samples amounting to 190 specimens were collected during September 2015 - February 2016 and sex ratio, length-weight relationship (LWR), relative condition factor, gonad somatic index and morphometric characters of males and females were obtained. Overall sex ratio was estimated as M: F = 1.00:0.85. Length at 50% maturity was estimated to be 17.6 cm for males and 18.6 cm for females. The minimum size at first maturity was 10.45 cm for males and 10.6 cm for females. Length-Weight relationship for both males (R^2=0.9806) and females (R^2=0.9773) were found to be curvilinear, highly significant by ANOVA test (P<0.0001) and positively isometric. Fulton's condition was significant between males and females but not significant (by Mann-Whitney Test) between sex and months. Spawning period revealed an increase from 10.5% in October to 16.09 % in November indicating the peak period of maturity in females. In males, an increase from 8.87% in September to 10.24% in October and a gradual decreaseto9.97% in November was recorded. The GSI values were highly significant among months with P<0.0001 for both sexes by ANOVA test. Most of the morphometric characters evidenced significant difference between sex while only few characters demonstrate no significance difference among males and females using t-test (P<0.05).Morphological characters, such as body shape and meristic counts, have long been used to delineate stocks and they continue to be used successfully (Villaluz and Maccrimmon,1988). The results provide inputs for fishery biologists and fishery managers in studying threadfin bream stocks.

Keywords: ANOVA, Mann –Whitney Test, T-Test, Length-Weight Relationship, Threadfin Bream.

Introduction: In India, about 240 species of fin fishes contribute to the fishery resources of Tamil Nadu state which has 1.05 million fishermen population. The coast consists of 3 major fishing harbors, 3 medium fishing harbors and 363 fish landing centers. The marine fishing output from the state contributes to 10-12 % of the total marine fish production in India and is estimated at 0.72 million tonnes [1].Fishes are at present are in high demand in food markets, widely consumed in many parts of the world because they possess high protein content, low saturated fat and omega fatty acids known to support good health [2]. Recent estimates quantify the per capita fish consumption in India to be around 8-10 kg per year and is likely to grow to 16.7 kg by 2015 [3].

The nemipterids popularly known as threadfin-breams constitute an important group with a considerable economic importance in the tropical waters of the Indo-West Pacific region [4]. The Japanese threadfin bream *Nemipterus japonicus* is a demersal fish species of the family Nemipteridaeis found abundantly in the Indian coasts. Satyanarayana et al. (1972) [5] reported that this species is

present in muddy or sandy bottoms of the coastal waters of depths of 50-150 m, usually in schools. This species is a valued food fish in many parts of the world and is caught commercially by hook and line and bottom trawl [6] whereas in India, it is by trawling. The diet of these species primarily consists of small fish, crustaceans, molluscs, polychaetes and echinoderms. The catch ratio of *N. japonicus* has increased within the last decade and has become as one of the main commercial species [7]. The biology of *N. japonicus* has been studied by various authors in different regions [8]-[11]from the Indian waters and Bakhsh (1994) [12] in Saudi Arabia and Amine (2012) [13] in Red Sea, Egypt. However, there has been no information available on the biology for this species especially in the Chennai coastal waters. An attempt is made to register the reproductive biology of the thread fin breams from Chennai, east coast of India.

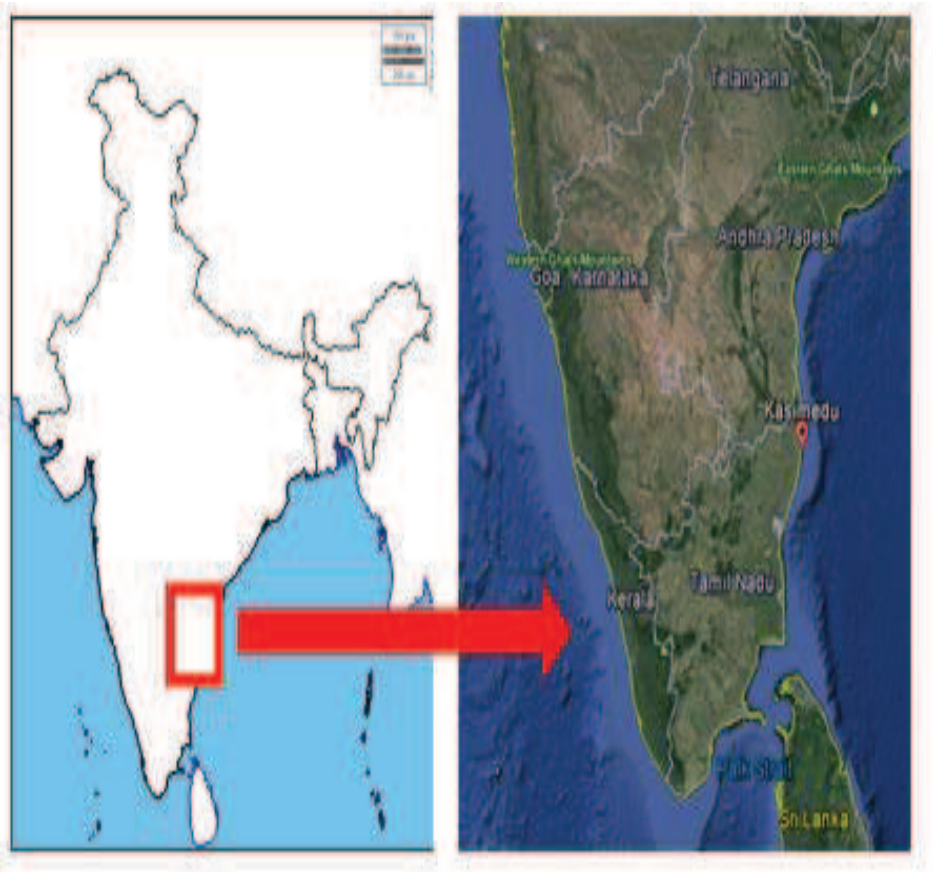

Fig.1. The Location Of Study Area

Materials and methods: For the present study, samples of *N.japonicus* were collected bi-monthly from commercial trawlers operated from the Kasimedu landing centre, Chennai (Fig.1) for a period of six months from September 2015 to February 2016. A total of 190specimens (129 males and 61 females) were collected. Only 19 variables were considered (16 morphometric, 2 meristic variables and Gonad weight) namely snout length (SL), eye diameter (ED), post-orbital length (POL), pre-dorsal length (PDL), pre-pelvic distance (PPD), width of dorsal fin (WDF), head length (HL), body depth (BD), standard length (STL), fin length (FL), total length (TL), caudal peduncle length (CPL), post-dorsal length (PDL1), total weight (TW) Gonad weight (GW), pectoral fin (PF), caudal fin (CF), dorsal fin spine minimum (DFL^{min})and dorsal fin spine maximum (DFL^{max})for statistical analysis. Gonads were carefully removed after dissecting the specimen and sex was documented following which, morphometric, meristic characters and gonad weight were recorded with a digital vernier caliper up to 0.1cm accuracy and a weighted digital weigh balance nearest 0 0.1g accuracy.

Sex ratio was estimated as the number of females to the number of male in the catch - sex ratio was determined using the equation: Sex ratio = No. of females/No. of males where, difference among male and female species was tested using Chi-square ($\chi 2$).

Gonadosomatic index (GSI) was calculated for both sexes and later % of gonad weight in relation to the total body weight was calculated by using the following formula:

$GSI = (Weight\ of\ gonads \div Weight\ of\ body) \times 100.$

Condition factor (Fulton factor) K: The well-being of each dominant species was studied by using Fulton's condition factor [14]. Fulton's condition factor (%) was calculated as:

$K = (TW \div FL^3) \times 100.$

Where TW is Total Weight (g), FL is Fork Length (cm).

Length-weight relationship: The relationship between Total length and Total Weight of most dominant fish was calculated using power function according to [15] procedure:

$$W = a \times L^b$$

Where' a' is an intercept of regression line and b represents the slope of regression line. For the statistical analysis, ANOVA, Mann-Whitney, t-test using PROC GLM procedure of SAS (19)was used and descriptive diagrams in Microsoft excel were generated from the data obtained.

Results:

Length-Weight Relationship: Length weight relationship parameters of fishes are an important fishery management tool and it is very much useful for cultivators and fisheries managers to ascertain the growth of the species. The analysis for males and females were separately done to study variation in growth. The total length of females ranged from 10.6 cm to 25.59 cm, and that of males from 10.45 cm to 24.8 cm. The corresponding total weight ranged from 19.89 to 282.19 gm, and 20.44 to 256.32 gm. Both males and females exhibited highly significant difference among weight and length from ANOVA test ($P<0.0001$)(Fig 2).

Relationship between L and W were estimated as:

1) $W=0.0066\times L^{3.3242}$($R^2=0.9806$, n=129) for males

2) $W=0.0157\times L^{3.029}$($R^2=0.9773$, n=61) for females

3) $W=0.0083\times L^{3.2448}$($R^2=0.9788$, n=190) for both sexes combined

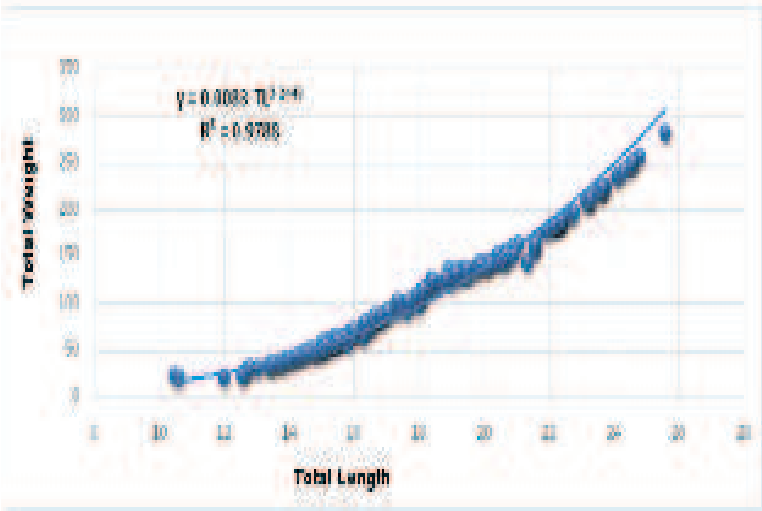

Fig.2. Comparison Between Male And Female N.Japonicus On Regression Line Of Length-Weight Relationship

The condition factor (k): The mean values of condition factor ranged between 3.52 to 4.04 and 3.39 to 3.73 formales and females, respectively (Fig.3).The maximum average values recorded was from 3.73 for males and 4.04 for females during the month of February. There was a decline in values of K during September 2015 for males and November 2015 for females. There was an increase twice in 2015 during October and December months for the combined sexes. However, Mann-Whitney U test did not exhibit significant variation ($p>0.05$).

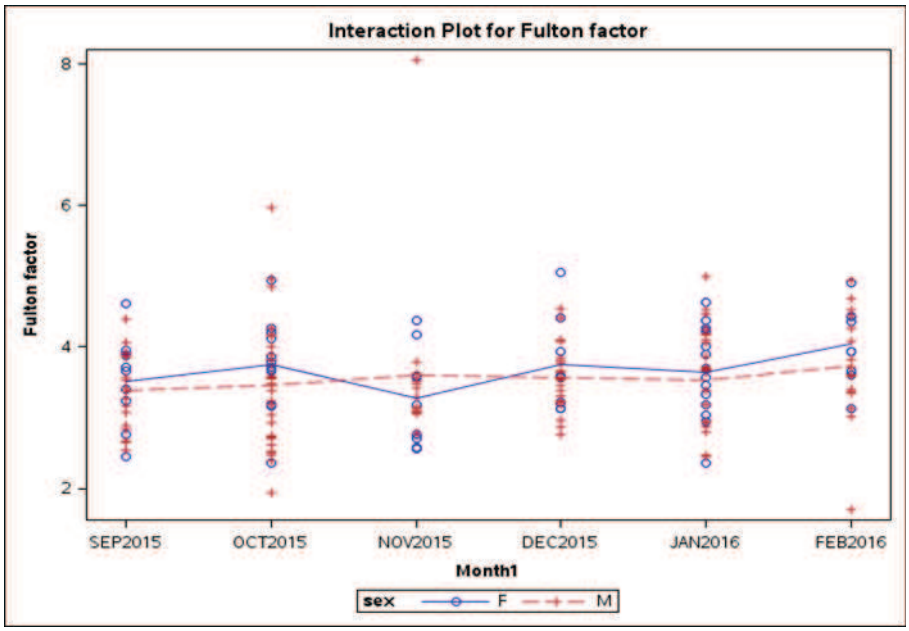

Fig.3.Monthly Changes Of The Mean Fulton Factor For Female And Male Of N. Japonicus

Sex Ratio: Sex ratio was calculated monthly for the collected samples(133 males and 62 females) adopting Chi-square test. From fig.(3), the overall sex ratio (M/F) was1:0.85.In published reports females are found to be higher than males but in the present study, males dominate females throughout the study period. The highest percentage of males(more than 70%) was observed in December 2015 (74.2%) and October 2015 (70.7%). In the case of females, November 2015 and February 2016, 36% was recorded.

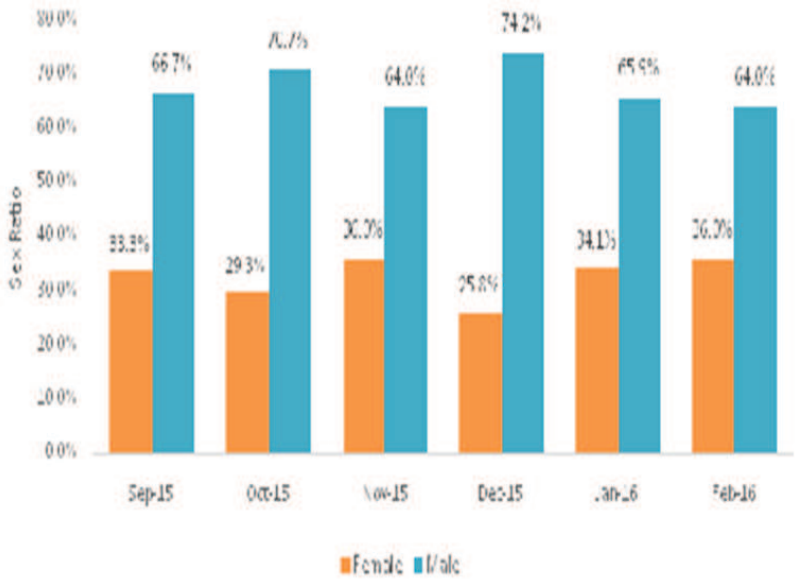

Fig.4. Lengthwise Frequency Distribution of Males and Females

Length at First Sexual Maturity: First sexual maturity was determined and recorded in *N.japonicus* was for both the sexes. The total length at 50% maturity was estimated at 17.6 cm for males and 19.1 cm for females (Fig.4). The smallest ripe males and females were 10.45 cm and 10.60 cm respectively.

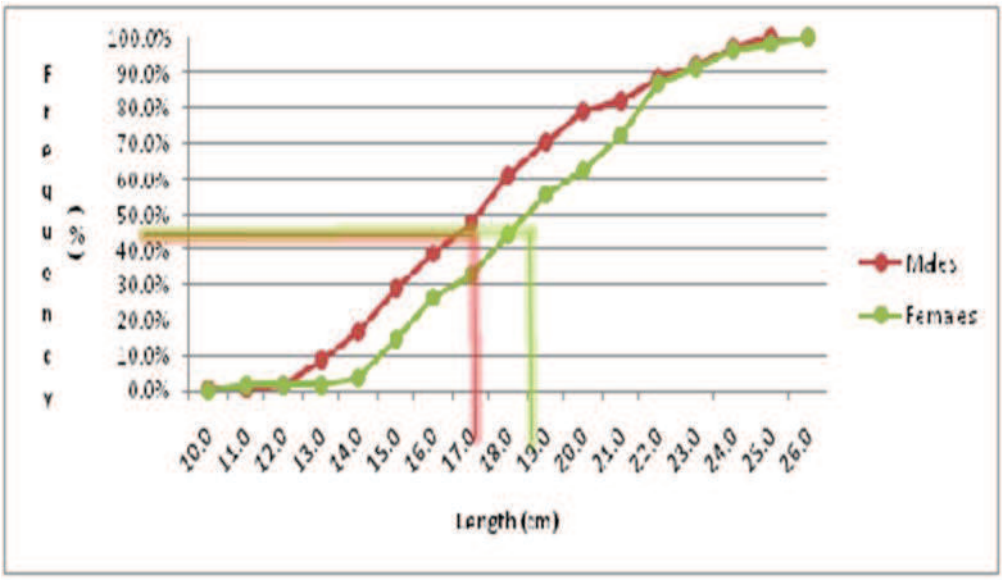

Fig.4: Length at First Sexual Maturity for Males And Females

Gonad Somatic Index (GSI): Gonad somatic index of fish increases with maturation being maximum during peak period of maturity and abruptly declines after spawning. Monthly average variation in GSI for both sexes of *N. japonicus* was quite apparent Fig. (5). It increases from 10.5% in October to 16.09 % in November 2015 indicating the peak period of maturity for the females.

There is gradual decrease in GSI from 14.69% in December 2015 to 14.40% in January 2016 indicating the onset of spawning in the case of females. GSI values increase gradually from 14.43% in February 2016 indicating the preparatory period.

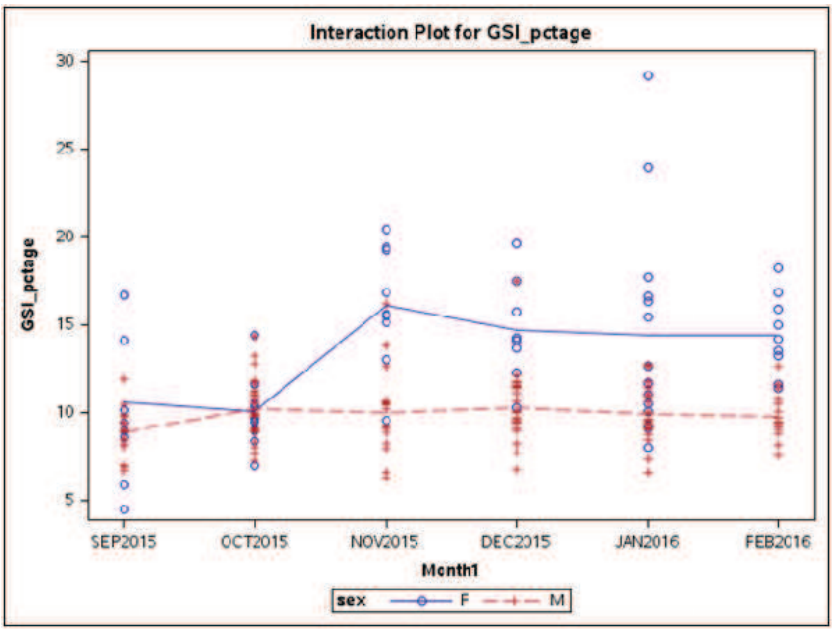

Fig.5: Monthly changes of the mean Gonadosomatic Index (GSI)for females and males of *N.japonicus*

Table 1.Comparing the morphometric and meristic characters between sexes of *N.japonicus*(t-Test: Two-Sample Assuming Unequal Variances)

No.	Variable	Significance
1	SL	0.0244
2	ED	0.0081
3	POL	0.0452
4	PDL	0.0228
5	PPD	0.0535
6	WDF	0.0024
7	HL	0.0106
8	BD	0.0004
9	STL	0.0290
10	FL	0.0429
11	TL	0.0188
12	CPL	0.0951
13	PDL1	0.1495
14	TW	0.03306
15	DFL^{min}	0.0177
16	DFL^{max}	0.0161

Most of the morphometric and meristic characters between sexes of *N.japonicus* exhibited significant difference while four characters did not exhibit any difference among the sexes($P<0.05$). This highlights that the sexes of *N.japonicus* did not exhibit much variation during the study from Chennai neritic waters.

Discussion: Sex ratio is an important factor in any study involving sexually reproducing species, as it gives the number of males and females in a particular species population. In the present study involving *N.japonicus*, male population was dominated over females M: F = 1:0.85 with percentage of males was 68% and 32%for females. Females were found to be larger in size class of (10.6-25.59 cm) than males (10.45-24.8cm)males in a work carried out 4 decades ago Krishnamoorthi(1974) [16]. In the present study the females were larger in size as reported by [16]. Murty (1984) [17] found females were smaller in size than males and males grew quicker and to longer size. This indicated that male and female are not balanced in the *N.japonicus* population in the east coast of India along the Chennai coastal water. In addition, [10]in the Northern of Persian Gulf found that the sex ratio of *N.japonicus* was 1.0:2.6 and the females out numbered the males. Manojkumar(2004) [9] reported the sex ratio between males and females was 1.0:1.01 in the Gujarat whereas, Raje (2002) [18] documented males out numbering females with ratio 2.2:1.0. As with the most *Nemipterus* species, *N.japonicus* exhibit size differences in sex-ratio and mostly dominated by males.

The length-weight relationship is yet another important factor in biological studies and stock assessments of fishes [19]. Thus, length-weight relationship plays an important role in fishery science and population dynamics. Statistical analysis of LWR reveal that the slope values obtained from L-W relationships are indicative of isometric or allometric growth difference between sexes. Murty (1984) [11] estimated values of slope for males as 2.43 and females as 2.95 from Kakinda in Indian waters. Bakhsh (1994) [12]recorded 2.43 for males and 2.47 for females from the Jizan Region of Red Sea. Mathews and Samuel (1989) [20] found that this value was 2.97 for Kuwait waters whereas Vivekanandan and James (1986) [21]estimated it 2.94 for Madras waters in India. In addition, 2.66 for Karnataka [22]; 2.99 Manojkumar (2004) [9] for Veraval waters; 2.83 by Afshari et al (2013) [23] northern Oman sea was also recorded. In our study, the species show a strict positive isometric growth, as their slope (b values) observed is3.324 and 3.029 for males and females respectively. Both sexes exhibit significant differences in length and weight by ANOVA tests.

First sexual maturity is vital in all species because it enables the specific growth and reproduction dynamics in the lifetime of an individual fish. According to Hodgkiss and Mann (1978)[24] the length at which 50% of fish attainment of sexual maturity (M50) is considered to be the length of onset of its

sexual maturity. Based on our result from commercial trawlers from east coast Chennai, the smallest female attained first maturity at10.60 cm length and the smallest male at 10.45 cm length depicting that males reach first sexual maturity much sooner than females. The 50% maturity for females and males were at length of 19.1 and17.6 cm, respectively. Murty(1984)[11] determined the length at first maturity females has 12.5 cm length in Madras, Vivekanandan and James (1986) [21] estimated the females has 14.5 cm length and Bakhsh(1994) [12] reported the smallest size at first maturity as 10.0 and 9.5 cm for males and females respectively.

The gonad somatic index is a tool for measuring the sexual maturity of fish in correlation to ovary development and testes development. GSI is generally indicative of reproductive success which is the most critical stage in the life cycle of a fishes, which determines its survival. They can be affected by other factors such as temperature and food availability. In the present study, the spawning seasons for females and males were very consistent. The spawning season peaks for female, namely October – November 2015 and February 2016.For males it was found to occur from September-October and December 2015.The spawning of *Nemipterus* species has been studied by [4],[25],[11],[12]that varied with the region and by months whereas [26],[21] resembles the results in this study. From this study it is understood that the preparatory period for *N.japonicus* females is during February whereas for males it is December.

The study of condition factor is very essential in understanding the life cycle including spawning season of fish and leads to adequate management for sustainable production. A high condition factor (CF) reflects good environmental quality, while a low CF reflects poor environmental factor. Condition factor is another important quantitative parameter that is related to maturity, gonadal development and general well-being of the fish. It determines the present and future population success by influencing growth, reproduction and survival [27]-[29]. According to Braga and Gennari (1990) [30], condition factor vary according to season and is influenced by environmental conditions. Study concurs with Amal (2012) [31], who observed the mean values of condition factor 0.9577 to 1.728 for males and 1.007 to 1.622 for female *N. japonicus* in the Gulf of Suez, Egypt. In the present study, the condition factors for males and females were recorded as 3.52 to 4.04 and 3.39 to 3.73 respectively.

In general, fishes show similar growth pattern in males and females. In some cases there is differential growth in initial stages after which there will be a compensatory growth period in males as well as females which results in similar growth rate. The observed growth differences of males and females of *N.japonicus* add to the complexity of management of the fishery. Most of the morphometric characters evidenced significant difference between sex while only few(post-orbital length (POL), pre-pelvic distance (PPD), caudal peduncle length (CPL) and post-dorsal length (PDL1) characters demonstrate no difference among males and females.

The present study was attempted to identify the length at first maturity of the threadfin bream *Nemipterus japonicas* and to understand the biological changes. The study will form a base to carry out conservation plans especially when the fishing ban is proposed for a particular region.

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