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REPRODUCTIVE BIOLOGY OF *NEMATALOSA NASUS* (BLOCH, 1795) OFF MANGALORE COAST, KARNATAKA

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ABSTRACT : ***Nematalosa nasus*** **is one of the important species comes under shads belongs to the clupeids group, clupeiod fisheries is one of the major fisheries in Indian country. In the present study, the complete reproductive biology with breeding seasonality of *N. nasus* along Mangalore coast studied for the first time. Six maturity stages were described macroscopically (male and female) and microscopically (female) throughout the maturation cycle. The spawning season in Mangalore lasts from September (2013) to April (2014), with peak spawning activity in October (2013) and November (2013). The size at first maturity was estimated to be 162 mm for both male and female respectively. The size frequency distribution of oocytes (ova diameter) provided evidence for its multiple spawning. The batch fecundity of this species was estimated between 1,02,093 to 8,32,129 eggs per individual. GSI indicated protracted spawning which extend from September (2013) to April (2014). The overall sex ratio exhibited equally was 1:1 (Male : Female).**

Key words : *Nematalosa nasus,* Mangalore coast, reproduction, breeding seasonality.

INTRODUCTION

Nematalosa nasus commonly called as 'Bloch's Gizzard Shad' in English and locally known as 'Swadi'(Kannada). This species is known to inhabit estuaries and coastal areas, occasionally ascending into upper reaches of the tidal zone, it belongs to shads which comes under clupeids. Clupeids (Herrings, Shads, Sardines) are important marine forage fish which exhibits shoaling behaviour and dominant pelagic group of fish landed in Indian waters. This group comprises of 106 species among 250 species that contribute to pelagic fisheries in Indian coast. Different types of gears are employed to exploit shads which include seines, shallow trawls, lift nets, gill nets and purse-seines. They are mainly characterized by toothless mouth and gizzard like stomach (Ayyappan, 2011).

Reproduction is one of the inevitable process exhibits dynamically and one of the most impressive specializations developed in marine teleosts (Qasim, 1973). Sketchy observations on reproductive biology are not enough and there is paucity of information on reproductive biology of *N. nasus* along Mangalore coast. This study was initiating with a view to gain in-depth knowledge in reproductive biology with breeding seasonality of *N. nasus*.

MATERIALS AND METHODS

N. nasus were collected monthly over a period from September 2013 to April 2014 at fish landing center of Mangalore, Karnataka. A total of 288 specimens were examined for study. Total length (TL) and Standard length (SL) of each individual was measured to nearest 0.5mm. Month wise sex ratio was determined and Chi-square test was performed to examine the homogeneity of Male and Female distribution. The size at first maturity (L_{50}) was determined by plotting cumulative percentage for male and female considering all maturity stages of fish against size groups of different length (James and Badrudeen, 1981). Total weight of specimen and weight of gonad weighed after dissecting to the accuracy of 0.01g with the help of an electronic balance.

Gonado-Somatic index (GSI) was calculated by commonly followed method (James, 1967; Baragi, 1977) is expressed as GSI = weight of gonad (g)/Weight of fish (g) x 100. The gonads were then preserved in 5% buffered formaldehyde for subsequent analysis. Fecundity was estimated gravimetrically and ovaries of the stages IV and V were considered for fecundity estimation. Subsamples of ovary were taken from anterior, middle and posterior region to the watching glass. Number of mature ova in the sample was counted physically. Absolute and relative fecundity were calculated by following the standard formulas (Garg *et al*, 2002). For ova diameter studies of intra-ovarian eggs total of 500 ova were measured from each subsample of the ovary under a compound microscope using calibrated ocular micrometer.

RESULTS AND DISCUSSION

Reproduction involves a sequential and cyclic change in gonads, a thorough knowledge of maturation cycle will help to understand and predict annual changes that a population undergoes. This involves morphological changing pattern and condition of gonads to ascertain the maturity stages.

Maturity stages and its occurrence in different months

Classification of maturity stages is a paradigm in fisheries biology for initiation of studies on breeding seasonality with reproductive biology of fish. Based on gross macroscopic characteristics gonads were classified into six stages by following standard key. In *N. nasus* ovary from stage I to V coloration noticed was pale yellow color to red color with increase in size and vascularisation, stage VI was appeared in dull brownish color with scattered and different diameters of eggs this may be because of partial spawning and eggs were remained as residual eggs which may regenerate and revert to the stage I for the continuation of maturation cycle. In male *N. nasus* whitish to red color was appeared from stage I to V with increment in volume in developing stages with blood pronounce.

Direct evidence on the spawning period (season) of a species was identified by the occurrence of different maturity stages (especially mature and spent) in various months. A perusal of data on distribution of maturity stages shows that almost all stages were present throughout the study period, atleast 3-4 stages of maturity were found in the monthly samples in most of the months. Clark (1934) reported that if there is any periodicity in the spawning, all the fish collected at any particular time they are expected to belong same stage of maturity. However observation did on *N. nasus* not indicate any such periodicity. Ripe specimens of female *N. nasus* occurred during the period October (2013) to November (2013) indicating this as a peak spawning season.

Size at first maturity

The timing of sexual maturity is a critical transition where onset of sexual maturity correlated with size of the fish. Cumulative percentage frequencies of male and female were calculated and plotted against different size groups presented in Fig.1. The size at maturity of *N. nasus* was 162 mm (TL) for both male and female, both sexes exhibited same growth rate which resulted in equal size at maturity, attaining maturity at same time may result in reproduction success. Chubb and Potter (1984) stated that in *Nematalosa valminghi* minimum size at matutity was 15.9 cm for both male and female.

Sex ratio

Number of male and female proportion may reflect certain change in fish population. Fig. 2 & 3 shows *N. nasus* maximum number of males and females were observed in the size group of 140-160 mm in the month of December (2013). Chi-square values indicated significant difference in the month of December (2013), whereas no significant difference was observed in size groups, exhibited an equal sex ratio of 1:1 (Male : Female) indicating equal proportion of contribution in their population due to same growth rate between the sexes, similar results were reported by Annigeri (1989), who reported an equal sex ratio 1:1 (M : F) in *Sardinella dayi* from Karwar.

GSI

GSI values used for indication of intense spawning activity, increase in gonad weight with progress of maturity and spawning, variations in average GSI of mature fish were analyzed to find its relation with spawning. GSI values in Fig. 4 shows the average GSI values plotted against months. The GSI value was highest (8.25) in female *N .nasus* in the month of September (2013) indicating peak spawning activity and lowest (1.46) recorded in the month of February (2014) indicating sexual resting period or termination of spawning where as in male highest value (7.54) was recorded in the month of October (2013) and lowest (1.14) in January (2014). GSI values recorded higher in females than males. Chen and Hsiao (1996) studied on *Nematalosa come* from Southern Taiwan and stated GSI values demonstrated that spawning activity reached a peak during February-April.

Fecundity

Knowledge about fecundity of a fish is essential for evaluating commercial potentialities of its life stock, life history, potential culture and actual management of fishery (Lagler, 1967). Fig. 5(a,b,c) represents the relation between fecundity of fish with length, weight and ovary weight of fish. In *N. nasus* fecundity varied from 1,02,093 to 8,32,129 eggs, with an average of 3,67,657 eggs per individual. In case of *N. nasus* linear regression of log fecundity showed significant correlation with all the variables *viz.* log length of fish (r=0.85), log weight of fish (r=0.88) and log ovary weight (r=0.96). Similar fecundity results were reported by earlier workers like Panhwar *et al* (2011) they reported that *Tenualosa ilisha* fecundity was 87,267 - 6,14,482 in the females ranging from 210-350 mm in total length.

Ova diameter studies

Ova diameter studies have become an integral part of the fishery research, it has been widely accepted that

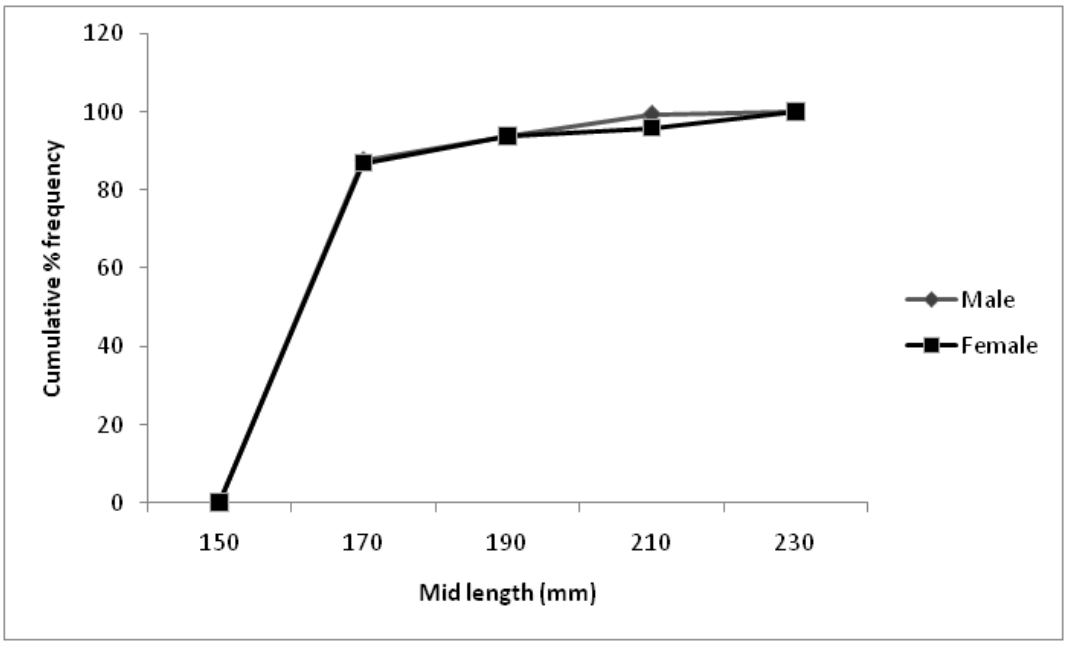

Fig. 1 : Estimation of size at maturity by cumulative percentage frequency method.

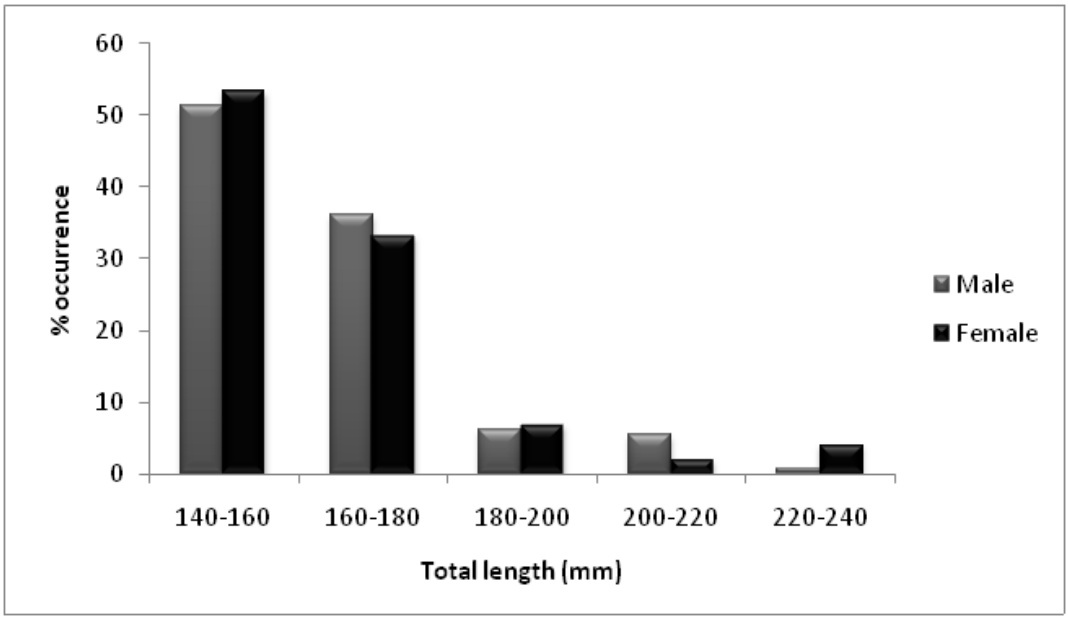

Fig. 2 : Sex-ratio of *N. nasus* in different size groups.

ova diameter studies gives reliable evidence on breeding season. The progression of intra-ovarian eggs depicts the spawning periodicity. Fig. 6 gives the spectrum of progression of ova diameter in different maturity stages. The ova diameter from stage I to VI ranged between 0.02 to 0.74. This is in conformity with Annigeri (1963) who reported that in *N. nasus* the egg diameter ranged from 0.019 mm to 0.66 mm.

The ova diameter study in the present investigation revealed that the presence of multiple groups of eggs in ovaries which were destined to be mature and shed periodically by representing unrhythmic spawning bursts which could not be sharply differentiated or separated in each stage depicting the prolonged spawning season indicating fish *N. nasus* as a continuous spawner. The highest number of yolked ova recorded in *N. nasus* mature ovary during the months of October (2013) and November (2013), confirmed this to be the breeding season. Prabhu (1956) also supported the above result by reporting that observation on the spawning period and its duration, as determined by a study of intra-ovarian eggs would be more accurate if ova represented by

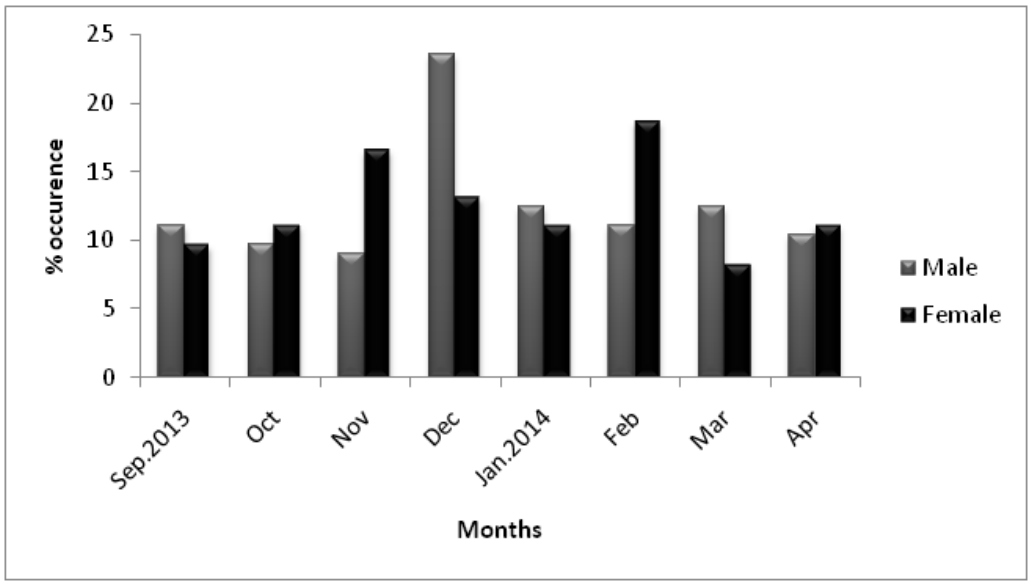

Fig. 3 : Sex -ratio of *N. nasus* in different months.

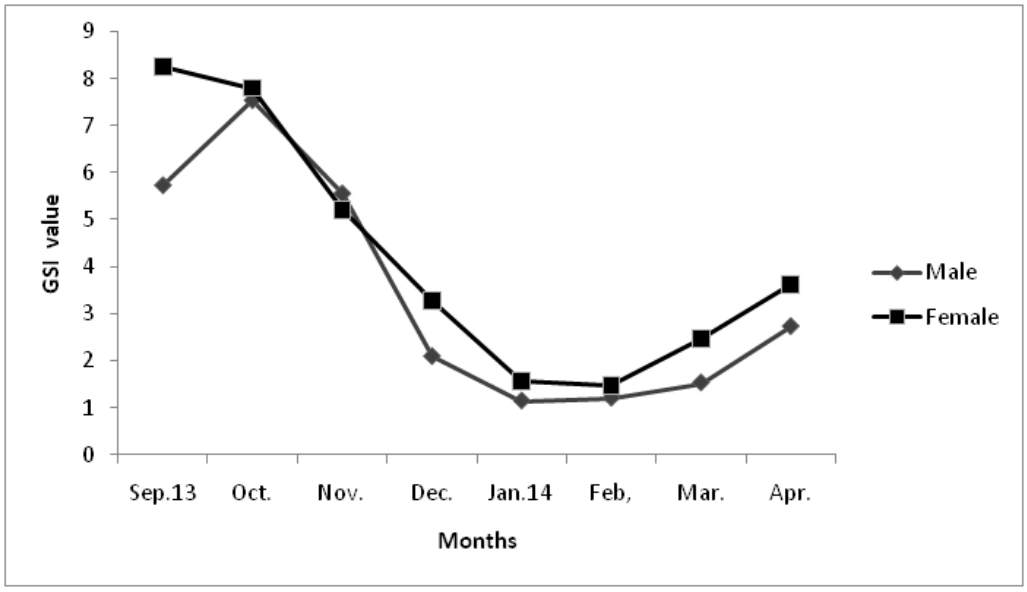

Fig. 4 : Monthly variations of GSI of *Nematalosa nasus*.

various modes studied in relation to different stages of maturity represented by the respective modes in the ova diameter frequency curve and inference made on periodicity of spawning in different species concluded four distinct types of spawning, type A) Spawning taking place only once a year during definite short period, type B) Spawning taking place only once a year with a longer duration, type C) Spawning twice a year, type D) Spawning throughout the year but intermittently. Qausim (1973) also reported that in Indian Ocean, several species of fish are continuous breeders with prolonged spawning season, lasting 7-9 months in a year.

CONCLUSION

The present study on some aspects of reproductive biology with breeding seasonality of *N. nasus* revealed the following, females and males were in equal proportion in the population and both sex mature at same size. The breeding season extends from September (2013) to April (2014) with a peak spawning activity in the month of October (2013) and November (2013) which was strongly evident by GSI. Ova diameter peaks confirmed that *N. nasus* is a fractional (batch/multiple) spawner and prolonged spawner with asynchronous oocytes development.

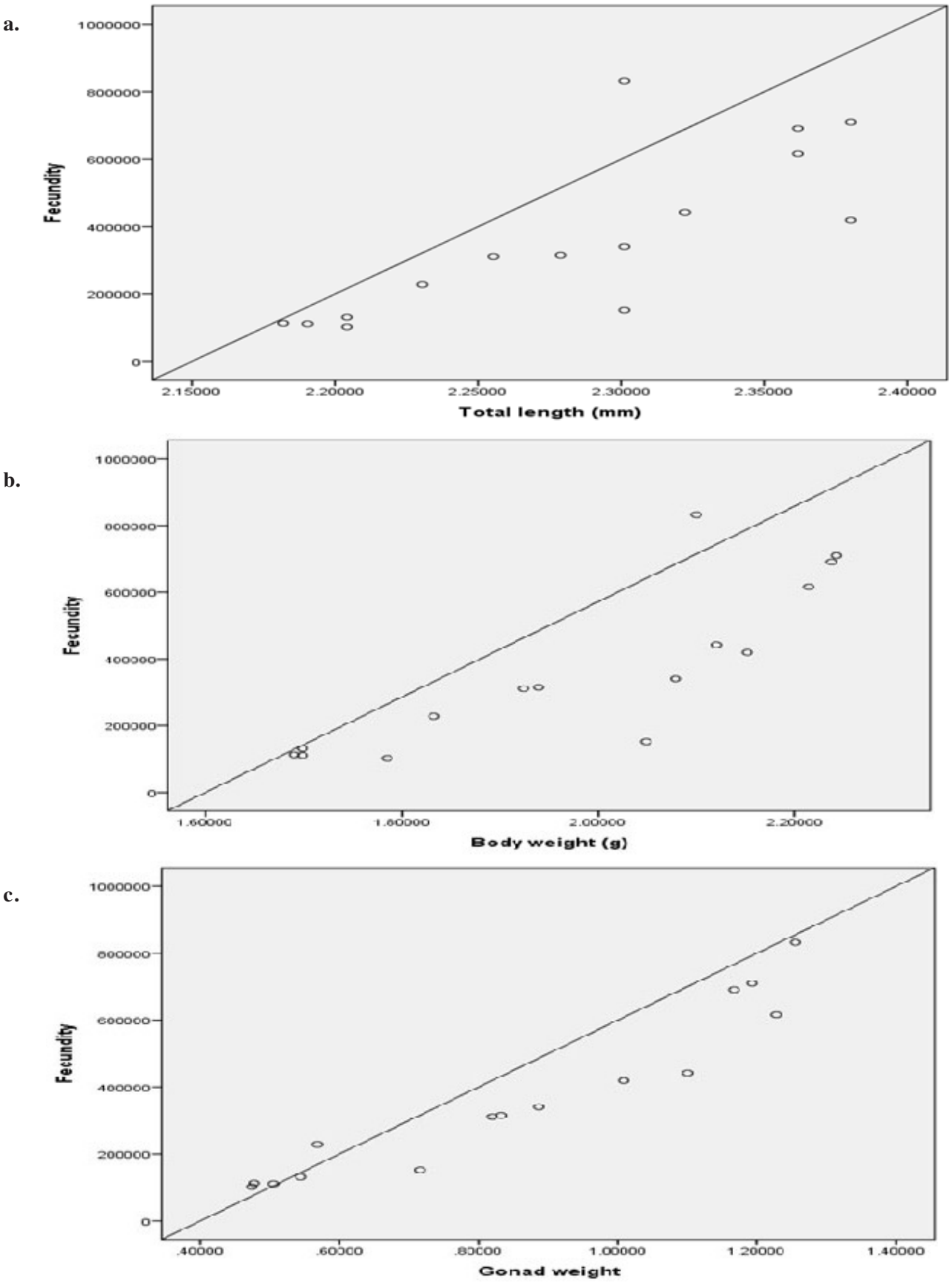

Fig. 5 : Linear regression plot of *N. nasus* representing relation between fecundity of fish with length, weight and ovary weight of fish.

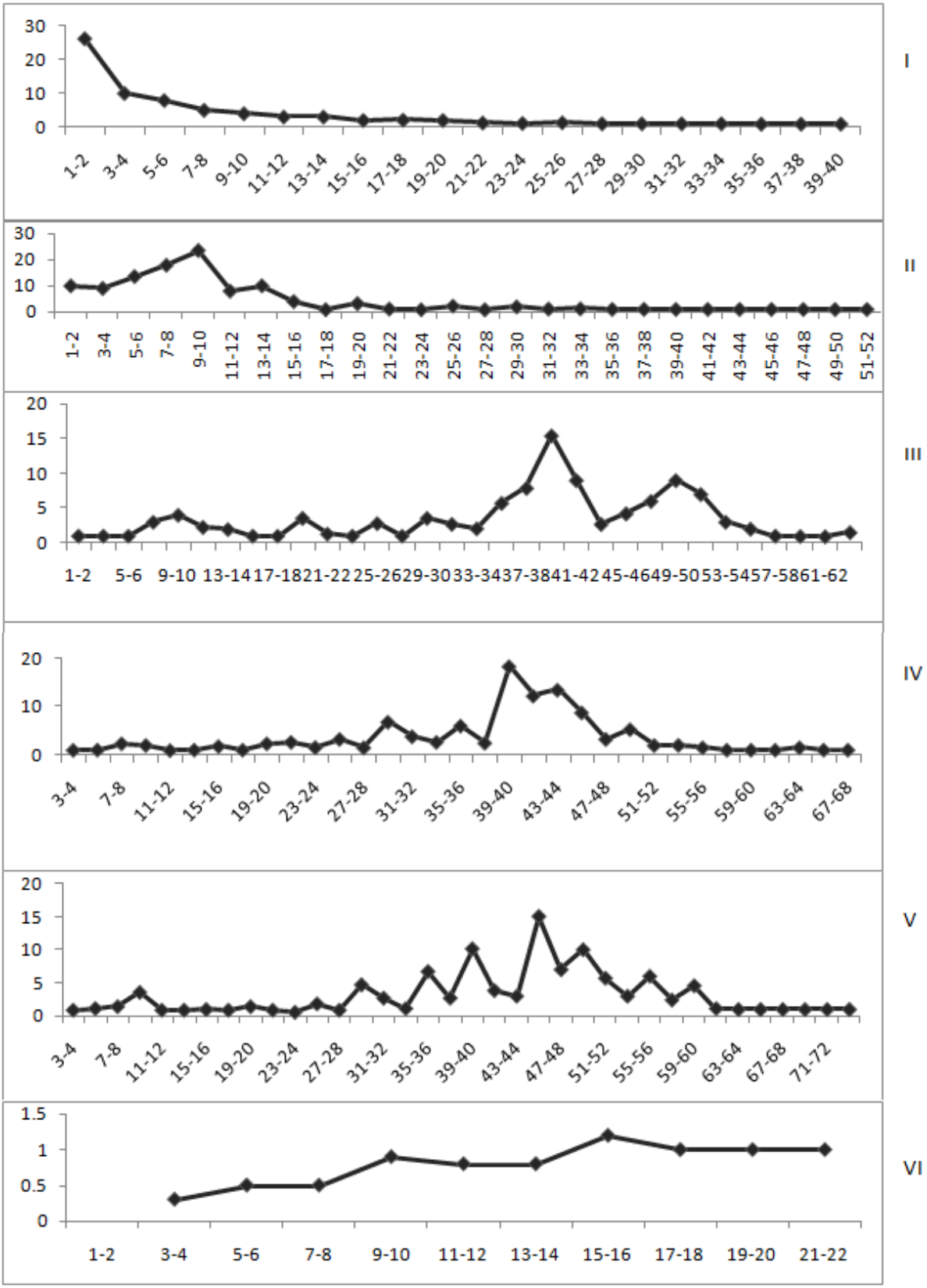

Fig. 6 : Ova diameter frequency polygon of *N. nesus*.

X axis – Ova diameter range
1 O.M.D = 0.01 mm

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