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OBSERVATIONS ON THE SPAWNING BIOLOGY OF *NIBEA ALBIDA* (CUVIER) IN THE COCHIN ESTUARY*

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ABSTRACT

The maturity and spawning of *Nibea albida* (Cuvier) in the Cochin Estuary were studied from January to December 1990. The spawning season of the species was found to be during July to November. The ova diameter frequencies of fully ripe ovary showed the presence of two batches of mature eggs which are sharply differentiated from the general stock of immature ova, suggesting the indication of two successive spawning with a very short interval. Comparatively high gonadosomatic values were observed from August to November indicating intense gonadial activity and from December onwards a noticeable fall was observed upto June. The size at first maturity for male is around 195 mm SL and for female is around 215 mm SL. The sex ratio in all the months of the year conformed with the expected 1 : 1 ratio. Fecundity of the species varied from 1,08,864 to 13,87,440 eggs in fishes ranging in size from 198.0 to 520 mm SL and the relationships obtained were log F= —0.2979 + 2.3751 log L, log F=3.3419 + 0.8220 log W for length and weight respectively. The 'r' values were 0.9419 for SL and 0.9602 for body weight.

INTRODUCTION

Nibea albida constitutes an important fishery in Cochin Estuary and also has considerable importance due to its suitability for brackish-water culture. The reproductive biology of other sciaenids in Indian waters has been studied by Rao (1963), Rajan (1964), Annigeri (1967), Kutty (1967) and Baragi and James (1980). The present investigation was undertaken to understand in detail some of the aspects such as spawning periodicity, season, minimum size at first maturity, sex ratio and fecundity of *N. albida* of Cochin Estuary.

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MATERIAL AND METHODS

Fishes were collected every fortnight between January and December 1980 from Cochin Estuary. The stage of maturity of the gonad was recognized by using ICES scale (Loven and Wood, 1937) with suitable modifications suggested by Qasim (1973) for tropical and subtropical fishes. Measurements of ova diameter were taken from ovaries at different stages of maturity using the method adopted by Clark (1934), Hickling and Rutenburg (1936), De Jong (1939), Prabhu (1956) and Baragi and James (1980). The ovaries were treated with modified Gilsons fluid (Simpson, 1951) for the studies on ova diameter and fecundity. Ova taken from

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anterior, middle and posterior regions of a few ovaries at different stages of maturity indicated a more or less uniform pattern of distribution (Baragi and James, 1980). Hence 300 ova were measured from ovaries at different stages of maturity using an ocular micrometer at a magnification giving a value of 50μ to each division. The immature group of ova with a diameter less than one micrometer division present in all stages were not measured. The spawning season was determined from the percentage occurrence of different maturity stages of gonads during different months of the year and confirmed by the Gonado-somatic indices.

Classification of maturity stages

Five maturity stages were determined on the basis of the colour, shape, size and microscopic structure of the gonads as suggested by Qasim (1973).

Stage I (Immature) : Ovary thin, thread-like, slightly reddish or pink, occupying nearly ¼ of the body cavity, translucent and jelly-like. Ova not discernible to naked eye, under the microscope small transparent ova visible with a nucleus in the centre. Testes thread-like, white and occupying nearly ¼ in length of body cavity.

Stage II (Maturing virgin and recovering spent) : Ovary flattened, reddish grey, extending nearly ½ of body cavity. Maturing group of ova visible to naked eye as very small white spots and appears opaque due to the deposition of yolk, nucleus not visible. Testes occupying more than ½ in length of body cavity, ribbon-like and white in appearance.

Stage III (Ripening) : Ovary broad, swollen, granular and yellowish, extending ¾ of the body cavity. Ova visible to naked eye through the ovarian wall. Mature ova irregular and completely opaque due to the thick deposition of yolk. Ova marked by the vacuoles of the yolk. Testes ribbon-like, broad, creamy white and soft, occupying ¾ of the body cavity. Outer margin of each lobe irregular.

Stage IV (Ripe) : Ovary massive structural fully occupying the body cavity and encloses the intestine. Ovary fully packed with ova, ovarian wall transparent. Most of the ova completely transparent, delicate, yolk segmented and with a single oil globule. Blood vessels are very prominent above the ovary and conspicuous grooves present on the ventral side of each lobe. Testes occupying nearly the full body cavity, creamy white and very soft, completely opaque, flattened, lobulated, wrinkles very prominent on margin of each lobe. Milt oozes out on gentle pressing.

Stage V (Spent) : Ovary shrunken, flabby, blood-shot, translucent, occupying nearly ½ of the body cavity. Majority of the ova transparent and invisible to naked eye with a very few yellowish residual eggs. Testes reddish-white, flabby and shrunken, occupying more than ¼ in the length of body cavity.

Results and Discussion

Development of ova to maturity and frequency of spawning

A total of 93 ovaries of *N. albida* of different maturity stages were examined during the present investigation and the pooled ova diameter frequencies from 3 regions are presented in Fig. 1.

During stage 1 majority of the ova measured between 1-2 microdivision (md) and only an immature stock of ova were represented with a very prominent mode of 1 md. Very few eggs with 3 md were also recorded. These immature stock of ova were discernible in all stages and was found to be increasing during the spawning period. In stage II, apart from the immature stock, the shifting of mode from 1 md to 3 md was discernible which indicates the passing of the immature ova into maturing ones. After the stage II the development of these ova seem to be very rapid. In stage III a distinct batch of ova get separated out and progress towards maturity and the mode in Stage II (3 md) is shifted to 6 md forming 27% of the total number of ova. In this stage another minor mode of 5 md was also observed with 18% of the total number of ova. maturing ova were also discernible which constituted a minor mode with 7 md and these two batches of maturing and mature eggs were completely separated from the general immature stocks. In spent ovaries the mode again shifted back to 1-2 md and another very small mode of 8 md was also discernible.

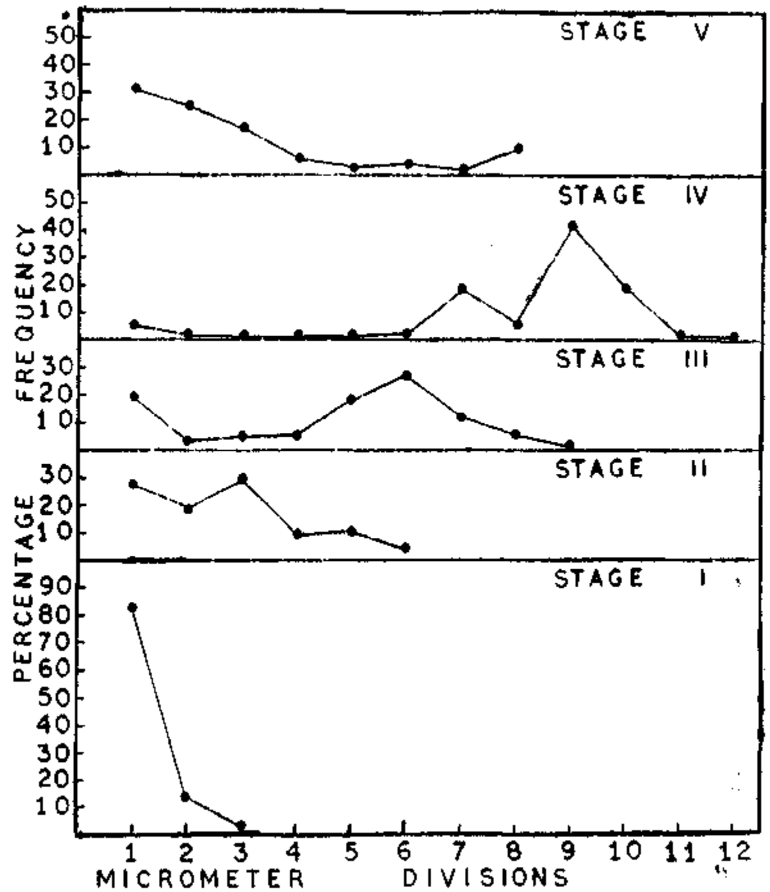

Fig. 1. Percentage frequency of ova diameter in *N. albida*.

The most advanced batch of ova was encountered in stage IV and two batches of ova can be clearly demarcated. The most advanced batch with a diameter of 9 md which constituted 42% of the total number of ova, were fully ripe and transparent with a single oil globule and it is presumed that this batch gets spawned first. Another batch of opaque

The ova diameter frequencies of fully ripe ovary shows that there are two batches of mature eggs which are differentiated from the general stock of immature ova indicating two successive spawning. The interval between two successive spawning appears short due to the fact that these two groups of mature ova are not sharply differentiated and hence the second batch of opaque eggs may not take much time to ripen. The pattern of occurrence of fully spent females confirms the above inference. Similar observations were also reported in *J. carutta* (Appa Rao, 1967) from Visakhapatnam and in *J. dussumieri* (Devadoss, 1967) from Bombay Coast. The ova diameter frequencies of fully ripe ovary also indicate that individual fish spawn twice during the spawning season.

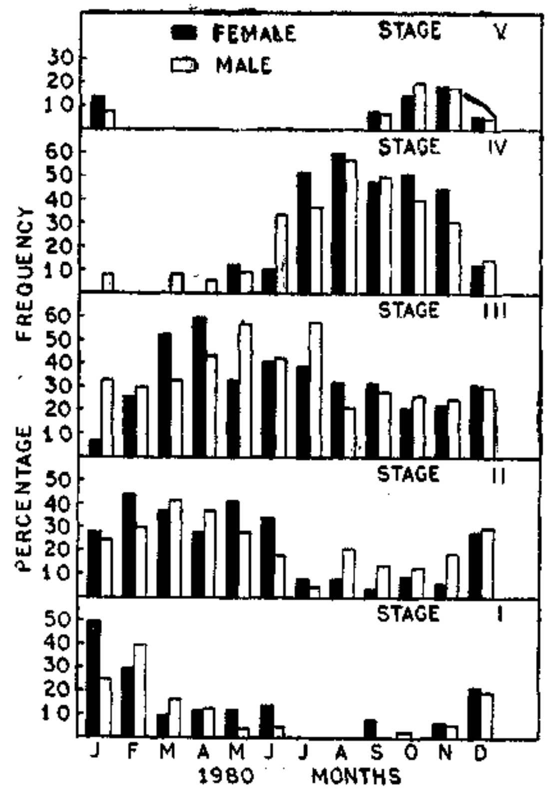

Fig. 2. The monthly percentage occurrence of different stage of maturity of adult *N. albida*.

Spawning season

The percentage occurrence of maturity stages of ovary and testes are depicted in Fig. 2. It is evident that maturing and mature gonads (Stage II and III) occurred almost in all months with a higher percentage from January to July. Fully matured ovaries and testes (Stage IV) were recorded from May to December with a very high percentage in July to November, the maximum of 55% recorded in August. During January, March and April females of Stage IV were encountered in very scarce numbers. Specimens with oozing gonads (ovaries and testes) were not met from the area during the period of investigation. Spent ovaries and testes were encountered from September to January with higher percentages in October and November. Fishes with fully ripe gonads were collected in higher percentages from July to November, indicating spawning during these months. It may be also presumed that the final stage of maturity is reached in the sea only, so fishes with ripe gonads may migrate to the sea for spawning. The occurrence on specimens with spent ovaries and testes is higher percentages during October-November also confirms that the spawning season is from July to November.

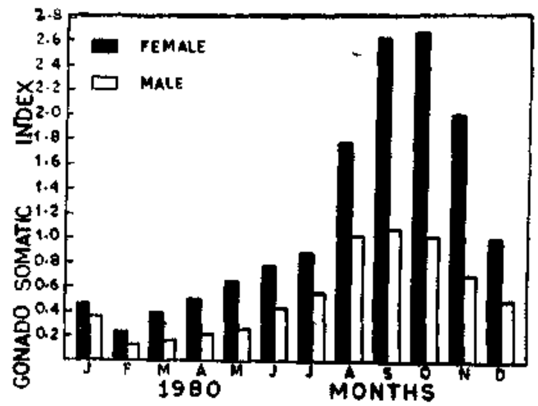

Fig. 3. The gonado-somatic indices of *N. albida*.

Gonado-somatic index (GSI)

Applying the method of June (1953) and Yuen (1955), the relative weight or the gonado-somatic index was calculated by using the formula

$$GSI = \frac{\text{weight of gonad}}{\text{weight of fish}} \times 100$$

Gonado-somatic indices were high from August to December indicates intense gonadal activity during these periods (Fig. 3). The GSI values were gradually increasing from March when gonads begin to mature, reaching the maximum in September-October, when most of the adults are fully mature. From December onwards there is a noticeable fall and it may be due to the discharge of gametes and hence there appears the spent fishes. High GSI values from August to December indicated that majority of the individuals have fully riped gonads and spawn during these months.

Size at first maturity

Percentage occurrence of mature males and females are shown in Fig. 4. It can be seen

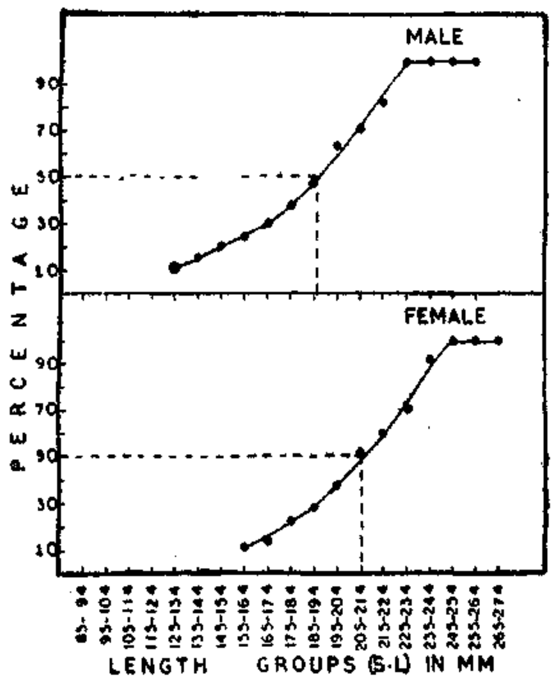

Fig. 4. Size at first maturity of male and female *N. albida*.

that upto 115-124 mm SL all males are immature and the mature males appeared in 135-144 mm SL group. The percentage of mature males increased upto 215-224 mm SL group. In males hundred per cent maturity was found in size groups above 215-224 mm SL. In females below 155-164 mm SL group all were found to be immature or maturing. The percentage occurrence of mature females steadily increased upto 245-254 mm SL group when all females were found to be mature. The 50% level in the maturity curve which may be taken to represent the mean length at which maturity was attained, are 195 mm SL in males and 215 mm SL in females. From the observation it is evident that males attain maturity at a lesser size than females.

Venkatasubba Rao (1963) reported that the size at first maturity of *P. diacanthus* is 85 mm. In *O. rubber* female attain maturity at 200 mm and in *J. dussumieri* it is 160 mm (Devadoss, 1969). Baragi and James (1980) observed that the size at first maturity of *J. osseus* is 125 mm in females and 95 mm in males. But in the present investigation it is observed that in *N. albida* the mean length at which maturity was attained is 195 mm SL in males and 215 mm SL in females. On comparison with other sciaenids it is clear that *N. albida* attains maturity only at a larger size in both the sexes.

Fecundity

The total number of eggs in the 31 fully riped ovary were enumerated by adopting Holden and Raitt's (1974) formula $F = \frac{nG}{g}$, where F = fecundity, n = number of eggs in subsample, G = total weight of the ovary, g = weight of subsample in the same units. The number of ova varied from 1,08,864 to 13,87,940 in the size range 198-520 mm SL. The regression equation after logarithmic transformation of the variables, can be expressed as '$\log F = -0.2979 + 2.3751 \log L$.' (where F = fecundity in thousands of ova, log L = standard length in mm), $r = 0.9419$ (Fig. 5). The relationship between body weight of the fish and fecundity is expressed in the regression lies as log

$F = 3.3419 + 0.8220 \log W$ (where F = fecundity in thousands of ova, log W = weight of fish in grams), r = 0.9602 (Fig. 6). The exponential value is usually reported as '3' when fecundity is related to length and '1' when fecundity is related to weight (Begenal, 1978). But in the present studies, the exponential value is less than cube when fecundity is related to standard length. Moreover, the exponential value is found to be less than '1' when fecundity is related to weight. The difference in exponential value and fecundity may be due to age, season, environment (Polder and Ziglstra, 1959). According to Bagenaı (1978) the changes in the environment may also result in significant changes in fecundity.

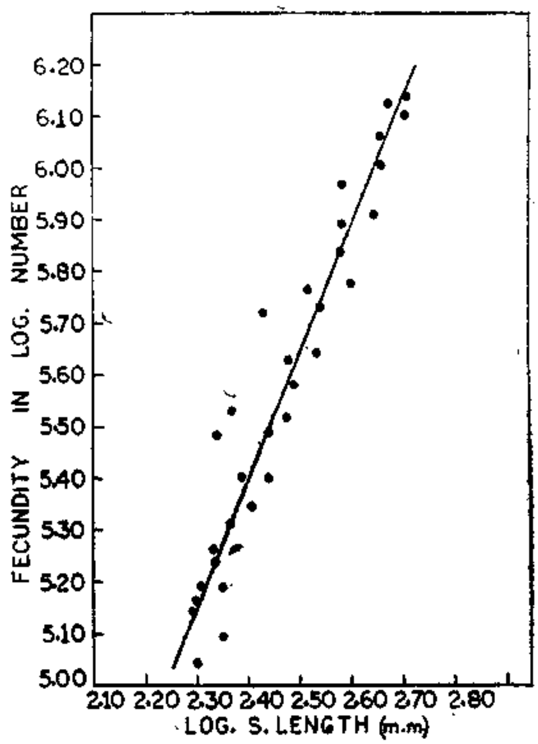

Fig. 5. Fecundity — standard length relationship in *N. albida*.

Sex ratio

The sexes were determined after examining the gonads and Table 1 shows the monthly distribution of the two sexes. The ratio was tested by Chi-square

$$\left(X^2 = \frac{(O-E)^2}{E}\right)$$

analysis for difference from the hypothetical 1 : 1 ratio or null hypothesis (Snedecor, 1961). The sex ratio was not skewed much in all months of the year 1980 and it nearly conformed with the expected 1 : 1 ratio for all months. The mean ratio of males to females were 1.00 : 1.07 for the year 1980 and the Chi-square value for the year was 0.87 which showed that the variation is insignificant.

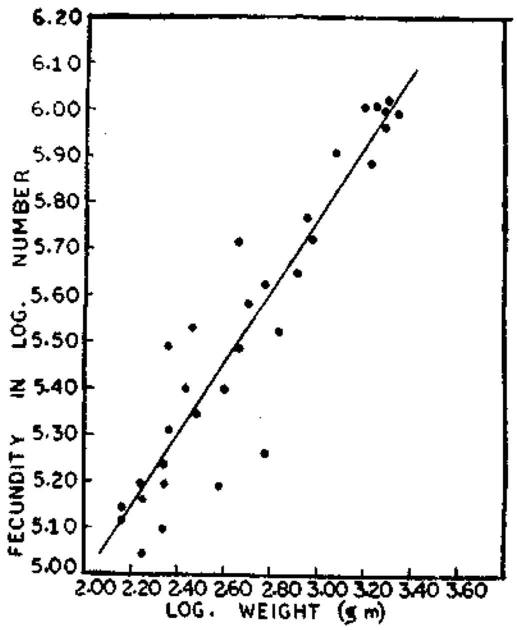

Fig. 6. Fecundity — body weight relationship in *N. albida*.

Detailed studies on the reproductive biology of *N. albida* is not available ; so there is no scope of comparison. However, pertinent literature on the reproductive biology of related species of the family sciaenidae from Indian waters are available (Venkatasubba Rao, 1963 ; Rajan, 1964 ; Annigeri, 1967, Kutty, 1967 ; Appa Rao, 1967 ; Devadoss, 1969 ; Baragi and James, 1980). In *P. diacanthus* the breeding season extends from June to August along the Bombay Coast (Venkatasubba Rao, 1963). Rajan (1964) reported that *P. coibor* breeds in the northern part of Chilka Lake from May to August. The breeding season of *O. rubber* extends from July to October along the Bombay Coasts (Appa Rao, 1967). *J. dussumieri* breeds twice, one in December to January and the other from June to September in Bombay Coast (Appa Rao, 1967). Annigeri (1967) observed that the breeding season of *O. argenteus* extends from October to January at Mangalore. Recently, Baragi and James (1980) reported that the spawning season of *J. osseus* extends throughout the year along the south Kanara Coast. Gopinath (1942) observed that the postlarval forms of *S. albida* along the Trivandrum Coast from November to March.

The multiplicity of modes in the mature ovary of *N. albida* denotes its repeated spawning. The multiplicity of modes of the ovarian eggs in the frequency curves suggest three possibilities :

(1) that either the fish spawn more than once during a spawning period or the spawning season may be a prolonged one and the process of maturation may be continuous.

(2) that the secondary mode represents the eggs which are to be carried over to the next spawning season.

(3) that they comprise eggs which never ripen but will degenerate and be resorbed at the close of breeding season (Clark, 1934).

But in *N. albida* no maturing ova were present in ovaries between two successive spawning interval, hence the possibility of being carried over to the next season can be ruled out. Similarly the percentage of degenerating ova in spent fishes are very low and so the possibility of complete degeneration or resorption of secondary and tertiary modes can also be ruled out. So the first possibility can be taken for granted, but this conclusion disagrees with Clark's (1934) statement that if several groups of maturing ova are present in an ovary, but only one batch of egg is spawned by each female in one breeding season, the number of eggs in maturing group is expected to maintain a constant ratio to the number of eggs in the mature group throughout the entire breeding season. While reviewing the spawning habits of Indian teleosts, Qasim ·(1973) found that along the east coast of India, fishes spawn mostly in pre-monsoon months and along the west coast during the monsoon and post-monsoon periods. The present observation on the spawning period of *N. albida* from the southwest coast of India are in full agreement with the above view.

REFERENCES

ANNIGERI, G. G. 1967. Maturation of the intra-ovarian eggs and the spawning periodicities in the fishes of Mangalore area based on ova-diameter measurements. *Indian J. Fish.*, **10** (1) : 23-32.

APPA RAO, T. 1967. Maturity and spawning habits of some sciaenids in offshore waters at Visakhapatnam. *Ibid.*, **11** (1) A : 121-126.

BAGENAL, T. B. 1978. Fecundity. *In* : T. B. Bagenal (Ed.) *Methods for Assessment of Fish Production in Fresh waters*. IBP Handbook No. 3. Blackwell Oxford. pp. 166-178.

BARAGI M. VIJAYAKUMAR AND P. S. B. R. JAMES 1980. Reproductive biology of Sciaenid Fish *Johnieops osseus* (Day) from the South Kanara Coast. *Indian J. Mar. Sci.*, 9 (1) : 19-24.

* CLARK, F. N. 1934. Maturity of California Sardine (*Sardina caerulea*) determined by ova diameter measurements. *Fish Bull. Sacramento.*, **42** : 1-49.

DE JONG, J. K. 1939. A preliminary investigations of the spawning habits of some fishes of Java Sea. *Treubia*, **17** : 307-327.

DEVADOSS, P. 1969. Maturity and spawning in *Otolithus rubber* (Schn.) and *Johnius dussumieri* (C. and V.). *Indian J. Fish.*, **16** (1 & 2) : 117-128.

GOPINATH, K. 1942. Distribution and feeding of the post-larval fishes of the Trivandrum Coast. *Curr. Sci.*, **11** : 337.

HICKLING, C. F. AND E. RUTENBURG 1936. The ovary as an indication of spawning period in fishes. *J. Mar. Biol. Ass. U.K.*, **21** : 311-317.

HOLDEN, M. J. AND D. F. S. RAITT (Eds.) 1974. Manual of fisheries Science. Part-2. Methods of resources investigation and their application. *FAO Fish. Tech. Pap.*, **115** : Rev. 1 : 224 pp.

*JUNE, F. C. 1953. Spawning of yellow fin tuna in Hawaiian waters. *U.S. Fish. Wildl. Serv. Fish. Bull.*, **54** : 47-64.

KUTTY, M. NARAYANAN 1967. A note on the biology of the 'Koth' *Otolithoides brunneus* (Day). *J. mar. biol. Ass. India*, **9** (1) : 197-198.

LOVERN, J. A. AND H. WOOD 1937. Variations in the chemical composition of herring. *J. Mar. Biol. Ass. U.K.*, **22** : 281-293.

* POLDER, J. J. W. AND J. J. ZIJLSTRA 1959. Fecundity in the North Sea herring. ICES, C.M. 1959. *Doc. hr.*, **84**.

PRABHU, M. S. 1956. Maturatio n of intra-ovarian eggs and spawning periodicities in some fishes. *Indian J. Fish.*, **3** : 59-90.

QASIM, S. Z. 1966. Sex ratio in fish population as a function of sexual difference in growth rate. *Curr. Sci.*, **35** : 140-142.

——— 1973. An appraisal of the studies on maturation and spawning in marine teleosts from the Indian waters. *Indian J. Fish.*, **20** (1) : 166-1881.

RAJAN, S. 1964. The biology and fishery of *Pseudosciaena coibor* (Hamilton) from the Chilka Lake. *Ibid.*, **11** : 639-662.

REYNOLDS, J. D. 1974. Biology of small pelagic fishes in the new Volta Lake in Ghana. Part III. Sex and Reproduction. *Hydrobiologia*, **45** (4) : 489-508.

SIMPSON, A. C. 1951. The fecundity of the plaice. *Fish. Invest. Ministry Agric. Fish. Food* (G.B.) *Ser. Salmon fresh water fish.*, 11 **17** (5) : 1-27.

SNEDECOR, G. W. 1961. *Statistical methods applied to experiments in agriculture and biology.* Allied Pacific Pvt. Ltd., Bombay.

VENKATASUBBA RAO, K. 1963. Some aspects of the biology of 'Ghol' *Pseudosciaena diacanthus* (Lacépède). *Indian J. Fish.*, **10 A** (2) : 413-459.

* YUEN, H. S. H. 1955. Maturity and fecundity of big eye tuna in the Pacific. *U.S. Fish. Wildl. Serv., Spec. Sci. Rep.* **150**, pp. 30.

* Not referred to in original.