

Observations on the Maturation and Spawning of the Brown Pomfret, *Parastromateus niger* (Bloch) in Saurashtra Waters

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(With a plate)

INTRODUCTION

The biology of the Brown Pomfret, *Parastromateus niger* (Bloch), has not been studied so far, though it forms a fishery of considerable importance along all the Indian coast and a major fishery along that of Saurashtra. Our knowledge on pomfrets is very meagre, being restricted to the general accounts given by Chidambaram & Venkataraman (1946), Moses (1947), Devanesan & Chidambaram (1948), and other fisheries reports. Rege (1958) made a preliminary study on the biology of the Silver Pomfret, *Pampus argenteus* (Bloch), in Bombay waters. De Jong's (1939) observations on the spawning habits of *Stromateus niger* in the Java Sea is the only account available on this fish. The importance of biological studies on these fish has been stressed by Gokhale (1960). Detailed studies were, therefore, undertaken on the biology of *P. niger* at Veraval on the Saurashtra coast during 1961-63. The present paper deals with its spawning habits.

MATERIAL AND METHODS

Samples were collected at weekly intervals from the gill-net catches off Veraval. Some representative samples were also taken from Madhwa, Mangrol, and Porbandar. In all 620 fish were examined. Large samples were available during September-November and April-May, when the fish forms a fishery. During other months it is only landed in small quantities, and during June-August fishing is called off because of the south-west monsoon.

The fish were measured, weighed, and dissected. After noting the sex and stage of maturity, the gonads were measured, weighed, and

preserved in 5% formalin for further examination. The spawning habits were studied by direct observation on mature and spawning fish and occurrence of juveniles, as well as by the indirect method of studying the size-distribution of the ova in the ovary. Details of the method of study and the discussions are given in different sections of the paper.

All lengths given relate to fork length unless otherwise stated.

STRUCTURE OF THE GONADS

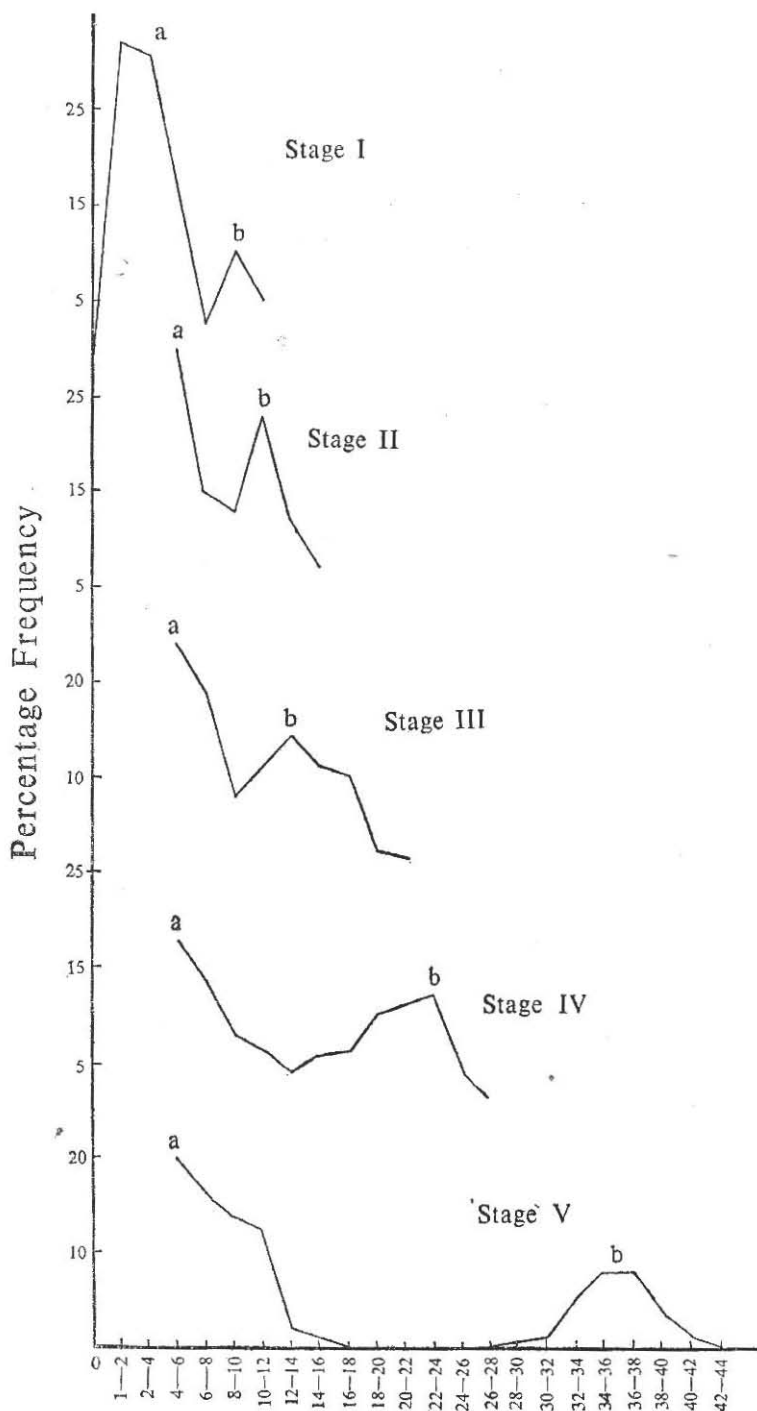
The gonads could be distinguished as ovaries or testes in fish of about 15 cm. and more in length. In fish below this size the gonads take the form of a thin strip of tissue and are indistinguishable. The ovary first becomes apparent as two small, compact lobes, wine-coloured and united at the anterior end, and the testes as two thin, long strips of tissue, white in colour. In both the ovary and the testes, the right lobe is shorter than and about half the length of the left in early stages; they become subequal later. In contrast to the condition found in most perch-like fishes, the lobes of the gonads extend behind the cloaca on the sides of the intestinal coils, so that the gonads open outside at the anterior end. This condition may be the result of the dorso-ventral deepening of the body, characteristic of the pomfrets.

CLASSIFICATION OF MATURITY STAGES

For the study of seasonal changes in the gonad condition, an arbitrary classification of the stages of maturity was made. These stages of maturity, which correspond to the scale adopted by the International Council for the Exploration of the Sea, were based mainly on the diameter and extent of yolk formation in the ova in the case of females, and the presence of milt and the extent of its response to pressure of the testes in the case of males, as followed by Clark (1934) and Bowers & Holliday (1961). They were, however, recognizable externally by such features as colour, shape, and size. The various stages of maturity were defined as follows:

FEMALES

- | | | |
|-------|------|--|
| Stage | I. | Ovaries thin, small piece of tissue, wine-coloured. Microscopic transparent ova, largest ova 0.21 mm. in diameter, not visible to naked eye. |
| Stage | II. | Ovaries with compact lobes, right lobe often shorter than the left, pale yellow in colour. Ova with traces of yolk, largest 0.32 mm. in diameter, visible to naked eye. Includes also recovering spent ovaries which are large, bag-like, and bloodshot. |
| Stage | III. | Ovaries large, yellow in colour. Ova large, semi-opaque, largest 0.42 mm. in diameter. |



Diameter of ova in m.d. (m.d. = 0.021 mm.)

Brown Pomfret, *Parastromateus niger* (Bloch)

Ova-size distribution in various stages of maturity

- Stage IV. Ovaries large, bright yellow in colour. Large ova completely opaque, fully laden with yolk, largest 0.63 mm. in diameter.
- Stage V. Ovaries large and jelly-like, 'speckled' appearance due to large transparent ova. Ova largest, maximum diameter 0.95 mm., still retained inside the follicles.
- Stage VI. Ovaries very much distended, ripe ova shed into the cavity of the ovary and oozing out through the oviduct.
- Stage VII. Ovaries shrunken, bag-like, and bloodshot. A few large ova may be present.

MALES

- Stage I. Testes thin, long strip of tissue, white in colour.
- Stage II. Testes slightly larger in size, compact, right lobe shorter than the left, white in colour. Traces of milt in the central core. Also includes spent-recovering, which are large and hard.
- Stage III. Testes much longer. Transverse grooves and wavy margins appear. Milt is being formed.
- Stage IV. Testes much larger, white in colour, wavy margins and transverse grooves. Milt oozes out when pressed hard.
- Stage V. Testes very long and broad, milky white in colour, turgid due to milt, but not oozing.
- Stage VI. Testes as above, but oozing milt.
- Stage VII. Testes hard, contracted and dull white in colour. Without any milt.

MATURATION AND SIZE-FREQUENCY OF OVA

It is well known that the size distribution of the ova in a teleostean ovary is indicative of its spawning habits. A study of the ova-diameter frequency in the ovaries of *P. niger* was therefore made to show the maturation of ova through various stages and the spawning habits of the fish, on the lines followed by Clark (1934), Hickling & Rutenberg (1936), De Jong (1939), Prabhu (1956), and many others. Samples of ova from ovaries preserved in formalin were spread out evenly on a slide. The diameters of the ova were measured without any selection by means of a micrometer having a magnification of 1 m.d. = 0.021 mm. For determining the exact stage of maturity by the largest ova, only a few ova were measured from each ovary. For the ova-diameter frequency studies, three ovaries from each stage of maturity were taken and 300 to 500 ova were measured from each. Ova below 5 m.d. were disregarded except in stage I, as they were too many and evidently immature. The measurements were grouped in intervals of 2 m.d. and plotted against their percentage frequency. These curves of ova-diameter frequencies are presented in the Plate.

Before going into the details of the study, it is necessary to describe the development of the ova through the various stages of maturity to

spawning. The oocytes take their origin from ovigerous lamellae which project into the ovarian cavity from all sides of the ovary. Several batches of oocytes are produced every season and undergo a remarkable process of maturation, which is accompanied by yolk formation and increase in size. As maturation progresses, the minute clear and transparent ova increase in size and the yolk granules are gradually added, first around the nucleus and then towards the periphery. As yolk formation advances the ova become opaque. Before being spawned, the ova again become transparent and acquire an oil globule which aids in floating on the sea.

Following Walford (1932) and Prabhu (1956), the various stages of development of the ova can be conveniently classified as follows :

1. Immature : Minute, transparent ova with distinct nucleus and clear cytoplasm, up to 0.21 mm. in diameter
2. Maturing : Small semi-opaque ova in which yolk laying has started but is not yet complete, 0.21 to 0.42 mm. in diameter
3. Mature : Large opaque ova, full of yolk, 0.42 to 0.63 mm. in diameter
4. Ripe : Large, transparent ova with an oil globule, about to be spawned, 0.63 to 0.95 mm. in diameter.

The size-distribution of ova in ovaries of stages I to V is plotted in the Plate. In stage I, which is immature, there are only immature eggs extending in diameter from 0 to 12 m.d. with a small mode at 10 m.d. indicating the separation of some eggs. As maturation progresses, this batch of eggs separates from the immature stock, characterized by gradual increase in size and formation of yolk around the nucleus. This batch of eggs is represented by the mode *b* at 12 m.d. separating from the general egg stock, *a*, in stage II. In stage III, this process is carried further forward, with increase in size and yolk formation, and the mode *b* is formed at 16 m.d. In stage IV, the mode *b* at 24 m.d. represents the mature eggs, large, fully yolked, and opaque. Thus, there is only one batch of eggs, distinctly separated from the general egg stock. There is no indication of any other batch of maturing eggs. In stage V, the mature eggs increase very much in size and become 'ripe', transparent with an oil globule. These ripe eggs are represented by the mode *b*, extending from 30 to 44 m.d. and are about to be spawned during this season. All the mature eggs have already become ripe, and a fresh batch of maturing eggs will be produced from the general egg stock probably only after the spawning season.

Thus, in the process of maturation, only one batch of eggs separates from the general egg-stock and undergoes maturation to be spawned during the spawning season. As this single batch of mature ova is distinct from the general egg stock, individuals of this species have a single spawning season in a year, restricted to a short and definite

period. De Jong's (1939) observations on the spawning habits of *Stromateus niger* in the Java Sea corroborate these observations. Data on the distribution of different stages of maturity and occurrence of juvenile fish also prove this view, but the spawning season for the species as a whole is considerably protracted because all the fish do not spawn at the same time.

SPAWNING SEASON AND SPAWNING GROUNDS

The spawning season was also determined by direct observation of the condition of the gonads during different months, and by the occurrence of juveniles. The maturity-distribution of females and males during 1962-63 is given in Table I. The data for 1961-62 give a similar picture and hence are not presented here. —

The Table shows that, among females, early stages I and II occur throughout the period. Mature fish in stages III and IV start appearing in April and continue till November. Ripe fish (stage V) were recorded only in September, but actual spawners (stage VI) were found in September and October. As there was no fishing during June-July, we do not have data for these months. But the occurrence of spent-recovering fish in August indicates that spawning has already started in July. Spawning is continued till October, with the peak of activity in August-September.

Maturity-distribution among the males presents a similar picture. The early stages occur throughout the period. Stages III and IV occurred during April to November. Stage V was recorded in September. Oozing males (stage VI) were not recorded, but spent males were recorded in October. This also suggests that the spawning period extends from July to October.

Although individual spawning is restricted to a short and definite period, as seen from the ova-diameter frequency studies, the spawning period of the species as a whole is protracted over a period of four months.

Juvenile pomfrets first appear in September, and occur in good numbers in the trawl nets during October to December. This corroborates the spawning period determined for the species. The wide range in the size of the juveniles, from 3 to 15 cm., recorded during November is further evidence of protracted spawning.

Mature fish in stage IV or above and also juvenile fish were recorded throughout a 100-mile stretch along the Saurashtra coast from Diu Head (Madhwad) to Porbandar. This indicates that the fish spawn throughout this stretch of coast. A few females in 'running' condition (stage VI) were recorded off Veraval at 15-20 fathoms. The ripe ova which oozed out from them had a mean diameter of 0.83 mm. (range: 0.74-0.90 mm.) and the oil globule 0.22 mm. (range: 0.21-0.23 mm.).

TABLE I

DISTRIBUTION OF VARIOUS STAGES OF MATURITY OF *Parastromateus niger* DURING AUGUST 1962 TO MAY 1963

		Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	
STAGES OF MATURITY	FEMALES	I.	1	..	3	1	44	7	16	1	2	..
		II.	1	1	5	3	1	2	..	5	5	2
		III.	6	7	5	4	..	..	..	..	3	..
		IV.	9	23	15	7	..	1	..	..	4	4
		V.	..	2	..	..	..	..	..	..	..	..
		VI.	..	2	1	..	..	..	..	..	..	..
		VII.	6	12	3	..	..	..	..	..	..	..
	MALES	I.	..	..	5	5	48	7	13	2	2	..
		II.	3	5	3	1	4	6	..	7	14	2
		III.	5	6	6	6	3	5	..	..	6	6
		IV.	2	3	6	6	..	1	..	..	2	2
		V.	..	1	..	..	..	..	..	..	..	..
		VI.	..	..	..	..	..	..	..	..	..	..
		VII.	..	..	2	..	..	..	..	..	..	..

While the adult fish are pelagic in habit, the juveniles appear to be demersal, as they are caught only in the trawl-nets and bottom-set nets.

SEX RATIO

The distribution of sexes in commercial fish landings during 1962-63 is given in Table II. Fish below 15 cm. in length, i.e. indeterminates, were landed in very small quantities. Out of the total 409 sexed, 195 were males and 214 females, showing a more or less equal distribution of the sexes. In the 15-25 cm. group, males and females were more or less equal in number. Males were predominant, about twice as many as the females in the 25-35 cm. group. Females were remarkably numerous, about four times the males, in the next size-group 35-45 cm. In the last size-group, 45-55 cm., there were no males at all. As regards the distribution of the sexes from month to month, females predominated during August to October, during November to March the sexes were more or less equal in number but irregular in their pattern, and during April-May males were predominant.

TABLE II
SEX RATIO IN VARIOUS SIZE-GROUPS OF *Parastromateus niger* IN
COMMERCIAL FISH LANDINGS

—	Size-Groups								Total	
	15-25 cm.		25-35 cm.		35-45 cm.		45-55 cm.		♂♂	♀♀
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀		
1962, Aug.	—		4 : 7		6 : 14		0 : 2		10	23
Sept.	—		9 : 8		6 : 37		0 : 2		15	47
Oct.	1 : 2		19 : 11		2 : 18		0 : 1		22	32
Nov.	5 : 1		12 : 9		1 : 5		—		18	15
Dec.	48 : 44		6 : 1		1 : 0		—		55	45
1963, Jan.	7 : 6		10 : 3		2 : 1		—		19	10
Feb.	13 : 16		—		—		—		13	16
March	—		8 : 2		1 : 4		—		9	6
April	—		23 : 4		1 : 10		—		24	14
May	—		9 : 4		1 : 2		—		10	6
Sex ratio over the total period	74 : 69		100 : 49		21 : 91		0 : 5		195	214

It was pointed out earlier that the fish spawn during July to October. In accordance with some of the classical observations on other species (Van Oosten 1938 ; Nikolsky 1963), in *P. niger* also the males appear to migrate to the spawning grounds earlier than the females, as indicated by their predominance during April-May. During August-October which is the spawning period, females outnumber the males. It is also found that males are predominant over females in the first size group, become less in number in the next group, and are completely absent in the last group.

SIZE AT FIRST MATURITY

The size at first maturity, an important tool in fishery management (Nikolsky 1963), was determined only approximately.

Fish measuring below 15 cm. were indeterminates and those between 15-25 cm. immatures. Unfortunately, enough fish were not available in the group 25-30 cm. as the selectivity of the gill-nets was rather high. Most of the fish landed were above 30 cm. However, the percentages of mature fish in the various centimetre groups during the spawning season were calculated separately for females and males. The length of the smallest fish with spent gonads was determined. From these observations it was concluded that most of the females attain first maturity at 32 cm. and the males at 30 cm.

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SYNOPSIS

The maturation and spawning habits of the Brown Pomfret, *Parastromateus niger* (Bloch), have been studied for the first time. The study was made at Veraval, Saurashtra, where the fish forms a major fishery. The structure of the gonads, and the stages of maturity have been described. The spawning habits were studied by the ova-diameter frequency method, and the distribution of various stages of maturity in time, and the occurrence of juveniles.

The fish has a single, restricted spawning in a year, but the spawning season is considerably protracted because all the fish do not spawn at the same time. Spawning occurs during July to October in the coastal waters off Saurashtra from Diu to Porbandar. The size at first maturity

has been calculated approximately. The sex-ratio in various size-groups during different months is discussed.

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