CONTRIBUTIONS TO THE BIOLOGY OF THE PANGA, *PTEROGYMNUS LANIARIUS* (PISCES : SPARIDAE): AGE, GROWTH AND REPRODUCTION

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ABSTRACT

All the fish used in this investigation were caught by commercial side trawlers along the eastern Cape coast of South Africa. Age and growth of *P. laniarius* was determined from otoliths collected monthly from April 1974 to September 1975. The validity of annuli was proved by monthly edge examination of the otoliths. There is no difference in growth between the sexes. The Von Bertalanffy equation $L_t = 48{,}1\ (1-e^{-0{,}18(t + 0{,}32)})$ was found to describe the growth of the panga in length. Some fish become sexually mature at a total length of 26 cm. Fifty percent maturity is attained at a length of 28 cm, between the ages of 4 and 5 years. All fish are sexually mature at a total length of 32 cm, at an age of 6 years. The spawning season of the panga extends from mid-September to May.

INTRODUCTION

This study forms part of the overall project of the Zoology Department of the University of Port Elizabeth on the ecosystem dynamics of the Algoa Bay area. The panga, *Pterogymnus laniarius* (Cuvier, 1830) is a commercially exploited species of which a mean of 412 $\pm$ 129 metric tons were landed annually at Port Elizabeth during the period 1967 to 1975 (Hecht in press). This constituted approximately 17 per cent of the total annual landings, which makes this species the third most important trawlfish of the South African demersal fleet, not only along the eastern Cape coast but also along the south and west coasts of South Africa (Botha 1970).

No previous attempt has been made to study any aspect of the biology of this endemic fish. As growth, length and age at sexual maturity and reproduction are essential for the understanding of the dynamics of a species, it was deemed necessary to initiate such a study.

Due to the absence of any age and length studies on South African sparids, for growth calculations to be made it was necessary to establish initially whether the rings on the otoliths are formed annually at approximately the same time.

MATERIAL AND METHODS

The trawlers fishing along the eastern Cape coast are all 21 m side trawlers with standard otter trawling gear using nets with the regulatory 110 mm stretch mesh size. Trawling operations took place from Port Elizabeth in the area between Cape St Francis (24° 53,2′ E/34° 11,8′ S) and Bird Island (26° 28,4′ E/33° 52,4′ S), in waters ranging in depth from 54 to 115 m.

The otoliths for age and growth estimates were collected monthly between April 1974 and September 1975. Lengths of fish quoted in this study are all total lengths in centimetres. Both sagittal otoliths were removed from 1297 fish in 2-cm size class intervals. The otoliths were left to clear in a 0,75 per cent solution of NaCl for a period of five days. Ring counts were made from the lateral side, by immersing the otolith in a petri-dish containing xylene and examining it under a stereo microscope at 6 and 12 x magnification. Christensen's (1964) burnt otolith technique was used for otoliths of fish longer than 36 cm total length, as these were too thick to be read otherwise. The number of opaque rings indicated the fish's age in years. Each otolith was given a serial number and read four times at two-week intervals. When three such readings were found to correspond, their validity was accepted. Of the 1297 otoliths examined 96 per cent could be aged successfully. Length data were fitted to the Von Bertalanffy growth equation $L_t = L_\infty(1 - e^{-K(t-t_0)})$.

The number of zones in an otolith is generally accepted as representing the age in years of a fish. This is only valid if one set of rings is laid down each year, in which case the zones may be considered annual. The nature of the marginal area of the otoliths was, therefore, examined monthly, when the presence of either an opaque or hyaline zone was noted.

The length and age at sexual maturity of the panga was established by a macroscopic examination of the gonads after the various stages of seasonal activity had been identified (Hecht 1976). For the latter purpose Hjort's seven-stage International Maturity Scale taken from Ehrenbaum (1930) was used. Minor modifications were made to the International Scale as gross morphological differences were observed between the gonads of the herring, *Clupea harengus*, used by Hjort, and the panga.

Fish which had gonads in Stages I and II, i.e. immature and quiescent, were included in immature. Those fish with gonads in Stages III to VII, i.e. active; active/ripe; ripe; spawning and spent were regarded as being sexually mature. To eliminate possible error these data were only collected during the peak period of gonad activity.

The breeding season as well as the spawning period were determined by three methods.

1. By a monthly visual appraisal of the gonad activity stages (Komarov 1964; Sahrhage 1970; baird 1974).
2. By determining the gonosomatic index (GSI), i.e. gonad mass/body mass relationship, on a monthly basis (Nikolsky 1963; Van der Horst 1976).
3. By calculation of a monthly condition factor (Fulton 1902; Geldenhuys 1973).

To avoid the possible masking effect which immature fish could have on the results, only those fish larger than the determined length at 100 per cent maturity were used for this investigation.

A sample of 50 to 80 fish per month was measured for total length and mass to the nearest g and mm. Fish mass was taken as the mass of the fish minus the gut contents. Gonads were removed, non-reproductive tissue trimmed away and the remainder weighed to the nearest 0,01 g. From these data the above indices could be calculated. The gonads were also classified into one of the three stages: active, ripe or spent.

RESULTS AND DISCUSSION

Otolith zonation.

The frequency occurence of hyaline and opaque margins and the number of otoliths examined monthly are illustrated in Figure 1. From this figure it is evident that there is a definite seasonal variation in the formation of opaque and hyaline margins.

Opaque zone formation takes place from August to May, i.e. during the summer months, and the hyaline zones are laid down from April to July, i.e. during the winter months. The nuclei of the panga otoliths were all opaque.

Growth calculations.

In order to investigate the possibility of a difference in growth rate between the sexes, the mean observed length at age of a random sample en each age group of both males and females was tested statistically by means of the Student t distribution test. The results (Table 1) showed no significant difference in the growth rate at the one per cent level.

Table 2 shows the mean observed length at age as well as the annual length increment. The observed length at age data were fitted to the Von Bertalanffy equation, which for this species was found to be

$L_t = 48{,}1\ (1 - e^{-0{,}19\ (t + 0{,}82)})$. The calculated length at age is also shown in Table 2 and the growth of the panga is illustrated in Figure 2.

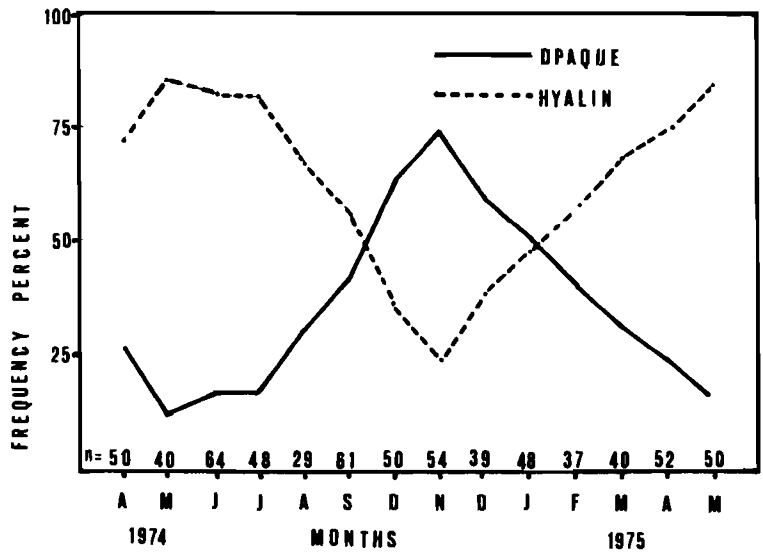

FIGURE 1

Seasonal changes in the marginal character of otoliths.

TABLE 1

Test of significance between the mean length at age of male and female panga.

Level of significance: ++ = P < 0,01

Age Years	Males			Females				
	$\bar{x}$(cm)	n	S.D.	$\bar{x}$(cm)	n	S.D.	d.F.	t
1	26,5	2		26,8	29	2,3	29	1,674++
5	29,9	27	2,4	30,1	30	3,6	55	0,573++
6	31,8	29	2,0	32,5	29	2,5	56	0,703++
7	34,9	30	3,8	35,9	30	2,2	58	0,712++
8	37,2	28	2,6	37,2	27	1,2	53,	0,315++
9	38,9	30	3,7	39,2	30	1,7	58	0,846++
10	40,9	30	2,5	40,7	30	2,3	58	0,726++
11	41,9	14	0,89	42,1	30	4,5	42	0,361++

TABLE 2

Mean observed and calculated length at age of the panga in cm.

Age Years	Observed length	S.D.	Length increase	Calculated length
3	22,46	1,71		20,16
4	25,83	3,50	3,37	24,10
5	29,50	4,88	3,67	27,52
6	32,09	4,02	2,59	30,49
7	34,90	3,81	2,81	33,06
8	36,49	4,95	1,59	35,29
9	38,07	4,01	1,58	37,23
10	41,29	3,32	3,22	38,91
11	42,18	4,10	0,89	40,40

Reproduction

i. *Sexual maturity.*

During the period September to May the gonads of 796 fish were examined (Figure 3). It becomes evident that some fish approach maturity at a total length of 26 cm. More than 50 per cent of the fish reach sexual maturity at a total length of 28 cm, i.e. between the ages of four and five years. One hundred per cent maturity is attained at a total length of 32 cm, i.e. when the fish are about six years of age.

During the investigation it became evident that the panga is a protogynous hermaphrodite in which about 30 per cent of the population undergoes prenuptual sex reversal (Hecht 976). This may be one of the possible reasons for the seemingly high age at sexual maturity.

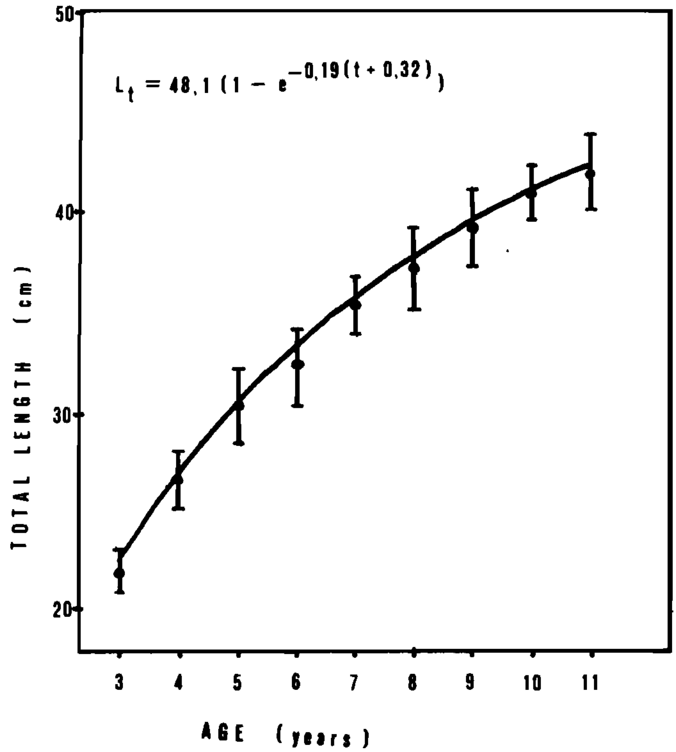

FIGURE 2
Growth in length of *Pterogymnus laniarius*.

ii. *Reproductive seasonality.*

Figure 4 illustrates the trends, on a monthly basis, from April 1974 to September 1975 of the condition factor (CF) and the separate GSI values for the males and females.

From the female GSI curve it appears that the breeding season extends from mid-September to May, i.e. spring to late summer. The condition factor is a poor indicator of the breeding season of this species. It does, however, follow the expected trend, i.e. it is low during the period of high reproductive activity and vice-versa (Botha 1971). The breeding

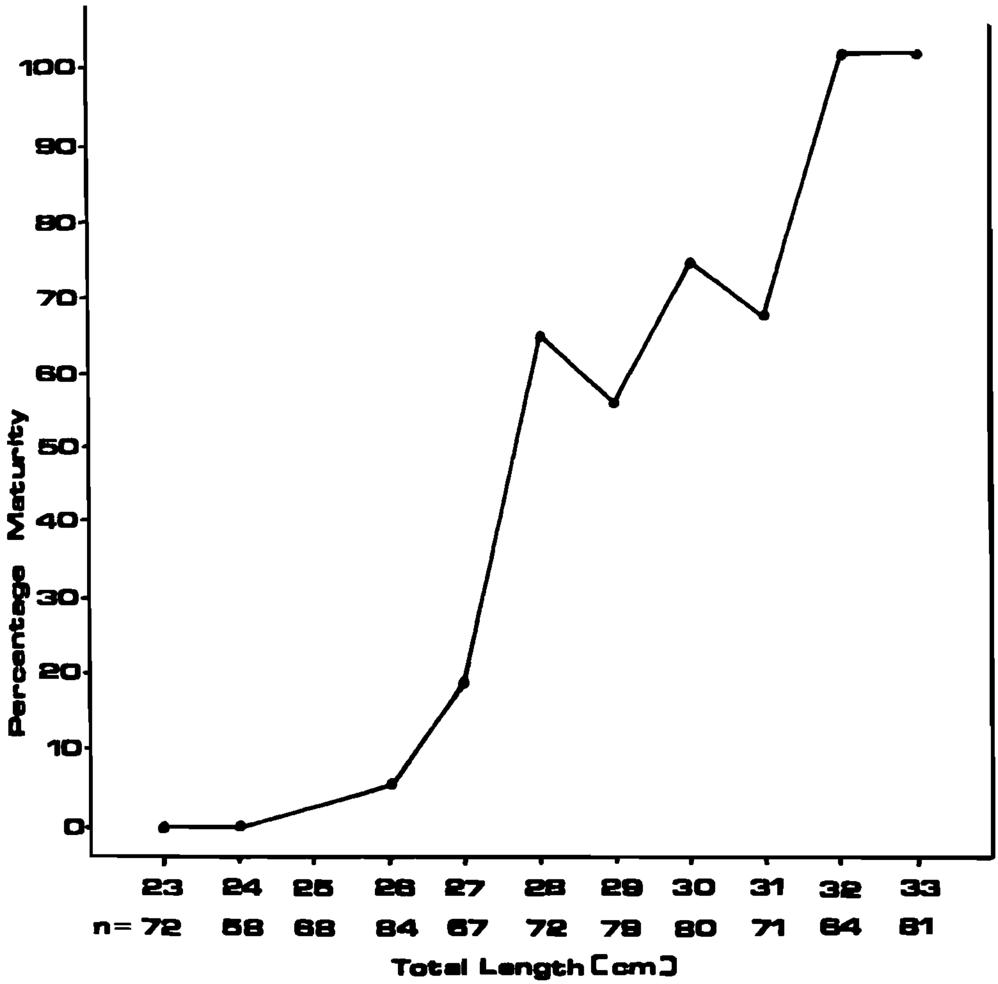

FIGURE 3

Length at sexual maturity (n = 796).

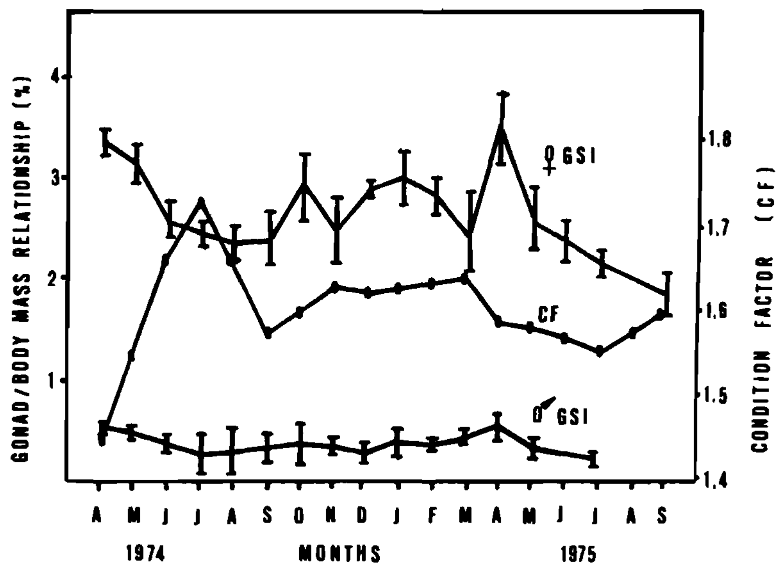

FIGURE 4
Monthly GSI and condition factor values of *Pterogymnus laniarius* (vertical bars indicate standard deviations).

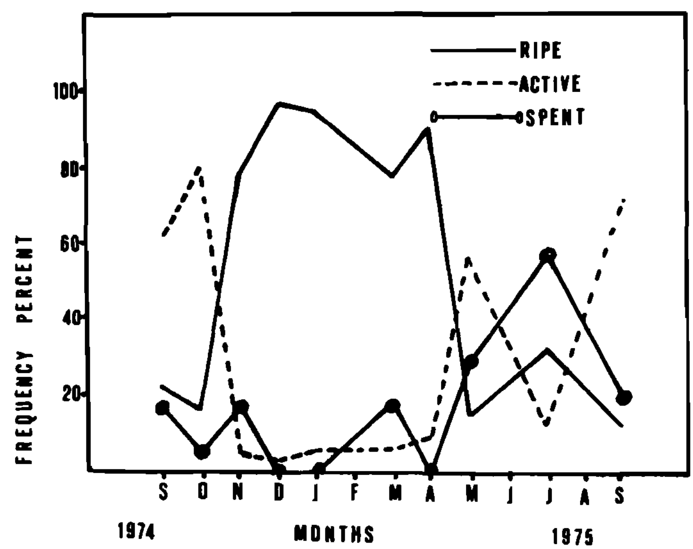

FIGURE 5
The frequency occurrence of ripe, active and spent ovaries from September 1974 to September 1975.

season as inferred from the female GSI curve is supported by the trend followed by the male GSI curve. Moreover, the same breeding season is shown by the data illustrated in Figure 5, from which an increase in the frequency of ripe ovaries is evident during October. The high frequency of ripe ovaries is maintained during the subsequent months until May, whereafter the frequency returns to the pre-October values. The low frequency of active ovaries during this period further substantiates the postulated breeding season of the panga.

From the data available at present it appears that spawning takes place more than once during the relatively long breeding season. The incidence of ripe ovaries, shown in Figure 5, gives a clear indication that spawning commences in April/May and recovery takes place in October.

The possible existence of more than one spawning period can be partly supported by evidence obtained from measuring the ova and oocytes at the start of the breeding season. The ovaries of 40 randomly collected mature fish were removed, given a longitudinal incision, turned inside out and fixed in Gilsons fluid (Simpson 1951). They were then treated according to the method documented by Pitt (1964).

On macroscopical examination of the material four distinct size groups of ova and oocytes were recognized. A subsample of 150 to 200 ova and oocytes of each size group was measured, whereupon the material could be divided into the various histologically determined stages of oocyte development (Hecht 1976) (Table 3). Although the rate of development from the yolk vesicle stage to the ripe ova stage is not known it would seem unlikely that ova and oocytes in Groups A, B and C are all spawned simultaneously. It is suggested that Group C oocytes are released at a later stage than Group A ova during the same year's breeding season. Group D oocytes probably form the recruitment stock of oocytes for the following year's breeding season. Baird (1974), using the above technique, established the South African mackerel, *Scomber japonicus*, to be an asynchronous spawner. More detailed work is, however, at present being carried out to determine with greater accuracy the spawning frequency of the panga.

TABLE 3

Size measurements of four oocyte groups of the panga and their grouping into developmental stages.

Group	*n*	*Size (μ)*	*Stage*
A	179	790–1150	Mature yolk stage and ripe ova
B	200	394–760	Secondary and tertiary yolk stage oocytes.
C	164	200–351	Yolk vesicle to secondary yolk stage oocytes.
D	181	98–174	Late-perinucleolus and yolk vesicle stage oocytes.

Finally considering the following evidence:
1. the opaque nuclei of the otoliths,
2. the time of opaque zone formation in November,
3. the high frequency occurrence of ripe ovaries in December, and
4. the high GSI values during this period,

a "birthdate" of 1 January is suggested for this species.

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