

PRAWNS OF GOA WITH A NOTE ON THE BIOLOGY OF
PARAPENAEOPSIS ACCLIVIROSTRIS (ALCOCK)

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ABSTRACT

Discarded fractions of the commercial landings along the coasts of Goa were found to contain both young ones and adults of several species of prawns | shrimps which seldom figure either in the catch statistics or among the component species taken to constitute the catch. Observations spread over a period of 8 years (1971-79) record the presence of about 28 species of prawns|shrimps in this territory, and these are listed.

Specimens of *Parapenaeopsis acclivirostris* (Alcock) were obtained regularly, though in very small numbers, from 25- to 45-meter depths during the period December 1972 to May 1973, based on which some preliminary observations on the biology of this species are also presented.

A preliminary study on the small prawns discarded from the commercial catches obtained from the inshore as well as the estuarine areas of Goa revealed the presence of both young ones and adults of several shrimps|prawns which normally do not figure in the recorded landings of Goa. As this study was found quite useful in evaluating the faunistic richness of the region, a thorough investigation in this line was undertaken at some selected centres along the coast of Goa as a part of the "All India co-ordinated study on prawn biology and resources" initiated in Goa during 1970. Samples thus collected over a period of about 8 years (1971-1979) have been analysed, and the species of prawns | shrimps found to occur are listed at the end of note.

A few specimens of *Parapenaeopsis acclivirostris* (Alcock) were noticed during December 1972 while analysing the trawl catches made from depths varying between 25 and 45 meters. Subsequent regular examination of trawl landings, especially from the above depth zone, showed the presence of both males and females of this species in stray numbers for a period December 1972 to May 1973. As no details on this species exist besides Alcock (1905), which gives the first description of the species based on 34 females collected from the coasts of India and the Persian Gulf, the discovery of its male from Bombay

(Kunju 1960) and some observations on the laboratory spawning and early development of its larvae (Thomas et al 1974), the few observations made on the biology of this species are briefly recorded here,

A total of 565 specimens (females 527, males 38) were collected during the period December 1972 to May 1973. The males were extremely rare in the samples, the percentage being 5.5 in December, 12.3 in January, 9.1 in February and March, nil in April and 4.3 in May. Petasma was fully developed in all the males, indicating sexual maturity.

The total length (from the tip of telson to tip of rostrum) of females ranged from 26 to 65 mm and that of males from 21 to 35 mm; indicating differential growth in the sexes.

Females measuring 51 mm and above dominated during December to January, with modal peak at 51-55 mm size group. Thereafter smaller size groups dominated in the catches with modes at 46-50 mm during February, April and May and at 41-45 mm in March. In the case of males, the size group 31-35 mm was dominant almost throughout the period of its occurrence except during February, when 26-30 mm size group dominated.

The smallest female with early maturing ovary measured 30 mm. Even though late-maturing and mature females were rather common in all size groups above 51 mm in December with a peak at 56-60 mm, no spent females could be noted during this month. But this condition changed by January, when about 26% of the total females measuring above 51 mm were in spent condition. But gradually the spent females measuring above 51 mm declined in number, and by March only 7% of them were in this condition. During April, however, there was a sudden increase in the percentage of spent females (16%), and all of them belonged to smaller size groups, viz., 46-55 mm, with a mode at 46-50 mm. After April the size group 46-55 mm gradually decreased, as had happened in the case of females measuring above 51 mm during January to March period, and by May there was no trace of these size groups in the trawl catches, they being now replaced by smaller females of 36-40 mm size group with about 5% in spent condition. Examination of samples obtained from the same depth during end of May to middle of June, however, was futile as no specimen of *P. acclivirostris* could be located. Investigations carried out to find whether these were available in shallower areas off Goa proved futile, too, indicating the possibility of their migration to other areas. There is every likelihood that the species congregate at this particular depth zone for breeding, and afterwards disperse to deeper zones. Whether they disperse singly or in groups is a matter of conjecture, but the discovery of a single large female from the deeper waters (15-20 fathoms) off Sassoon Docks, Bombay (Kunju 1960), may suggest that they disperse singly.

Trawling operations start in Goa during September and last up to the middle of June or till the monsoon intensifies. The central zone of Goa, i.e., off Calangute, especially the depth zone ranging from 20 to 40 m, is found to be more productive, as over 25% of the total catch from this zone is composed of prawns (Prabhu and Dhawan 1972). So, no sooner the season commences than there is considerable fishing in this zone. But, examination of discarded prawns from the trawlers during September to November did not reveal the presence of *P. acclivirostris*. The sudden appearance of both males and females of this species in the depth zone 25-45 meters by December and their total disappearance by May from this zone are hence noteworthy.

The number of males in the samples, compared to that of the females, is quite negligible. Alcock's (1905) material comprised only 34 females, collected from Madras, Ganjam coast, Visakhapatnam, Palk Strait and the Persian Gulf. But later, Kunju (1960) collected males from the dol net catches made off Sassoon Docks, Bombay, at depths of 6-7 fathoms. Out of the 19 specimens he had collected, 9 were males, with the size range of 26-46 mm, and the largest female measured 58 mm (the maximum size noted in the present collection is 65 mm).

The sudden appearance of larger females with ovary in different stages of maturity, the occurrence of larger females with spent ovary after a few months of their first appearance and the gradual shifting of modes of female with spent ovary from larger size group to smaller size group as the season advances are some of the interesting aspects of biology observed of this species during the present study.

The various species of prawns |shrimps from Goa that were recorded during the study are:- (1). *Solenocera crassicornis* (H. Milne Edw.), 2. *Penaeus monodon* Fab., 3. *P. canaliculatus* Oliver, 4. *P. indicus* H. Milne Edw., 5. *P. merguensis* de Man, 6. *Metapenaeus monoceros* (Fab.), 7. *M. affinis* H. Milne Edw., 8. *M. brevicornis* (H. Milne Edw.), 9. *M. dobsoni* (Miers), 10. *M. burkenroadi* Kubo, 11. *Parapenaeopsis stylifera* (H. Milne Edw.), 12. *P. hardwickii* (Miers), 13. *P. acclivirostris* (Alcock), 14. *P. cornuta* (Kishinouye), 15. *P. maxillipedo* Alcock, 16. *Parapenaeus longipes* Alcock, 17. *Metapenaeopsis mogiensis* (Rathbun), 18. *Acetes indicus* H. Milne Edw., 19. *A. sibogae sibogalis* Achuthankutty and George, 20. *Palaemon (Nematopalaemon) tenuipes* (Henderson), 21. *P. (Exopalaemon) styliferus* H. Milne Edw., 22. *P. (Palaemon) pacificus* (Stimpson), 23. *P. (Palaemon) sewelli* (Kemp), 24. *P. (Palaemon) semmelinkii* (de Man), 25. *Leptocarpus potamiscus* (Kemp), 26. *Macrobrachium rosenbergii* (de Man), 27. *M. idella* (Heller) and 28. *Hippolytina ensirostris* Kemp.

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the first year and 288 mm the second year (Zafar Khan 1985). As the young ones are fully represented in the catch, the instantaneous total mortality rate 'Z' is calculated employing the formula:

$$Z = -\log_e \left(\frac{N_{t+1}}{N_t} \right) \quad (\text{Ricker..... 1975})$$

The total mortality coefficient estimated are 2.655, 2.939 and 2.443 for the years 76-77, 77-78 and 78-79 (Table 2). Z is also estimated by Cushing's (1968) model:

$$Z = \frac{\ln(N_{t+1}) - \ln(N_t)}{T_{\max} - T_{\max-1}}$$

where N_t is the number of one-year-old fish and $N_{T_{\max}}$ the number at maximum age of fish in population. Estimated by this method, Z varied between 2.018 and 3.06. Though there is a small difference between the values of Z, the average of both are more or less same.

TABLE 1. *Estimated fishing effort and catch and catch per haul at Nawabunder during 1976-77 to 1978-79.*

	Effort No. of hauls	Catch in tonnes	CPUE in kg.
1976-77	37,108	4700.5	126.7
1977-78	43,840	2690.6	61.4
1978-79	56,972	3291.9	57.8
Average	45,973	3661.0	77.4

TABLE 2. *Estimated mortality rate at Nawabunder during 1976-77 to 1978-79.*

	Estimated CPUE of 0 year	Estimated of 1st year	Z (Ricker's model)	Z (Cushing's model)
1976-77	14,085	1054	2.655	3.06
1977-78	6,494	348	2.939	2.018
1978-79	4,579	429	2.443	2.337
Average	8,386	610	2.679	2.472

In the absence of positive linear relationship between Z and effort, estimate of natural mortality (M) is not possible using $Z = M + qf$. Therefore, M is estimated by Cushing's model (1968), wherein the unexploited state, if the number of one-year-olds is taken as 100 and number surviving to an age of 3.918 (NT_{max}) years as 1, is:

$$M = \frac{1 - e^{-TM}}{3.918 - 1} \cdot \frac{100}{1} = 1.575$$

T_{max} has been calculated as per Pauly's (1980) formula as follows:

$$K + t_0$$

where $K = 0.761$ and $t_0 = -0.024$ month (see Zafar Khan 1985).

Recently, Pauly (1980a) has shown a correlation between M , K , and T (average annual temperature at the surface). When this is applied to the present data ($K = 0.761$, $U = 367$ mm and $T = 26.5^\circ\text{C}$) thus:

$$\log M = -0.0066 - 0.279 \log U + 0.6543 \log K + 0.4634 \log T,$$

the M arrived at is 0.631.

M is also estimated as follows by the formula of Taylor (1958):

$$M = 2.9957/TM$$

where, TM is maximum age (3.918 years for *H. nehereus*) and M is found to be 0.764.

Rikhter and Effanov (1976) showed a close association between M and t_m or t_{m50} , where t_m is the age at first sexual maturity and t_{m50} the age at which 50% of the population is mature, also called by Rikhter and Effanov "the age at massive maturation". They demonstrated a hyperbolic relation with the equation:

$$M = 1.521 / (t_{m50})^{0.72} - 0.155$$

In the case of bombayduck t_m and t_{m50} are estimated as 202.5 and 266, respectively. So M may vary between 1.285 and 0.874.

Two sets of estimates are thus possible for M , one varying between 0.631 and 0.874, which is close to k , and the other between 1.285 and 1.575, which is almost twice k . *H. nehereus* has been observed to be highly cannibalistic, its own youngones forming a major food component (Zafar Khan, MS). Therefore 1.575, though a relatively high value, may nevertheless be a realistic estimate of M for the unexploited phase.

Independent estimate of Fishing mortality (F) is also made from exploitation rate (u), as the survival rate (S), size at first capture (Lc) and mean size (L) of fish above Lc are known (Allen 1953).

$$\text{Thus: } U = \frac{F}{1 - e^{-Z}} = \frac{F}{1 - S} = EA$$

where, $1 - e^{-Z} = 1 - S = A$.

The minimum length fully represented in the catch is considered to be the length at first capture (Lc) (Alagaraja 1984), which is 52.5 mm in the present case, as a primary mode at this length is present in most of the months. The mean lengths of the fish above Lc are 122.7, 121.3 and 129.5 for the period 1976-77, 1977-78 and 1978-79, respectively. Estimated F and u are given in Table 3. Based on these estimates, M is also estimated for the exploited phase which varies between 1.358 to 1.595. Average natural mortality coefficient for the period is 1.462. Thus it can be seen that the average annual standing stock of bombayduck off Nawabunder during 1976-77 to 1978-79 is 2926.0 tonnes.

TABLE 3. *Estimation of stock (in tonnes) of bombayduck during 1976-77 to 1978-79.*

Year	Z	M	F	Exploitation rate U	Catch Y	Annual stock Y U	Average stock Y F	MSY
1976-77	2.655	1.433	1.222	0.428	4700.5	10982.5	3846.6	5106.4
1977-78	2.938	1.595	1.343	0.433	2690.6	6213.8	2003.4	2943.0
1978-79	2.443	1.358	1.085	0.405	3291.8	8127.9	3033.9	3705.9
Average	2.679	1.462	1.217	0.422	3561.0	8438.4	2926.0	3918.4

An approximate estimate of maximum sustainable yield is made by using the equation proposed by Gulland (1979):

$$\text{MSY} \sim \text{PY} - Zt.0.5 \text{ Bt.}$$

Where Zt is the exponential rate of total mortality (= F + M) in the year t and Bt the standing-stock size in the year. It is evident from the table 3 that MSY varies between 2,943.0 t and 5,106.4 t. The average MSY is 3,918.4 t when the average yield at Nawabunder has been 3,561.0 t, indicating that the level of fishing for bombayduck in this region is rightly around the MSY.

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