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SOME OBSERVATIONS ON THE BIOLOGY AND FISHERY OF THE BANANA PRAWN *PENAEUS MERGUIENSIS* DE MAN OFF ORISSA COAST*

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ABSTRACT

In the context of a hatchery programme for the penaeid prawns, some aspects of the biology of *Penaeus merguiensis* along the Orissa Coast were studied over a three year period (1983-1985) and are presented in this paper. This species is caught both by mechanised boats (trawlers) and the artisanal craft, the catamarans. Postlarval or juvenile population of this prawn were not recorded so far in any of the estuarine creeks or even in the outer channel of the Chilka Lake. Length frequency distribution of the adult prawns sampled from offshore catches showed that generally females exhibited two modes and males one mode in most of the months, during August 1984 to July 1985. The length-weight relationship calculated for females was found to be log W = −4.6612 + 2.8239 log L. This prawn was found to exhibit strong schooling movements and was active during day and night as exemplified by its catch in trawlers as well as catamarans. The size of the smallest observed mature female was 132 mm. The mean sex ratio of males to famales was 1 : 1.5. Fully mature females were available from May/June to February/March with peak during July-August and November. Successful attempts have been made in developing hatchery techniques for this species based on the knowledge of its biology.

INTRODUCTION

THE BANANA PRAWN *Penaeus merguiensis* De Man, originally considered as a variety of *Penaeus indicus* (Alcock, 1906), is a species of considerable importance in the penaeid prawn fishery off Orissa Coast, India. This species is of commercial importance along the Indian coastline only off Orissa (East coast) and Karwar (West coast). In the general world-wide distribution it is confined to the Indo-Pacific area between longitude 67°E to 166°E and latitude between 25°N to 29°S (Holthuis and Rosa, 1965 ; Kirkega ard *et al.*, 1970).

Elsewhere in the world, the major fishery occurs off the Australian waters in the Gulf of Carpentaria where extensive studies have been made (Dall, 1957 ; Tuma, 1967 ; Hindley, 1975 ; Kirkegaard, 1975 ; Munro, 1975 ; Gwyther, 1980 ; Staples, 1980).

Because of the high contribution (60-70%) of this species to the penaeid prawn fishery off the Orissa Coast and lack of any prior study on this species in India, an attempt is made to study the population, its biology and fisheries. This study is also useful in the context of developing a suitable hatchery technology for this species.

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Material and Methods

The basic characters measured for studying the biology were carapace length (CL) (from eye-notch to mid-dorsal carapace edge), total length (TL) (from tip of rostrum to tip of telson) and total weight (measured to the nearest 0.1 g). These data were taken from samples obtained from trawlers as well as catamarans during 1983-1985. Observations on seasonal distribution, sex-ratio, maturity and spawning and fishery were made simultaneously when length-weight data were obtained from samples of trawler and catamaran catches. However, for length frequency distribution data from trawl catches alone were used. Maturity was recorded on the basis of stages already delineated by earlier workers (Rajyalakshmi, 1961 ; Rao, 1968). The catch effort statistics in general were not obtained in this study, because they are being regularly recorded by the concerned organisations. The data given in the reports (Anon., 1982 ; 1983 ; 1986) are however, used to support or interpret the other observations in this study.

For the study on juvenile distribution, commercial drag-net samples from the outer channel of the Chilka Lagoon and the catches received at ice plants were regularly scrutinized. The standard fry collection net (shooting net) operations were conducted during October-January at the mouth of the Chilka Lagoon during 1983-1985 at one place *i.e.* at the 1 m depth zone near the shore line during rising high and receding low tides and once in a continuous 24 hour operation to study the postlarval recruitment and distribution.

The sampling places in general are as follows :

Estuarine phase

Chilka Lagoon, Ramachandi Lagoon, Mahanadi estuarine complex, Rushikulya Estuary, Bahuda Estuary, Bado Noi Estuary (Fig. 1).

Inshore and offshore phase

(5 m - 40 m depth) Catamaran catches at Puri and Paradip. Trawler catches off Paradip, Astharang and Ramachandi (Fig. 1).

Hydrological conditions off the Orissa Coast

The Orissa coastline (480 km in length) extends from 19°06'N to 21°36'N latitude and 84°36'E to 87°30'E longitude. The coast is bisected with a number of creeks connected to the Mahanadi and the Brahmani River systems (Fig. 1).

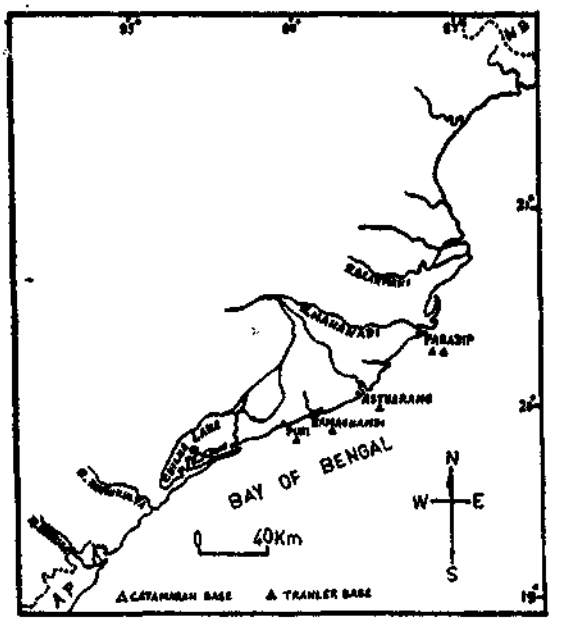

Fig. 1. Coastline of Orissa showing survey and sampling areas.

The waters of the Bay of Bengal are subjected to two important influences. Firstly, several major rivers carrying large amounts of silt-

laden waters empty into the Bay of Bengal. Secondly, the northeast and southwest monsoon set up 4 distinct patterns in the movements of the surface waters of the Bay during different months of the year (LaFond, 1954). Orissa Coast lies mid-way in this opposing current systems and carries the maximum amount of turbid waters that emanate from the Hooghly Estuary and the Mahanadi complex. It was shown (Rao, 1958) that during the months of November-December the waters are uniformly transparent along the east coast of India. This period also corresponds to the season of maximum prawn landings off Orissa Coast.

Results

Population study

P. merguiensis is caught both by trawling and non-mechanised gill-netting, sometimes in the shallow 10 m zone and extending to a depth of 40 m. Both types of fishing are discontinued when strong winds start blowing from March with strong wave causing entanglement of nets. This suspension of operation extends upto June for trawlers. Therefore for this period there is no exploratory or other type of study to prove if there are any deeper water concentrations of the species in the offshore waters.

Operations of the shooting net revealed the absence of postlarvae in the backwaters or in the outer channel of Chilka Lagoon. Even juveniles below 80 mm were rarely encountered. This fact is further confirmed by the absence of any commercial fishery for marketable sized prawns of this species in the Chilka Lagoon.

Length frequency distribution

The length frequency distribution of females of *P. merguiensis* is shown in Fig. 2 a, for the period from August 1984 to July 1985. The female prawns showed two modes in most of the months. In August 1984, the mode was at 165 mm and this mode remained in most of the succeeding months in 1984 and 1985 (Fig. 2 a). The mode shifted to 225 mm in September and in October it reverted to 175 mm and reached 165 mm in November and remained stable in January 1985 indicating entry of new recruits into the fishery. Sampling could not be done in December. The mode once again moved to 175 mm in February

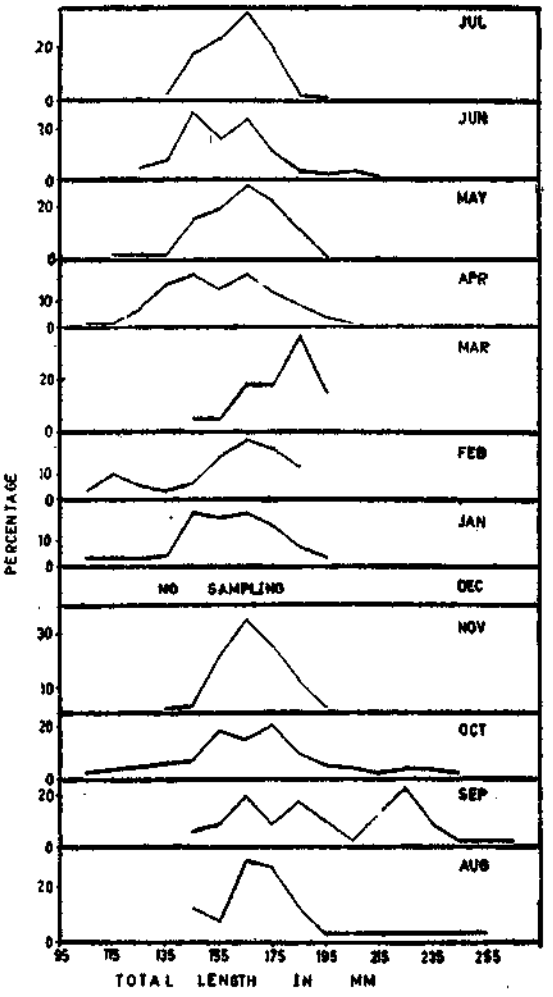

Fig. 2 a. Length frequency distribution of *Penaeus merguiensis* during August 1984 to July 1985 : Female.

and 185 mm in March. Once again new recruits entered the fishery when the length frequency distribution showed a mode at a

smaller length of 165 mm in April and this mode was maintained in May and July. However, in June the length frequency polygon showed a mode at 145 mm.

The length frequency distribution of males is shown in Fig. 2 b. The male prawns showed one conspicuous mode in most of the months except in February and March 1985 when two modes were seen and in April three modes

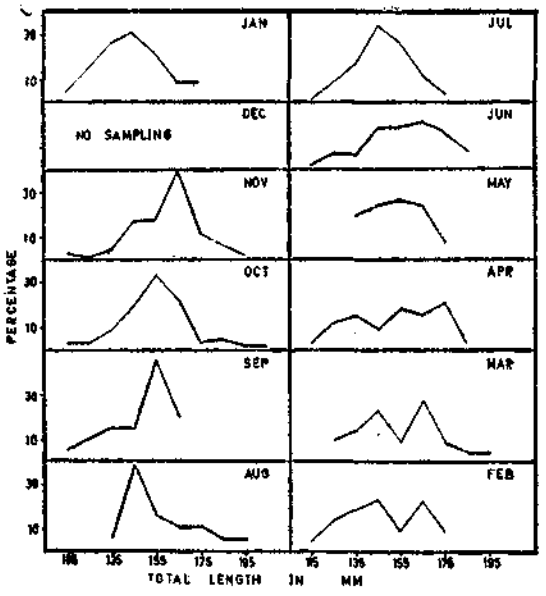

Fig. 2 b. Length frequency distribution of P. *merguiensis* during August 1984 to July 1915 : Male.

were noticed. The mode at 145 mm in August 1984 progressed to 155 mm in September and remained at that size in October. This further moved to 165 mm in November. The single mode at 145 mm seen in January 1985 was also seen in February in addition to another mode at 165 mm. These two modal sizes remained unchanged in March, but advanced to 155 mm and 175 mm in April. The mode at 155 mm remained in May and shifted to 165 mm in June. In July the modal value was 145 mm as in August of the previous year indicating entry of new recruits into the fishery.

Growth rate and life span

The total length recorded from sampling of both trawler and catamaran catches (Fig. 2 a, b) indicated a single peak at 165 mm/45g throughout the season of peak capture. However, the length frequency distribution shows a peak at 180 mm at the maximum length. This picture indicates a short life span of the species.

Basically then, the small size group at 95 mm to 110 mm enter the capture fishery from April onwards and dwindle by July-August. The larger size groups take over from July and continue to dominate the fishery till March of the following year *i.e.*, through summer to monsoon and winter the size group distinction is of the order of ± 10 mm indicating every little variation in the rate of growth. But the maximum difference in size occurs in March entry into the population and constant migration as well. But the population as a whole retains this structure.

The juvenile phase

A distinct *P. merguiensis* juvenile population has not been identified or detected in any of the adjacent nursery areas along the coast of Orissa so far. Dall (1957) has shown that there is a distinctively long rostrum in juvenile phase which progressively shortens with age. Because a similar elongated rostrum occurs in *P. indicus* as well at this phase, it is possible that this phase has not been recorded properly in the collections made from tow nets or drag nets. Alternately, there is also the possibility of the species having no inland nursery areas along this coast line due to the type of hydrological environment of the Orissa Coast.

The immature groups

Commencing from March-April onwards the immature size groups are captured in the inshore coastal waters in the gill nets operated by the catamarans. The size groups vary from 80 mm to 120 mm. This operation

is confined to a shallow zone of 5-10 m during day time.

These size groups are rarely seen to have any mature ovaries. The smallest size where a greenish ovary was recorded is at 132 mm, in the shallow region. Later, by July and progressively through winter, those that go into deeper waters at 30-40 m and are captured by the trawlers as well as catamarans, the percentage of females with ovaries in different maturity stages increases as also that of spent females.

Length-weight relationship

The length-weight relationship of the female *P. merguiensis* confirms to the general formula.

$$W = aL^n \text{ or } \text{Log } W = \log a + n \log L$$

The logirithmic values of observed lengths and corresponding weight were plotted and the straight line fitted (Fig. 3). The equation obtained was as follows :

$$\text{Females : } \log W = -4.6612 + 2.8239 \log L$$

Behavioural characteristics and schooling

Comparing the catches taken during day and night operations of trawlers and the early morning to mid-day operation of catamarans, it is evident that the immature adults and mature adults as well are equally active during day or night. This is in distinct contrast to the tiger prawns *Penaeus monodon*, *Penaeus semisulcatus* and *Penaeus japonicus*, the larger sizes of which are predominantly captured from night operations, from depths greater than 25 m whereas immature adults occurred inshore in 10-15 m probably on their migration towards deeper waters.

The study of catch compositions throughout the season suggested a strong schooling movement of adult *P. merguiensis*. While immature adults appear to be much dispersed along the shoreline as seen from the too few a number captured in each catamaran gear in the near shore waters, the deep water trawls brought in dense quantities of either *P. indicus* or *P. merguiensis*. This suggests segregation of species and schooling in the same fishing ground.

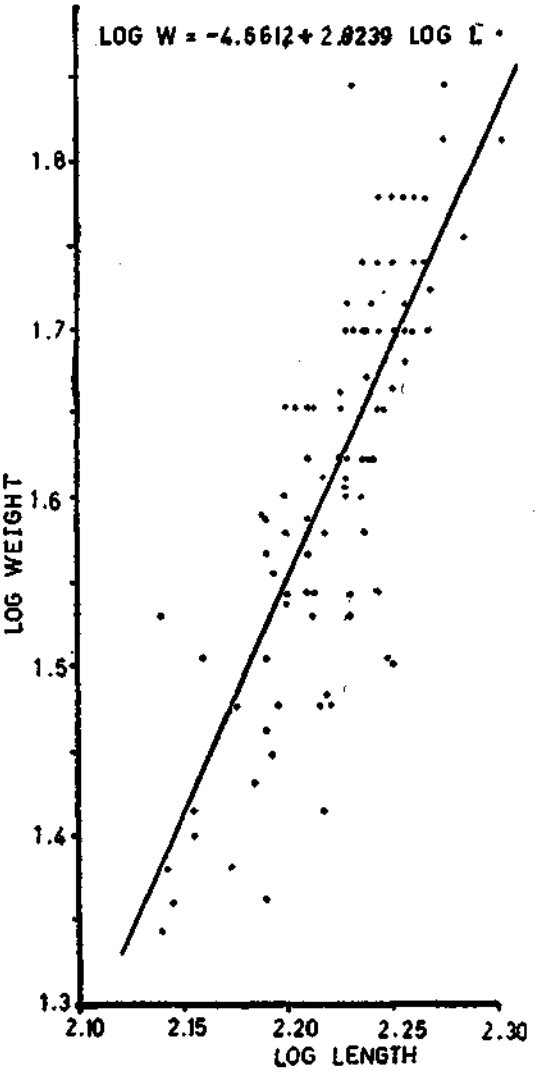

Fig. 3. Length-weight relationship of *Penaeus merguiensis* (female).

However the type of schooling denoted as 'boils' in the Gulf of Carpentaria (Lucas *et al.*, 1979) has not been reported by the fishermen in the Indian waters.

Sex-ratio

In the immature adults and mature ones the sex-ratio showed increasing numbers of females as the size increased. The mean ratio of males to females was 1 : 1.5 combining the data from all the months of occurrence. Monthwise (Table 1) in the mature size groups, the male to female ratio was 1 : 2. This is in distinct contrast to observations made in the Gulf of Carpentaria by Munro (1975) where males were found to be relatively more numerous than females in all the months except January and September. Even when the proportion of females in spent condition increased in the later part of the season (winter to summer), the females continued to be higher in proportion to males.

TABLE 1. *Sex ratio of* P. merguiensis *in artisanal catches off Puri Coast in* 1984-85

Year and Month	Male (%)	Female (%)
1984		
August ..	31	69
September ..	36	64
October ..	49	51
November ..	63	37
December ..	—	—
1985		
January ..	26	74
February ..	42	58
March ..	37	63
April ..	31	69
May ..	31	69
June ..	37	63
July ..	50	50

This type of distribution suggests either (1) differential growth in sexes, (2) early mortality of males (3) migration of males as compared to females to a different zone after mating, or (4) differential capture by the gear. From the three year study it appears that there is a differential growth in sexes but it is of a small order; maximum-sized males and females differing in length by 30 mm. The third alternative of males migrating away from the fishing zone is deemed not possible because the trawl sweeps across several depth zones. The second and fourth points might have some basis and need further study.

Maturity

A slight variation in the onset and ending of maturity season was observed in this species during each year (1983-1985). A high density of spent females occurred in September 1983 in the nearshore waters. There were smaller size groups in full maturity starting from February to August. The larger sizes overlapped from August onwards and one mass spawning occurred in September. Following this, during the winter months of October-January recovering (I), II and III stages were available together with a large number of spent females. The trend differed in 1984 in that the catches were very poor in February-May period and the incidence of mature females was also poor. Recovery occurred in July/August and continued to be good upto February 1985. During March to July, the catch was poor, but spent recovering and maturing ones were observed in the catches. From August onwards the percentage of mature females increased in the catches and fully mature ones dominated in winter months of October-November. The catch was once again poor in December.

The percentage of females in different stage of maturity from August 1984 to July 1985 is shown in Fig. 4. Except for April to July 1985, in all the preceding months more than 50% of the females were either in immature (I) or spent recovering (V) stages. The stage II and III females increased in the samples during January to April 1985. The percentage of mature females (IV) was greater in catches from May to August.

Fishery

Vessels and gear

Two types of vessels operate in this area. (i) The mechanised trawler (45-75 hp) and (ii) The artisanal (non-mechanized) craft termed as catamaran. About 200 trawlers operate from the Paradip Port as permanent base and around 30-50 trawlers are 'migratory' and come from other states during the fishing season. These operate from Astharang and recently (1984) from Ramachandi. Trawler operations are primarily for prawns and operate for about 12-72 hours.

The catamaran is the principal craft of the fishing villages operated by 2-5 men. For prawn fishing, drift gill nets of 5 cm mesh size, 150′ long are operated at a depth of 20-50 m (12-13 km from shore) for the larger prawns and for smaller prawns the depth zone is 15-20 m (6-7 km from shore).

Landings

The total catches of prawns off Orissa Coast was recorded as 2031 tonnes (1982-83), 35% of which was from mechanised vessels (Anon 1983). Species-wise break up of the 1981 prawn catches from both coasts of India gave the landings of *P. merguiensis* as 1096 t which formed 0.8% of total penaeid landings and

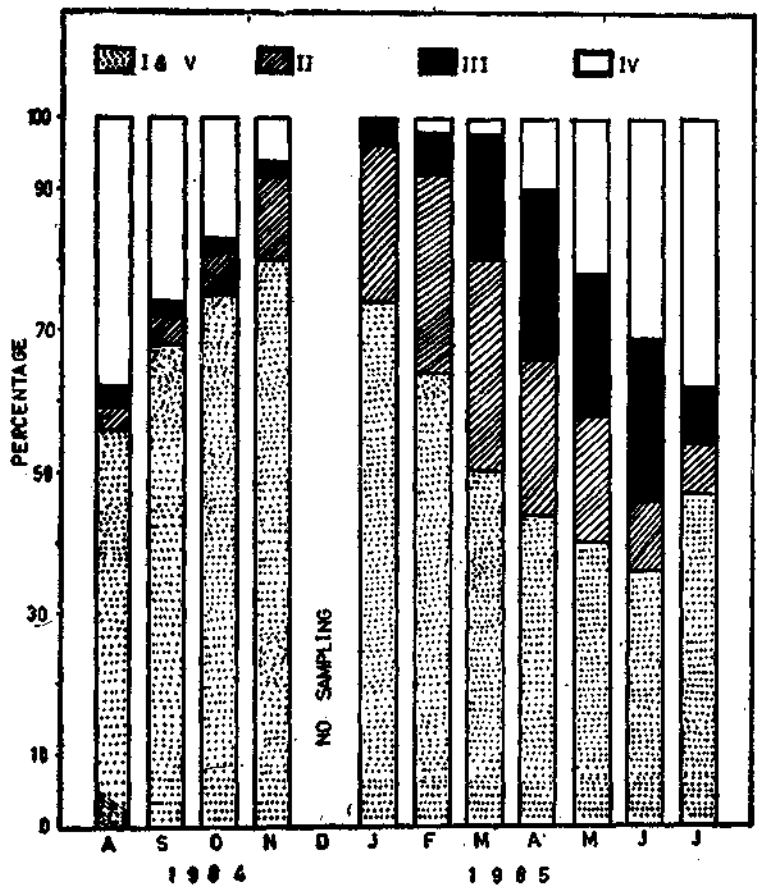

Fig. 4. Monthwise distribution of maturity stages in *Penaeus merguiensis*.

the other white prawn *P. indicus* at 7,537 t being 5.2% of total prawn landings (Anon., 1982).

Since as shown earlier, abundant capture of *P. merguiensis* is off the coast of Orissa, the landing figure show that a total of 1,328 t of penaeid prawns were landed in Orissa (Anon., 1982). Of these around 60% was *P. merguiensis*, followed by *P. monodon* and *M. affinis*, the smaller quantities of *P. semisulcatus*, *P. iaponicus*, *M. monoceros* and *Parapenaeopsis sp.* This trend was observed during 1983 and 1984 also. During 1983-'84 and 1984-'85 the total penaeid landings off Orissa Coast were 1,940 and 2,519 t respectively (Anon., 1986).

Discussion

The informations available on *P. merguiensis* are from the waters of Australia and Papua New Guinea (Tuma, 1967 ; Munro, 1975 ; Lucas *et al.*, 1979 ; Gwyther, 1980 ; Staples, 1980). In the Gulf of Carpentaria most of the impregnated females were found in waters deeper than 13 m (Munro, 1975) and the greatest number of them were found between the months of March and September (Tuma, 1967). Mating was found to take place in winter and the main spawning season during late winter and early summer (Munro, 1975). In the present studies also maximum number of mature/spent females occurred during winter months of October/November and upto early summer, the first batch of mature females appearing by late monsoon *i.e.* August and late spawners continuing to occur upto early summer *i.e.*, March so that an almost 10 months spawning is indicated as in Australian waters.

Studies from Australian waters (Hynd, 1974 ; Hindley, 1975 ; Munro, 1975 ; Staples, 1979) showed a high correlation in the distribution of this species in juvenile and adult stages between rivers to offshore areas. Juveniles have been found in the estuarine areas of rivers in eastern Australia although much variabiltyi was reported (Hynd, 1974) on their occurrence. In the present studies, however no such relationship of juvenile population to estuarine areas or rivers could be found. Similarly postlarval or juvenile population was not observed even in the outer channel or the mouth of the Chilka Lake which are the high saline areas of the lake water body. However further sampling is very much needed because of factors such as day-night variations, tidal rythms etc., which may obscure their catchability (Staples and Vance, 1979).

Kirkegaard (1975) included this species in what he termed as the mixed cycle species ' with postlarvae and juveniles inshore in waters less than oceanic salinity and adolescents and adults offshore, but there is a particular type in which postlarvae settle in approximately oceanic salinity and juveniles migrate into the lower salinities '. It is also further shown that in this species that one of the explanations for observed fluctuations in the size distribution is the difference in the extent of coastal swamps available during successive monsoon periods. This explanation seems to be applicable to the absence of postlarval juvenile phase in the inshore areas of Orissa which are vastly influenced by the specific hydrological regime of this coast. Regarding the management of prawn fisheries in India, in the recent times a limited ruling has been given on the depth of trawler operations such that the trawlers have been limited to areas beyond 20 m or so where it is supposed that catamarans or other non-mechanised craft do not venture. In fact, the present studies indicate that catamarans at Puri have recently been venturing further and further out, to depths of 30 to 50 m.

With this system which operates on the basis of unlimited entry, the number of trawlers increase overnight by steaming in from the

bordering states. It is thus quite impossible to arrive at total capture or capture per unit of effort. Management measures for this type of open entry and unlimited fishing is next to impossibility particularly when it is a multispecies fishery.

In future, a method of monthly returns of catch and effort should be made compulsory from all professional trawlers in operation. Possibly the processing factories also can help in this regard by filing returns by categories which can help to a certain extent in laying down policies.

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