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THE FISHERY OF *POLYNEMUS HEPTADACTYLUS* CUV. & VAL. IN INDIA<sup>x</sup>

by

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ABSTRACT

The catch statistics of *Polynemus heptadactylus* locally called 'Shende' with respect to regional and seasonal abundance, depth-wise distribution and the influence of lunar phases on the catches based on the landings by the New India Fisheries Company's bull trawlers 'Arnala' - 'Paj' and 'Satpati' - 'Pilotan' working in the Bombay and Saurashtra waters, are presented.

INTRODUCTION

The average annual landings of polynemid fishes in India for the period of 8 years from 1950 to 1957 have been estimated at 5,097 metric tons, amounting to 0.82% of the total of all fish landings (Banerji, 1958). The average annual landings for the 10 year period from 1956 to 1965 show a very slight increase to 5,955 metric tons forming 0.88% of the total marine fish catch (Annual Scientific Reports, CMFRI, 1956 to 1965). The annual state-wise distribution of polynemids shows heavy concentration on the coasts of Maharashtra and Gujarat on the north western part of the country. To the above mentioned 5,955 metric tons, Maharashtra contributed 2,692 (44.7%) metric tons and Gujarat 2,100 (34.9%) and other western states in the south hardly 1%. Along the eastern coast, Madras ranked first with 623 metric tons (10.3%) and Andhra next with 334 (5.5%).

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*Eleutheronema tetradactylum*, *Polydactylus indicus* and *Polynemus heptadactylus* are the 3 important commercial species contributing to the major portion of the polynemid fishery in the north western part of India. The report on the marketing of fish in the Indian Union (1951) shows that the Indian "Salmon" (*E. tetradactylum*) has contributed 1.3% or 4,677 metric tons to the sea and estuarine fishes landed in the country; of these, 1,806 metric tons have been fished from the Bombay coast forming 3.23% of the total catch. The magnitude of the catch of *P. indicus* in the Bombay and Saurashtra waters can be judged from the works of Mohamed (1955), Jayaraman et al (1959) and Nayak (1959). Deshpande (1962) has given an account of 'Dara' (*P. indicus*) with particular reference to its fishing methods along the Bombay coast. Though *P. heptadactylus* occurs in good quantities in these inshore and offshore waters, no published account on the fishery of this species is available. The introduction of the New India Fisheries Company's bull trawlers in the Bombay and Saurashtra waters and the maintenance of the catch data in detail by their skippers for *P. heptadactylus* gave an opportunity to know in detail about its fishery.

*P. heptadactylus*, locally called 'Shende' is obtained throughout the year in Bombay and is landed in two types of gears, the 'Dol' or bag nets and trawl nets. The 'Dol' nets are operated by the local fishermen from the ages past in the inshore waters in the vicinities of Sasson Docks, Versova, Danda and other fishing villages. 'Bokshi' is a miniature type of 'Dol' operated during the monsoon, very close to the shore in very shallow waters. The catches obtained from there are meagre and occasional. The motor fishing boats 'Champa', 'Bumili' and Bangada' of the Government of India, Deep Sea Fishing Station, Bombay operated otter trawls at the mouth of the Bombay harbour. The two sets of bull trawlers, 'Arnala' - 'Paj' and 'Satpati' - 'Pilotan' belonging to the New India Fisheries Company, were fishing in the offshore waters of Bombay and Saurashtra. Details of these bull trawlers and the gear used by them are given in Table I. They fished throughout the year at depths between 21 to 87 meters.

The catch of *P. heptadactylus* from 'Dol' nets and to a greater extent from the otter trawls, was dominated by the juveniles not exceeding 80-90 mm in length, and these were seldom marketed fresh, but mostly sundried along with shrimps and other smaller varieties of fish. The catches from these two sources were meagre and for want of precise data no estimate of their total landings could be made.

The bull trawlers landed large sized adults in appreciable numbers throughout the year. During their continuous fishing for about 8 years in the Bombay and Saurashtra waters from April 1956 to October 1963, 'Shende' contributed an annual average of 3% to the total catch. During the monsoon months this fish fetched good price in Bombay markets and was always preferred to small sciaenids, locally called 'Dhoma'.

A detailed study on the various aspects of biology, namely, systematics and distribution, food and feeding habits, age and growth, length-weight relationship, maturation and spawning of *Polynemus heptadactylus* has been carried out by this author and the results were incorporated in a thesis for a Ph.D. degree. The present paper presents an account on the fishery of the same species.

## FISHING GROUNDS AND CATCH ANALYSIS

The commercial bull trawlers 'Arnala' - 'Paj' and 'Satpati' - 'Pilotan' of the New India Fisheries Company, fished on the continental shelf of the north western part of India for a continuous period of 8 years from April 1956 to October 1963. The fishing areas are 600 square nautical miles each having 30 minutes of latitude by 20 minutes of longitude. These are numbered serially or lettered alphabetically and grouped into 6 regions (Fig. 1). The regions with their corresponding areas fished were Bombay: 48, 43, 43A, 42, 38, 37, 36, 32, 31, 30; Cambay: 25, 24, 23, 19, 18, 17, 16, 13, 12, 11, 10, 9; Veraval: 1, 2, 3, 4; Porbundar: A, B, D, E, G, H, I; Dwarka: K to N and Kutch. P to Z.

The entries by haul, by area and by depth of the catch data in the log books were processed to assess the regional and seasonal abundance of *P. heptadactylus*. The influence of tides and lunar phases on the catches of *P. heptadactylus* have also been studied. The catch rate or the catch in kilograms per hour of trawling have been used as a measure of determining the relative productivity of the different grounds or the relative abundance of the yields in different seasons or in different depth zones.

## THE CATCH

In the total average annual catch of 3,288,013 kg for all fishes from the bull trawlers in the Bombay and Saurashtra waters for the period of 8 years from April 1956 to October 1963, *P. heptadactylus* comprised 94,973 kg, forming 2.8% at a catch rate of 21.74 kg per hour of trawling (Table II). Excepting in 1956, the year when these vessels started fishing, the annual catches were over 100,000 kg with catch rates of over 22 kg per hour till 1961. In the last two years, the catch of the species was less than 50,000 kg, at about 12 kg per hour in each of these two years. A gradual decline in the catch rates and percentages was noticed year after year from 1959 to 1962 in Cambay and Porbundar regions and from 1960 in Veraval. In 1963 there was, however, some increase in the catch rates and percentages in almost all the regions.

Regarding the regional distribution pattern of this species, Cambay, Dwarka and Kutch fall in line with each other by their good catches, the catch rates were almost equal as were the percentages of catches (Table II). Veraval and Porbundar were equally good for this species recording moderate catch rates and percentages of the catches. The Bombay region appeared to be extremely poor and far below average. The findings of Rao *et al* (1966) from the catch analysis for the 6 year period from 1957 to 1962, were the same. It is seen from the table that the Bombay region, with the least productive trawling grounds for *P. heptadactylus*, did not yield this species in the 3 years of 1960, 1962 and 1963. However, a good catch rate of 41.14 kg per hour with 16.1% for a small catch of only 72 kg was recorded in 1961 and a good catch of 2,430 kg (0.49%) was obtained at a catch rate of 3.51 kg per hour in 1956. In Cambay the yield was high to the extent of 77,238 kg forming 6% in 1957 and the highest catch rate of 40.02 kg per hour was recorded in 1958. In Veraval which is moderately rich for this species the maximum catch rate of 24.96 kg per hour and the maximum percentage catch of 4.46 were in 1959. In Porbundar the maximum catch rate of 23.65 kg per hour and the maximum percentage of 3.75 were in 1957. In Dwarka region the catch of 39,834 kg, catch rate of 44.96 kg per hour and the percentage catch of 6.24 were the highest in 1958. In Kutch the best catch was in 1960, the highest catch rate was in 1959 and the percentage catch was the highest in 1957. Though the catches were falling in the successive years from 1959 in Dwarka and from 1961 in Kutch regions, there was no marked decline in the catch rates and the percentage catches, the low yields there from being the results of the low amount of fishing effort expended.

#### RELATIVE ABUNDANCE IN DIFFERENT AREAS

A detailed distribution of the catch by areas was studied for the period from April 1957 to March 1959. In a general way it is considered that areas yielding 20 kg or less per hour of fishing as poor, over 20 kg and up to 40 kg per hour as moderately rich and above that range as rich grounds for *P. heptadactylus*. Areas under different regions and the catch rates on the above basis are shown in Fig 1. It may be noted that yields in any particular area have not been constantly high or low. The highest catch rate in one of the two years has been taken as the basis for determining the relative richness of the grounds.

From the catch data for the period of 8 years, it has been inferred that Bombay region is the poorest for *P. heptadactylus*. Hence the area-wise analysis for this region is not discussed in the following account. In the Cambay region (Table III) the areas '25', '19', '12' and '11' are rich with catch rates of up to 49 kg per hour; '18', '17' and '10' are moderately rich with the catch rates ranging between 29 and 40 kg per hour and '24' and '9' are poor in their yields. In Veraval region the two areas '3' and '2' are moderately good since the catch rates have not exceeded 26 kg per hour. The same is true with the areas 'A', 'B', 'D' and 'E' in Porbunder region with catch rates up to 59 kg per hour and 'M' and 'N' moderately rich with the catch rates ranging between 24 and 30 kg per hour. Amongst the areas in Kutch region, 'Q' alone has proved to be rich with 41 kg per hour and 'P', 'R' and 'V' moderately rich up to 35 kg per hour and the remaining 'S', 'U' and 'X' poor often recording nil catch.

#### SEASONAL VARIATION IN THE CATCHES

The average monthly catches of *P. heptadactylus* from 1956 to 1963 are presented in Table IV. There are certain apparent seasonal trends in the monthly averages, but these are not real. Detailed examination of the data has shown that there was no marked season for this fishery and that the catches occurred high or low in any month in the 6 regions. The apparent seasonal trends seen from Table IV are high yields from 8,870 kg to 15,063 kg at catch rates from 22.98 to 36.77 kg per hour with high percentage catch from 2.76 to 4.41 in January to May prior to the monsoon; poor yields not exceeding 6,424 kg, catch rates not above 14.4 kg per hour and percentage catch not higher than 1.95 in monsoon months of June to August; good yields in September, comparable with those in months prior to the monsoon and fairly good yields in October to December with the catch going up to 6,776 kg at a catch rate of 21.97 kg per hour and percentage catch up to 2.59. However, in the monthly data for individual years, there are deviations from the general trends, for instance in 1957, the catch rates from January to March are not high and on the contrary the monsoon months have registered very high catch rates; in 1958, the catch rate of 95 kg per hour in September and the catch of 21,600 kg in August were the highest for the year. The monsoon months of June, July and August have also given fairly high catch rates, being 13.06 kg, 14.82 kg and 44 kg per hour of fishing respectively.

For assessing regionally the seasonal catch trends, if any, the monthly fluctuations in catches in the 6 regions for a period of 2 years from April 1957 to March 1959 have been examined. As seen from Fig. 2, in the Bombay region in most of the months, the catch was either nil or very poor, and it is not possible to find any seasonal trends. In Cambay the catch rates were the highest in May 1957 (112.46 kg per hour) and in August 1958 (52.88 kg per hour). Taking the 2 year period, however, there was no clear seasonal trend. The monsoon



month have also registered high catch rates, as in other months except July 1958 when the catch rate was the poorest. In Verval, in general, the catch rates were moderate in most months. The highest catch rate was in the postmonsoon month of October 1958 (113.76 kg hour). Here again the same months, June and August of 1957 and July 1958 the catch rates were at least moderately high. In Porbandar region April and May of both years had high catch rates. In the monsoon months of June 1957 and July 1958, they were fairly good. Dwarka is a very productive region, the highest monthly catch rate for the 2 year period being 292.92 kg per hour in April 1957. There was no fishing in the monsoon months in this region, nor in Kutch; in the latter there was fishing only for 4 months out of a total of 24. It is therefore difficult to assess the seasonal trends in these 2 regions. One point that needs mention is that these regions are the farthest from Bombay base. Hence during the inclement weather conditions of the monsoon months, fishing is either nil or much restricted in these regions in almost all years. In Dwarka and Kutch when there was fishing in the monsoon months of 1960 and 1961 the catch rates were high.

#### DEPTH-WISE DISTRIBUTION

The catch data for the period April 1957 to March 1959 were analysed for the distribution by depth of *P. heptadactylus*. The fishing operations during this period was carried out at depths between 21 and 80 meters. There was only 1 haul beyond 80 meters (87 meters) in April 1957 in Cambay region and the catch was nil. The fishing was concentrated more at the depths 21-50 meters in all the regions in both the years. The deeper zones between 51 and 80 meters in general, were fished between April and August in all regions except Dwarka and Kutch.

In order to ascertain the density of catch at different depths in different regions, the analysis was carried out in detail in the depth zones of 10 meter intervals. This study was not extended to Bombay and Kutch regions since the data were insufficient. In Cambay region, but for the months September and October in the second year when the fishing was carried out from shallow to almost all deeper depth ranges, fishing in general, was restricted to very deep depth ranges from April to August and to lower ranges from September to March (Table V). The catch and the catch rates were extremely good, recording up to 13,484 kg at the rate of 115.14 kg per hour in May 1957 in the greater depth range of 61-70 meters in this region. The catch and catch rates were either good or moderately good in other deeper ranges. Amongst the lesser depth ranges, fishing was mostly done in the 31-40 meter range and the yield was generally not very high; in September 1957 the catch rate was very high recording 102 kg per hour from 21-30 meter range. In September and October 1958 when almost all the depth ranges were covered, the catch rates appeared to increase from the smaller depths to the greater in the former month and reverse in the latter month.

In Veraval region (Table VI) the fishing was concentrated between 31-70 meters in the earlier part in both years and up to 50 meters in the latter part. The depth ranges of 51-60 and 61-70 meters have proved to be equally good for this species with moderate catch rates going up to 60 kg per hour, but occasionally nil or very poor catches. In the depths less than 50 meters, the maximum yield was from 31-40 meters, the highest catch rate being 194.79 kg per hour in October 1957.

The fishing in Porbundar region (Table VII) was extended up to the 51-60 meters zone in both years. The best of the yields from this region came from 41-50 meters with up to 87.92 kg per hour in May 1957 and then from 31-40 meters, with up to 44.47 kg per hour in April 1957. In September of the first year and October of both the years the catch was nil in depths less than 40 meters.

In April of the first year and October to March of both years, the fishing did not extend beyond the 41-50 meter range in Dwarka region (Table VIII). The range of 31-40 meters mostly gave the best yields, the highest rate being 111.52 kg in April 1957. Very often the catch rates were good in both the shallower range of 21-30 and the deeper range of 41-50 meters in this region.

From the above it is clear that the yield of *P. heptadactylus* was good in all the depths fished up to 80 meters in Cambay, 70 meters in Veraval, 60 meters in Porbundar and 50 meters in Dwarka. In general, the depth of 31-70 meters appears to be very good for this species. It is also to be noted that a relatively greater coverage is given for the fishing at greater depths in southern than in the northern regions of Bombay and Saurashtra waters.

#### INFLUENCE OF TIDES IN THE CATCH

Variations in the catch abundance caused by the spring and neap tides which in turn are influenced by the variations in the phases of moon are indicated in the works of Hickling (1946), Rounsefell and Everhart (1953) and Jayaraman *et al.* (*loc. cit.*). It is clear from these earlier works that the spring and neap tides have a well marked influence on the fisheries for certain species of fishes whereas in certain others, it is either nil or very unsteady.

Following the previous workers, the months for the period April 1957 to March 1959 were divided into spring and neap tide periods. Each of these periods was of about 7-8 days, with either of the two phases of moon (Full or New) in the centre in the case of spring tides and with either of the remaining two phases of moon (First or Last quarter) in the case of neap tides. As in the case of depth analysis, it was not possible to correlate the catches with the tidal factor from Bombay and Kutch regions because of the poor catch and poor fishing respectively in them.



Of the 12 months of fishing in each of the 2 years in Cambay region (Fig 3), the neap tide catch was noticed to be maximum in 7 months in both the years, the highest catch rate of 138.80 kg per hour for a catch of 7,884 kg being obtained in May 1957. In the same month the highest spring tide catch of 8,892 kg was also obtained with a catch rate of 95.81 kg per hour. There was no spring tide catch in July 1958. The variations between the spring and neap tide catches were wide during the 5 months of April, May, July and September 1957 and also of June 1958.

The tidal influence on the catches was very marked in the Veral region during 1957-58 season (Fig. 4). Excepting the months of August and November of 1957 and February 1958, the neap tide catch was greater throughout. The maximum catch rate of 194.79 kg per hour for a catch of 1,422 kg was obtained in October 1957 when the spring tide catch was nil, in spite of the fact, that the effort put in here was nearly half that during the neap tide period. The spring tide catch rate of 138.46 kg per hour for a catch of 360 kg was recorded in November 1957 when the corresponding neap tide catch was only 18 kg with a poor catch rate of 4.86 kg per hour. This well marked difference was not observed in the following year, 1958-59. Of the 11 months of fishing during this season, with October 1958 registering a nil catch, the spring tide catch was greater throughout excepting in the months of July and August 1958 and January 1959. The spring tide catch rates were high in April 1958 and March 1959, being 42.75 kg and 41.78 kg per hour respectively. The highest neap tide catch rate of 31.46 kg per hour was recorded in January 1959.

In Porbandar region excepting in November and December 1957, June 1958 and January 1959, the catch rates at neap tides were higher throughout (Fig. 5). However, the differences observed during these 4 months in the tidal catch rates were extremely small, ranging from 2.46 kg in February 1959 to 4.79 kg per hour in December 1957.

Excepting in January 1957 and 1958 and February of 1959, the neap tide catches were greater all through in Dwarka region (Fig. 6). The maximum neap tide catch rate of 127.05 kg per hour for a catch of 1,512 kg was in October 1958 when the catch rate was 38.07 kg per hour for the spring tide catch of 792 kg. The maximum spring tide catch rate of 61.68 kg per hour for a catch of 1,980 kg was obtained in April 1957.

From the records of catch statistics in the 2 years as detailed above, it is inferred that the landings of *P. heptadactylus* are influenced to a greater extent by the tides, the catches being more during the neap tides than during spring tides in all the regions.

## GENERAL CONSIDERATIONS

The spawning of *P. heptadactylus* was found to be prolonged and, when all the individuals together are taken into account, extends over the entire year; further, the spawning is in batches. No well defined season for the fishery has been observed and this may possibly be due to nature of the spawning and also to the wide distribution of the species. There appears to be no evidence of a breeding migration, at least on the trawling grounds of Bombay and Saurashtra waters. Being superior in taste to many other small fishes, though not classed as a quality fish, it has some advantage of getting into a better market.

The fish is believed to mature after the completion of the second year. The bulk of the trawl catch is made up of the third and fourth year classes. So when the fish enters this fishery they may have completed the first spawning or even the second. Again, the annual increase in weight per fish after the third year varies between 46-70 gm, meaning thereby a greater contribution to the fishery by the heavier fish. Thus the nature of spawning in this fish, the wide distribution of adults in the trawling grounds and the age as well as the maturity condition in which it enters the trawl fishery may help in acquiring a sustained yield for its fishery.

The earlier works of Jayaraman *et al.* (*loc. cit.*) and Rao *et al.* (*loc. cit.*) show that the trawl fishes from Bombay and Saurashtra waters exhibit, to some extent, a regional distribution pattern. It is seen that *Polydactylus indicus* ('Dara') and *Otolithoides brunneus* ('Koth') are mostly confined to the Dwarka and Kutch regions; *Pseudosciaena diacanthus* ('Ghol') is spread over all the regions, *Pomadasyss hasta* ('Karkara') dominates in the northern sector from Porbunder to Kutch, *Muraenesox talabonoides* ('Wam') in the southern sector from Bombay to Veraval and 'Dhoma', a mixed lot of small sciaenoids, comparatively more abundant in the southern region from Bombay to Porbunder. *P. heptadactylus* ('Shende') though available in all the 6 regions, is more plentiful in Dwarka and Kutch in the north and also Cambay in the south.

'Shende' resembles members of 'Dhoma' in its small size but not in the distributional pattern. A comparison of this species with 'Dara', a species belonging to the same family shows that there is a great difference in the sizes of these two species. 'Dara' grows to over a meter, whereas 'Shende' to only about 30 cm. In the trawl landings 'Dara' which is found to dominate in Dwarka and Kutch are all juveniles called 'Chelna'; the adults are captured from the inshore waters in gill nets by the local fishermen from north of Bombay towards the Gulf of Cambay and also in the Gulf of Kutch (Nayak, 1959). Unlike this, the trawl specimens of 'Shende' from offshore waters in Cambay, Dwarka and Kutch are all adults and those from the inshore catch by the bag nets of the local fishermen are almost all juveniles. By age, the

bulk of the trawl catch of 'Dara' can be grouped into I, II and III year groups with IV and above year groups occurring rarely. In the trawl catches of 'Shende', the I year group is totally absent and the II year group forms a very small percentage. The catch is mainly represented by the III and IV year groups. Fish belonging to V and above year groups are poorly represented.

The season for 'Dara' fishery is of a short duration, from November to May, whereas 'Shende' catches of fair magnitude occur almost all through the year. 'Dara' prefers shallower waters up to 40-45 meters and is known to enter the shallower waters for breeding, whereas 'Shende' seems to be a deeper water species since it appears in much greater abundance in the 31-70 meter depth range and is believed also to breed in the deeper waters because the ripe and spent specimens are much more common from the trawl catches than from the inshore catches (Nayak, 1965).

The neap tide catches were found to be better than the spring tide catches for 'all fish' and 'Dara' by Jayaraman *et al.* (*loc. cit.*). They have also pointed out instances of 'Ghol', 'Koth' and 'Karkara' yielding better catches during spring tides. They were of the opinion that spring tide period was poorly represented compared with the neap tide period because most of the bull trawl fishing at that time was during the neap tide phases. Such a disparity in fishing during the two lunar phases was not evident in the New India Fisheries bull trawlers which were operating in 2 sets. The yield of 'Shende' like that of 'Dara' was higher during neap tides than during spring tides.

#### SUMMARY

*Polynemus heptadactylus* is landed locally by the 'Dol' nets and also by the otter trawls and bull trawls. The inshore catches by the 'Dol' nets and the otter trawls are mostly juveniles and those by the bull trawls are mostly adults. The catch data of the New India Fisheries Company's bull trawlers 'Arnala' - 'Paj' and 'Satpati' - 'Pilotan' for the period of 8 years from April 1956 to October 1963, are analysed and presented here.

The catch in different areas showed a decline in the latter part of the period of observation; however, an improvement in the catch was noticed in 1963.

The regions Cambay, Dwarka and Kutch have shown rich fishing grounds, Veraval and Porbunder moderately rich ones and Bombay poor ones for this fish. The areas '25', '19', '12' and '11' in the Cambay region, 'K' and 'L' in Dwarka region and 'Q' in Kutch region were rich, registering over 40 kg per hour of trawling.

No marked seasonal variation in the catch of *P. heptadactylus* was noticed. Both high and low yields and high and low catch rates appeared in all months of the year.

The fishing was carried out within the depth zone of 21-80 meters. The catch analysis for the period of 2 years from April 1957 to March 1959 showed that the greater depths, between 51 and 80 meters, were fished mostly during the period April to August and depths below 50 meters from September to March. Though the range of depths fished differed in different regions, it was observed that in general, the yields were better in the depth zones between 31-70.

The catch of *P. heptadactylus* was found to be influenced by the tidal factors, the catches in general, being higher during the neap tides in the different regions than during spring tides.

The nature of its spawning and the age and maturity condition of the trawl specimens may help in obtaining a steady yield of this species.

*P. heptadactylus* exhibited some habits different from those of another trawl species, *Polydactylus indicus*. *P. heptadactylus* in the trawl catches were mostly adults and in the inshore catches were juveniles; the age groups being reversed in the case of *P. indicus*. The commercial trawl catches of 'Shende' were found to be sustained mainly by the III and IV year groups whereas those of 'Dara' consisted mainly of the I, II, and III year groups. The former preferred deeper waters and bred intensively there, the latter in shallower waters. Both the species yield better catches during the neap tide period.

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TABLE I

DETAILS OF THE NEW INDIA FISHERIES BULL-TRAWLER AND GEAR USED BY THEM

Particulars	VESSELS			
	Satpati	Pilotan	Arnalla	Pa.
Overall length (metres)	29.19	29.11	29.31	29.24
Beam (metres)	5	5	5	5
Draft (metres)	1.8/2.4	1.8/2.4	1.8/2.4	1.8/2.4
Gross tonnage (metric tons)	93.18	94.16	94.16	94.16
Net tonnage (metric tons)	44.87	45.78	45.78	45.78
Engine	Diesel, Kobe Akasa, Japan			
Engine Power B.H.P.	250	250	250	250
Auxiliary Engine	Yanmar Diesel			
Auxiliary Engine B.H.P.	20	20	20	20
Winch Capacity (metric tons)	4.06	4.06	4.06	4.06
Number of men	16-17	15-16	16-17	15-16
Type of net	Bull-trawl	Bull-trawl	Bull-trawl	Bull-trawl
Length of Head rope (metres)	60.06	67.06	67.06	67.06
Length of Foot rope (metres)	69.58	68.58	68.58	68.58
Mesh of belly & bating (cms.)	8.89	8.89	8.89	8.89
Mesh at cod end (cms.)	5.08	5.08	5.08	5.08

TABLE III

AREA-WISE DISTRIBUTION OF *P. HEPTADACTYLUS* IN THE DIFFERENT REGIONS DURING 1957-1959

Area	1957 - 1958		1958 - 1959	
	Catch in kg	kg/hr	Catch in kg	kg/hr
<b>CAMBAY REGION</b>				
25	108	2	198	42
24	1,350	10	216	16
19	36	11	414	41
16	5,562	29	5,076	38
17	2,896	30	4,410	34
12	5,094	48	3,510	33
11	23,210	49	53,010	45
10	34,830	40	4,032	16
9	0	0	-	-
<b>VERAVAL REGION</b>				
3	9,090	26	6,030	22
2	7,362	22	6,264	18
<b>FORWARDER REGION</b>				
A	39,348	33	15,624	17
B	72	9	1,188	21
D	4,176	23	3,654	16
E	3,600	20	6,426	29
<b>DWARAKA REGION</b>				
K	10,518	59	6,516	15
L	2,682	57	900	45
M	14,688	30	7,416	26
N	7,812	29	6,778	24
<b>KUTCH REGION</b>				
P	56	27	-	-
Q	54	41	612	22
R	-	-	720	35
S	-	-	18	14
T	-	-	0	0
V	-	-	630	30
X	-	-	0	0

Table II

Annual Regional distribution of *P. heptadactylus* in the landing of New India Fisheries Bull-trawlers

Year	All Regions Catch in kg (kg per hour)	Bombay Catch in kg (kg per hour)	Cambay Catch in kg (kg per hour)	Veraval Catch in kg (kg per hour)	Forwarder Catch in kg (kg per hour)	Dwaraka Catch in kg (kg per hour)	Kutch Catch in kg (kg per hour)
1956	22,693 (7.96)	2,430 (3.51)	16,488 (13.03)	0	18 (0.40)	3,762 (5.04)	-
1957	147,294 (27.01)	72 (0.95)	77,238 (38.42)	11,988 (22.86)	33,732 (23.65)	24,174 (17.30)	90 (33.83)
1958	157,608* (31.25)	180 (2.26)	70,074 (40.02)	12,662 (19.75)	33,372 (20.52)	39,894 (44.56)	342 (9.20)
1959	102,150 (23.75)	414 (4.46)	28,908 (22.58)	12,654 (24.76)	13,122 (14.44)	20,070 (24.14)	26,982 (39.58)
1960	133,460 (25.86)	0	2,592 (17.95)	4,914 (12.72)	8,154 (8.98)	13,428 (36.41)	104,372 (31.23)
1961	104,400 (22.61)	72 (41.14)	3,81 (8.52)	2,14 (11.62)	1,25 (11.94)	5,06 (44.16)	3,45 (28.45)
1962	48,492 (12.27)	0	2,610 (3.61)	1,224 (4.64)	3,978 (4.30)	2,556 (18.20)	38,124 (20.21)
1963	43,680 (12.29)	0	3,105 (4.12)	5,670 (16.11)	4,626 (4.70)	4,806 (40.50)	25,473 (19.12)
	1.63		0.64	2.51	0.66	4.74	2.20
Average	94,973 (21.74)	396 (3.24)	25,824 (24.11)	6,863 (17.04)	13,100 (14.03)	14,897 (25.15)	38,714 (26.92)
	2.89	0.53	3.52	2.80	2.13	3.74	2.87

\* includes 144 kg from an unclassified area



Table IV  
Monthly catch in kg (kg per hour) and percentage of *P. heptadactylus* in the  
New India Fisheries bull-trawler landing during 1956-1963

Month	1956	1957	1958	1959	1960	1961	1962	1963	Average
January	-	396 (0.83) 0.14	13,266 (25.35) 3.74	12,834 (22.91) 4.10	19,236 (40.26) 4.53	16,344 (37.98) 4.26	14,806 (34.78) 3.20	6,642 (19.23) 2.03	11,952 (26.01) 3.29
February	-	2,592 (6.35) 0.92	19,404 (42.34) 6.90	7,776 (15.12) 2.60	17,514 (37.49) 4.01	7,398 (13.55) 1.75	5,778 (13.45) 1.39	8,568 (23.00) 2.36	9,861 (22.98) 2.76
March	-	7,452 (17.17) 2.70	14,688 (27.50) 3.85	11,034 (19.8) 3.78	24,480 (53.10) 5.34	30,384 (65.44) 6.93	7,866 (19.4) 2.00	9,540 (12.96) 2.48	15,063 (31.40) 4.02
April	0	28,890 (60.91) 9.54	8,938 (37.57) 5.10	16,774 (43.32) 5.80	15,030 (35.60) 4.08	17,676 (44.43) 4.57	6,048 (22.6) 2.64	6,732 (19.29) 2.53	12,749 (35.77) 4.41
May	0	19,782 (85.47) 11.78	10,224 (34.63) 5.24	10,116 (33.2) 6.2	13,680 (30.50) 3.82	10,512 (31.31) 3.89	6,606 (17.1) 1.93	36 (2.73) 0.72	8,870 (27.34) 4.12
June	54 (0.16) 0.02	15,390 (29.56) 5.03	2,592 (13.06) 2.64	4,194 (15.87) 2.8	4,032 (8.27) 1.04	4,500 (9.89) 1.56	144 (0.40) 0.04	1,917 (3.71) 0.59	4,103 (10.46) 1.58
July	5,850 (17.74) 2.34	15,804 (30.71) 5.32	7,308 (14.82) 2.53	1,332 (4.43) 0.88	2,124 (4.60) 0.74	2,934 (6.71) 1.24	411 (0.80) 0.11	1,008 (2.2) 0.33	4,597 (10.27) 1.70
August	5,616 (17.02) 1.67	9,018 (17.60) 2.29	21,600 (44.55) 5.53	6,552 (18.15) 3.19	4,554 (10.38) 1.80	1,903 (3.88) 0.64	1,908 (4.4) 0.48	162 (0.30) 0.05	6,424 (14.44) 1.95
September	2,736 (8.29) 0.88	16,326 (38.91) 6.92	19,936 (95.00) 5.71	8,694 (27.12) 4.7	11,661 (28.25) 3.56	3,546 (7.60) 1.06	1,674 (7.3) 0.84	7,041 (21.55) 2.57	8,827 (23.95) 3.22
October	4,680 (14.41) 1.77	5,904 (13.59) 2.60	14,400 (35.86) 4.14	7,560 (28.90) 4.42	7,478 (21.12) 2.60	3,402 (13.80) 1.16	252 (4.1) 0.29	2,034 (10.80) 1.56	5,714 (20.50) 2.52
November	1,620 (5.08) 0.46	11,664 (23.92) 5.36	16,272 (37.58) 4.78	4,936 (30.8) 2.60	7,363 (29.47) 2.65	846 (5.32) 0.51	1,296 (6.8) 0.81	-	6,279 (21.97) 2.59
December	2,142 (5.13) 0.81	14,076 (24.80) 4.66	10,080 (19.55) 2.72	8,388 (31.6) 3.07	6,246 (13.51) 1.60	4,950 (13.31) 1.15	1,548 (7.34) 0.93	-	6,776 (16.71) 2.16

Table V  
Depth-wise distribution of monthly catch in kg (kg per hour) of *P. heptadactylus* in Cambay Region, 1957-59.

Month	1957 - '58						1958 - '59					
	21-30m.	31-40m.	41-50m.	51-60m.	61-70m.	71-80m.	21-30m.	31-40m.	41-50m.	51-60m.	61-70m.	71-80m.
April	-	-	-	4,806 (72.81)	4,560 (111.45)	54 (36.00)	-	-	-	576 (36.00)	5,364 (44.22)	-
May	-	-	-	3,246 (104.18)	13,484 (119.14)	54 (38.57)	-	-	-	342 (24.78)	5,256 (39.84)	-
June	-	-	108 (77.14)	1,952 (48.44)	8,712 (29.95)	-	-	-	-	72 (9.60)	1,512 (44.86)	684 (45.00)
July	-	-	18 (2.06)	3,342 (37.60)	13,230 (82.63)	-	-	-	-	36 (0.33)	234 (13.00)	-
August	-	-	4,086 (16.72)	6,894 (30.09)	144 (22.15)	-	-	-	2,826 (21.99)	17,676 (63.03)	152 (30.56)	-
Sep.	306 (102.00)	12,324 (70.04)	6,462 (34.92)	-	-	-	-	1,548 (21.33)	8,946 (42.86)	6,480 (51.75)	1,530 (109.28)	-
Oct.	126 (11.55)	3,114 (14.40)	504 (22.70)	-	-	-	450 (44.54)	6,732 (41.04)	2,790 (33.25)	2,898 (37.94)	345 (38.98)	-
Nov.	-	36 (8.00)	0	-	-	-	-	216 (60.00)	-	-	-	-
Dec.	-	437 (8.65)	-	-	-	-	90 (20.00)	216 (18.76)	-	-	-	-
Jan.	-	617 (17.47)	-	-	-	-	-	3,528 (36.31)	-	-	-	-
Feb.	-	953 (32.61)	594 (38.57)	-	-	-	-	1,962 (22.39)	-	-	-	-
March	-	1,440 (54.54)	810 (61.83)	-	1,116 (37.07)	-	-	1,260 (27.87)	0	-	-	-



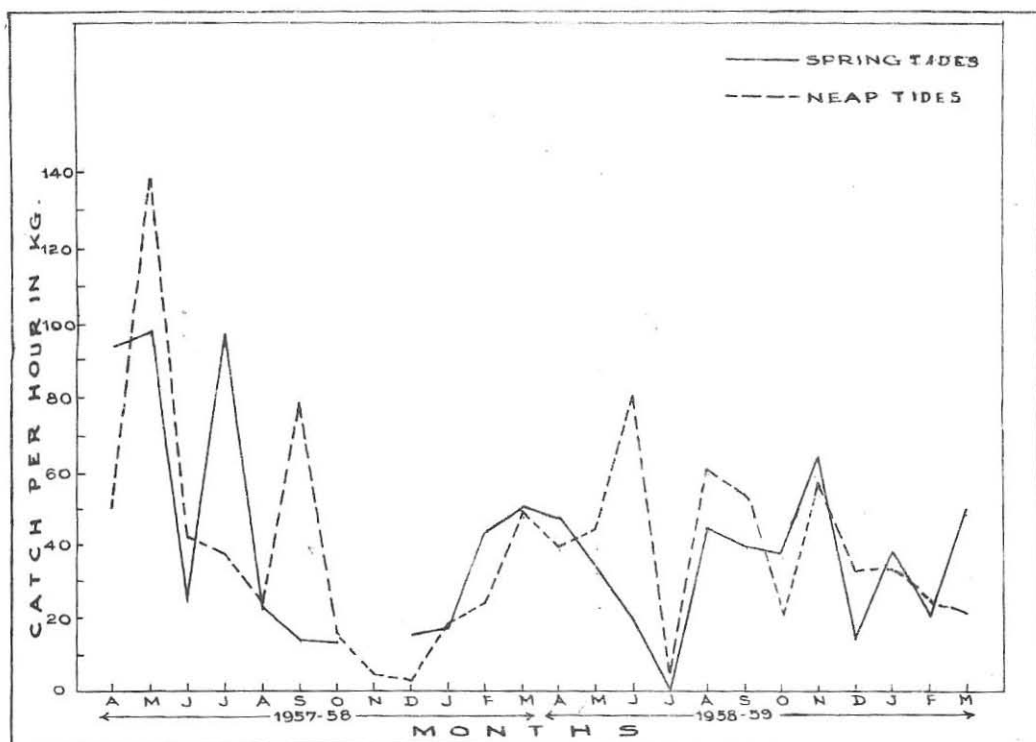


Fig. 3. Monthly spring tide and neap tide catch per hour in kg of *P. heptadactylus* in Cambay region during 1957-1959.

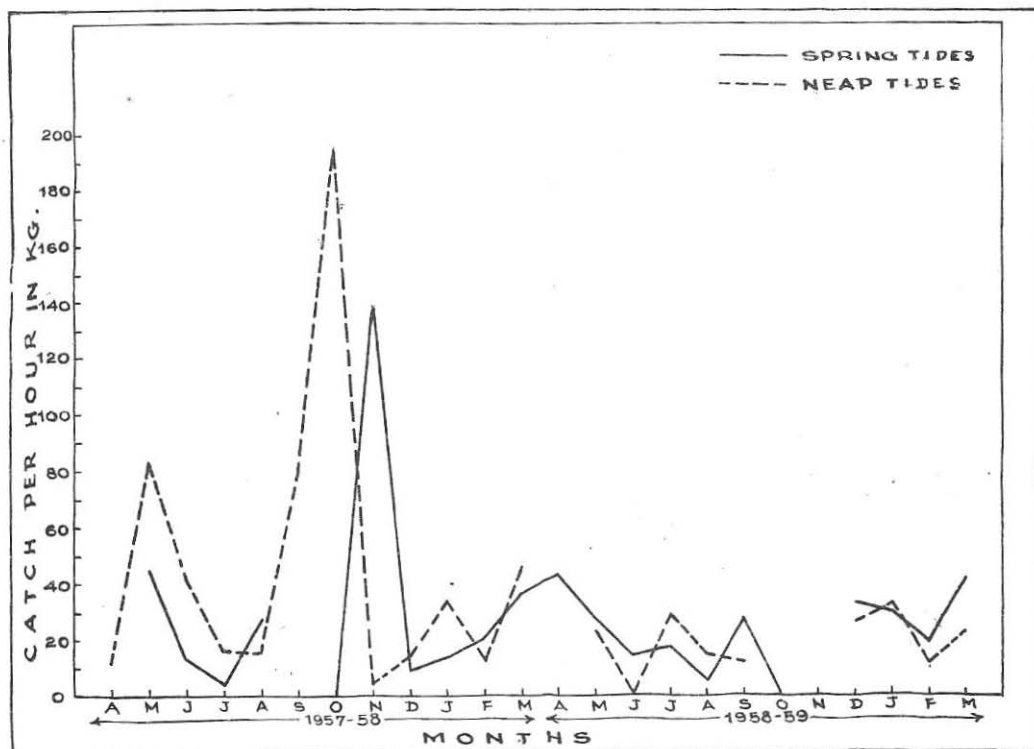


Fig. 4. Spring tide and neap tide catch per hour in kg of *P. heptadactylus* in Veraval region during 1957-1959.

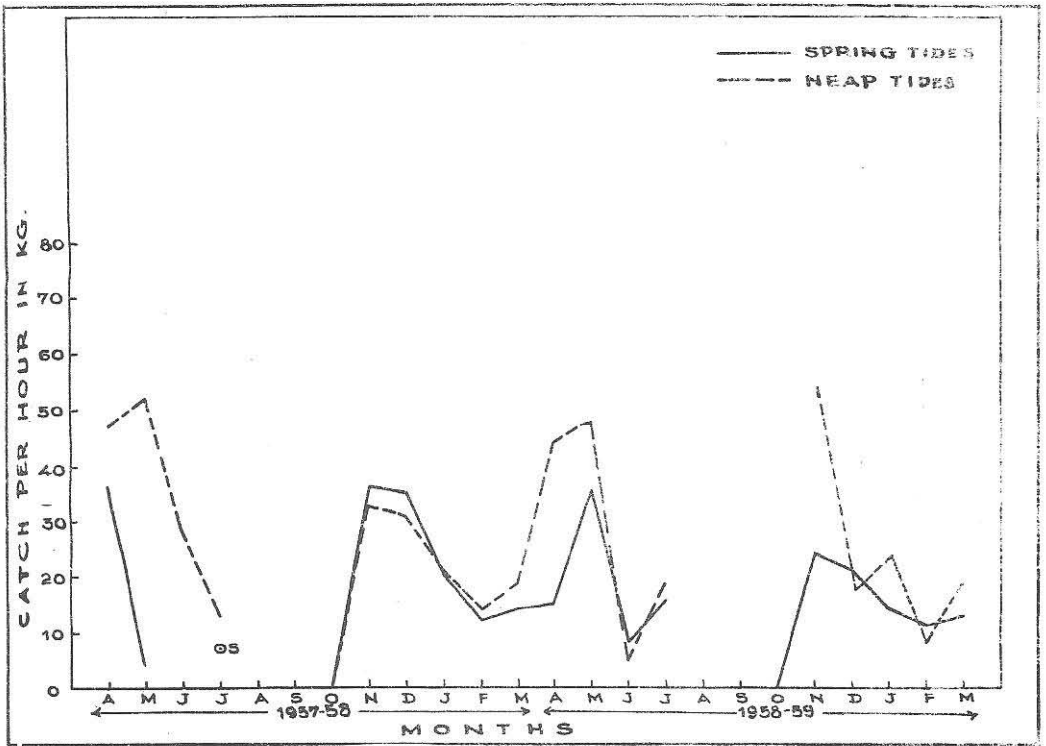


Fig. 5. Monthly spring tide and neap tide catch per hour in kg of *P. heptadactylus* in Porbandar region 1957-1959.

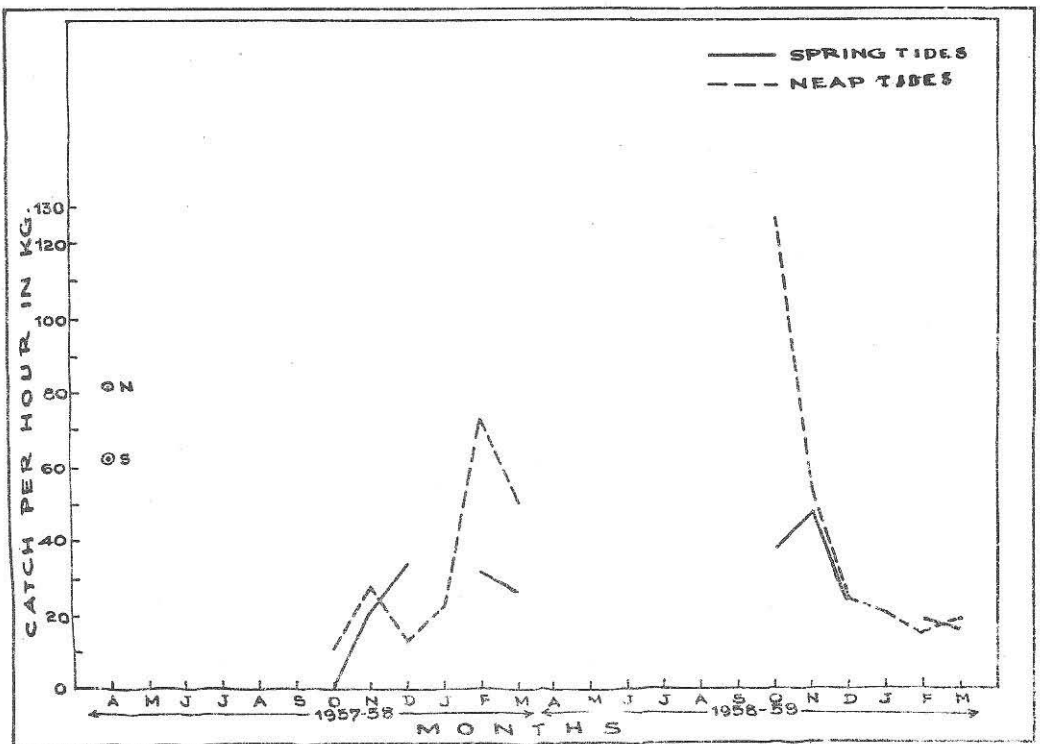


Fig. 6. Monthly spring tide and neap tide catch per hour in kg of *P. heptadactylus* in Dwarka region during 1957-1959.

RESULTS OF THE EXPLORATORY FISHING OPERATIONS OF THE GOVERNMENT  
OF INDIA VESSELS AT BOMBAY BASE FOR THE PERIOD  
1961 - 1967<sup>x</sup>

by

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ABSTRACT

The fishing vessels of the Government of India, Deep Sea Fishing Station, Bombay, conducted exploratory fishing operations in areas between latitudes  $15^{\circ}\text{N}$  to  $23^{\circ}10'\text{N}$  and longitudes  $68^{\circ}10'\text{E}$  to  $73^{\circ}50'\text{E}$ , covering 25,100 nautical square miles on the continental shelf during 1961-1967. The paper presents the results of operations giving details of regional, seasonal and depth distribution of fish categories. The vessels, of different specifications, have been grouped into 3 categories based on B.H.P. and their annual catch rates estimated separately. There was an increase in the abundance of fish catches from the  $18^{\circ}\text{N}$  latitude zone to the  $22^{\circ}\text{N}$  latitude zone. A similar increase in the abundance was also noted from the  $18^{\circ}\text{N}$  latitude zone to the  $15^{\circ}\text{N}$  latitude zone. The seasonal catch trends showed the highest yields in the fourth quarter and the poorest in the third quarter. In spite of the inclement weather conditions which makes fishing operations difficult, the catch rates in some of the monsoon months were high. The seasonal trends in individual categories of fishes varied to some extent from those of the total fish catches. In general, the concentration of fish was high in depths from 41 to 60 metres.

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