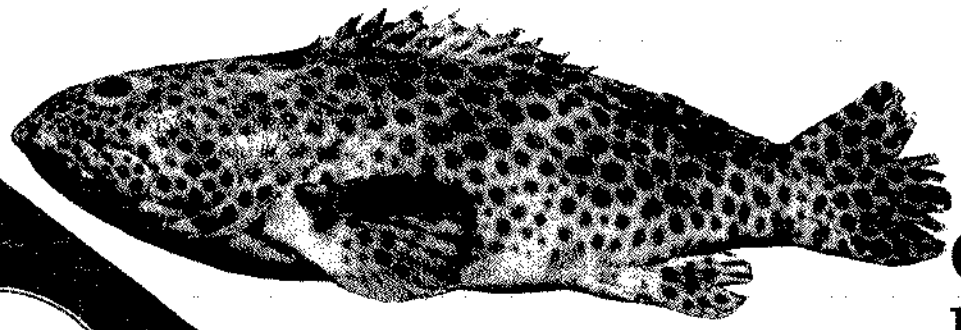

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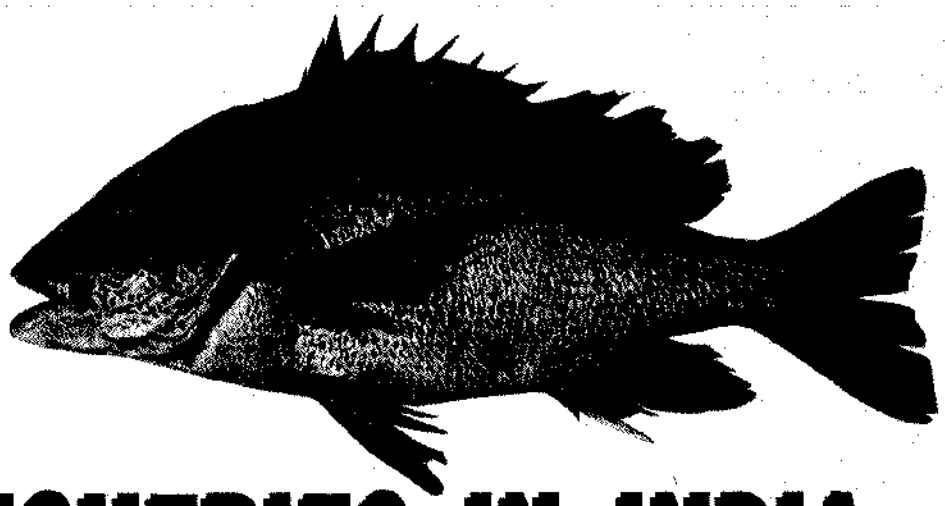

PERCH FISHERIES IN INDIA

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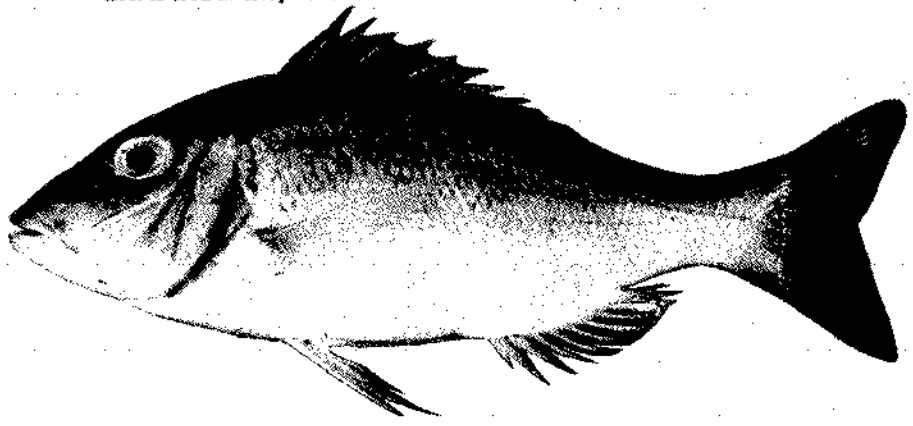

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PERCH FISHERIES IN INDIA

K. Rengarajan
P. Sam Bennet

Editors

February 1994

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SOME PERCH FISHES OF INDIA

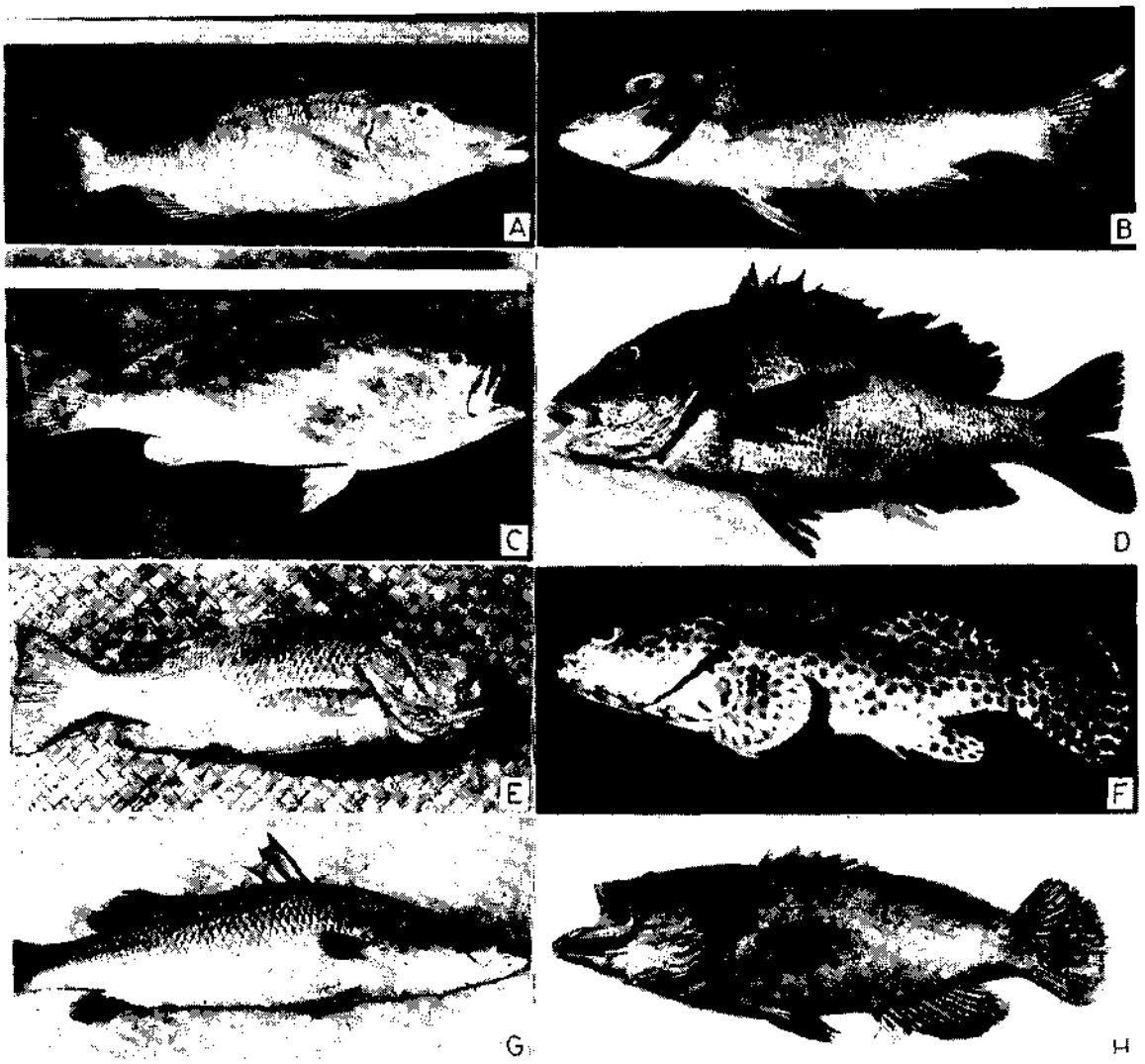

PLATE I. A. *Lethrinus miniatus*, B. *L. nebulosus*, C. *Epinephelus undulosus*, D. *Lutjanus rivulatus*, E. *Lutjanus argentimaculatus*, F. *E. malabaricus*, G. *Lates calcarifer* and H. *Serranus* sp. (Photos by P. Sam Bennet and S. Lazarus).

SOME PERCH FISHES OF INDIA

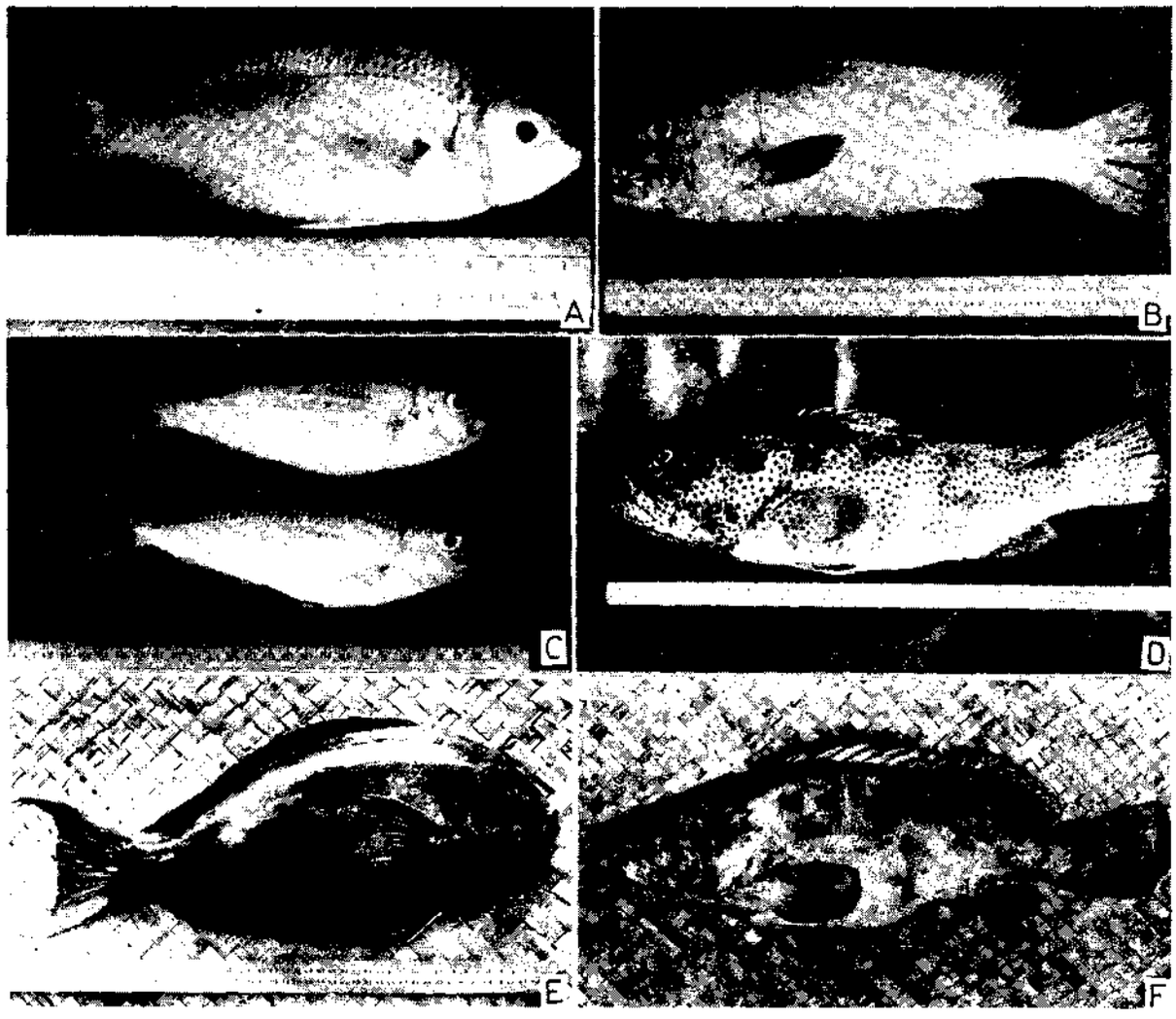

PLATE II. A. *Scolopsis bimaculatus*, B. *Diagramma griseum*, C. *Nemipterus delagoae*, D. *Epinephelus tauvina*, E. *Siganus javus* and F. *E. caeruleopunctatus*. (Photos by P. Sam Bennet and S. Lazarus).

PREFACE

The group of fishes popularly called "Perches" (Order Perciformes) include a wide variety of species of families such as Serranidae, Lutjanidae, Lethrinidae (called "major perches" because of their larger size) and Nemipteridae and Siganidae (called "minor perches" in view of their much smaller size). The major perches are usually abundant in the rocky grounds and coral areas, mostly off Kerala and Tamil Nadu where these are exploited by drift nets, hooks and lines, and traps, with an average annual production of 39,841 tonnes during 1988 - '92. Among minor perches, the Family Nemipteridae popularly called "Threadfin-breams" and "Pink perches" are abundant in the shelf and slope waters upto a depth of about 200 m, exploitable by trawl nets. Until the seventies, a fishery for this group was almost non-existent in India. But due to the gradual expansion of bottom trawling operations, there has been an increase in the production of threadfin-breams. Their average annual production was 67,072 t during 1988 - '92, with an all time peak of 82,644 t in 1990. All perches together are at present contributing to about 5% of the total marine fish production, the former 2% and the latter 3% with a total of 1,06,910 t. The west coast of India contributes more (71.6%) than the east coast.

As per a recent estimate by the Government of India, the catchable potential of all the perches within the 50 m depth zone is about 1,14,000 t and that beyond 50 m it is 1,25,000 t, total being 2,39,000 t. Within the former zone, the southwest sector is the most productive, followed by southeast and northwest. The rocky grounds of Wadge Bank, about 12,000 km^2 and of Quilon Bank about 3,300 km^2 are found to be especially rich for major perches. Although accurate estimates are not available, it appears that about 40,000 - 60,000 t can be caught per year additionally. Since these grounds are not trawlable, their exploitation is possible only by drift nets, hooks and lines, and traps. The experimental fishing results of FORV *Sagar Sampada* recently indicated several potential non-conventional perch resources like *Psenes indicus, Priacanthus* spp. and *Centrolophus niger* which could also be exploited. Future intensification of fishing would support the export market that has come into existence recently, especially for major perches. By ensuring the quality of the produce from the time of capture by providing mother ship operation facilities, there seems to be considerable scope for developing a sustained export market for this valuable resources.

In view of the growing potential for perches, it has been considered essential to bring together all available scientific data and information on perches, for the benefit of the fishing industry, fishery administrators, scientists and planners in a bulletin. This publication deals with the present status, the catchable potential, biology of the component species and the fishery of major perches at important centres like Vizhinjam, Muttom, Tuticorin and Kilakarai.

I appreciate the efforts of all authors in contributing to the various Chapters in the bulletin. It is hoped that the present publication would serve as a basis for further expansion of perch fishery and exploitation of these under-exploited and under-utilised resources to the optimum.

Cochin - 682 014,
February 1994.

P. S. B. R. James
Director

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THE PRESENT STATUS OF 'MAJOR PERCH' FISHERIES IN INDIA

P. S. B. R. JAMES, S. LAZARUS AND G. ARUMUGAM

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ABSTRACT

The fisheries belonging to Families Serranidae, Lutjanidae and Lethrinidae are popularly known as Rock-cods, Snappers and Pig-face breams respectively and are collectively termed as 'Major Perches'. They form about 12% of the perch catch with an annual landing of 10,336 tonnes constituted by rock-cods (41.3%), snappers (35.4%) and pig-face breams (23.3%). Bulk of the catch comes from Tamil Nadu (42.4%), Maharashtra (18.9%) and Kerala (14.8%). Gujarat and Andhra Pradesh support respectively 9.5% and 9.3% of the catch. The remaining catch is shared by Karnataka, Orissa, Pondicherry and Goa. Lethrinids do not form appreciable fishery in the northern States and in the southern States there exists a multispecies fishery for all the three major perch groups. Trawl net accounts for 42% of the catch and the rest of the quantity is contributed by 'other mechanised' and nonmechanised units equally. The peak fishery season is from October to April. The results of the studies particularly on fisheries and fishing grounds carried out during various exploratory surveys and other cruises are discussed in this account.

INTRODUCTION

Perch-like fishes available in Indian waters are represented by more than 20 families. Commercially important ones come under the Families Serranidae, Lutjanidae, Lethrinidae, Nemipteridae, Priacanthidae, Sparidae, Acanthuridae and Siganidae. Of these, fishes belonging to the first three families, popularly known as rock-cods, snappers and pig-face breams, grow to large sizes and have good market both in India and abroad. Because of their economic importance they are being exploited intensively and their landings have shown marked increase in recent years. An attempt is made here to examine their present level of exploitation on all India basis to suggest ways to improve their production.

Literature so far available on this important resources in India is scanty and inadequate in general. They deal with some aspects of experimental fishing (John, 1948*; Chidambaram and Rajendran, 1951; Gopinath, 1954; Silas, 1969; Bapat *et al.*, 1982; Anon., 1978), catch statistics (Chacko and Rajendran, 1955; Rao, 1973; Madan Mohan, 1983; Rao and Kasim, 1985; Kasim *et al.*, 1989) and perch-trap fishery (Prabhu, 1954; Lal Mohan, 1985).

* For full reference, please see page 134.

DATA BASE

Fishery date collected by the Fishery Resources Assessment Division of the Central Marine Fisheries Research Institute for the period 1985-89 were utilised for the present study. Even though the date collected is for the entire group; only rock-cods, snappers and pig-face breams are described here in detail. These three groups together are called 'Major Perches' in this account considering their large size and economic importance.

PERCH FISHERY IN GENERAL

Average perch landings in India have been estimated at 89031.8 tonnes per year and they form about 5% of total fish catch of the country (Fig. 1 a). Bulk of the perch landings (60%) come from two southern States *viz.* Kerala and Tamil Nadu (Fig. 1 b) contributing respectively 37627.8 t (42.3%) and 15648.8 t (17.6%) to the perch fisheries. Among the other States perch landings are notably good in Maharashtra and Gujarat. They produce 10994.4 t (12.3%) and 7580.4 t (8.5%) of perches annually and occupy respectively third and fourth places. Of the remaining States, Andhra Pradesh and Karnataka have reasonable production of perch

and they take the fifth and sixth places by producing 6864.4 t (7.7%) and 6177.4 t (6.9%) respectively per year. The remaining perch catch of 4138.6 t is being shared by Orissa (1845.2 t). Statewise average perch landings and all fish landings are given in Table 1.

and Gujarat. East coast's contribution is only 37627.8 t annually.

Perch fishery in India is dominated by the group threadfin-bream with landings of 53365 t annually and forms 59.9% of the total perch catch

TABLE 1. *Statewise average (1985 - '89) landings (tonnes) of perches and other fishes*

	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondicherry	Kerala	Karnataka	Goa	Maharashtra	Gujarat	Total
Rock cods	--	10.2	40.2	1427.2	4.0	783.6	311.6	42.2	1174.8	471.8	4265.6
Snappers	--	57.0	924.2	864.0	24.6	517.0	15.8	16.6	775.6	459.4	3654.2
Pig-face breams	--	0.8	--	2093.6	20.8	233.4	1.8	12.8	5.2	47.8	2416.2
Threadfin breams	--	400.0	1623.4	5287.8	410.0	30716.0	3617.8	800.6	6981.4	3527.2	53365.0
Other perches	100.2	1377.2	4276.6	5976.2	391.6	5377.8	2230.4	469.2	2057.4	3074.2	25330.8
Total perches	100.2	1845.2	6864.4	15648.8	851.8	37627.8	6177.4	1341.4	10994.4	7580.4	89031.8
Total fish catch	22238.2	51135.2	131368.4	264655.0	13912.2	425705.6	198423.0	76008.4	322835.0	263097.4	1769378.4

TABLE 2. *Statewise and quarterwise average landings (t) of perches (percentage in parenthesis)*

States	I quarter	II quarter	III quarter	IV quarter	Total
West Bengal	32.2 (32.1)	3.0 (3.0)	5.8 (5.8)	59.2 (59.1)	100.2
Orissa	768.6 (41.6)	104.6 (5.7)	123.0 (6.7)	849.0 (46.0)	1845.2
Andhra Pradesh	2552.2 (37.2)	1940.0 (28.3)	1245.0 (18.1)	1127.2 (16.4)	6864.4
Tamil Nadu	3388.6 (21.7)	4220.8 (27.0)	5123.0 (32.7)	2916.0 (18.6)	15648.8
Pondicherry	209.0 (24.5)	217.0 (25.5)	287.2 (33.7)	138.6 (16.3)	851.8
Kerala	7318.0 (19.4)	3745.2 (10.0)	21566.0 (57.3)	4998.6 (13.3)	37627.8
Karnataka	3246.8 (52.6)	1732.6 (28.0)	143.0 (2.3)	1055.0 (17.1)	6177.4
Goa	872.8 (65.0)	322.0 (24.0)	45.0 (3.4)	101.6 (7.6)	1341.4
Maharashtra	3265.0 (29.7)	2948.0 (26.8)	929.4 (8.5)	3852.0 (35.0)	10994.4
Gujarat	3210.0 (42.3)	878.4 (11.6)	815.2 (10.8)	2676.8 (35.3)	7580.4
Total	24863.2 (27.9)	16111.6 (18.1)	30283.0 (34.0)	17774.0 (20.0)	89031.8

Among the two coasts, west coast produces 63721.4 t of perches amounting to 71.6 % of the total perch catch (Fig. 2 a). This is mainly due to good catch experienced in Kerala, Maharashtra

(Fig. 2 c). The 'other perches' representing sixteen families consititute about 28.5% of the catch. Remaining 11.6% of the catch relates to 'major perches' such as rock-cods, snappers; and pig-face breams.

TABLE 3. *Statewise and quarterwise average landings (t) of 'major perches' (percentage in parenthesis)*

States	I quarter	II quarter	III quarter	IV quarter	Total
West Bengal	---	---	---	---	---
Orissa	15.6 (22.9)	20.6 (30.3)	2.8 (4.1)	29.0 (42.7)	68.0
Andhra Pradesh	341.6 (35.4)	220.8 (22.9)	200.4 (20.8)	201.6 (20.9)	964.4
Tamil Nadu	1623.4 (37.0)	992.6 (22.6)	1011.4 (23.1)	757.4 (17.3)	4384.8
Pondicherry	26.2 (53.0)	6.0 (12.1)	14.6 (29.6)	2.6 (5.3)	49.4
Kerala	1176.4 (76.7)	36.8 (2.4)	48.2 (3.1)	272.6 (17.8)	1534.0
Karnataka	162.4 (49.3)	27.6 (8.4)	8.8 (2.7)	130.4 (39.6)	329.2
Goa	42.0 (58.7)	6.8 (9.5)	13.4 (18.7)	9.4 (13.1)	71.6
Maharashtra	397.2 (20.3)	240.4 (12.3)	217.8 (11.1)	1100.2 (56.3)	1955.6
Gujarat	367.4 (37.5)	75.4 (7.7)	11.0 (1.1)	525.2 (53.7)	979.0
Total	4152.2 (40.2)	1627.0 (15.7)	1528.4 (14.8)	3028.4 (29.3)	10336.0

TABLE 4. *Species of 'major perches' reported from different States*

States	Family SERRANIDAE Rock cods, Groups, etc.	Family LUTJANIDAE Snappers, Sea perch, Bass, etc.	Family LETHRINIDAE Pig-face breams, Emperors Long eye, etc.
West Bengal	Species not known	Species not known	Species not known
Orissa	"	"	"
Andhra Pradesh	"	"	"
Tamil Nadu	*Epinephelus tauvina, E. malabaricus, E. undulosus, E. areolatus, E. merra, E. fasciatus, E. sonnerati, E. bleekeri, E. diacanthus.*	*Lutjanus rivulatus, L. malabaricus, L. fulviflamma, L. kasmira, L. argentimaculatus, L. waigiensis, L. lineolatus, L. decussatus, L. gibbus, Pristipomoides typus.*	*Lethrinus nebulosus, L. miniatus, L. mahsenoides, L. reticulatus, L. harrak, L. elongatus.*
Kerala	*Epinephelus diacanthus, E. chlorostigma, E. boenack, E. areolatus, E. bleekeri, E. fasciatus, E. flavocaeruleus, E. hexageenatus, E. merra, E. morrhua, E. tauvina, E. sonnerati, Plectropomus maculatus, Promicrops lanceolatus.*	*Lutjanus biguttatus, L. rivulatus, L. argentimaculatus, L. gibbus, L. johni, L. lineolatus, L. quinquelineatus, L. russelli, L. malabaricus, Pristipomoides typus, P. filamentosus, Pinjalo pinjalo.*	*Lethrinus nebulosus, L. elongatus, L. reticulaus, L. lentjan, L. elongatus, L. microdon, L. ornatus, L. mahsenoides.*
Karnataka	*Species not known*	*Lutjanus argentimaculatus, L. rivulatus.*	Species not known
Goa	"	Species not known	"
Maharashtra	*Epinephelus diacanthus, E. fasciatus, E. chlorostigma, E. areolatus E. malabaricus, E. caeruleopunctatus, Promicrops lanceolatus, Serranus grammicus.*	*Lutjanus johni, L. argentimaculatus, L. lutjanus, L. malabaricus, L. sanguineus, L. waigiensis.*	Species not known
Gujarat	*Epinephelus diacanthus, E. salmnoides, E. fasciatus.*	*Lutjanus russelli, L. malabaricus, L. johni.*	Species not known

In general, peak landings of perch-like fishes in India are observed in the third quarter

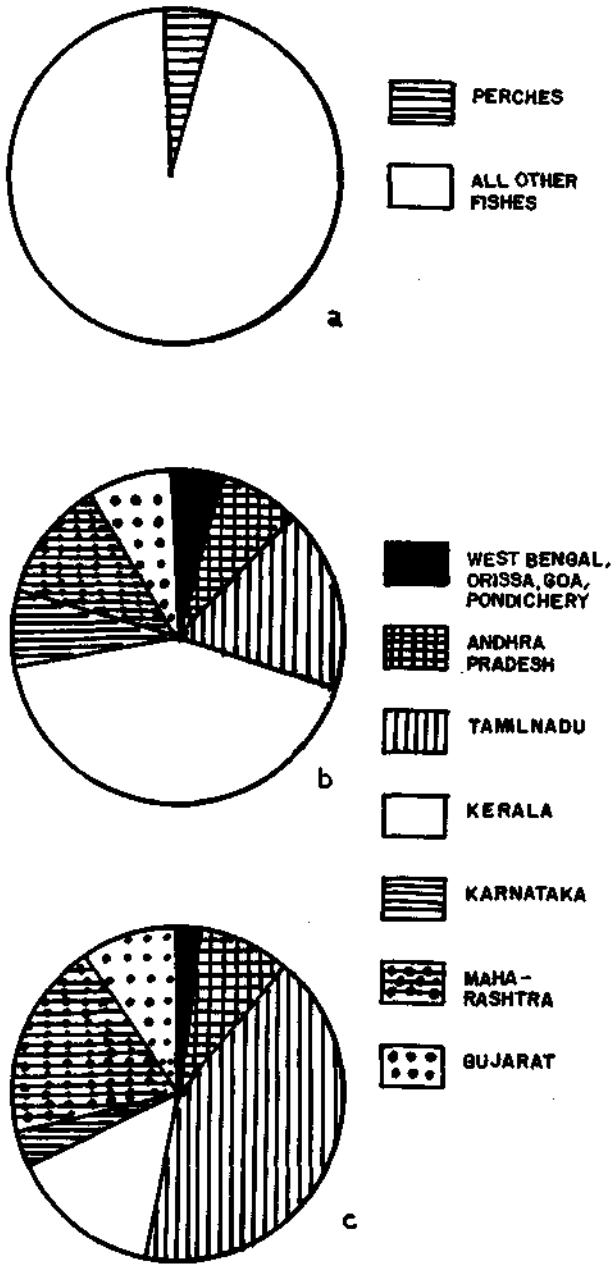

Fig. 1 a. Percentage of perches in the total fish catch of India (Average of 1985- '89), b. Statewise contribution (%) of the perches and c. major perches (%).

(Fig. 2e). This trend is seen in Kerala, Pondicherry and Tamil Nadu where 57.3%, 33.7% and 32.7% of the perch catch are recorded respectively during the third quarter. In West Bengal and Orissa and in Maharashtra peak perch fishery is on the fourth quarter. In the other States it is seen in the first quarter. Second quarter appears to be a lean season for this resource in West Bengal, Orissa and Kerala and third quarter for Karnataka, Goa, Maharashtra and Gujarat. In Andhra Pradesh, Tamil Nadu and Pondicherry the lean period is the fourth quarter (Table 2).

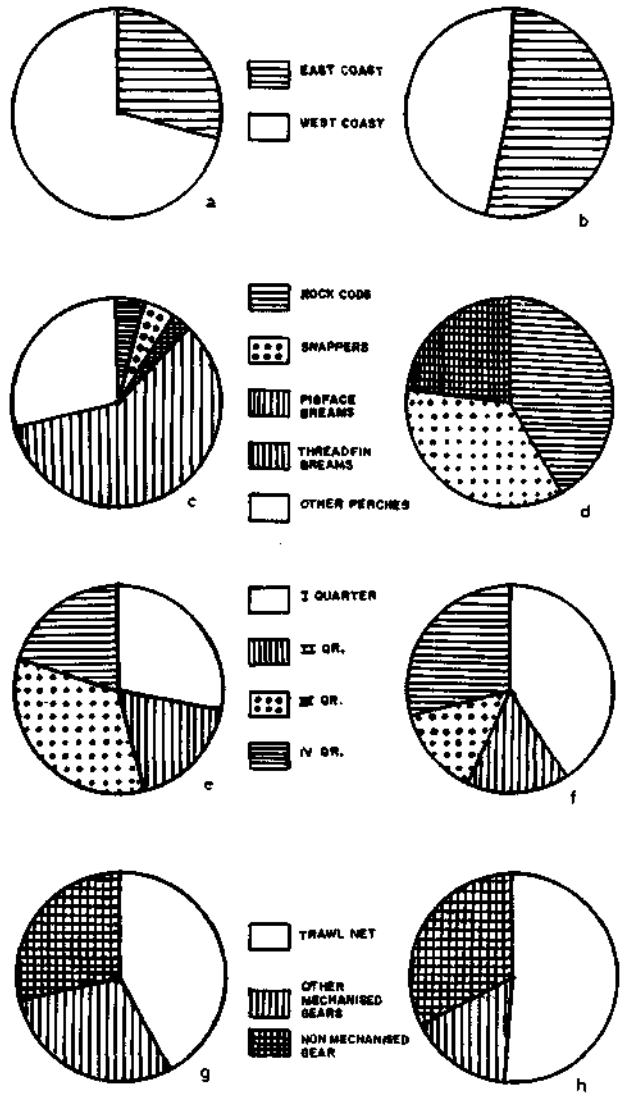

Fig. 2. Average (1985-'89) landings (%) of perches and major perches : a and b. Contribution by east and west coasts - a. perches and b. major perches; c and d. Groupwise contribution - c. perches and d. major perches; e and f. Quarterwise landings - e. perches and f. major perches; g. Gearwise contribution of major perches and h. Catch per effort of major perches.

MAJOR PERCHES

The average annual production of major perches during 1985-89 period has been esti-

mated at 10336.0 t and it formed 11.7% of the total perch and 0.6% of the total all fish catch of the country (Fig. 3). Their representation to

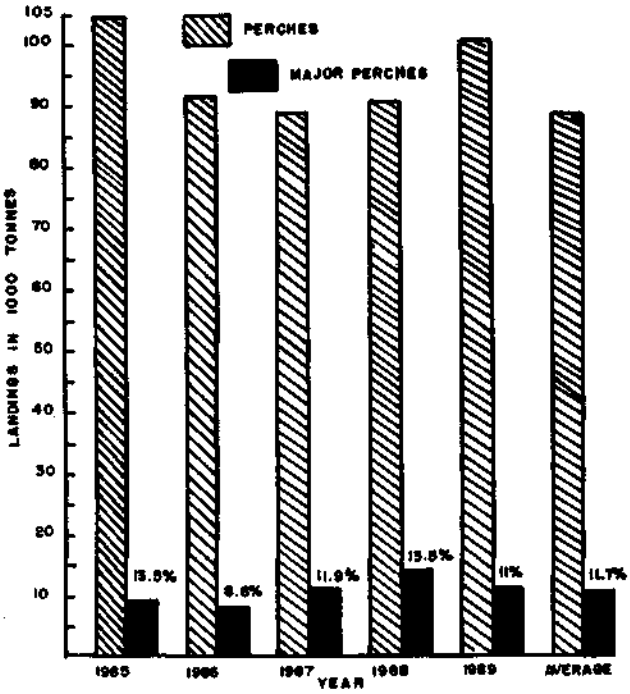

Fig. 3. Annual landings (1000 t) of perches and major perches in India during 1985 - '89 with percentage contribution of major perches.

the perch fishery is more in the east coast than in the west coast. Major perches formed 21.6% (4466.6 t) of the total perch catch in the east coast and 7.6% (4869.4 t) in the west coast (Fig. 2 b). The three groups, rock-cods, snappers and pig-face breams form respectively 41.3%, 35.4% and 23.3% of the total major perch landings of the country (Fig. 2 d). In general the peak landing falls during the fourth and first quarter periods when the sea is comparatively calm with good clarity of water (Fig. 2 f).

State-wise landings of major perches

Tamil Nadu ranks first in the production of major perches when compared to other States (Table 3). It produces 4384.8 t annually forming 42.4% of the major perch landings of India. There is fishery throughout the year with peak landings during first quarter forming 37.0% of the year's catch. Same trend is seen for individual groups also. There is fishery for all the three groups in this State and their landings are estimated at 1427.2 t, 864.0 t and 2093.6 t respectively for rock-cods, snappers and pig-face breams.

Maharashtra comes second by producing 1955.6 t of major perches annually and it forms 18.9% of the group's landings (Table 3). About 56% of the catch are landed in fourth quarter and the rest during the other three periods. Rock-cods form 60% of the catch by landing 1174.8 t which is followed by snappers amounting to 775.6 t (39.7%). About five tonnes of pig-face breams are landed in Maharashtra annually (Table 1). Peak landing is observed in the fourth quarter for rock-cods (55.4%) and snappers (58.8%) and in the third quarter for the pig-face breams (57.7%).

By producing 1534 t of major perches annually, Kerala occupies the third place and its contribution forms 14.8% of the total catch. Like Maharashtra, in Kerala also rock-cods dominate the catch (51.1%). Snappers and pig-face breams constitute respectively 33.7% and 15.2% of the catch of major perches. January to March period records about 77% of the year's catch and the fourth quarter has about 18% of the catch. The lean period is from April to September and lands 5% of the catch. Almost the same seasonality is observed for all three groups in Kerala (Table 3).

Fourth and fifth places are held by Gujarat and Andhra Paradesh by producing respectively 979 t (9.5%) and 964 .4 t (9.3%) of the major perches annually. In Gujarat the season extends from October to March for all groups, whereas in Andhra Pradesh it is first quarter for snappers (36.3%) and third quarter for rock-cods (35.3%). Fishes from all three groups form fishery in Gujarat. But in Andhra Pradesh main fishery is by snappers (95.8%) and the rest (4.2%) by rock-cods.

Karnataka's share to this resource is only 3.2% with annual average landings of 329.2 t. Perch season extends from October to March contributing 89% of the year's catch. Rock-cods are dominant in Karnataka (Table 3). Snappers deviate from the other two groups in their season of occurrence. While for rock-cods and pig-face breams the season extends from October

to March, for snappers it is in the fourth quarter. The other periods witness only stray landings.

States, it is not advisable to attempt on the distribution of each species on an all India basis. However, with the available information it is

TABLE 5. *Gearwise contribution (%) of 'major perches'*

State	Rock cods			Snappers			Pig-face breams		
	TN	OM	NM	TN	OM	NM	TN	OM	NM
Andhra Pradesh	41.9	--	58.1	5.4	10.7	83.9	--	--	--
Tamil Nadu	10.8	51.8	37.4	8.6	24.5	66.9	23.3	18.8	57.9
Kerala	4.5	91.5	4.0	4.4	92.4	3.2	--	91.2	8.8
Karnataka	98.3	0.2	1.5	89.5	10.5	--	--	--	100.0
Maharashtra	94.5	4.1	1.4	94.2	5.4	0.4	--	50.0	50.0
Gujarat	79.8	18.9	1.3	83.1	12.5	4.4	96.6	3.4	--
Average	55.0	27.8	17.2	47.5	26.0	26.5	20.0	27.2	36.1

TN = Trawl net; OM = Other mechanised unit; NM = non-mechanised unit.

About 2% of the catch representing all the groups come from Orissa (0.7%), Pondicherry (0.5%), Goa (0.7%) and West Bengl's contribution is nil to this resource. The season being October to December for Orissa and January to March for Pondicherry and Goa (Table 3).

Species composition

Some information is available on the species composition of major perches from Kerala, Tamil Nadu, Maharashtra and Gujarat (Table 4). In general the areas between Vizhinjam and Kanyakumari in west coast and Kanyakumari and Rameswaram in east coast are known for their multispecies fishery of major perches. In the absence of a full list for all seen that lethrinids do not form appreciable fishery in the northern States and in the southern States there exists a multispecies fishery for all three major perch groups.

Gear-wise contribution

Major portion of the catch of major perches in India is by trawl net. Trawl net accounts for 42% of the total catch (Fig. 2 g). It is predominant in Gujarat, Maharashtra and Karnataka (Table 5). The 'other mechanised' and non-mechanised fishing units contribute equally (29% each) to the resource. Of these two categories of units the former's contribution to the catch is more in Kerala and the latter's in Tamil Nadu and Andhra Pradesh. About 55% of

TABLE 6. *Catch (kg) per effort (unit) for the 'major perches'*

States	Rock cods			Snappers			Pigface breams		
	TN	OM	NM	TN	OM	NM	TN	OM	NM
Andhra Pradesh	0.30	--	0.02	0.50	2.70	0.30	--	--	--
Tamil Nadu	0.24	1.13	0.12	0.11	0.32	0.15	0.91	0.72	0.32
Kerala	0.09	0.90	0.04	0.08	0.70	0.03	--	0.10	0.01
Karnataka	1.60	0.01	0.04	0.06	0.02	--	--	--	0.02
Maharashtra	6.7	0.10	0.10	4.40	0.09	0.02	--	0.03	0.01
Gujarat	1.6	0.08	0.03	3.00	0.06	0.02	0.70	0.06	0.05
Average	1.75	0.37	0.06	1.36	0.65	0.10	0.81	0.22	0.08

TN = Trawl net; OM = Other mechanised unit; NM = non-mechanised unit.

rock-cods and 47.5% of snappers are landed by trawl nets. In the case of pig-face breams 43% and 33% respectively are landed by non-mechanised units and other mechanised units (Table 5). The data from Orissa, Pondicherry and Goa could not could not be compared, because of their inadequate nature.

'Other mechanised' and 'non-mechanised' units consist of a variety of gear such as handline, longline, bottom set gill net, drift gill net, boat seine, shore seine, baited basket traps, etc. and are known by a variety of local names. Among the indigenous gears, longline, botton set gill net and traps play a major role in the explotitation of major perches in India especially in Tamil Nadu and Kerala, Though prohibited, dynamite fishing is attempted secretly in places like Vizhinjam when perches congregate near the shore in the rocky beds.

The catch per effort estimated for different categories of units for the three groups of fishes are given in Table 6. The catch per effort obtained now is not encouraging as it rarely crosses the 1 kg limit. The reason for this poor recording is due to the fact that in all the above categories of units perches occur as bycatch and effort given is for the whole year without considering the perch season. If the data for the perch season alone and the units exclusively used for the exploitation of major perches are calculated separately a better picture will emerge. Madan Mohan (1983) while describing the 'Kalava' fisheries of Pulluvilai in Kerala reports a maximum CPUE of 50.11 kg for hooks and line during January 1980.

MARKETING

At present there exists good export market for major perches. Because of this the practice of auctioning the catch in the landing centre has been stopped in many places. Like prawn and cuttlefish the perches are being weighed in the beach itself and sold at pre-fixed price. The price varies from Rs. 18 to Rs. 30 per kilogram depending on the demand. Fish weighing 1 kg and above are selected for export and below that size are sent to local markets. Perches are exported in the frozen form after removing the gut. Catches from bottom set gtill nets are not preferred for export since they invariably land in spoiled or semispoiled condition. These are salted, sun-dried and sold in interior markets. France appears to be the main market for Indian major perches.

DISCUSSION

There is vast scope for increasing the landings of this multispecies resource. Exploratory surveys and other studies conducted in the past have identified certain areas rich in perch stock. Hornell (1916) suggested the existence of rich hook and lines fishing grounds off Trivandrum Coast. John (1948) reported that the sea off Anjengo and Chavara near Quilon at 60 - 70 fathoms depth provides good perch fishing grounds. According to him these grounds are not suitable for trawling, because of rocky bottom. The existence of 'Kalava' (*Epinephelus* spp.) grounds in the rocky coastal areas of Quilon - Trivandrum belt has known for long time to the fisherman of these areas and they have been fishing in these grounds for decades during January - April every year. This type of fishing is known as 'Thankal fishing' locally.

Mother-ship operations conducted by the erstwhile Madras Government during February - March 1949 in the Wadge Bank region (Chidambaram and Rajendran, 1951) yielded 15 kg of fish per handline per hour consisting of *Epinephelus* spp. (69%), *Lutjanus* spp. (9%), *Aprion pristipoma* (11%) and others. In this *Epinephelus tauvina* alone constituted 50% of the catch by weight.

Mother-ship handline operations conducted by the Travancore presidency during January - April 1949 and January - March 1950 (Gopinath, 1954) off Kayamkulam - Anjengo belt of the Kerala Coast revealed the existence of very good perch grounds in the area. The catch consisted of *Epinephelus* spp. (73%), *Lutjanus* spp. (15%) and the rest other fishes by weight.

Major perches forming one of the important fisheries at Tuticorin and their exploitation by handlines from the rocky areas lying between 5 and 40 fathoms and deeper fishing banks providing more and larger fish are reported by Chacko and Rajendran (1955). The annual catch

given by them is 220 t and it contains species like *Serranus undulosus, S. miniatus, S. salmoides, Lethrinus nebulosus, L. miniatus, L. ornatus, Lutjanus malabaricus, L. lineolatus* and *L. rivulatus*. These species are reported to be more common on fishing grounds beyond the 18 m limit known as 'Lomian kadal'.

The erstwhile Indo-Norwegian Project organised several trips in the late fifties to survey the 'Kalwa' grounds off the Kerala Coast. Their line fishing operations extended to almost all the rocky coastal areas lying in 73-110 m depth zone from Trivandrum to Cannanore. The catches from these grounds consisted of *Epinephelus chlorostigma* (80%), *E. areolatus, E. diacanthus* and *E. tauvina* (10%) and the rest by *Aprion microlepis* by number. Madan Mohan (1983) found a difference in the catch composition of 'Kalava' fisheries of the above area during 1980 - '81 season. According to him the catch consisted of Lutjanidas (72%), Serranids (21.3%), Lethrinids (3.78%) and the rest by other species.

The Research vessel *Varuna* conducted handline operations during 1963 between Mangalore and Karwar in the west coast and reported good perch grounds, rich with specis of *Epinephelus, Lutjanus* and *Lethrinus* (P. Sam Bennet, per. comm.). The same vessel conducted handline operations for rock-cods (Kalava) in the month of April to July 1977. During monsoon due to rough weather handline operations were difficult and collapsible traps were used thereafter (Anon., 1978). The same report gives details about the trap fishing conducted by the M. V. *Kalava* II also. The areas of operation were between 09° 00' - 12° 00' N and between Cochin and Chettua region respectively for the former and latter vessels. Trap fishing was done for 258.75 hrs and yielded 5717 kg of of major perches consisting of *Epinephelus chlorostigma, E. areolatus, E. tauvina, E. merra, E. diacanthus* and *Pristipomoides argyrogrammicus*. The catch/ hour for trap fishing worked out to 22.09 kg and for line fishing it was 33.67% kg and no species list was given.

The pattern of distribution of 'Kalava' grounds on the southwest coast has been described by Silas (1969) based on R. V. *Varuna* collections. According to him the 'Kalava' grounds off Kerala Coast are different from the perch fishing grounds on the Wadge Bank where trawling for perches is possible for over a larger portion of the Bank. He has recorded a variety of major perches in good numbers from the 'Kalava' grounds. They include *Epinephelus chlorostigma, E. areolatus, E. diacanthus, E. morrhua, E. tauvina, Lutjanus gibbus, Pristipomoides typus* and *Argyrops spinifer*.

In the northwest coast good fishing for perches were located by M. T. *Murena* off Bombay, off Veraval and off Okha (Bapat *et al.*, 1982). Among the major perches only lutjanids and serranids were recorded during bottom trawl surveys. The catch of *Lutjanus* spp. was estimated at 999 kg with a catch rate 2.51 kg/hr and in the case of serranids it was 2406 kg with a catch rate of 6.05 kg/hr. Species such as *Epinephelus areolatus, E. fasciatus, E. malabaricus, E. diacanthus, Promicrops lanceolatus* and *Serranus grammicus* were reported under serranids from the above area.

Apart from these reports occurrence of different species of major perches in the EEZ of India and their depthwise distribution have been reported by Sivakami (1989) and Balachandran and Nizar (1989) based on the data collected by FORV *Sagar Samapda*.

Even after all these studies Kerala's share in the major perch landings seems to be only 14.8% (Fig. 1 c). At the same time Tamil Nadu ranks first with 42.4% among all these States. This may be due to the introduction of high opening bottom trawl for pair trawling operations as reported by Kasim *et al.* (1989). These units yield not only higher catch of about four times than the conventional trawler, but also fishes of large sizes. But in the case of all perch catch Kerala ranks first by producing 42.3% of the all India catch (Fig. 1 b) and this is attributed to the good catch of threadfin-breams in that State.

Jones and Benerji (1973) expressed the scope for the increase in perch production in view of the potential yield from Indian waters. Accordingly the landings have increased from 12865 t in 1969 to 49312 t in 1978 and to

101591 t in 1989. This is achieved mainly due to the mechanisation of fishing fleet, introduction of small scale mechanised trawlers and fitting outboard motors to country crafts. Mechanisation and motorisation have changed not only the fishing pattern, but the constituent fisheries also. The use of outboard motors in the country crafts in Kerala have brought new demersal resources, mainly perches to the artisanal sector. Expansion of this type fishing operations to other regions is expected to increase not only the general fish production, but perch production also considerably.

In the light of the above findings it is high time that serious steps are taken to exploit this untapped resource by developing suitable techniques to suit the uneven shelf bottom of both the coasts. So far the experimental surveys were conducted mainly around the southern regions only. Steps to be taken to have some more surveys in the northern regions also to find out new perch grounds. At the same time care should be taken to protect the stock from over fishing also. Already *Lethrinus nebulosus* facing higher fishing pressure by gears like Podi valai, Olai valai, and Hooks and line at Tuticorin, has been indicated by Kasim *et al.* (1989). Such studies should be undertaken periodically on an all India basis atleast in some selected centres to conserve the stock.

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PERCH FISHERIES IN INDIA - A CRITICAL ANALYSIS

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ABSTRACT

Perches as a single group contribute substantially to the annual all India marine fish production. Due to various reasons there was a spurt in the production of perches from 1981 onwards. In this context an attempt is made to study the production of different groups of perches by the multi-gear system under operation in the Indian inshore coastal waters. Regionwise, Statewise, Gearwise, Groupwise, Quarterwise data were used for the present study. Maximum catchable potential of perches is arrived at 1.16 lakh tonnes by adopting Relative Response Model against the present all India annual average of 90,000 t.

INTRODUCTION

During the last fifteen years (1975 - '89), total perch landings in India have shown variations ranging from 18,000 tonnes in 1976 to 103,000 t in 1989. However, from 1981 onwards the total perch landings showed an increasing trend except for a small decline during 1987. Upto 1983 the estimates centred around an average of 38,000 t and around 87,000 t during the rest of the period. Landings from the maritime States during this period also experienced similar trend as in the case of all India perch landings. In this chapter an analysis of the total perch landings is made and the maximum catchable potential of the perch resources from the presently exploited regions is obtained using Relative Response Model.

To get the correct picture of the perch fishery a detailed study is made in this paper on the data available during 1985 - '89 on important perch groups *viz.* Rock cods, Snappers, Pig-face breams, Threadfin breams and other perches. These data on Statewise, gearwise, groupwise and quarterwise catch and effort indicated the groups that contributed more to the total perch landings and the gear responsible for such contributions (Tables 4 - 13).

TOTAL PERCH LANDINGS

All India : As indicated earlier, since 1981 there was an increasing trend in the over all perch landings in India (Fig. 1). Taking this portion for analysis, three point moving averages of landings were taken as follows and maximum catchable potential obtained (Table 1).

Using Relative Response Model (Alagaraja, 1984) the maximum catchable potential of perches from the presently exploited regions is estimated at 116,000 t against the last five year's average landings of 90,000 t.

TABLE 1. *Estimation of maximum catchable potential (000' t) using Relative Response Model*

Year	Landings	3 point moving averages	C_t	C_{t+1}
1982	45	44	44	57
1983	56	57	57	66
1984	71	66	66	79
1985	72	79	79	85
1986	93	85	85	92
1987	90	92	92	95
1988	93	95	r^2 = 0.98	
1989	103		a = 21.64	
			b = 0.8136	
			c = 116	

REGIONWISE LANDINGS

Northeast region : West Bengal and Orissa have contributed relatively less when compared to other maritime States of India. In West Bengal,

the total perch landings varied from nil (1977 and 1978) to 225 t (1979) and almost nil landings in the previous years. The landings once again plunged down to 13 t in 1980 and were around 60 t during 1981-87. However, in 1988 and 89 the landings reached 125 t and 170 t respectively. Average annual landings during 1985-89 were 100 t only.

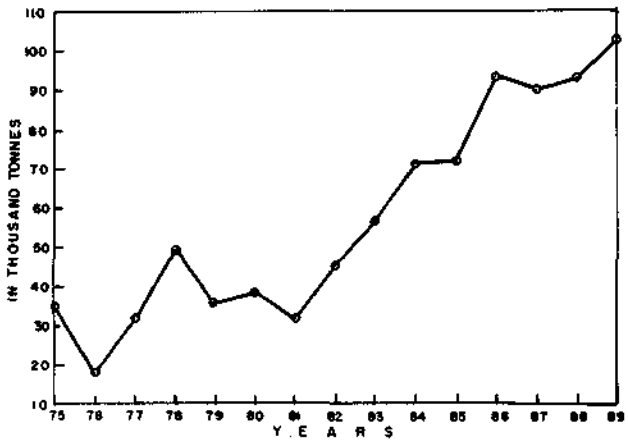

Fig. 1. Total annual perch landings in India from 1975 to 1989.

In Orissa also there was no definite trend in landings of perches, the landings ranged from about 30 t in 1976 to 2,700 t in 1987. Barring 1982 when the landings were 1800 t, the highest till 1986, the landings fluctuated with no trend at all. In 1987 the landings were maximum and then started decreasing to 1,476 t in 1989 (Table 2). The landings during the last five years centred around 1,800 t.

Southeast region : In Andhra Pradesh, Tamil Nadu and Pondicherry the landings were more when compared to Northeast region. In Andhra Pradesh there was no trend in the annual perch landings. The landings varied from 1,800 t in 1976 to 11,100 t in 1984. From 1984 onwards there was a declining trend in the landings except in 1987, when the landings were 9,400 t reaching 4,400 t in 1989 the average for the last five years being 6,900 t.

In Tamil Nadu the estimated perch landings varied from about 5,300 t in 1976 to 18,500 t in 1987. Here also there was no definite trend noticed during 1975-'89. Fluctuating around 7,000 t during 1975-81, the landings jumped to 12,400 t in 1982 and 14,300 t in 1983 then declined to 12,000 t in 1984. After 1984 the trend was almost increasing till 1989 with a jump to 18,500 in 1987 and with 17,000 t and 17,800 t respectively in 1988 and 1989. The average during 1985-89 was at 15,600 t. In Pondicherry including Karaikkal, the total annual perch landings did not exceed 1,500 t during 1975-'89. The total perch landings varied from 390 t in 1975 and 1977 to about 1,500 t in 1983. In this Union Territory also no trend was noticed in the perch landings during 1987-'89 (Table 2) and the average for the last five years was 850 t.

Southwest region : In Kerala, Karnataka and Goa perch landings were high when compared to all other regions in India. Among the maritime States, Kerala ranked first in the contribution to perch landings. In Kerala also there was no trend noticed in the perch landings during 1975-'89, the landings varied from 3,000 t in 1976 to 49,000 t in 1989. However, after 1983 almost an increasing trend was noticed barring a big jump to 46,000 t in 1986. The average landings during 1985-'89 were 38,000 t. In Karnataka, having no definite trend, the landings ranged from 170 t in 1978 to 10,000 t in 1988 with an average of 6,200 t during 1985-'89. The perch landings in Goa also did not show any trend during 1975-89 with range from 45 t in 1975 to 2,500 t in 1987 and with an average of 1,340 t during 1985-'89.

Northwest region : In Maharashtra and Gujarat also there was no definite trend in the perch landings during 1975-'89. In Maharashtra the landings were minimum during 1976 with 1,460 t and maximum during 1988 with 17,400 t with an average of 11,000 t during the last five years (Table 2). In Gujarat a minimum of about 1,000 t during 1979 and a maximum of 10,400 t during 1985 was recorded with an average of 7,600 t during 1985-89.

Island territories : The contribution to perch landings was varying from 140 t in 1976 to 1,200 t in 1988 in Andaman and Nicobar Islands and from 90 t in 1989 to 380 t in 1980 in Lakshadweep Islands. In these regions also no definite trend could be seen in the perch landings during 1975-'89. During the last five

years the average landings in Andaman and Nicobar Islands were 700 t and in Lakshadweep 120 t (Table 2).

TABLE 2. *Statewise total annual perch landings (t) during 1975-89*

Year	West Bengal	Orissa	Andhra	Tamil Nadu	Pondicherry	Kerala	Karnataka	Goa	Maharashtra	Gujarat	Andaman	Lakshadweep	India
75	15	186	4888	8153	389	14741	727	45	2484	3261	157	186	35232
76	1	31	1751	5341	769	3069	454	310	1460	4641	142	193	18162
77	0	55	2727	7918	391	14121	1489	505	2973	1213	196	211	31799
78	0	173	1945	9241	487	24989	174	781	6951	4174	234	163	49312
79	225	151	3095	5919	1004	20239	181	203	3225	973	239	203	35657
80	13	341	4639	6886	666	17814	1069	269	3712	2454	302	376	38541
81	37	122	5694	6453	932	8549	399	1183	2617	4832	192	315	31325
82	52	1790	7138	12397	1302	11179	518	908	5716	3437	361	230	45028
83	20	899	8828	14267	1372	9916	4428	1495	8244	5026	604	252	56053*
84	88	681	11125	11804	832	26882	2241	1640	5849	8688	864	205	71289**
85	67	932	8070	12120	1427	30710	1865	1350	3870	10422	864	115	71812
86	78	1650	6974	13031	895	46004	4728	1531	7888	9572	884	86	93321
87	60	2722	9362	18463	774	30135	9645	2493	9805	5638	718	157	89972
88	125	2445	5547	16804	740	32304	9956	583	17423	5359	1153	139	92578
89	171	1476	4369	17827	423	48986	4693	750	15986	6911	884	86	102562

* Includes 720 tonnes landed by large trawler
** Includes 390 tonnes landed by large trawler

Among the regions, Southwest region dominates other regions contributing 54,000 t of perches including 46,000 t of Threadfin breams followed by Northwest region with 23,000 t of perches and 12,000 t of Threadfin breams, Southeast region with 23,000 t of perches and 9,000 t of Threadfin breams and Northeast region with 2,000 t of perches (Table 3).

TABLE 3. *Regionwise Threadfin breams and total perch landings during 1981-89 (in tonnes)*

Regions	1981	1982	1983	1984	1985	1986	1987	1988	1989
Northeast region									
Threadfin breams	7	831	523	460	338	489	343	546	282
Total perches	159	1831	911	765	999	1728	2782	2570	1647
Southeast region									
Threadfin breams	4140	6722	7280	5344	5032	6636	9225	6591	9128
Total perches	13079	20837	24459	23761	21617	20900	28599	23091	22619
Southwest region									
Threadfin breams	7260	9885	12359	23026	26224	42627	30060	30985	45776
Total perches	10131	12605	15839	30763	33925	52263	42273	42843	54429
Northwest region									
Threadfin breams	4211	6164	7012	8940	7146	10426	7378	15103	12490
Total perches	7449	9153	13270	14537	14292	17460	15443	22782	22897

STATEWISE, GEARWISE, QUARTERWISE AND IMPORTANT GROUPWISE LANDINGS OF PERCHES DURING 1985-'89

West Bengal : During the five years, contribution from smaller trawlers to perch landings was nil. Other mechanised units such as gill nets

TABLE 4. *Estimated quarterwise and gearwise landings of perches (tonnes) during 1985 - '89 in West Bengal*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total			
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other perches	0	28	3	31	0	0	0	0	0	0	2	2	0	30	4	34	0	58	9	67
Total perches	0	28	3	31	0	0	0	0	0	0	2	2	0	30	4	34	0	58	9	67
Total landings	0	5413	551	5964	0	75	172	247	0	2252	889	3141	47	12969	1173	14189	47	20789	2785	23541
Effort (in units)	0	6027	12781	18808	0	1061	8945	10006	0	25684	10768	36452	124	32341	15408	47873	124	65113	47902	113139
1986																				
Rock cods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other perches	0	14	4	18	0	0	7	7	0	1	10	11	0	29	13	42	0	44	34	78
Total perches	0	14	4	18	0	0	7	7	0	1	10	11	0	29	13	42	0	44	34	78
Total landings	65	1549	5299	6913	0	26	450	476	0	1659	1279	2938	43	4967	777	5787	108	8201	7805	16114
Effort (in units)	93	8747	15837	24677	0	1873	12824	14697	0	20277	13046	33323	124	13554	16292	29970	217	44451	57999	102667
1987																				
Rock cods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other perches	0	24	17	41	0	0	2	2	0	1	6	7	0	9	1	10	0	34	26	60
Total perches	0	24	17	41	0	0	2	2	0	1	6	7	0	9	1	10	0	34	26	60
Total landings	0	11512	2225	13737	0	68	165	233	0	1247	357	1604	295	6086	786	7167	295	18913	3533	22741
Effort (in units)	0	13810	19707	33517	0	1197	8276	9473	0	11760	14875	26635	419	29331	13030	42780	419	56098	55888	112405
1988																				
Rock cods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other perches	0	56	14	70	0	0	6	6	0	2	3	5	0	9	35	44	0	67	58	125
Total perches	0	56	14	70	0	0	6	6	0	2	3	5	0	9	35	44	0	67	58	125
Total landings	0	2283	773	3056	0	6	118	124	0	1242	367	1609	308	3034	3886	7228	308	6565	5144	12017
Effort (in units)	0	7232	12601	19833	0	340	6798	7138	0	12347	11514	23861	540	23174	34832	58546	540	43093	65745	109378
1989																				
Rock cods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other perches	0	0	1	1	0	0	0	0	0	0	4	4	0	165	1	166	0	165	6	171
Total perches	0	0	1	1	0	0	0	0	0	0	4	4	0	165	1	166	0	165	6	171
Total landings	256	1242	741	2239	0	175	10	185	0	11065	1001	12066	0	20550	1738	22288	256	33032	3490	36778
Effort (in units)	798	12117	15816	28731	0	1298	1484	2782	0	22579	10547	33126	0	35676	12490	48166	798	71670	40337	112805

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

TABLE 5. *Estimated quarterwise and gearwise landings of perches (tonnes) during 1985 - '89 in Orissa*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total		
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	0	0	1	1	0	0	0	0	0	0	10	10	5	0	1	6	5	0	12	17
Snappers	0	0	7	7	0	0	14	14	0	0	0	0	0	0	1	1	0	0	22	22
Pig-face breams	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	4
Threadfin breams	76	0	0	76	0	0	0	0	0	1	0	1	262	0	1	263	338	1	0	340
Other perches	124	0	138	262	0	0	21	21	17	0	62	79	133	0	55	188	274	0	276	550
Total perches	200	0	146	346	0	0	35	35	17	5	72	94	400	0	58	458	617	5	311	933
Total landings	11312	44	5558	16914	100	98	2441	2639	1274	448	5249	6971	14308	1649	4438	20395	26994	2239	17686	46919
Effort (in units)	28965	1224	211408	241597	588	1587	101996	104171	3922	5711	140507	150140	34608	19553	117238	171398	68083	28075	571149	667306
1986																				
Rock cods	0	0	1	1	0	0	2	2	0	0	0	0	0	0	0	0	0	0	3	3
Snappers	0	0	9	9	0	0	74	74	0	0	0	0	8	15	106	129	8	15	189	212
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	139	0	24	163	0	0	4	4	0	0	0	0	322	0	0	322	461	0	28	489
Other perches	53	118	134	305	0	0	69	69	5	78	151	234	270	0	68	338	328	196	422	946
Total perches	192	118	168	478	0	0	149	149	5	78	151	234	600	15	174	789	797	211	642	1650
Total landings	19016	1391	5725	26132	54	56	3442	3552	933	1497	6305	8735	9879	1407	7214	18500	29882	4351	22686	56919
Effort (in units)	27055	7098	159488	193461	655	731	104606	105992	3763	10850	146302	160915	25201	9794	197135	232130	56674	28473	607531	692678
1987																				
Rock cods	0	0	22	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	22
Snappers	0	0	33	33	0	0	8	8	0	0	0	0	0	0	2	2	0	0	43	43
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	151	0	3	154	0	0	0	0	23	0	1	24	164	0	1	165	338	0	5	343
Other perches	941	41	199	1181	6	9	160	175	14	7	54	75	706	43	134	883	1667	100	547	2314
Total perches	1092	41	257	1390	6	9	168	183	37	7	55	99	870	43	137	1050	2005	100	617	2722
Total landings	9191	2722	9068	20981	46	164	5486	5696	3321	626	3021	6968	13826	1433	9590	24849	26384	4945	27165	58494
Effort (in units)	28358	27658	201973	257989	608	1559	142061	144228	11227	12768	117033	141028	42823	13290	289926	346039	83016	55275	750993	889284
1988																				
Rock cods	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	359	0	1	360	0	0	1	1	0	0	0	0	159	0	26	185	518	0	28	546
Other perches	217	26	212	455	2	4	12	18	66	29	57	152	1141	10	119	1270	1426	69	400	1895
Total perches	576	26	217	819	2	4	13	19	66	29	57	152	1300	10	145	1455	1944	69	432	2445
Total landings	5813	652	6273	12738	191	55	2023	2269	4408	2159	2310	8874	15259	1390	5780	22429	25668	4256	16386	46310
Effort (in units)	22992	5686	184256	212934	1160	658	100856	102674	17296	11420	90361	119077	40240	11324	172365	223929	81688	29088	547838	658614
1989																				
Rock cods	0	0	1	1	0	0	4	4	0	0	0	0	0	0	0	0	0	0	5	5
Snappers	0	0	0	0	0	0	1	1	0	0	0	0	7	0	0	7	7	0	1	8
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	190	0	17	207	1	0	9	10	0	0	3	3	57	0	5	62	248	0	34	282
Other perches	163	55	384	602	6	8	108	122	16	5	12	33	204	183	37	424	389	251	541	1181
Total perches	353	55	402	810	7	8	122	137	16	5	15	36	268	183	42	493	644	251	581	1476
Total landings	4745	1110	6485	12340	457	579	2373	3409	1801	3100	4219	9120	11379	5061	5725	22165	18382	9850	18802	47034
Effort (in units)	21807	10247	206433	238487	1853	4509	63687	70049	13783	20709	135542	170034	46253	41364	182852	270469	83696	76829	588514	749039

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

TABLE 6. *Estimated quarterwise and gearwise landings of perches (in tonnes) during 1985 - '89 in Andhra Pradesh*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total		
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	0	0	3	3	2	0	4	6	6	0	2	8	1	0	3	4	9	0	12	21
Snappers	84	0	858	942	14	0	413	427	32	0	228	260	41	0	45	86	171	0	1544	1715
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	553	0	4	557	312	0	6	318	181	0	0	181	366	0	4	370	1412	0	14	1426
Other perches	762	2	1547	2311	553	2	489	1044	645	2	246	893	412	1	247	660	2372	7	2529	4908
Total perches	1399	2	2412	3813	881	2	912	1795	864	2	476	1342	820	1	299	1120	3964	7	4099	8070
Total landings	8568	14	36012	44594	6794	15	18097	24906	10689	22	14293	25004	7399	3	16861	24263	33450	54	85263	118767
Effort (in units)	22285	124	605010	627419	25241	181	495385	520807	38439	267	639806	678512	19665	54	451069	470788	105630	626	2191270	2297526
1986																				
Rock cods	3	0	4	7	1	0	0	1	5	0	0	5	3	0	23	26	12	0	27	39
Snappers	21	0	82	103	13	0	98	111	42	0	68	110	15	7	233	255	91	7	481	579
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	799	0	13	812	387	0	99	486	260	0	1	261	503	0	10	513	1949	0	123	2072
Other perches	1172	0	798	1970	406	7	173	586	699	0	215	914	607	0	207	814	2884	7	1393	4284
Total perches	1995	0	897	2892	807	7	370	1184	1006	0	284	1290	1128	7	473	1608	4936	14	2024	6974
Total landings	11693	32	29598	41323	8833	23	18080	26936	14312	75	26420	40807	13776	34	29349	43159	48614	164	103447	152225
Effort (in units)	23594	187	580061	603842	26280	190	453219	479689	40778	553	509638	550969	25796	212	558831	584839	116448	1142	2101749	2219339
1987																				
Rock cods	0	0	0	0	4	0	7	11	3	0	38	41	0	0	0	0	7	0	45	52
Snappers	40	0	102	142	21	0	264	285	13	0	67	80	3	1	133	137	77	1	566	644
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	688	0	5	693	792	0	110	902	545	0	0	545	209	0	40	249	2234	0	155	2389
Other perches	1280	1	395	1676	507	1	2831	3339	620	0	248	868	256	0	138	394	2663	2	3612	6277
Total perches	2008	1	502	2511	1324	1	3212	4537	1181	0	353	1534	468	1	311	780	4981	3	4378	9362
Total landings	14813	153	33236	48202	8632	165	24930	33727	11381	171	15635	27187	7711	406	21927	30044	42537	895	95728	139160
Effort (in units)	23509	659	572202	596370	20626	583	427684	448893	32157	726	525821	558704	21922	2542	536450	560914	98214	4510	2062157	2164881
1988																				
Rock cods	3	0	0	3	4	0	4	8	7	0	7	14	1	0	1	2	15	0	12	27
Snappers	43	0	238	281	24	3	122	149	17	0	375	392	13	0	35	48	97	3	770	870
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	458	0	11	469	213	0	23	236	251	0	0	251	171	1	6	178	1093	1	40	1134
Other perches	798	7	820	1625	331	1	326	658	463	167	121	751	334	2	146	482	1926	177	1413	3516
Total perches	1302	7	1069	2378	572	4	475	1051	738	167	503	1408	519	3	188	710	3131	181	2235	5547
Total landings	11683	545	23023	35251	4570	209	15734	20513	8545	1542	14554	24641	9735	722	32698	43155	34533	3018	86009	123560
Effort (in units)	27397	4295	722958	754650	21069	1524	508052	530645	29207	8742	532138	570087	25613	6617	647571	679801	103286	21178	2410719	2535183
1989																				
Rock cods	7	0	11	18	15	0	3	18	0	0	3	3	4	0	19	23	26	0	36	62
Snappers	19	75	115	209	8	4	76	88	6	6	77	89	11	2	414	427	44	87	682	813
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	294	0	21	315	474	0	4	478	151	0	2	153	150	0	0	150	1069	0	27	1096
Other perches	354	5	266	625	309	0	240	549	252	3	151	406	343	18	457	818	1258	26	1114	2398
Total perches	674	80	413	1167	806	4	323	1133	409	9	233	651	508	20	890	1418	2397	113	1859	4369
Total landings	7835	1062	27235	36132	4662	814	16709	22185	8589	303	23358	32250	12446	1605	18510	32561	33532	3784	85812	123128
Effort (in units)	18406	11647	621550	651603	18210	2672	360469	381351	26854	2600	482573	512027	25106	15788	498756	539650	88576	32707	1963348	2084631

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

TABLE 7. *Estimated quarterwise and gearwise landings of perches (in tonnes) during 1985 - '89 in Tamil Nadu*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total		
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	50	39	235	324	21	3	711	735	21	0	443	464	23	66	175	264	115	108	1564	1787
Snappers	30	44	125	199	16	0	113	129	100	0	372	472	47	0	91	138	193	44	701	938
Pig-face breams	77	2	536	615	23	2	540	565	33	3	385	421	2	0	349	351	135	7	1810	1952
Threadfin breams	136	0	22	158	854	0	11	865	890	0	71	961	744	0	72	816	2624	0	176	2800
Other perches	231	72	417	720	732	4	579	1315	590	0	894	1484	507	4	613	1124	2060	80	2503	4643
Total perches	524	157	1335	2016	1646	9	1954	3609	1634	3	2165	3802	1323	70	1300	2693	5127	239	6754	12120
Total landings	16023	1147	26451	43621	24221	553	28060	52834	26656	1614	24149	52419	23305	2115	26342	51762	90205	5429	105002	200636
Effort (in units)	76041	13982	974407	1064430	94656	8774	599347	702777	121314	9642	788616	919572	92605	47552	959070	1099227	384616	79950	3321440	4214006
1986																				
Rock cods	62	100	201	363	15	43	153	211	96	1	490	587	0	55	119	174	173	199	963	1335
Snappers	32	5	144	181	22	52	36	110	43	5	55	103	0	1	88	89	97	63	323	483
Pig-face breams	166	1	711	878	172	8	346	526	262	5	160	427	30	6	465	501	630	20	1682	2332
Threadfin breams	307	0	46	353	858	8	57	923	1820	0	383	2203	392	0	132	524	3377	8	618	4003
Other perches	295	51	352	698	779	0	508	1287	745	7	1047	1799	535	0	559	1094	2354	58	2466	4878
Total perches	862	157	1454	2473	1846	111	1100	3057	2966	18	2135	5119	957	62	1363	2382	6631	348	6052	13031
Total landings	21037	4326	19517	44880	24113	2534	23237	49884	29111	1858	45937	76906	26460	8465	35452	70377	100721	17183	124143	242047
Effort (in units)	87296	60581	844577	992454	96222	44879	853402	994503	129324	62053	809969	1001346	98956	93008	965257	1157221	411798	260521	3473205	4145524
1987																				
Rock cods	21	131	850	1002	10	10	62	82	25	29	100	154	32	141	99	272	88	311	1111	1510
Snappers	15	34	870	919	1	3	80	84	43	19	60	122	20	146	88	254	79	202	1098	1379
Pig-face breams	83	37	522	642	190	31	301	522	188	83	138	409	106	27	197	330	567	178	1158	1903
Threadfin breams	1056	0	133	1189	1988	0	30	2018	2431	0	109	2540	905	0	123	1028	6380	0	395	6775
Other perches	808	17	988	1813	1398	5	709	2112	1128	26	655	1809	632	35	495	1162	3966	83	2847	6896
Total perches	1983	219	3363	5565	3587	49	1182	4818	3815	157	1062	5034	1695	349	1002	3046	11080	774	6609	18463
Total landings	34260	12586	29213	76059	33979	2931	33208	70118	34721	7068	37036	78825	31858	16344	30429	78631	134818	38929	129886	303633
Effort (in units)	105027	133922	775346	1014295	96541	67269	852752	1016562	139767	120835	838847	1099449	112123	168769	837434	1118326	453458	490795	3304379	4248632
1988																				
Rock cods	52	104	306	462	51	379	168	598	116	36	120	272	37	85	80	202	256	604	674	1534
Snappers	0	59	350	409	13	70	61	144	106	0	85	191	6	38	160	204	125	167	656	948
Pig-face breams	93	93	524	710	124	223	317	664	239	106	257	602	54	48	515	617	510	470	1613	2593
Threadfin breams	368	0	167	535	1861	0	35	1896	1305	0	88	1393	1182	0	50	1232	4716	0	340	5056
Other perches	375	49	510	934	1182	82	742	2006	758	15	1508	2281	526	23	903	1452	2841	169	3663	6673
Total perches	888	305	1857	3050	3231	754	1323	5308	2524	157	2058	4739	1805	194	1708	3707	8448	1410	6946	16804
Total landings	29573	7177	27784	64534	39425	5284	26150	70859	38226	5088	38991	82305	35586	8205	34175	77966	142810	25754	127100	295664
Effort (in units)	116153	177487	2563783	2857423	121850	96869	836795	1055514	122611	211613	917071	1251295	83004	153570	886234	1122808	443618	639539	5203883	6287040
1989																				
Rock cods	33	277	175	485	22	106	19	147	34	90	136	260	16	29	33	78	105	502	363	970
Snappers	5	44	184	233	26	7	66	99	18	85	97	200	0	4	36	40	49	140	383	572
Pig-face breams	125	150	420	695	122	56	169	347	55	94	224	373	91	17	165	273	393	317	978	1688
Threadfin breams	1069	0	68	1137	2077	0	26	2103	3053	3	99	3155	1373	0	37	1410	7572	3	230	7805
Other perches	666	88	535	1289	1234	14	368	1616	2135	30	770	2935	408	28	515	951	4443	160	2188	6791
Total perches	1898	559	1382	3839	3481	183	648	4312	5295	302	1326	6923	1888	78	786	2752	12565	1122	4140	17826
Total landings	26313	7922	26272	60507	33357	5599	30348	69304	48198	7748	32978	88924	33449	2725	26391	62565	141317	23994	115989	281300
Effort (in units)	83735	177185	827302	1088222	110236	98228	736272	944736	127599	125485	740770	993854	108997	42355	756400	906752	430567	443253	3059744	3933564

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

TABLE 8. *Estimated quarterwise and gearwise landings of perches (in tonnes) during 1985 - '89 in Pondicherry*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total		
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	2	2
Snappers	0	0	0	0	0	0	0	0	0	0	13	13	0	0	1	1	0	0	14	14
Pig-face breams	0	0	0	0	0	0	20	20	0	0	15	15	0	0	0	0	0	0	35	35
Threadfin breams	34	0	0	34	177	0	12	189	227	0	19	246	277	0	60	337	715	0	91	806
Other perches	52	0	46	98	234	0	25	259	116	0	49	165	25	0	23	48	427	0	143	570
Total perches	86	0	46	132	411	0	57	468	343	0	98	441	302	0	84	386	1142	0	285	1427
Total landings	453	42	3066	3561	1087	128	2588	3803	1826	164	3412	5402	1615	18	2081	3714	4981	352	11147	16480
Effort (in units)	4648	923	114889	120460	7009	1678	98234	106921	7365	722	70913	79000	8268	651	93391	102310	27290	3974	377427	408691
1986																				
Rock cods	0	0	0	0	0	0	3	3	0	0	3	3	0	0	0	0	0	0	6	6
Snappers	0	0	17	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	17
Pig-face breams	0	0	11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11
Threadfin breams	112	0	25	137	129	0	3	132	255	0	9	264	20	0	8	28	516	0	45	561
Other perches	41	0	42	83	69	0	18	87	71	1	24	96	9	0	25	34	190	1	109	300
Total perches	153	0	95	248	198	0	24	222	326	1	36	363	29	0	33	62	706	1	188	895
Total landings	989	0	1821	2810	1373	3	1642	3018	2424	277	2835	5536	363	18	2516	2897	5149	298	8814	14261
Effort (in units)	5360	0	65420	70780	9918	47	74954	84919	9936	2607	46862	59405	2820	543	93550	96913	28034	3197	280786	312017
1987																				
Rock cods	0	0	5	5	0	0	3	3	0	0	2	2	0	0	0	0	0	0	10	10
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3
Threadfin breams	0	0	0	0	0	0	0	0	18	0	34	52	3	0	6	9	21	0	40	61
Other perches	113	2	24	139	219	0	5	224	253	0	29	282	25	0	30	55	610	2	88	700
Total perches	113	4	30	147	219	0	8	227	271	0	65	336	28	0	36	64	631	4	139	774
Total landings	631	57	2589	3277	1119	107	2622	3848	1860	96	2609	4565	369	0	1397	1766	3979	260	8237	13456
Effort (in units)	3526	695	78549	82770	8276	1298	100466	110040	7323	2117	53832	63272	1580	0	67025	68605	20705	4110	299872	324687
1988																				
Rock cods	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	1	1	2
Snappers	0	24	33	57	0	0	2	2	0	3	2	5	0	0	0	0	0	27	37	64
Pig-face breams	0	15	8	23	0	0	2	2	0	2	6	8	0	8	0	8	0	25	16	41
Threadfin breams	185	0	11	196	71	0	6	77	99	0	0	99	4	0	25	29	359	0	42	401
Other perches	31	34	44	109	17	0	0	17	16	0	5	21	0	8	77	85	64	42	126	232
Total perches	216	73	96	385	88	0	10	98	115	6	14	135	4	16	102	122	423	95	222	740
Total landings	1082	265	1499	2846	791	164	2339	3294	1462	62	3170	4694	155	27	1988	2170	3490	518	8996	13004
Effort (in units)	4904	1612	61142	67658	2675	1408	61754	65837	8428	1253	58329	68010	806	217	64370	65393	16813	4490	245595	266898
1989																				
Rock cods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snappers	0	0	5	5	0	0	0	0	0	0	23	23	0	0	0	0	0	0	28	28
Pig-face breams	0	7	3	10	0	0	0	0	0	0	0	0	0	0	4	4	0	7	7	14
Threadfin breams	86	0	12	98	32	0	7	39	50	0	26	76	12	0	0	12	180	0	45	225
Other perches	6	1	13	20	18	0	13	31	21	0	41	62	18	0	25	43	63	1	92	156
Total perches	92	8	33	133	50	0	20	70	71	0	90	161	30	0	29	59	243	8	172	423
Total landings	886	194	1576	2656	369	558	3649	4576	1435	26	2552	4013	717	44	354	1115	3407	822	8131	12360
Effort (in units)	5566	3451	50113	59130	2963	3052	58900	64915	8801	297	61387	70485	4792	1372	25030	31194	22122	8172	195430	225724

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

TABLE 9. *Estimated quarterwise and gearwise landings of perches (in tonnes) during 1985 - '89 in Kerala*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total			
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	4	111	169	284	0	2	2	4	1	0	0	1	1	181	10	192	6	294	181	481
Snappers	0	30	80	110	0	0	0	0	0	0	0	0	0	19	8	27	0	49	88	137
Pig-face breams	0	27	35	62	0	0	1	1	0	0	0	0	0	110	29	139	0	137	65	202
Threadfin breams	2588	33	100	2721	2450	9	102	2561	17746	45	92	17883	694	38	299	1031	23478	125	593	24196
Other perches	1501	92	320	1913	257	71	77	405	169	966	519	1654	363	398	961	1722	2290	1527	1877	5694
Total perches	4093	293	704	5090	2707	82	182	2971	17916	1011	611	19538	1058	746	1307	3111	25774	2132	2804	30710
Total landings	22362	38380	16064	76806	23944	15729	14148	53821	31799	45165	26717	103681	19019	52472	20198	91689	97124	151746	77127	325997
Effort (in units)	111766	199223	473610	784599	95341	119504	291001	505845	51963	177489	203860	433312	108779	306314	521158	936251	367849	802530	1489629	2660008
1986																				
Rock cods	0	156	107	263	3	0	2	5	3	1	11	15	2	46	4	52	8	203	124	335
Snappers	0	31	42	73	0	8	6	14	0	0	20	20	0	21	0	21	0	60	68	128
Pig-face breams	0	12	185	197	0	1	4	5	0	19	0	19	0	0	67	67	0	32	256	288
Threadfin breams	2139	11	67	2217	2127	3	16	2146	30098	188	572	30858	3073	3	42	3118	37437	205	697	38339
Other perches	1000	85	303	1388	482	5	16	503	67	599	100	766	930	2974	353	4257	2479	3663	772	6914
Total perches	3139	295	704	4138	2612	17	44	2673	30168	807	703	31678	4005	3044	466	7515	39924	4163	1917	460044
Total landings	22673	25815	23121	71609	25956	15776	10517	52249	42186	66681	19304	128171	24807	92288	13782	130877	115622	200560	66724	382906
Effort (in units)	145734	224129	420133	789996	108632	226605	384445	719682	46833	231805	213372	492010	101364	328058	287820	626242	402563	1010597	1305770	2718930
1987																				
Rock cods	5	529	64	598	2	6	4	12	2	0	9	11	136	185	4	325	145	720	81	946
Snappers	0	235	40	275	0	0	0	0	0	1	2	3	0	121	1	122	0	357	43	400
Pig-face breams	0	14	7	21	0	1	0	1	0	0	19	19	0	1	32	33	0	16	58	74
Threadfin breams	4226	8	47	4281	1616	42	47	1705	15470	174	211	15855	1319	33	114	1466	22631	257	419	23307
Other perches	1704	978	151	2833	634	40	19	693	68	532	83	683	654	266	279	1199	3060	1816	532	5408
Total perches	5935	1764	309	8008	2252	89	70	2411	15540	707	324	16571	2109	606	430	3145	25836	3166	1133	30135
Total landings	31658	13476	5908	51042	42195	10134	7823	61052	37201	72095	15065	124361	32857	23759	11118	67734	143911	119464	39914	303289
Effort (in units)	163160	161875	33919	664254	170893	114498	299306	584697	62379	269991	276581	608951	189973	221581	337272	748826	586405	767945	1252378	2606728
1988																				
Rock cods	141	528	50	719	27	17	0	44	15	3	17	35	12	87	1	100	195	635	68	898
Snappers	6	745	11	762	1	0	0	1	0	0	0	0	20	98	0	118	27	843	11	881
Pig-face breams	52	95	128	275	0	2	5	7	0	99	0	99	0	2	27	29	52	198	160	410
Threadfin breams	4279	110	122	4511	2660	33	13	2706	15156	6	55	15217	2480	4	93	2577	24575	153	283	25011
Other perches	2219	416	34	2669	817	0	76	893	104	526	6	636	257	615	34	906	3397	1557	150	5104
Total perches	6697	1894	345	8936	3505	52	94	3651	15275	634	78	15987	2769	806	155	3730	28246	3386	672	32304
Total landings	42990	9296	5978	58264	50901	19489	6929	77319	52362	92434	6739	151535	49716	119275	12699	181690	195969	240494	32345	468808
Effort (in units)	221851	175853	363234	760938	211389	152674	300816	664879	87007	290831	198758	576596	342827	509765	333096	1185688	863074	1129123	1195904	3188101
1989																				
Rock cods	0	1076	44	1120	22	22	2	46	13	1	4	18	21	52	1	74	56	1151	51	1258
Snappers	5	940	32	977	40	3	1	44	0	1	0	1	1	16	0	17	46	960	33	1039
Pig-face breams	0	129	17	146	0	0	0	0	0	0	0	0	0	47	0	47	0	176	17	193
Threadfin breams	7365	23	276	7664	5120	106	54	5280	22414	838	138	23390	5608	754	31	6393	40507	1721	499	42727
Other perches	475	31	5	511	1319	281	50	1650	102	529	16	647	663	259	39	961	2559	1100	110	3769
Total perches	7845	2199	474	10418	6501	412	107	7020	22529	1369	158	24056	6293	1128	71	7492	43168	5108	710	48986
Total landings	46347	50731	6146	103224	48345	69160	6225	123730	46298	144601	9122	200021	58227	150251	12073	220551	199217	414743	33566	647526
Effort (in units)	210266	290739	426459	927464	172675	274652	336624	783951	71336	375027	199699	646062	141024	380339	290460	811823	595301	1320757	1253242	3169300

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

TABLE 10. *Estimated quarterwise and gearwise landings of perches (in tonnes) during 1985 - '89 in Karnataka*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total			
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	1	0	36	37	0	0	5	5	6	0	8	14	5	8	0	13	12	8	49	69
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	33	1	34	0	33	1	34
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	487	79	11	577	455	1	0	456	4	0	0	4	176	64	0	240	1122	144	11	1277
Other perches	167	0	13	180	151	0	3	154	0	0	12	12	104	1	34	139	422	1	62	485
Total perches	655	79	60	794	606	1	8	615	10	0	20	30	285	106	35	426	1556	186	123	1865
Total landings	8948	9081	1457	19486	8147	4932	948	14027	946	15264	5646	21856	8160	50166	5149	63475	26201	79443	13200	118844
Effort (in units)	53482	12905	60627	127014	43017	10386	48779	102182	9599	9464	78857	97920	32777	28115	112151	173043	138875	60870	300414	500159
1986																				
Rock cods	0	0	3	3	0	0	15	15	0	0	0	0	0	0	3	3	0	0	21	21
Snappers	0	0	1	1	0	0	0	0	0	0	0	0	0	19	1	20	0	19	2	21
Pig-face breams	0	0	0	0	0	0	1	1	0	0	0	0	0	0	4	4	0	0	5	5
Threadfin breams	1504	79	0	1583	1264	1	0	1265	0	0	0	0	144	0	1	145	2912	80	1	2993
Other perches	666	24	5	695	498	7	30	535	1	289	31	321	59	55	23	137	1224	375	89	1688
Total perches	2170	103	9	2282	1762	8	46	1816	1	289	31	321	203	74	32	309	4136	474	118	4728
Total landings	2135	31740	1913	54978	16239	5436	1143	22818	3788	26066	4381	34235	14034	57964	5247	77245	55386	121206	12684	189276
Effort (in units)	77142	22765	72215	172122	5399	6533	53152	113584	8297	8733	86745	103775	34261	34118	78755	147134	173599	72149	290867	536615
1987																				
Rock cods	0	0	4	4	0	0	3	3	0	0	0	0	467	1	0	468	467	1	7	475
Snappers	0	0	0	2	0	0	0	0	0	0	0	0	17	0	0	0	17	2	0	19
Pig-face breams	0	0	3	3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	4	4
Threadfin breams	1761	0	1	1762	1775	0	1	1776	0	0	0	0	1316	0	0	1316	4852	0	2	4854
Other perches	1802	4	22	1828	908	0	24	932	10	12	128	150	1371	0	12	1383	4091	16	186	4293
Total perches	3563	6	30	3599	2683	0	29	2712	10	12	128	150	3171	1	12	3184	9427	19	199	9645
Total landings	43526	10616	959	55101	22790	7513	965	31268	1124	24150	3478	38752	34857	55702	4895	95454	102297	107981	10297	220575
Effort (in units)	102686	13809	39207	154982	55193	7986	45672	108851	15226	15963	63337	94526	127044	53182	38102	218328	300149	90940	186318	576687
1988																				
Rock cods	697	1	0	698	95	0	5	100	0	0	1	1	34	6	0	40	826	7	6	839
Snappers	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	3498	0	0	3498	1771	0	0	1771	0	0	0	0	666	0	0	666	5935	0	0	5935
Other perches	2145	0	25	2170	390	3	15	408	13	47	92	152	438	12	1	451	2986	62	133	3181
Total perches	6340	1	25	6366	2256	3	21	2280	13	47	93	153	1138	18	1	1157	9747	69	140	9956
Total landings	44193	34143	2909	81245	15500	9472	1089	26061	2300	19497	2104	23901	21630	58056	1515	81201	83623	121168	7617	212408
Effort (in units)	88917	34841	26730	150488	41703	9170	49283	100156	13786	11103	50927	75816	63206	69381	47082	179669	207612	124495	174022	506129
1989																				
Rock cods	51	6	5	62	10	0	2	12	0	11	17	28	52	0	0	52	113	17	24	154
Snappers	0	2	0	2	0	0	0	0	0	1	0	1	0	1	0	1	0	4	0	4
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	2081	0	0	2081	893	0	0	893	0	0	0	0	56	0	0	56	3030	0	0	3030
Other perches	1033	7	8	1048	320	0	15	335	12	8	12	32	88	0	2	90	1453	15	37	1505
Total perches	3165	15	13	3193	1223	0	17	1240	12	20	29	61	196	1	2	199	4596	36	61	4693
Total landings	33270	25259	582	59111	15040	7699	1259	23998	4355	39294	2056	45705	7799	112392	2007	122198	60464	184644	5904	251012
Effort (in units)	113862	81286	19529	214677	57464	20799	36580	114843	21704	28540	40625	90869	20991	48753	36666	106410	214021	179378	133400	526799

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

TABLE 11. *Estimated quarterwise and gearwise landings of perches (in tonnes) during 1985 - '89 in Goa*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total			
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	205	0	0	205	0	0	0	0	0	0	0	0	0	0	0	0	205	0	0	205
Snappers	0	0	0	0	0	0	32	32	0	0	0	0	0	46	0	46	0	46	32	78
Pig-face breams	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Threadfin breams	412	0	0	412	337	2	0	339	0	0	0	0	0	0	0	0	749	2	0	751
Other perches	6	2	101	109	20	13	113	146	0	0	40	40	0	6	14	20	26	21	268	315
Total perches	623	2	102	727	357	15	145	517	0	0	40	40	0	52	14	66	980	69	301	1350
Total landings	13299	1962	652	15913	9508	661	2093	12262	1367	1228	1656	4251	3443	11506	1551	16500	27617	15357	5952	48926
Effort (in units)	37054	9091	11114	57259	33441	3271	8412	45124	2635	6750	13425	22810	9917	24074	6521	40512	83047	43186	39472	165705
1986																				
Rock cods	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	2
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	762	0	0	762	532	1	0	533	0	0	0	0	0	0	0	0	1294	1	0	1295
Other perches	17	1	5	23	0	2	10	12	0	0	1	1	68	0	130	198	85	3	146	234
Total perches	779	1	6	786	532	3	10	545	0	0	1	1	68	0	131	199	1379	4	148	1531
Total landings	14284	3832	1940	20056	7171	879	229	8279	358	1487	5265	7110	14054	3035	1871	18960	35867	9233	9305	54405
Effort (in units)	26156	26992	10364	63512	19932	10013	7968	37913	2160	9373	7095	18628	56221	19459	5113	80793	104469	65837	30540	200846
1987																				
Rock cods	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1
Snappers	0	0	0	0	0	1	0	1	0	0	4	4	0	0	0	0	0	1	4	5
Pig-face breams	0	0	0	0	0	0	0	0	0	63	0	63	0	0	0	0	0	63	0	63
Threadfin breams	1620	23	0	1643	235	0	0	235	0	0	0	0	6	14	1	21	1861	37	1	1899
Other perches	270	18	28	316	2	12	76	90	1	0	10	11	97	1	10	108	370	31	124	525
Total perches	1890	41	28	1959	237	14	76	327	1	63	14	78	103	15	11	129	2231	133	129	2493
Total landings	23703	3454	309	27466	6591	856	705	8152	214	6490	146	6850	6228	16107	874	23209	36736	26907	2034	65677
Effort (in units)	39895	27046	3943	70884	33704	5457	3346	42507	2664	5697	1920	10281	20743	21014	5872	47629	97006	59214	15081	171301
1988																				
Rock cods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	13	0	0	13	26	0	0	26	0	0	0	0	0	0	0	0	39	0	0	39
Other perches	313	0	5	318	39	3	6	48	7	48	17	72	83	8	15	106	442	59	43	544
Total perches	326	0	5	331	65	3	6	74	7	48	17	72	83	8	15	106	481	59	43	583
Total landings	22835	9384	220	32439	4239	3309	164	7712	359	2255	52	2666	3387	43553	1411	48351	30820	58501	1847	91168
Effort (in units)	38031	14535	2180	54746	19671	8900	4810	33381	2271	4011	1628	7910	8889	23807	11535	44231	68862	51253	20153	140268
1989																				
Rock cods	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
Snappers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	4	0	0	4	0	0	0	0	0	1	14	15	0	0	0	0	4	1	14	19
Other perches	551	0	3	554	135	2	10	147	1	1	17	19	0	2	6	8	687	5	36	728
Total perches	555	3	3	561	135	2	10	147	1	2	31	34	0	2	6	8	691	9	50	750
Total landings	10677	11699	285	22661	4039	5235	96	9370	3397	22626	702	26725	18	60915	177	61110	18131	100475	1260	119866
Effort (in units)	22221	15173	4756	42150	21633	13288	5893	40814	19493	12916	7298	39707	195	25791	3039	29025	63542	67168	20986	151696

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

TABLE 12. *Estimated quarterwise and gearwise landings of perches (in tonnes) during 1985 - '89 in Maharashtra*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total			
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	73	5	0	78	77	0	0	77	0	0	0	0	94	25	1	120	244	30	1	275
Snappers	51	39	0	90	23	2	0	25	0	0	1	1	94	6	13	113	168	47	14	229
Pig-face breams	0	0	1	1	0	0	0	0	0	0	13	13	0	0	0	0	0	0	14	14
Threadfin breams	689	40	0	729	781	0	0	781	331	1	0	332	666	146	0	812	2467	187	0	2654
Other perches	123	43	21	187	65	15	72	152	64	11	12	87	226	26	20	272	478	95	125	698
Total perches	936	127	22	1085	946	17	72	1035	395	12	26	433	1080	203	34	1317	3357	359	154	3870
Total landings	26524	51408	2666	80328	15746	45220	1260	62226	15587	12760	2407	30754	60365	97736	4624	162725	117952	207124	10957	336033
Effort (in units)	40170	103636	34249	178055	30737	98483	42174	171394	16656	57797	109411	183864	89076	271387	26527	396990	176639	531303	222361	930303
1986																				
Rock cods	28	14	2	44	28	15	0	43	0	2	2	4	475	73	0	548	531	104	4	639
Snappers	29	56	1	86	3	39	2	44	3	29	10	42	583	149	0	732	618	273	13	904
Pig-face breams	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Threadfin breams	1219	109	0	1328	1836	9	0	1845	277	0	0	277	1064	0	5	1069	4396	118	5	4519
Other perches	169	30	2	201	91	25	49	165	47	24	51	122	1209	111	17	1337	1516	190	119	1825
Total perches	1445	209	6	1660	1958	88	51	2097	327	55	63	445	3331	333	22	3686	7061	685	142	7888
Total landings	40426	42203	1380	84009	33368	42271	979	76618	23221	17512	2074	42807	51601	58485	1840	111926	148616	160471	6273	315360
Effort (in units)	95516	131923	27860	255299	62981	86857	45249	195087	16599	79624	73521	169744	35417	159808	88437	283662	210513	458212	235067	903792
1987																				
Rock cods	179	3	2	184	15	4	0	19	60	0	0	60	607	0	0	607	861	7	2	870
Snappers	43	174	1	218	0	122	0	122	150	16	6	172	382	55	0	437	575	367	7	949
Pig-face breams	0	1	2	3	0	0	2	2	0	0	2	2	0	0	0	0	0	1	6	7
Threadfin breams	1578	108	0	1686	2564	0	0	2564	417	10	5	432	667	0	0	667	5226	118	5	5349
Other perches	774	125	10	909	509	16	17	542	451	17	29	497	612	65	5	682	2346	223	61	2630
Total perches	2574	411	15	3000	3088	142	19	3249	1078	43	42	1163	2268	120	5	2393	9008	716	81	9805
Total landings	46283	30925	1462	78670	27631	30227	2039	59897	21533	15513	3353	40399	51065	50840	4337	106242	146512	127505	11191	285208
Effort (in units)	93439	126773	41665	262787	51353	90165	76831	218349	26706	67079	83905	177690	72186	168450	58410	299046	244594	452467	260811	957872
1988																				
Rock cods	500	31	13	544	309	12	0	321	299	6	3	308	443	18	7	468	1551	67	23	1641
Snappers	151	1	0	152	63	18	0	81	239	0	4	243	562	39	0	601	1015	58	4	1077
Pig-face breams	0	1	0	1	0	0	0	0	0	0	0	0	0	1	2	3	0	2	2	4
Threadfin breams	4723	0	0	4723	3538	0	2	3540	547	0	0	547	3536	0	0	3536	12346	0	2	12346
Other perches	481	257	1	739	249	8	16	273	298	2	17	317	959	62	5	1026	1987	329	39	2355
Total perches	5855	290	14	6159	4159	38	18	4215	1383	8	24	1415	5500	120	14	5634	16897	456	70	17423
Total landings	40286	30273	646	71205	41296	44179	1890	87365	21659	8477	1077	31213	55769	64644	5048	125461	159010	147573	8661	315244
Effort (in units)	80263	173526	28425	282214	71186	181390	51190	303766	20132	60967	77189	158288	58330	192615	36514	287459	229911	608498	193318	1031727
1989																				
Rock cods	405	25	0	430	439	10	0	449	57	2	0	59	1489	19	3	1511	2390	56	3	2449
Snappers	141	13	0	154	2	17	0	19	185	0	0	185	342	19	0	361	670	49	0	719
Pig-face breams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threadfin breams	2893	0	0	2893	2862	2	0	2864	595	56	0	561	3631	0	0	3631	9981	58	0	10039
Other perches	876	68	0	944	803	9	0	812	290	2	4	296	702	25	0	727	2671	104	4	2779
Total perches	4315	106	0	4421	4106	38	0	4144	1127	60	4	1191	6164	63	6	6230	15712	267	7	15986
Total landings	46665	35832	646	83143	43852	33990	1409	79251	18425	12098	956	31479	61793	61666	44998	168457	170735	143586	48009	362330
Effort (in units)	62273	135890	20759	218922	46484	120750	33745	200979	11937	63339	39177	114453	50996	185269	42212	278477	171690	505248	135893	812831

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

TABLE 13. *Estimated quarterwise and gearwise landings of perches (in tonnes) during 1985 - '89 in Gujarat*

Groups	I Qr				II Qr				III Qr				IV Qr				Annual Total			
	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL	TN	OM	NM	TOTAL
1985																				
Rock cods	165	21	16	202	26	9	20	55	0	0	0	0	143	6	0	149	334	36	36	406
Snappers	211	29	0	240	18	56	0	74	0	0	0	0	531	41	0	572	760	126	0	886
Pig-face breams	35	2	0	37	0	0	0	0	0	0	0	0	6	3	0	9	41	5	0	46
Threadfin breams	2866	0	0	2866	465	0	0	465	0	0	0	0	1161	0	0	1161	4492	0	0	4492
Other perches	1012	150	342	1504	419	111	259	789	6	30	313	349	1148	272	530	1950	2585	563	1444	4592
Total perches	4289	202	358	4849	928	176	279	1383	6	30	313	349	2989	322	530	3841	8212	730	1480	10422
Total landings	57275	32192	20266	109733	15206	14468	11794	41468	255	11671	4333	16259	60152	36291	23812	120255	132888	94622	60205	287715
Effort (in units)	36490	132186	141135	309811	12911	56917	133833	203661	682	70710	101467	172859	40045	144502	111115	295662	90128	404315	487550	981993
1986																				
Rock cods	66	16	16	98	1	0	0	1	26	4	3	33	89	4	6	99	182	24	25	231
Snappers	92	68	0	160	21	2	0	23	0	0	0	0	96	0	0	96	209	70	0	279
Pig-face breams	18	0	0	18	0	0	0	0	0	0	0	0	22	3	3	28	40	3	3	46
Threadfin breams	2186	0	0	2186	255	0	0	255	2101	0	0	2101	1365	0	0	1365	5907	0	0	5907
Other perches	1521	51	335	1907	53	16	109	178	17	0	199	216	428	234	146	808	2019	301	789	3109
Total perches	3883	135	351	4369	330	18	109	457	2144	4	202	2350	2000	241	155	2396	8357	398	817	9572
Total landings	57294	24501	15498	97293	17784	35126	5719	58629	3964	7565	3926	14825	25263	41540	18695	85498	104305	108732	43208	256245
Effort (in units)	42874	101514	153946	298334	20312	91725	103404	215441	2887	48863	85663	137413	21582	113346	113786	248714	87655	355448	456799	899902
1987																				
Rock cods	194	86	2	282	6	9	1	16	0	0	0	0	581	29	4	614	781	124	7	912
Snappers	180	23	0	203	1	3	0	4	0	0	0	0	76	29	0	105	257	55	0	312
Pig-face breams	25	5	0	30	0	0	0	0	0	0	0	0	10	0	0	10	35	5	0	40
Threadfin breams	902	1	0	903	241	0	0	241	23	0	0	23	862	0	0	862	2028	1	0	2029
Other perches	1118	144	105	1367	76	46	109	231	16	5	279	300	232	34	181	447	1442	229	674	2345
Total perches	2419	259	107	2785	324	58	110	492	39	5	279	323	1761	92	185	2038	4543	414	681	5638
Total landings	51177	25825	13071	90073	21811	10220	5697	37728	5505	5718	3267	14490	36401	35074	23134	94609	114894	76837	45169	236900
Effort (in units)	36619	119123	105042	260784	25228	93409	134233	252870	6696	41626	122288	170610	28352	136806	83724	248882	96895	390964	445287	933146
1988																				
Rock cods	65	14	0	79	24	2	0	26	0	0	0	0	38	14	2	54	127	30	2	159
Snappers	61	3	0	64	11	13	13	37	0	0	0	0	173	21	0	194	245	37	13	295
Pig-face breams	0	2	0	2	0	0	0	0	0	0	0	0	57	0	0	57	57	2	0	59
Threadfin breams	1226	0	0	1226	364	0	0	364	14	0	0	14	1153	0	0	1153	2757	0	0	2757
Other perches	267	4	252	523	81	5	202	288	6	0	164	170	479	26	603	1108	833	35	1221	2089
Total perches	1619	23	252	1894	480	20	215	715	20	0	164	184	1900	61	605	2566	4019	104	1236	5359
Total landings	31996	12988	10853	55837	16466	15640	5316	37422	3345	6735	7538	17618	35612	25632	35242	96486	87419	60995	58949	207363
Effort (in units)	26929	106809	208620	342358	17897	93126	102736	213759	4422	48934	188554	241910	32656	114008	186725	333389	81904	362877	686635	1131416
1989																				
Rock cods	143	28	7	178	67	5	0	72	8	2	0	10	346	40	5	391	564	75	12	651
Snappers	224	7	0	231	0	69	0	69	12	0	0	12	189	24	0	213	425	100	0	525
Pig-face breams	13	0	0	13	0	0	0	0	0	0	0	0	35	0	0	35	48	0	0	48
Threadfin breams	942	5	0	947	734	5	0	739	27	0	0	27	738	0	0	738	2441	10	0	2451
Other perches	545	14	225	784	262	55	148	465	213	345	263	821	824	37	305	1166	1844	451	941	3236
Total perches	1867	54	232	2153	1063	134	148	1345	260	347	263	870	2132	101	310	2543	5322	636	953	6911
Total landings	35150	17398	17306	69854	23547	18409	5247	47203	6358	32106	24273	62737	52642	56871	37957	147470	117697	124784	84783	327264
Effort (in units)	28698	126225	173118	328041	22421	84523	95412	202356	6377	118128	216559	341064	36343	206318	107761	350422	93839	535194	592850	1221883

TN = Trawl net; OM = Other mechanised gear; NM = Non-mechanised gear; Qr = Quarter

contributed more ranging from about 30 t in 1987 to 170 t in 1989 maximum being in first and fourth quarters. Only other perches were recorded in the landings (Table 4).

Orissa : In Orissa maximum contribution came from smaller trawlers followed by nonmechanised units and other mechanised units. Fourth and first quarters contributed the maximum according to the order of magnitude throughout the five year period. The contribution from trawlers ranged from about 620 t in 1985 to about 2,000 t in 1987. In the case of nonmechanised units the contribution ranged from 310 t in 1985 to 620 t in 1986 and in other mechanised units from 5 t in 1985 to about 250 t in 1989. Other perches contributed maximum followed by Threadfin breams (Table 5).

Andhra Pradesh : First quarter landings were more in 1985, '86 and '88 when compared to other quarters in these years. In 1987 second quarter and in 1989 fourth quarter contributed maximum to the perch landings. The contribution of perch landings in the third quarter during the five year period were also, however, good, unlike in West Bengal and Orissa. Smaller trawlers contributed more to the perch landings in this State during 1986 to 1989. In 1985 nonmechanised units landed 4,100 t which was slightly more than that of trawlers (4,000 t). Except Pig-face breams all other groups landed during the five years. Maximum contribution, however, came from other perches followed by Threadfin breams. No definite trend could be traced in the perch landings during the five year period (Table 6).

Tamil Nadu : Interestingly during the second and third quarter, perch landings were more than those of other two quarters in this State throughout the five year period. Throughout the period other perches dominated the total perch landings except in 1989, followed by Threadfin breams, Pig-face breams, Rock-cods and Snappers. This trend was more or less maintained in all the quarters too. Except in 1985 in all the years trawler landings were more ranging from 5,100 t in 1985 to 12,600 t in 1989 registering almost an increasing trend in the five year period. Threadfin breams dominated the trawl landings ranging from 2,600 t in 1985 to 7,600 t in 1989, followed by other perches ranging from 2,100 t in 1985 to 4,400 t in 1989. The others in the order of abundance in the landings were Pig-face breams, Rock-cods and Snappers. Nonmechanised units landed other perches more ranging from 2,200 t in 1989 to 3,700 t in 1988, followed by Pig-face breams, Rock-cods and Snappers. The contribution from other mechanised units was relatively very much less, the maximum being 1,400 t only in 1988 (Table 7).

Pondicherry : The total perch landings varied from 420 t in 1989 to 1,430 t in 1985. A clear cut declining trend in perch landings was noticed in this Union Territory. Threadfin breams dominated the perch landings throughout the five year period except in 1987 when other perches dominated the perch landings. Contribution from other groups was relatively less. Landings in the second and third quarters were more than in other two quarters in 1985, '86 and '87 whereas in 1988 and '89 the contribution in the first quarter and third quarter respectively was maximum. There was otherwise no quarterwise trend in this Union Territory. Trawlers contributed maximum in all the five years followed by nonmechanised gears. Contribution from other mechanised units was very much less (Table 8).

Kerala : During the five year period the total perch landings in Kerala varied from 31,000 t in 1985 to 49,000 t in 1989. Throughout the period Threadfin breams dominated the perch landings contributing more than 75% of the perch landings. This is particularly due to the maximum contribution of smaller trawlers to the perch landings in the State. Small trawlers contributed more than 80% of the perch landings. The contribution from other mechanised and nonmechanised units was less than 20%. Landings in the third quarter accounted for more than 50% of the annual perch landings in all the five years. The contribution in the first quarter ranked second in 1985, '87, '88 and '89. In 1986 fourth quarter ranked second. The contribution from other quarters in the rest of the years was relatively less. Among the groups as mentioned earlier, Threadfin breams dominated the perch landings followed by other perches maintaining the quarterwise trend of the total perch landings (Table 9).

Karnataka : The total perch landings in Karnataka fluctuated from about 1,900 t in 1985 to 10,000 t in 1988. There was an increasing trend in the perch landings till 1988 then the landings dropped to 4,600 t in 1989. Threadfin breams dominated the perch landings in all the five years followed by other perches and Rock-cods. Contribution from Threadfin breams ranged from 1,300 t in 1985 to 6,000 t in 1988, from other perches from 490 t in 1985 to 4,300 t in 1987 and from Rock-cods from 20 t in 1986 to 840 t in 1988. Landings in the first quarter were always higher than those in other quarters followed by the second quarter except in 1987 when fourth quarter landings ranked second. Major contribution came from the small trawlers, the contribution varying from 1,600 t in 1985 to 9,700 t in 1988 forming more than 98% of the total perch landings in 1987 and '88. Trawlers landed more of Threadfin breams resulting in high percentage of this group in the total perch landings as indicated above. Contribution from other mechanised and nonmechanised units was relatively very much less (Table 10).

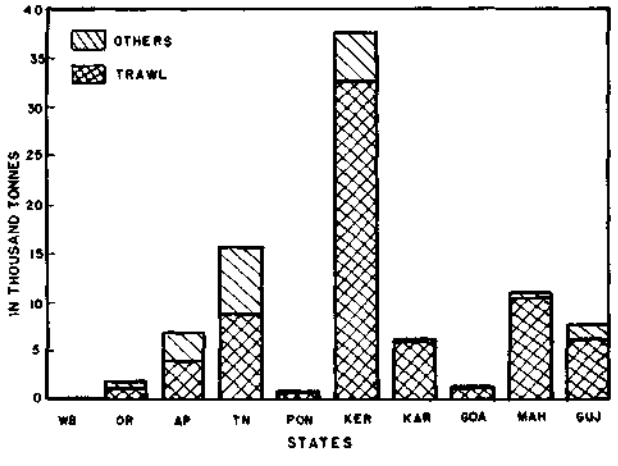

Fig. 2. Average (1985-'89) annual gearwise contribution of perches.

Goa : The total perch landings started increasing from 1,350 t in 1985 to 2,500 t in 1987 then decreasing to 580 t in 1988 and then going up to 750 t in 1989. In the first three years maximum contribution to the perch landings came from Threadfin breams followed by other perches. In the last two years the trend was reversed in that other perches contributed more to perch landings followed by Threadfin breams. The contribution from Threadfin breams showed an increasing trend in the first three years from 750 t in 1985 to 1,900 t in 1987 and suddenly dropping to 40 t in 1988 and to 20 t in 1989. First quarter landings were always maximum followed by second quarter except in 1988 when fourth quarter ranked second. The landings in other quarters were relatively less during 1985-'89. Among gears, trawls dominated in their contribution to the perch landings followed by nonmechanised units. The contribution of trawls followed the over all trend so far as their quarterwise contribution was concerned (Table 11).

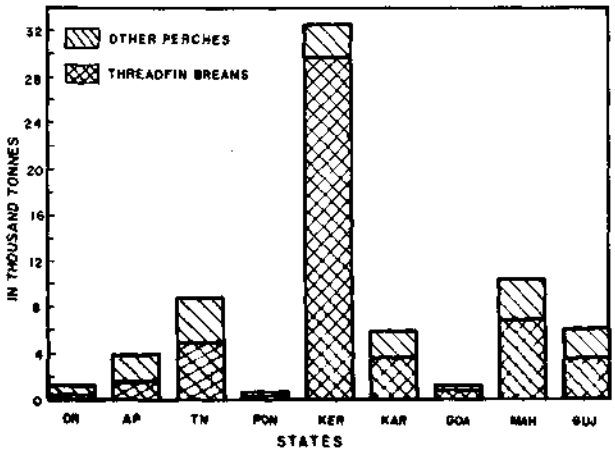

Fig. 3. Average (1985-'89) annual trawl contribution of perches.

Maharashtra : An increasing trend in the total perch landings was noticed during 1985-'88 the landings ranging from 3,900 t in 1985 to 17,400 t in 1988 and dropping to 16,000 t in 1989. Among the groups Threadfin breams dominated the perch landings following the same trend as the total perch landings starting with 2,700 t in 1985 reaching the maximum at 12,300 t in 1988 and dropping to 10,000 t in 1989. Other perches, Rock-cods, Snappers and Pig-face breams were landed in the order of abundance. Landings in the fourth quarter were high in 1985 (1,320 t), '86 (3,700 t) and 1989 (6,230 t). However, in 1987 the landings in the second quarter was maximum (3,249 t) and in 1988 the landings in the first quarter was maximum (6,200 t). In general landings in the third quarter was high throughout the period 1985-'89. Major contribution to the perch landings came from trawls forming more than 90% of the total perch landings followed by the contribution of other mechanised units and nonmechanised units.

Their contribution in the quarters followed the same trend as that of total perch landings as mentioned above (Table 12).

Gujarat : There was a decreasing trend in total perch landings during 1985-'88. The landings started declining from 10,400 t in 1985 to 5,400 t in 1988 and increased to 6,900 t in 1989. In the first three years the landings in the first quarter were maximum followed by those in the fourth quarter and in the last two years, landings in the fourth quarter were maximum followed by those in first quarter. Other perches, followed by Threadfin breams dominated the perch landingss in 1985, '87 and '89. During 1986 and '88 Threadfin breams dominated the total perch landings followed by other perches. Rock-cods, Snappers and Pig-face breams were also landed in this State. About 80% of perch landings were accounted for by the trawls followed by nonmechanised units and other mechanised units. The trend in the landings of these units followed that of total perch landings as indicated above (Table 13).

CONCLUSIONS

Over the last five years 1985-'89, the average all India perch landings were about 90,000 t against the catchable potential of 1,16,000 t in the presently exploited area extending upto 50 m depth. Kerala ranked first with an average of 38,000 t out of which 33,000 t was contributed by trawls, 4,000 t by other mechanised units and 1,000 by the nonmechanised units. Tamil Nadu ranked second with an annual average of 16,000 t, trawlers contributing 9,000 t mechanised units 1,000 t and non-mechanised units 6,000 t. Maharashtra landed 11,000 t of perches on an average during 1985-'89, trawlers contributing 10,000 t and others 1,000 t. Gujarat landed annually an average of 8000 t out of which trawlers contributed 6000 t. Andhra Pradesh contributed 7000 t annually in the last five years with trawler contribution of 4,000 t and nonmechanised units 3,000 t. The annual average perch landings during 1985-'89 from Karnataka were 6,200 t out of which 6,000 t were landed by trawl units. The contribution from the rest of the States was less than 2,000 t per year (Fig. 2). Major contribution to perch landings came from trawls among gears and Threadfin breams among groups. Among the States that contributed to heavy landings of Threadfin breams by trawls Kerala ranked first with 30,000 t followed by Maharashtra (7,000 t), Tamil Nadu (4,900 t), Karnataka and Gujarat (4,000 t each) (Fig. 3). Domination of other perches in the total perch landings during 1985-'89 in the entire Northeast region comprising West Bengal and Orissa and also Andhra Pradesh and Tamil Nadu in the east coast and Gujarat in the west coast was noticed. In the rest of the States, Threadfin breams contributed the maximum. Landings in the first and the fourth quarters were maximum in West Bengal, Orissa and Andhra Pradesh in the east coast and in Maharashtra and Gujarat in the west coast during the five year period whereas those were maximum in the second and third quarters in Tamil Nadu in the first and third quarters in Pondicherry, in the third quarter in Kerala and in the first quarter in Karnataka and Goa.

The present level of exploitation of perches is below the level of maximum catchable potential as indicated above and atleast 1,00,000 t can be exploited without affecting the perch resources from the presently exploited regions.

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PERCH FISHERY BY TRADITIONAL METHODS AT TUTICORIN

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ABSTRACT

The perch fishery at Tuticorin by traditional fishing units are dealt with. Rocky areas upto 50 m depth support many species of perches falling under ten broad families. On an average perches contribute 10.9% in the total fish landings by traditional gears. Lethrinids, Serranids and Nemipterids form the bulk of perch landings with Lethrinids alone contributing 38.1%. Drift nets, hook and lines and bottom set gill nets are the important gears in the fishery. Perch fishery by motorised as well as non-motorised units are described in detail.

INTRODUCTION

Perches form about 10% in the total marine fish landings by traditional methods and contribute annually over 500 tonnes to the total fish catch at Tuticorin. The present study gives a detailed account of the exploitation of perch resources by indigenous craft and gear, analysing the data for the ten year period from 1979 to 1988. On an average perches contribute 31.0 to 88.5 t every month to the fishery. Lowest monthly landing of 31.3 t was in 1982 and the highest recorded landing of 88.6 t was in 1985. Traditional fishermen have, with long experience handed down for generations, evolved special skill to capture the perch resources scatterred sparcely among reefs and rocky crevices. Main gear used by them in deeper waters is the hook and line operated from "Tuticorin type" boats and Catamaran. In shallower waters and around islands indigenous drift nets and bottom set gill nets are being used in the perch fishery. Recent technological innovations include the addition of out-board motors (motorisation) to the sail boats.

FISHING GROUNDS

Tuticorin is a major fishing centre in the Gulf of Mannar, southeast coast of India. Main perch grounds are the rocky areas called "paars" situated beyond 15 m limit. Description of the rocky areas around Tuticorin is given by Chacko and Rajendran (1955). The rocks and reefs support variety of corals, sponges and sea grass (Mahadevan and Nayar, 1967). Perches are scattered along the Parrs and are seldom known to occur in dense schools in the reef and rocky areas which extend upto 50 m depth. The area is not much affected directly by the great Indian Ocean Currents. Only currents prevalent in the region are the monsoon drifts connected with Southwest and Northeast Monsoons. Seasonal distribution of salinity in this region show important connection between salinity and prevalent water currents (Sewell, 1925).

PERCHES

Fishes falling under ten families are recorded among the perches at Tuticorin. The families and constituent species are given below following the classification adopted by Munro (1955).

FAMILY LATIDAE

Lates calcarifer

Psammoperca waigiensis

FAMILY SERRANIDAE

Epinephelus malabaricus

E. tauvina

E. undulosus

E. areolatus

E. fasciatus

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E. merra
Enneacentrus sonnerati
Plectropomus maculatus

FAMILY PRIACANTHIDAE
Priacanthus hamrur

FAMILY LUTJANIDAE
Lutjanus rivulatus
L. malabaricus
L. fulviflamma
L. argentimaculatus
L. kasmira
L. vaigiensis
L. gibbus
L. lineolatus
L. decussatus
L. sanguineus
Aprion virescens

FAMILY NEMIPTERIDAE
Nemipterus delagoae

FAMILY LOBOTIDAE
Lobotes surinamensis

FAMILY SCOLOPSIDAE
Scolopsis bimaculatus

FAMILY PLECTORHYNCHIDAE
Gaterin schotaf (*Diagramma griseum* Day)

FAMILY LETHRINIDAE
Lethrinus nebulosus
Lethrinella miniata
L. mahsenoides
L. ramak

FAMILY SIGANIDAE
Siganus javus
S. oramin

TREND OF PERCH FISHERY AT TUTICORIN

Annual and monthly trends of relative abundance of perches in the fishery, and groupwise and gearwise importance are examined. Records of perch landings are mostly in the form of periodical reports and Chacko and Rajendran (1955) analysed the catches in detail. They recorded 220 t of perch landings at Tuticorin. Fishing techniques and catch trends improved since then. Estimated total perch landings by indigenous units during 1979 to 1988 came to 6509.3 t.

Annual fishery

Lowest annual landings was during 1982 with 375.4 t. Highest recorded landing of 1062.7 t was in 1985. In between the extremes, fluctuations in catch were noticed. Annual landings were higher than average during 1980 and 1984 to 1987. During other years annual fishery was lower than the ten year average. Continuous higher landings were noticed from 1984 to '87. Similarly three years of continuous low catch was seen from 1981-'83 (Table 1 and 2).

TABLE 1. *Monthly landing (t) of perch at Tuticorin by indigenous gear*

Year	Monthly average	Months which recorded higher landings than the average
1979	39.2	February, March, January, September, October.
1980	66.4	January, March, February, September, May.
1981	42.8	March, January, April, February, November.
1982	31.3	September, November, August, January, October.
1983	48.4	September, May, January, February, July.
1984	67.1	October, September, August, June, May.
1985	88.6	March, April May, July, September.
1986	62.9	January, August, September, May, February.
1987	63.7	July, September, March, April, May.
1988	32.0	June, July, August, April, May.

Monthwise fishery

Average monthly perch landings fluctuated between 31.3 t in 1982 and 88.6 t in 1985

(Table 1.) Good catches were recorded during January, February, March and September. During other months catches were moderate. General observations do not clearly indicate any seasonal preponderance of perches at Tuticorin, though perches may be caught in increased quantities during some months.

TABLE 2. *Annual landings in tonnes of perch at Tuticorin (monthwise) by indigenous gear during 1979 - 1988*

Months	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Total
January	63.075	159.240	73.101	40.743	61.134	48.450	75.667	108.747	54.794	18.931	703.882
February	78.506	102.588	62.629	29.702	58.463	45.221	59.809	64.856	48.072	25.942	575.788
March	68.382	111.698	126.152	20.915	47.949	61.097	137.646	33.926	93.912	33.491	735.168
April	25.282	39.375	71.374	31.396	41.506	30.028	124.339	61.503	88.712	39.663	553.178
May	27.774	68.900	Nil	18.878	63.078	65.274	106.463	73.304	68.615	38.066	530.352
June	14.087	42.773	26.593	10.980	50.011	71.633	75.570	42.037	50.456	64.105	448.245
July	16.242	13.921	13.374	24.512	55.915	70.360	100.434	63.639	118.747	59.908	537.052
August	46.275	52.022	260.223	45.102	37.809	89.016	69.436	81.756	59.968	42.527	549.934
September	56.458	99.171	21.816	48.836	75.930	121.604	89.149	74.763	101.577	15.152	704.456
October	47.323	48.578	21.433	39.536	31.726	135.025	81.011	54.555	49.552	19.164	527.903
November	6.933	28.868	51.122	46.604	33.215	43.004	73.126	57.073	23.363	16.061	379.369
December	20.600	29.513	19.931	18.249	24.525	24.192	70.118	39.206	6.344	11.298	263.976
Total	470.937	796.647	513.548	375.453	581.261	804.904	1062.768	755.365	764.112	384.308	6509.303

TABLE 2 A. *Percentage of perch in total fish landings*

Year	Total fish landings (t)	Total perch landings (t)	%
1979	6464.4	470.9	7.3
1980	7457.4	796.6	10.7
1981	5470.6	513.6	9.4
1982	4512.0	375.4	8.3
1983	6712.6	581.3	8.7
1984	6602.6	804.9	12.2
1985	7438.8	1062.8	14.3
1986	5503.4	755.4	13.7
1987	5807.0	764.1	13.2
1988	3491.1	384.3	11.0
Total	59459.9	6509.3	10.9

Percentage of perch fishery

Perches contributed 10.9% in the total fish landings by traditional fishing gears during the period. Of the 59459.9 t of estimated fish caught during the ten years by traditional fishermen, perches contributed 6509.3 t. During 1979 total contribution of perch was 7.3% in total fish landings. Percentage contribution increased to 10.7% in 1980. There was gradual decrease to 9.4% in 1981 and 8.3% in 1982 (Table 2 A). Gradual increase in contribution of perches to the total fish catch was recorded during the next three years to the extent of 8.7% in 1983, 12.2% in 1984 and 14.3% in 1985. Next three years witnessed a decline in perch fishery in comparison with total fish landings with 13.7% in 1986, 13.2% in 1987 and 11.0% in 1988 (Table 3).

TABLE 3. *Groupwise perch landings at Tuticorin (1979 - 1988)*

Perch groups	Landingss (t)	%	Rank
Latidae	83.031	1.28	6
Serranidae	1714.918	26.35	2
Priacanthidae	45.719	0.70	8
Lutjanidae	714.768	10.98	4
Nemipteridae	998.397	15.34	3
Lobatidae	41.443	0.64	9
Scolopsidae	78.414	1.20	7
Plectorhynchidae	317.161	4.87	5
Lethrinidae	2481.374	38.1	1
Siganidae	34.078	0.52	10

Groupwise fishery

Of the ten groups of perches recorded in the fishery, Lethrinids ranked foremost

contributing 38.1% in total perch landings. During the ten year period total contribution of Lethrinids came to 2481.3 t. Next in importance was Serranids, which contributed 26.3% in total perch landings. Nemipterids came third in importance with 15.3% catch. Other groups according to the level of contribution to the total perch fishery by traditional gears are in Table 3.

Gearwise fishery

Five gears were regularly employed in perch fishery at Tuticorin eventhough, perches in stray numbers occurred in all gears (Table 4). Details of craft and gear operated by traditional fishermen with mesh size of nets and hook numbers are given by Bennet and Arumugham (1989). An important development during the period was the introduction of motors to the crafts employed in the traditional fishery. This not only enhanced the catch of boats by allowing more fishing time, but also brought the catches earlier for the market to get improved prices. The irony of it was that in the perch fishery no appreciable improvement in total landings was noticed due to motorization from that of non-motorised boat landings (Table 5).

TABLE 4. *Gearwise perch landings at Tuticorin (1979 - 1988)*

Name of gear		Landings (t)	%	Rank
Drift net :	Paru valai			
	motorised	40.908	0.63	10
	non-motorised	672.981	10.33	4
Drift net :	Podi valai			
	motorised	72.222	1.12	9
	non-motorised	116.578	1.79	7
Handline :	*motorised*	167.864	2.58	6
	non-motorised	1948.965	29.94	1
Longline :	*motorised*	1079.812	16.59	3
	non-motorised	1903.432	29.24	2
Gill net :	Sinki valai			
	motorised	76.678	1.18	8
	non-motorised	429.863	6.60	5

Line fishery : By far major portion of perch landings in the traditional sector was by Longline and Handlines. Hooks and lines were ideally suited for fishing the perches distributed over wide areas and are not concentrated in large shoals. Over 45.8% of perch caught during the ten years of study were by Longline units. Next important gear for perch was the Handline. Perches formed an important component in Handline catch contributing 32.5% in total perch landings. Hook No. 5 to 14 were used by Handline units.

TABLE 5. *Motorised and non-motorised boats Average (t) of perches at Tuticorin (1979 - 1988)*

Groups	non-motorised 1979-1988	motorised 1986-1988
Latids	7.17	3.77
Serranids	124.84	155.52
Priacanthids	4.01	1.89
Lutjanids	46.91	81.89
Nemipterids	93.61	20.77
Lobatids	3.80	1.15
Scolopsids	7.19	2.18
Plectorhynchid	27.68	13.44
Lethrinids	188.74	198.00
Siganids	3.24	0.57
Total	507.18	479.18
(For 1986-88)	634.59	

Drift net fishery : Drift nets of different sizes are the next important gear used in the fishery. Large meshed drift nets called *Paru valai* were used in deeper waters and over rocky Paars where larger perches were scattered. Paru valai caught 10.9% total perch caught in the traditional sector. Other fishes caught in Paru valai include seerfish, tuna, carangids, barracuda, sharks, *Rachycentron* and rays. Smaller perches were caught by smaller meshed drift nets called *Podi valai* operated at the fringe of Paars or at adjoining sandy stretches. Podi valai were operated during all the months to catch medium sized fishes including perches. Only 2.9% of the total perch caught were landed by Podi valai. Remaining portion comprised of tuna, seerfish, *Chirocentrus* sp., *Hilsa toli*, barracuda, sharks and carangids.

Gill net fishery : Bottom set gill net called *Sinki valai* (lobster net) were operated near coral and shingle bottom areas for crabs and

3lobsters. Perches formed major portion in Sinki valai landings. Of the total perch landings 7.8% were by Sinki valai. Other fishes like rays, soles, parrotfish and catfish as well as crabs and lobsters formed the Sinki valai landings.

Seasonwise fishery

Analysis was made on the total perch fishery by different gears during different months. The fishery was carried on all round the year and no definite periods of high catch was noticed from fishery data. From pooled gearwise fishery data highest aggregate landing was recorded during March with 735.1 t. Lowest catch for the ten year period with 263.9 t was recorded during December. The Northeast monsoon with turbulent months of October to December seems to be unfavourable for perch fishery in the Gulf of Mannar in general and especially off Tuticorin where major perch grounds are located. Boats seldom venture into deep water perch grounds during the period.

When landing data for various gears were treated separately, Paru valai units reported good landings during January to May with highest catch of 114.1 t in January. July recorded lowest aggregate catch of 22.6 t. Podi valai units showed improved landings from March to August with the peak at 25.0 t in June. Handlines which landed about 32.5% of total perch catch reported January to March and November as good season for perches by this gear with the peak in January. Longline units popularly called *Ayiramkal thoondil* accounted for over 45.8% of perches mostly larger ones. Except for November and December all the months recorded good landings. Peak perch fishery by Longline was noticed during March and September. By bottom set gill nets good quantity of perch was caught between June and September with high catch during September.

Group - gear relationship

Perch groups Serranids, Lutjanids and Lethrinids were caught by all the gears. Handline (non-motorised) units landed nine groups of perches and Podi valai non-motorised units recorded eight groups. *Diagramma* sp. was landed by all gears except motorised Handline units. Likewise, *Lates calearifer* was fished by all units operated except motorised units of Handline and Longline. Handline units were alone used to catch *Nemipterus* spp. *Priacanthus hamrur* was caught by Handlines and Longlines.

Paru valai (motorised)

Six groups of perches mostly larger forms were landed by motorised Paru valai units. Most common group was Lethrinids forming 40.56% of perch caught by the gear. Other groups were Serranids, Lutjanids, Latids, Plectorhynchid and Lobatids.

Paru valai (non-motorised)

This gear also was commonly operated for larger perches and landed seven groups. As in the case of motorised units, *Lethrinus* ranked first in the catches with 37.89% in total perch caught by the gear. Perch groups with lesser percentage were Serranids, Lutjanids, Plectorhynchid, Latids, Labotid and Siganids.

Podi valai (motorised)

A total of 72.2 t of perches were landed by this gear contributed by six groups. Lethrinids formed the important group with 48.55%. Other groups according to their contribution were Lutjanids, Serranids, Scolopsid, Plectorhynchid and Latids.

Podi valai (non-motorised)

Landings by non-motorised units were considerably more than of motorised units. Total landings came to 116.578 t. Lethrinids formed 47.32% followed by Serranids, Latids, Siganids, Lobatid, Lutjanids, Plectorhynchid and Scolopsid.

Handline (motorised)

Selected groups of perches were dominant by this gear which was an important one in perch fishery. *Lethrinus* spp. ranked foremost in total catch by the gear closely followed by Nemipterids. During particular seasons large quantities of *Nemipterus* spp. were caught by Handline. Serranids, Lutjanids and Scolopsid were also landed by this gear.

Handline (non-motorised)

Good quantities of Nemipterids and Lethrinids were landed by this gear which was very popular around Tuticorin for Nemipterids fishery. Nemipterids formed 48.0% in the total perch catch by this gear. Other groups caught include Lethrinids, Serranids, Lutjanids, Scolopsid and Plectorhynchid.

Group - gear relationship of perches at Tuticorin (1979 - 1988)

Gear	Groups of perches										Total number of groups in each gear
	1	2	3	4	5	6	7	8	9	10	
Paru valai											
motorised	x	x	-	x	-	x	-	x	x	-	6
non-motorised	x	x	-	x	-	x	-	x	x	x	7
Podi valai											
motorised	x	x	-	x	-	-	x	x	x	-	6
non-motorised	x	x	-	x	x	x	x	x	x	x	8
Handline											
motorised	-	x	-	x	x	-	x	-	x	-	5
non-motorised	x	x	x	x	x	-	x	x	x	x	9
Longline											
motorised	-	x	x	x	-	-	-	x	x	x	6
non-motorised	x	x	x	x	-	-	-	x	x	x	7
Sinki valai											
motorised	x	x	-	x	-	x	-	x	x	x	7
non-motorised	x	x	-	x	-	x	-	x	x	x	7
Total	8	10	3	10	2	5	4	9	10	7	

1 - Latids, 2 - Serranids, 3 - Priacanthid, 4 - Lutjanids, 5 - Nemipterids, 6 - lobatid, 7 - Scolopsid, 8 - Plectorhynchid, 9 - Lethrinids, 10 - Siganids.

Longline (motorised)

Operation of this gear covers large areas over rocky Paars and deeper waters and is important in the perch fishery. Lethrinids formed 41.75%. Serranids, Lutjanids and small quantities of other groups also were landed by this gear.

Longline (non-motorised)

As in the case of motorised Longline units Lethrinids and Serranids were important groups of perches landed contributing 48.0% and 35.62% respectively in total perch catch.

Different groups of perches landed by different nets

Groups	Motorised unit			Non motorised unit		
	Landings (t)	%	Rank	Landings (t)	%	Rank
Paru valai						
Latids	3.532	8.63	4	36.668	5.45	6
Serranids	13.942	34.08	2	196.149	29.15	2
Lutjanids	5.494	13.43	3	113.000	16.79	3
Lobatid	0.377	0.92	6	25.335	3.76	5
Plectorhynchid	0.975	2.38	5	41.104	6.11	4
Lethrinids	16.588	40.56	1	254.990	37.89	1
Siganids	--	--	-	5.735	0.85	7
Total	40.908			672.980		
Podi valai						
Latids	1.950	2.70	6	11.971	10.27	3
Serranids	11.194	15.50	3	19.697	16.90	2
Lutjanids	13.536	18.74	2	6.652	5.71	6
Lobatid	--	--	-	9.350	8.02	5
Scolopsid	5.512	7.63	4	0.270	0.23	8
Plectorhynchid	4.968	6.88	5	1.999	1.71	7
Lethrinids	35.060	48.55	1	55.169	47.32	1
Siganids	--	--	-	11.470	9.84	4
Total	72.222			116.578		
Hand-line						
Latids	--	--	-	10.598	0.54	9
Serranids	35.756	21.30	3	249.298	12.79	3
Priacanthids	--	--	-	26.385	1.35	7
Lutjanids	2.302	1.37	4	81.437	4.18	4
Nemipterids	62.317	37.12	2	936.080	48.03	1
Scolopsid	1.038	0.62	5	71.594	3.66	5
Plectorhynchid	--	--	-	51.239	2.63	6
Lethrinids	66.451	39.59	1	511.039	26.23	2
Siganids	--	--	-	11.295	0.59	8
Total	167.864			1948.965		
Long-line						
Latids	--	--	-	11.835	0.62	6
Serranids	396.205	36.70	2	678.076	35.62	2
Priacanthids	5.662	0.52	5	13.672	0.72	5
Lutjanids	216.838	20.08	3	246.223	12.93	3
Plectorhynchid	9.224	0.85	4	36.532	1.92	4
Lethrinids	450.783	41.75	1	914.324	48.04	1
Siganids	1.100	0.10	6	2.770	0.15	7
Total	1079.812			1903.432		
Sinki valai						
Latids	5.833	7.61	5	0.644	0.15	7
Serranids	9.461	12.34	3	105.140	24.46	3
Lutjanids	7.483	9.76	4	21.801	5.07	4
Lobatid	3.063	3.99	6	3.318	0.77	5
Plectorhynchid	25.150	32.80	1	145.970	33.96	2
Lethrinids	25.084	32.71	2	151.886	35.33	1
Siganids	0.604	0.79	7	1.104	0.26	6
Total	76.678			429.863		

Lutjanids, Plectorhynchid, Latids, Priacanthid and Siganids were also represented in motorised Longline catches.

Bottom set gill net (motorised)

Though operated for crabs and lobsters, many groups of perches were landed by the bottom set gill nets commonly called Sinki valai (lobster net). Plectorhynchid formed the important group forming 32.8% of perch landed by this gear followed by Lethrinids, Serranids, Lutjanids, Latids and Siganids in addition to lobsters and crabs.

Bottom set gill net (non-motorised)

Among the seven groups of perches landed by this gill net Lethrinids formed the major group contributing 35.3%. Other groups of perches landed include Plectorhynchid, Serranids, Lutjanids, Lobatid, Siganids and Latids.

SPECIESWISE LANDING PATTERN

Occurrence of various species of fish in different larger perch groups during various months (Table 6) reflects the quantity of various species caught according to their availability for fishing by different gears.

Latidae **(Koduwa)**

Two well known species of Latidae were caught at Tuticorin. In small number *Lates calcarifer* commonly called "Koduwa" occurred in Paru valai catches throughout the year. The period from November to January and June landed good quantities of *L. calcarifer* by Paru valai units. Handline units recorded good *L. calcarifer* fishery in February. Other units landed sporadic catches of this species. Estimated catch for the ten year period came to 40.2 t. "Koduwa" is a much sought after fish in the fresh fish trade. *Psammoperca waigiensis* locally called "Senkanni" was landed by small meshed Podi valai units in insignificant quantities especially during March. Other gears did not record this species.

Serranidae **(Kalawa, Rock-cods)**

Large and medium sized Serranids were caught by all the gears. *Epinephelus malabaricus* was the common species in the group and was caught in good quantities throughout the year by Paru valai, Handline, Longline and Sinki valai. No season of abundance could be recorded for this species. Among many other Serranids landed *E. tauvina, E. undulosus* and *E. aerolatus* recorded good fishery. All the species of Serranidae represented in the area were caught one time or other in various gears operated for perches, though some species in small numbers.

Lutjanidae **(Snappers)**

Many species of Lutjanidae were landed by drift nets, hook and lines, and gill nets. *Lutjanus rivulatus* and *L. malabaricus* formed the important species in perch fishery during all the months. Good landings were reported by Paru valai and Longline units. Other important species include *L. fulviflamma, L. argentimaculatus* and *L. kasmira*. Many other species of Lutjanidae landed at Tuticorin and their estimated total landings are given in Table 6.

Priacanthidae **(Bulls-eyes)**

Only one species of Priacanthidae, *P. hamrur* was reported from traditional fisheries at Tuticorin. All the catch of this species came from Handline and Longline units. January to May period was considered to be good for *Priacanthus* sp. though, some other months also recorded good landings.

Nemipteridae **(Threadfin bream)**

Handline units accounted for all the Nemipterid landings. *Nemipterus delagoae* was caught during all the months and an estimated 998.3 t was caught during the ten year period. Fairly good fishery for this species was reported during January, March, July and November.

Scolopsidae **(Monocle bream)**

Only *Scolopsis bimaculatus* was reported from the fishery. Podi valai and Handline units landed all the catch with greater share of the fishery by Handline units. Varrying quantities of Scolopsid were caught during all the months with no particular important season.

Lobotidae (Triple tail)

Drift nets and gill nets landed Lobotid throughout the year in small numbers. Conventional species landed by Paru valai, Podi valai and Sinki valai was *L. surinamensis*. The species was landed in small numbers without any important season and formed 3.6% in Paru valai, 4.9% in Podi valai and 1.2% in Sinki valai landings.

Plectorhynchidae (Sweet-lips)

All the gears operated for perches at one time or other landed *Diagramma griseum* the common representative of the group. The species was most common in Sinki valai landings. Larger specimens were caught in Paru valai and Longline units. Other units landed medium sized and smaller fish. Small quantities of the species were reported throughout the year.

TABLE 6. *Specieswise and gearwise average landing (t) of perches (1979 to 1988)*

Species	Paruvalai	Podivalai	Handline	Longline	Sinkivalai
Lates calcarifer	40.200	5.941	10.598	11.835	6.477
Psammoperca waigiensis	---	7.980	---	---	---
Epinephelus malabaricus	110.638	19.684	169.067	548.232	57.530
E. tauvina	28.719	4.916	32.336	162.185	22.828
E. undulosus	24.030	1.655	23.822	96.338	11.416
E. areolatus	18.996	1.192	14.742	85.597	10.273
Enneacentrus sonnerati	11.294	1.754	17.018	69.654	6.846
Epinephelus fasciatus	8.724	0.887	7.091	53.365	5.708
E. merra	5.126	0.531	13.039	37.426	---
Plectropomus maculatus	2.564	0.272	7.939	21.484	---
Priacanthus hamrur	---	---	26.385	19.334	---
Lutjanus rivulatus	51.815	11.293	36.613	181.749	14.823
L. malabaricus	20.075	3.045	8.817	65.453	4.715
L. fulviflamma	11.815	1.476	6.923	51.729	3.064
L. argentimaculatus	9.224	1.212	6.899	43.510	2.506
L. kasmira	7.379	1.075	6.605	31.732	1.948
Aprion virescens	5.918	0.715	2.046	24.489	2.228
L. waigiensis	2.648	0.392	2.795	19.955	---
L. gibbus	4.328	---	2.237	15.420	---
L. lineolatus	---	0.982	8.010	---	---
L. decussatus	3.610	---	1.117	16.312	---
L. sanguineus	1.682	---	1.677	12.712	---
Nemipterus delagoae	---	---	998.397	---	---
Lobotes surinamensis	25.712	9.350	---	---	6.381
Scolopsis bimaculatus	---	5.782	72.632	---	---
Diagramma griseum	42.079	6.967	51.239	45.756	171.120
Lethrinus nebulosus	199.658	67.268	446.295	1019.202	126.665
Lethrinella miniata	44.763	11.481	65.598	209.394	32.612
Lethrinus mahsenoides	17.100	6.395	37.789	87.605	11.831
L. ramak	10.057	5.085	27.808	48.906	5.862
Siganus javus	4.638	6.882	7.907	2.902	1.111
S. oramin	1.097	4.588	3.388	0.968	0.597
Total	713.889	188.800	2116.829	2983.244	506.541

***Lethrinidae* (Pig-face bream)**

Lethrinids formed one of the major groups of perches accounting for 38.1% of total perch landings and were much sought after by trade and local consumers. Common species of the group *L. nebulosus* formed 74.9% of the group and was caught by all gears throughout the year. Good fishery by Paru valai, Handline and Longline units was reported during January. *L. nebulosus* alone contributed 28.6% in all group perch landings during the period. Next important species in the group was *L. miniatus* accounting for 14.6% in the total fishery of the group. Many other species contributed the rest of the landings.

***Siganidae* (Spine-foot)**

Two species *Siganus javus* and *S. oramin* were represented in the fishery. They were never abundant in any of the gears and their contribution to perch fishery was also marginal.

Impact of Motorisation

Motorization has picked up very fast among traditional fisheries at Tuticorin as elsewhere along the coasts (Balan *et al.*, 1989). Started on a small scale in 1986, many indigenous crafts have been fitted with inboard type propellers (Bennet and Arumugham, 1991). Consequently reduction in non-motorised crafts was noticed.

Total average catch per units have given rosy picture for motorised units when compared to that of non-motorised units (Bennet and Arumugham, 1991). On the other hand, average all group perch catch for 1986 - 1988 did not give any advantage for motorised units. Average perch catch for non-motorised units came to 637.59 t as against 479.18 t for motorised units. Certain perch groups such as Serranids, Lutjanids and lethrinids recorded increased landings in motorised units. All other groups showed distinctly higher landings by non-motorised units.

Quality fishes such as tuna, seerfish, sharks, barracuda, polynemids and *Rachycentron* over took the total perch landings by motorised Paru valai catches. Conventional important fishes like barracuda and carangids were also landed in good quantity motorised Podi valai units schooling fishes like tuna, seerfish, carangids, barracuda and ribbonfish were landed more than perches. By Handlines, Nemipterids, Belonids and seerfish were landed in good quantity. Eventhough, perches were in abundance by motorised and non-motorised Longline units sharks, carangids, seerfish and rays were also landed in increased numbers. Bottom set gill nets also landed good quantity of rays, carangids, catfish, soles and Parrotfish giving second place to perches in both motorised and non-motorised units.

Perhaps the widely and sparcely distributed perches could not be taken in large quantities during the operational period of motorised units than other schooling fishes. Non-motorised units very often stay overnight at fishing grounds and catch increased quantity of perches that move to different depths during the night.

Remarks

Perches are one of the most important groups in the fisheries at Tuticorin contributing many conventional forms to the trade and local consumers. The foregoing observations have dealt exclusively with the fishery of perches by indigenous gears spreading over a ten year period from 1979 to 1988. Annual average landings came to 650.9 t with lowest catch of 375.4 t during 1982 and highest in 1985 of 1062.7 t. Fishery experienced fluctuations of four years of higher catch above annual average and equal number of years of lower catch. Apart from November and December when turbulent sea conditions prevail in the fishing grounds, due to Northeast monsoon, all other months recorded fairly good perch fishery. In total fish landings, perches constitute 7.3% to 14.3% (average 10.9%) by all indigenous gear combined.

Quality fishes of great commercial importance such as Lethrinids, Serranids, Latids and Lutjanids constituted about 76.7% in perch fishery, Lethrinidae alone formed 38.1%. Commercially less important perches formed 23.3% in total perch fishery with Nemipterids alone forming 15.3%.

It may be assumed that various species of perches are encountered independently and catches are obtained by effect of gear saturation over the fishing grounds of rocks and adjacent sandy stretches. Large concentrations in accessible areas give rise to better catch rates by particular gears. The most important example is the fishery for Lethrinids by Longline units and the fishery for Nemipterids by Handline units. Occurrence of dominating species as well as lesser important species month after month in fairly reasonable quantities, gives an indication of the extension of the range of stock and limited nature of fishing operations. Only a portion of the underlying population of perches is accessible to the fishery. Density of fish in core area of the range is not diminished and catch rates can be maintained at present level of fishing.

Motorisation of existing indigenous crafts was thought to be a boon to get better catch rates. No doubt, the legendary transformation of simple Tuticorin type boats into motorised units have recorded increased catch rates in many groups of fishes especially pelagic shoaling ones. On the other hand, results of observations indicate that perches are better caught by non-motorised units than motorised units. After all, the whole point about motorisation is to see what is better for the fisherman irrespective of the fish groups of caught.

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4

PERCH FISHERY AT VIZHINJAM

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ABSTRACT

Perch fishery at Vizhinjam (76° 59' 15" E and 08° 22' 30" N) for a period of 9 years (1979 - '87) is presented here.

Rocky inshore realms coupled with offshore 'Kalava' grounds make the southwest coast of India a congenial habitat for perches and perch-like fishes. Vizhinjam, a fishing village situated right on this coast, hence, forms an important centre for any detailed study pertaining to this group in general. Fifty species of perches and perch-like fishes belonging to 8 families have been identified from the commercial landings at Vizhinjam. A preliminary analysis of the larvae and juveniles from this area shows that early stages of several species of this group occur almost throughout the year in the collections.

Fishing activities at Vizhinjam are now controlled by the artisanal sector and 9 different types of gears are employed in exploiting them; but none is specific to perches. The annual landings of perches fluctuate considerably from year to year and their percentage in total fish catches fluctuated from 3.78 to 8.37 during the above period. Maximum landing of perches at Vizhinjam is noted during postmonsoon (September - January) followed by the monsoon period (June - August). But taking the landing of each family individually it could be seen that 5 families showed peak landing in the postmonsoon. While assessing the total landing quantitatively the families Nemipteridae, Lethrinidae and Priacanthidae respectively occupied the first 3 ranks in the order of abundance. Landings of all the other families, their seasonality are also given in detail.

Though 9 different gears are in vogue at Vizhinjam, Hooks and line account for about 73% of the total perch landings. Landing of perch by all the other gears, their seasonality both quantity and quality-wise, are also discussed.

The first attempt to mechanise the traditional crafts was made at Vizhinjam in 1982 with five OBM (Yamaha, Kerosene, Model - 8 BE, 7 HP) fitted catamarans and canoes. Gradually their number swelled upto 500 by 1988. In this process many traditional crafts got converted into OBM units and this 'revolution' was silent as the beneficiaries were fishermen themselves. Fishermen at Vizhinjam accepted OBM fitted country crafts as an 'ideal unit' as it has considerably improved the daily income.

No doubt, OBM units have helped the fishermen a lot in cutting down the time spent for reaching to and from the fishing ground enabling them to avail more time in the distant virgin grounds in search of quality fishes. This has even prompted other country crafts concentrating in the inshore areas to switch on to OBM fishing. This, in turn, resulted in a drastic cut in the effort expended in the inshore realms and this directly ended up in an overall cut in landings. Families of perches which showed such a dip in landings were Lutjanidae, Theraponidae, Ambassidae and Siganidae while in the case of Nemipteridae, Priacanthidae, Serranidae and Lethrinidae, there was an improvement in the landings due to OBM fishing in the distant grounds.

The present account is of special interest since it covers the perch fishery of both pre- (1979-'82) and post- (1983-'87) mechanisation (OBM) periods. The fishery of premechanisation period was somewhat of a regular nature with common species constituting the catches year after year with CPUE fluctuating moderately, but the fishery of postmechanisation period witnessed a drastic change in the species composition and seasonality with invariably higher CPUE. Hence an account of this sort depicting the salient features of the perch fishery at Vizhinjam for 4 years prior to the introduction of OBM and then comparing it with the next 5 years during which the OBM fishery has gained considerable momentum, may serve as basic work on OBM introduction by the traditional fishermen of Vizhinjam. Future changes in the fishery pattern at Vizhinjam, if any, may be evaluated by comparing it with the presently reported results.

Suggestions are also made to monitor the productivity of the distant fishing grounds on a long-term basis and to adopt corrective measures as and when required. Some methods to improve the landing from the inshore realms are also briefly outlined.

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INTRODUCTION

Vizhinjam, a small village situated about 16 km south of Trivandrum (76° 59' 15" E 82° 2' 30" N) is an important fish landing centre. The protection offered by breakwaters makes it a weather proof landing and launching centre for any type of fishing craft that is in vogue at present. The completion of the proposed Fishing Harbour is expected to considerably improve the fishing activities at this centre.

The Research Project on "Resource characteristics of perches" was initiated at Vizhinjam in 1979 with a view to evaluating the relative abundance of perch resources and to study the growth, feeding and reproductive biology of important species of perches. The availability of perches throughout the year was monitored first and from this study it could be noted that even though perches constitute quantitatively a sizeable fraction in total landings, no species was available allthrough the year in appreciably good numbers, this condition rather renders difficult to proper biological sampling. Attempts were initiated to study the biology of atleast a few of the more common species, but these attempts were not fully successful as the composition changed at short intervals and also the numerical abundance of the given species was often not adequate to yield statistically sound samples. However, what data could be collected on the biology of Nemipterids and other perches were published later (Madan Mohan, 1983, Madan Mohan and Gopakumar, 1981; Madan Mohan and Velayudhan, 1984, 1988).

The studies on perches at Vizhinjam were therefore confined mainly to an assessment of the total landings, group-wise analysis, etc. The inconsistency of the component species in landings made a species-wise analysis and quantitative assessment rather difficult. This prompted an assessment of perch landings family-wise and this procedure has been followed at Vizhinjam from 1979 to 1987.

PERCH LANDINGS AT VIZHINJAM

The coast extending from Kovalam to Cape Comorin is rocky and the crevices and outcrops provided by this enviornment afford a congenial habitat for many of the species of perches to dwell in. Exploratory fishing carried out by R. V. *Varuna* showed that the depth range 75 to 100 m along the southwest coast between 08° and 13° N has a hard bottom and many well known 'Kalava' grounds are located in this depth range. These 'Kalava' grounds are "small areas of hard bottom with shallow ridge-like features or outcrops which rise 2 - 5 m from the ground level and have a very irregular profile" (Silas, 1969). Such outcrops, according to the above author, do not form extensive beds, but occur in patches and this type of structure is seen only in the northern area of the southwest coast, but towards the southern part, *i.e.* 08° to 09° N, the 'Kalava' grounds tend to be "in the form of less elevated boulders or boulder-like formations and their numbers are also relatively more than the disjunct outcrops seen further north". The 'Kalava' grounds seen in this zone are smaller in area and are quite similar to those seen in the Wadge Bank. Several such 'Kalava' grounds could be located along the southwest coast. The 'Kalava' grounds off Kerala Coast are different from the perch fishing grounds on the Wadge Bank where trawling for perches is possible over a large portion of the Bank (Silas, 1969).

'Kalava' is a term used generally to include a heterogeneous group of percoid fishes popularly known as rock-cods, grunters, groupers, snappers, pig-face, etc. 'Kalava' fishing along the different areas of the southwest coast of India has been discussed at length in different works and in this context those of Hornell (1916), on 'Kalava' fishery on the Wadge Bank; of John (1948) dealing with 'Kalava' fishing off Anjengo and Chavara; of Gopinath (1954), on 'Kalava' fishing south of Alleppey and Wadge Bank and of Sivalingam and Medcof (1957) indicating the possibilities of trawling on the Wadge Bank are worth mentioning.

The above works provide the early information available on the perch resources in the offshore 'Kalava' grounds. But finding this to be insufficient for undertaking any systematic exploitation in these beds, the INP Vessel R. V. *Kalava* initiated the task of charting out the various 'Kalava' grounds located on the southwest coast of India between 08° N and 14° N.

The data collected by this vessel, as well as by R. V. *Varuna* on several previous occasions, have later been worked out by Silas (1969). The details on both quantitative and qualitative abundance of perches, their biology, number and extent of 'Kalava' grounds, etc. have been dealt with in detail by Silas (1969) (Fig. 1).

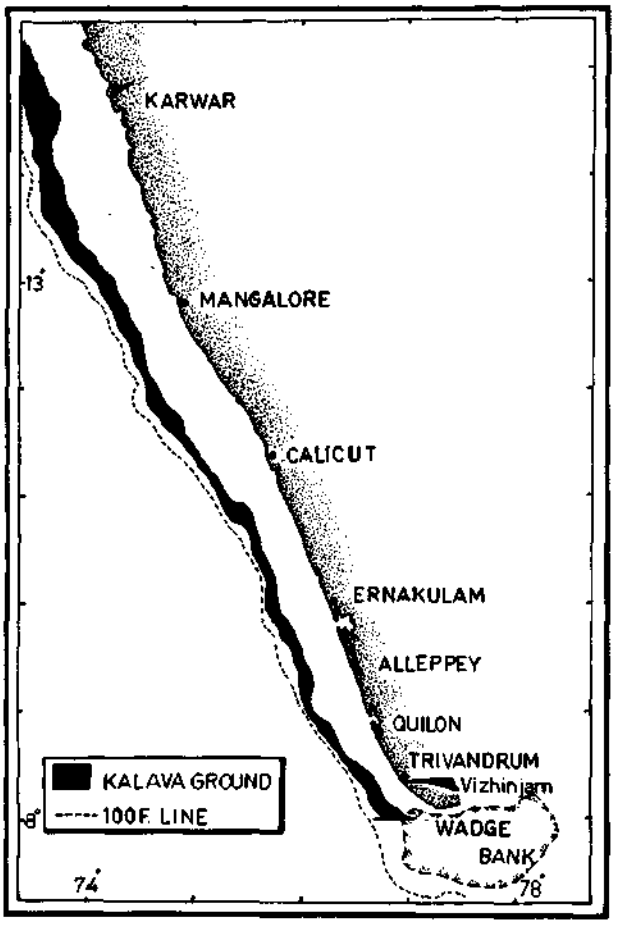


Fig. 1. Southwest coast of India showing the distribution of the offshore 'Kalava' grounds. Vizhinjam where the present studies were undertaken, is also marked (After Silas, 1969)

The survey had indicated good prospects for perch fishing along this coast. But, more data on recruitment, growth rate, age, etc. of different species of perches are needed for a proper estimation of the resource and its sustainable yield.

The inshore areas of the southwest coast between Vizhinjam and Cape Comorin is rich in young ones of both pelagic and demersal fishes. The third author could collect young ones of as many as 50 species of fishes from the inshore landings. Several young ones of perches were in these collections and they are studied and published elsewhere.

The general pattern of water circulation on the west coast of India is well known through several works. It is clock-wise during the southwest monsoon and anti clock-wise during the northeast monsoon (Ramamirtham, 1967). Therefore, the currents off the west coast of India flow southward parallel to the coast during the southwest monsoon and postmonsoon months and mainly north ward from December to February (northeast monsoon). The reversal of currents, thus, has considerable influence on the breeding, larval abundance, migration of fish eggs and larvae, etc. of this coast (David Raj and Ramamirtham, 1981).

The above paragraphs will attest that the geographic setting of Vizhinjam is ideally suited for the exploitation of rock dwelling animals, especially perches. The most commonly employed gear at Vizhinjam is the Hooks and line, which accounts for a sizeable fraction of perch landings. Recently when mechanisation of traditonal crafts such as catamaran and canoe, with OBM started at Vizhinjam, it became easier for the fishermen to cover the more distant fishing grounds. This trend which started by the end of 1982, gained momentum gradually. Now, such mechanised traditional crafts are able to explore deeper grounds (range 60 to 80 m) situated at a distance of 20 to 25 km off Vizhinjam that are well beyond the reach of traditional nonmechanised crafts. No doubt, this has considerably increased the catch per trip of all such mechanised units as it is true with any virgin ground, but a systematic study of these new grounds will have to be undertaken to see whether they are uniformly productive and at which level the fishing pressure could be maintained in future. Since mechanisation has just set in, it is possible to monitor the impact of mechanisation more closely at Vizhinjam than at any other place where mechanised vessels have been in operation for a considerably longer period.

The term Perch, as used here, includes fishes belonging to the following 8 families :

Serranidae, Lutjanidae, Lethrinidae, Theraponidae, Siganidae, Priacanthidae, Nemipteridae and Ambassidae. A list of more common species in the commercial landings at Vizhinjam is given below.

List of Species

Family Serranidae (Groupers, rock-cods, etc.)

Cephalopolis boenack (Bloch)
C. sonnerati (Val.)
Epinephelus diacanthus (Val.)
E. chlorostigma (Val.)
E. areolatus (Forsskal)
E. bleekeri (Vaillant)
E. fasciatus (Forsskal)
E. flavocaeruleus (Lac.)
E. hexagonatus (Schneider)
E. merra Bloch
E. tauvina (Forsskal)
Promicrops lanceolatus (Bloch)
Plectropomus maculatus (Bloch)

Family Lutjanidae (Snappers, sea-perch, bass, etc.)

Lutjanus argentimaculatus (Forsskal)
L. biguttatus (Val.)
L. decussatus (Cuvier)
L. fulviflammus (Forsskal)
L. gibbus (Forsskal)
L. johni (Bloch)
L. lemniscatus (Val.)
L. lentjanus Bloch [= *L. lineolatus* (Ruppell)]
L. malabaricus (Bl. & Sch.) [= *L. sanguineus* (Cuv.)]
L. quinquelineatus (Bloch)
L. rivulatus (Cuvier)
L. russelli (Bleeker)
L. sebae (Cuvier)
Pristipomoides filamentosus (Val.)
P. typus Bleeker
Pinjalo pinjalo (Bleeker)

Family Lethrinidae (Pig-face breams, Emperors, large-eye, etc.)

Lethrinus mehsenoides Val.
L. nebulosus (Forsskal)
L. lentjan (Lacepède)
L. reticulatus Val.
L. elongatus Val. [*L. mineatus* (Bl. & Sch.]
L. microdon Val.

Family Theraponidae (Therapon perch, grunters, etc.)

Therapon jarbua (Forsskal)
T. theraps (Cuvier)
Pelates quadrilineatus (Bloch)

Family Siganidae (Rabbitfishes)

Siganus canaliculatus (Park) [*S. oramin* (Bl. & Sch.)]
S. javus (Linn.)

Family Priacanthidae (Bulls-eye, big-eye, etc.)

Priacanthus hamrur (Forsskal)

Family Nemipteridae (Thread-fin breams)

Nemipterus bleekeri (Day) (= *N. delagoae* Smith)
N. japonicus (Bloch)
N. mesoprion (Bleeker ?)
N. metopias (Bleeker)
N. peronii (Val.) [(= *N. tolu* (Val.)]
Scolopsis bimaculatus Ruppell
S. vosmaeri (Bloch)

Family Ambassidae (Perchlets)

Ambassis commersoni Cuvier
A. dayi Bleeker

Trend of Perch Fishery at Vizhinjam

The data collected for 9 years (1979 to 1987) have been utilised in the present study. Details pertaining to catch, gear-wise C/E, group-wise composition, depth of operation of the gear, etc. were collected twice a week and

then computed for the month for all the 8 families dealt with here. The total annual catch varied from 169.967 t in 1979 to 541.245 t in 1987 with the average at 349.305 t (Fig. 3 A). The annual landings were below this average during 1979 to 1982 period and also in 1984.

The monthly variation in landings were quite considerable and hence, the months which recorded higher catch than the average monthly landings for the respective year, are given in Table 1.

TABLE 1. *Variation in the monthly landings of perch at Vizhinjam*

Year	Average monthly landings (Tonnes)	Months which recorded higher landings than the average
1979	14.16	Jan., Feb., Sept. and Dec.
1980	26.49	Aug. and Sept.
1981	15.00	Jan., Feb., Mar., Aug., Sept. and Dec.
1982	35.03	July, Aug., Sept. and Oct.
1983	36.97	July, Aug. and Sept.
1984	20.87	Jan., Aug., Sept. and Oct.
1985	42.85	July, Aug., Sept. and Dec.
1986	37.14	Jan., June, July, Aug. and Sept.
1987	45.10	Jan., Feb., July and Sept.

A perusal of the above Table 1, as also the graphic representation of the annual landings for the various years given in Fig. 2 indicates that the perch landings at Vizhinjam follow a bimodal pattern though in some years a multimodal pattern was also discernible. The main mode in the landings could be noted either during the monsoon (June to August) or postmonsoon. Out of nine years covered under the present study, the peak mode in landing could be observed in July on two occasions (1986 and 1987); in August on 4 occasions (1980, 1982, 1983 and 1985) and in September (post-monsoon period) on two occasions (1979 and 1984). In 1980, the peak landing occurred in January while that of September (postmonsoon period) was only a subsidiary one. The secondary peak in the landings could be noted during the postmonsoon months of January on 4 occasions (1979, 1980, 1984 and 1986); of December in 1985; in the premonsoon (February to May) month of April in 1983, of February in 1987 and of May in 1982. In 1981, the mode noted in January was the dominant one while those of March and September were of secondary nature with almost of the same intensity.

The landings of perches for the various years were added together both monthwise and yearwise and from this the total for the 9 year period was calculated both year-wise and month-wise. In the present account they are refered to as "pooled total for the period 1979 to '87" and "pooled total for each month for the period 1979 to '87" respectively. The percentage landing were calculated from this pooled figures for each month. For the various groups dealt with, the same procedure is followed uniformly. The landings of the different perch groups are indicated below and in Fig. 3 B - I.

Nemipterids : In this case two peaks could be noted in the pooled monthly total landings for the entire period, the dominant being that of August, when 24.4% of the total landing was effected (Fig. 3 B). After this monsoon peak, the landings registered a sharply decreasing trend throughout the postmonsoon period. In the ensuing premonsoon period, however, the landings showed some improvement, resulting in another peak in March when about 3.6% of the total was registered. Though the above figure (3.6%) would appear to be quite unimpressive, it is dealt with as a distinctive peak, because this has got somewhat smothered in the pooling of the different years' values, as is clear from the fact that the peak is clearly seen during March in 1979, 1980, 1981, 1984 and 1986, but got shifted to April in 1983, 1985 and 1987 (no data for 1982). The monthly landings started showing a decrease after this peak, and this trend continued through May and June. By July the landings improved considerably registering 22.6% of the total landings. A further improvement in the landings could be noted in August and it was in this month the maximum catch for the year was registered. Here also the monthly landings for the various years were consulted to find out whether the hike in landings is specific to August alone or not. It was so except in September 1981 (Fig. 3 B).

Lethrinids : Here only one mode in landing could be noted, which was in January (postmonsoon period) in all years, except in 1985

and 1987 when this got shifted to February (premonsoon). In the pooled monthly total the landing effected in this month accounted for 33% of the total catch (Fig. 3 C). The monthly landings, thence, declined steeply and reached the lowest level (0.6%) by May. A secondary peak could be observed in July in the pooled total for each month (3.8%); but such an increase could not be detected in the monthly landings for the various years except in 1983. In 1983 an unusual landing of 11.15 t of Lethrinids took place by both Boat-seine and Hooks and line (mechanised sector), and this was responsible for the hike noted in July. From November onwards the catch started registering an upward trend finally resulting in a peak in January.

Priacanthids : The landings of Priacanthids were very poor allthrough the early period of this investingation (upto 1983). In the annual landings it could be seen that they were scarcely available or even absent. However, the condition changed considerably by the introduction of mechanised units at Vizhinjam.

In this case two peaks could be noted in the pooled monthly landings for the entire period (Fig. 3 D), and the one noted in October (postmonsoon) formed the dominant one followed by the other in July (monsoon period). The landing noted in October accounted for 26.5% of the total while that of July, only for 8.8%.

The landings recorded in January contributed to about 10% of the total, but dwindled thereafter and reached the lowest level of 0.4% by May. By July the landings inproved registering about 8.8% of the total and this hike was found to be regular allthrough the different years. The landings then showed a sharp decrease and by August reached a lower level of 1.5% of the total. The landings from September onwards started registering an upward trend attaining a peak by October. This peak was rather well pronounced for the different years studied, except in 1986 and 1987 when it got shifted to December.

Lutjanids : The landings were rather regular throughout the period with occasional gaps in the monthly landings at the most for two months at a stretch and this trend continued upto 1985. But afterwards the gap increased with nil landings for several months at a stretch.

Of the 3 peaks noted in the pooled monthly landings for the entire period, the postmonsoon peak of January was well demarcated in all the years examined except in 1981 when it got shifted to the premonsoon month of February. The landings registered in January accounted for 20.3% of the total (Fig. 3 E) forming the peak. From this month onwards the landings started dwindling and by May it reached the lowest level (1.8%). During the monsoon period, however, the landings registered some improvement forming a minor peak in July (5.3%). From August onwards the landings again increased resulting in another peak by October (postmonsoon peak). This peak accounted for 11.3% of the total landings. After attaining this peak the landings came down abruptly to 3.3% level by November. In the later half of the postmonsoon period there was an abrupt hike in the monthly landings which culminated in the most dominant peak of January.

Serranids : In this case the landings were rather irregular with little or no catches during certain months. However, in the pooled total landings for each month it could be noted that the postmonsoon peak of January was the most dominant among the three noted. The landings registered in this month accounted for about 20.4% of the total. The landings started showing a decreasing trend from January onwards and by May it touched a lower level (1.8%). The landings increased by June (4.5%), but by July it declined again to the lowest level for the year (0.09%). Fig. 3 F indicated another peak in landings during August, but this peak (13.9%) was observed only in 1985 when an unusual landing of serranids occurred (22.7 t totally, of which 19.2 by Boat-seine in August 1985). From August onwards the landings showed a decreasing trend upto November. After November the landings improved and the climax was attained by January.

Siganids : October to February recorded very poor landings (0.1% to 2.2%) and for the rest of the period as many as three peaks in the landings could be noted, the most dominant

being that of August with 27.6% of the total landings in pooled data. The other two were noted in April and June registering 9.8% and 13.3% respectively of the total landings (Fig. 3 G). This trend could be noted both in the separate and pooled landing data alike. Monsoon period may be said to be the best season for the landing of siganids as the most dominant and the next mode in landings could be observed during the monsoon period.

Theraponids : For this group the landings were rather regular upto 1982, but later showed an irregular trend with wide gaps, in landings, for one or more months in between.

The most dominant mode noted in the landings (pooled total for each month) was in May and this could be seen both in the monthly as well as in pooled landings alike. The monthly percentage of landing noted in May was 25.0%. Soon after this, the landings came down to 10.7% by June and remained more or less in the same level throughout the monsoon period. The catch decreased further by September to a 4.3% level. A postmonsoon peak of a minor intensity could be observed during October (11.0%), but afterwards decreased by November (6.7%). However, a slight improvement in the landing could be seen by December (second peak in the postmonsoon period, 7.5% of the total landings). After this hike in landings there was an obvious declining trend attaining the lowest figure of 1.5% by February. The increase in landings noted during the next two months of the premonsoon period was spectacular and this ultimately resulted in the premonsoon peak of May (Fig. 3 H).

Ambassids : The year 1979 was the only period when the landings, in this case, were protracted. In other years the landings became poor and the number of months with nil catches also increased considerably : landings were nil in 1985 and 1986 and were confined to a single month in 1987 and to two months in 1984.

In the pooled monthly total for the entire period, the minimum landings were recorded in February (3.7%) and thence the landings, for the rest of the premonsoon period, were on the increase untill the monsoon peak of July was attained (Fig. 3 I). This peak, which registered 14.1% of the total, was the dominant one. In August, however, a steep fall in the monthly landings could be noted (4.7%), but this was later made up in September with a minor peak (10.3%). From October onwards the increase in landings was gradual, ultimately resulting in a peak in December (11.1% of the total).

SEASONALITY IN PERCH LANDINGS

Inorder to find out the seasonality in perch landings at Vizhinjam the year was divided into 3 seasons as follows :

Premonsoon period	-	February to March
Monsoon period	-	June to August
Postmonsoon period	-	September to January

The yearly as well as total (pooled) landings of different groups of perches for the entire study period (1979 to 1987) were computed both groupwise and gearwise. The same may be summarised as follows :

Seasonality : all groups combined

Taken for the entire 9 year period, the postmonsoon period accounted for the bulk in landings (41.2%), closely followed by the monsoon period (40.4%) (Fig. 3 A, 4 C). The landings recorded during the premonsoon period was low (18.4%). Quantitywise this may be expressed as follows :

Premonsoon period	-	579.9 t
Monsoon period	-	1220.4 t
Postmonsoon period	-	1293.3 t

Considered for individual years the maximum landing of perch occurred during the postmonsoon period except during the years 1982, 1986 and 1987 when this was noted in the monsoon period. The premonsoon period was generally characterised by low landings, except during 1979, 1981 and 1984 when the lowest landings were in the monsoon period.

Seasonality : groupwise

When, for each group, its landings were pooled for the various years, results indicated

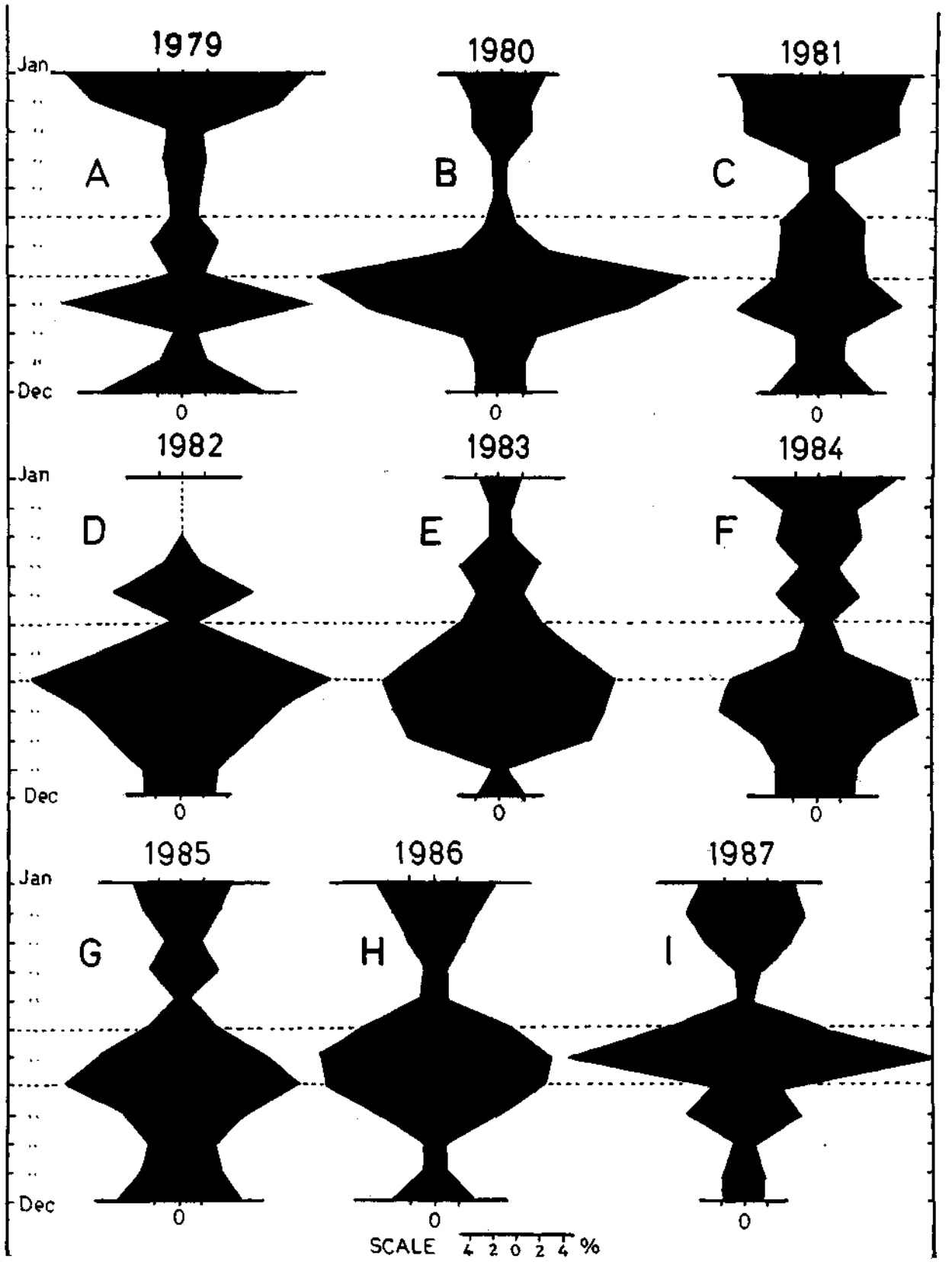


Fig. 2. A - I : Annual landings of perch at Vizhinjam from 1979 to 1987. The monthly landings (%) are also given.

that the maximum catch for 5 groups (Lithrinids, Lutjanids, Serranids, Ambassids and Priacanthids) was observed during the postmonsoon; for two groups (Nemipterids and Siganids) during the monsoon and for Theraponids, in the premonsoon. The period of minimum landings noted in the case of all the above 8 groups may be as follows :

Groups with monsoon minimum :
Lethrinids, Lutjanids, Serranids, Priacanthids and Theraponids.

Group with postmonsoon minimum :
Siganids.

Groups with premonsoon minimum :
Nemipterids and Ambassids.

Seasonality : operation of units

Here the number of units (%) that has been operated during each season is taken into consideration. The seasonality noted with reference to each gear may be given as :

Dominant during :

Premonsoon	-	Konchu vala, Nandu vala and Chala vala.
Monsoon	-	Boat-seine and Achil.
Postmonsoon	-	Hooks and line (non-mech. sector), Drift net (both sectors), Hooks and line (mech. sector), Shore-seine and Trawl.

Least dominant

Premonsoon	-	Boat-seine, Hooks and line (mech. sector) and Achil.
Monsoon	-	Hooks and line (non mech. sector), Drift net (both sectors), Shore seine, Nandu vala and Chala vala.
Postmonsoon	-	Konchu vala.

(Of the above gears some were operated for a particular period. For more details on seasonality in landings of individual group in relation to units see under "Gearwise perch production".

GROUPWISE PRODUCTION AT VIZHINJAM

Data collected (1979 to 1987) have been utilised here to assess the annual production, fluctuations in production, etc. The share of perch in total landings (of all fishes) for the above period at Vizhinjam ranged from 3.78% (1979) to 8.37% (1980) (Fig. 4 B).

The total production of perches for 1979 to 1987, was estimated at 3143.697 t. The composition of the various groups, their percentages, priority in the order of abundance (rank), etc. are furnished in Table 2.

TABLE 2. *Average groupwise perch landings and their percentage at Vizhinjam*

Groups	Total landings (t)	%
Nemipterids	1729.956	55.02
Lethrinids	332.464	10.60
Priacanthids	256.305	8.20
Siganids	223.894	7.11
Lutjanids	216.624	6.90
Serranids	189.931	6.01
Theraponids	161.666	5.13
Ambassids	32.857	1.03

Nemipterids : The yearly contribution by this group to the perch landings fluctuated between 50.4 t (1979) and 350.7 t (1987) with the average at 192.2 t and the percentage from 29.7 (1979) to 74.7 (1980). The landings were well above the average (*i.e.* 192.2 t) in 1980, 1983 and 1985 to 1987 (Fig. 5 A).

Species commonly met with in the commercial landings were *Nemipterus metopias* contributing to 83.8% of the total followed by *N. bleekeri* (13.06%) and *N. japonicus*. *N. metopias* and *N. japonicus* were available in landings from June to September, while *N. bleekeri*, in all months except June to August. August formed the peak period in the landings of *N. metopias*, September for *N. japonicus* and November for *N. bleekeri*.

Lethrinids : The annual landings of lethrinids ranged from 10.43 t (1982) to 56.58 t (1986) with the average at 36.9 t, and from 3.7% (1982) to 20.7% (1979). The annual landings were above

this average during 1985 to 1987 period (Fig. 5 B). Its position in the annual landings fluctuated considerably from year to year : this group occupied the second rank for 5 years (1979, 1980, 1981, 1984 and 1986), third rank for one year (1987), 5th rank for two years (1983 and 1985) and the 6th rank for one year (1982).

The landings were found through the year in the pooled monthly total for the entire period, but individual years were sometimes without any landings for several months at a stretch. The landings were poor during monsoon and only 5.2% of the total could be recorded during this period. During monsoon period of 1982 and 1985 lethrinids were totally absent.

Only one mode in the landing could be observed and that was usually in January (postmonsoon) or occasionally in February (premonsoon) of 1985 and 1987. Postmonsoon accounted for the bulk in landings (61.4% of the total).

Priacanthids : The yearly landings of this group varied from 0.4 t (1980) to 85.9 t (1985) with the average at 28.47 t and from 0.1% (1980) to 16.7% (1987). The annual landings during 1984 to 1987 were well above this average, while they were poor in the initial years (1979 to 1981) (Fig. 5 D).

Similarly, despite its third rank when the entire period is taken together, its annual landings fluctuated from 8th and 2nd as detailed below : 2nd rank in 1987 and 1985; 3rd rank in 1986; 4th in 1983; 6th in 1983; 7th in 1979 and 8th in 1980 and 1981. The landing during the monsoon was very poor and contributed only 11.7% of the total (Fig. 5 D). The best period was the postmonsoon period (74.1%).

Siganids : The annual landings, in this case, varied from 3.2 t (1980) to 60.15 t (1985) with the average at 24.87 t (Fig. 5 E). It fluctuated between 1.8% (1981) and 11.7% (1985) and the landings were above the average of 24.87 t only during the years 1984 to 1986.

Its position fluctuated considerably in the annual landings : occupied the 3rd position during 1982 and 1983 period, 4th position during 1984 to 1986 period, 5th position in 1987, 6th in 1980 and 7th in 1981.

March to September period formed the best period in their landings and as many as three peaks in the landings could be observed during this period. The monsoon accounted for the bulk in landings (65% of the total) (Fig. 3 G).

Lutjanids : The landings registered a decreasing trend in 1986 and 1987. The annual landings varied from 7.1 t (1986) to 47.3 t (1983) with the average at 24.0 t (Fig. 5 F) and from 1.6% to 18.9% (1979). The landings were above the average of 24.0 t during 1979, 1981, 1983 and 1985.

This group occupied the second rank in 1981 and 1983; third rank in 1979; 4th rank in 1980 and 1982; 5th rank in 1984 and 6th rank during 1985 to 1987 period. The postmonsoon period registered the bulk of the year's catch (56.1%), followed by the premonsoon period (29.5%).

Serranids : This group fluctuated between 3.3 t (1982) and 62.69 t (1985) with the average at 21.1 t and from 1.2 % (1982) to 12.2 % (1985). The landings were above the average (21.1 t) during 1985 to 1987 (Fig. 5 G). The maximum was registered during the postmonsoon period (49.7%) followed by the premonsoon period (31.9%).

Theraponids : The annual landings of theraponids varied from 2.9 t (1987) to 39.7 t (1982) with the average at 17.8 t and from 0.5% (1987) to 15.3% (1979). During 1979, 1980, 1982 and 1983 the annual landings were above the average of 17.8 t. Here also a downward trend in the annual landings could be noted from 1983 onwards (Fig. 5 H).

The landings, as seen in the pooled total for each month, were spread allthrough the year, but in the monthly landings for various years no such continuity could be observed. The number of months with no landings also increased towards the fag end of the period (1985 to 1987).

Its overall 7th rank varied considerably from year to year : 1979 to 1983 was from 2nd

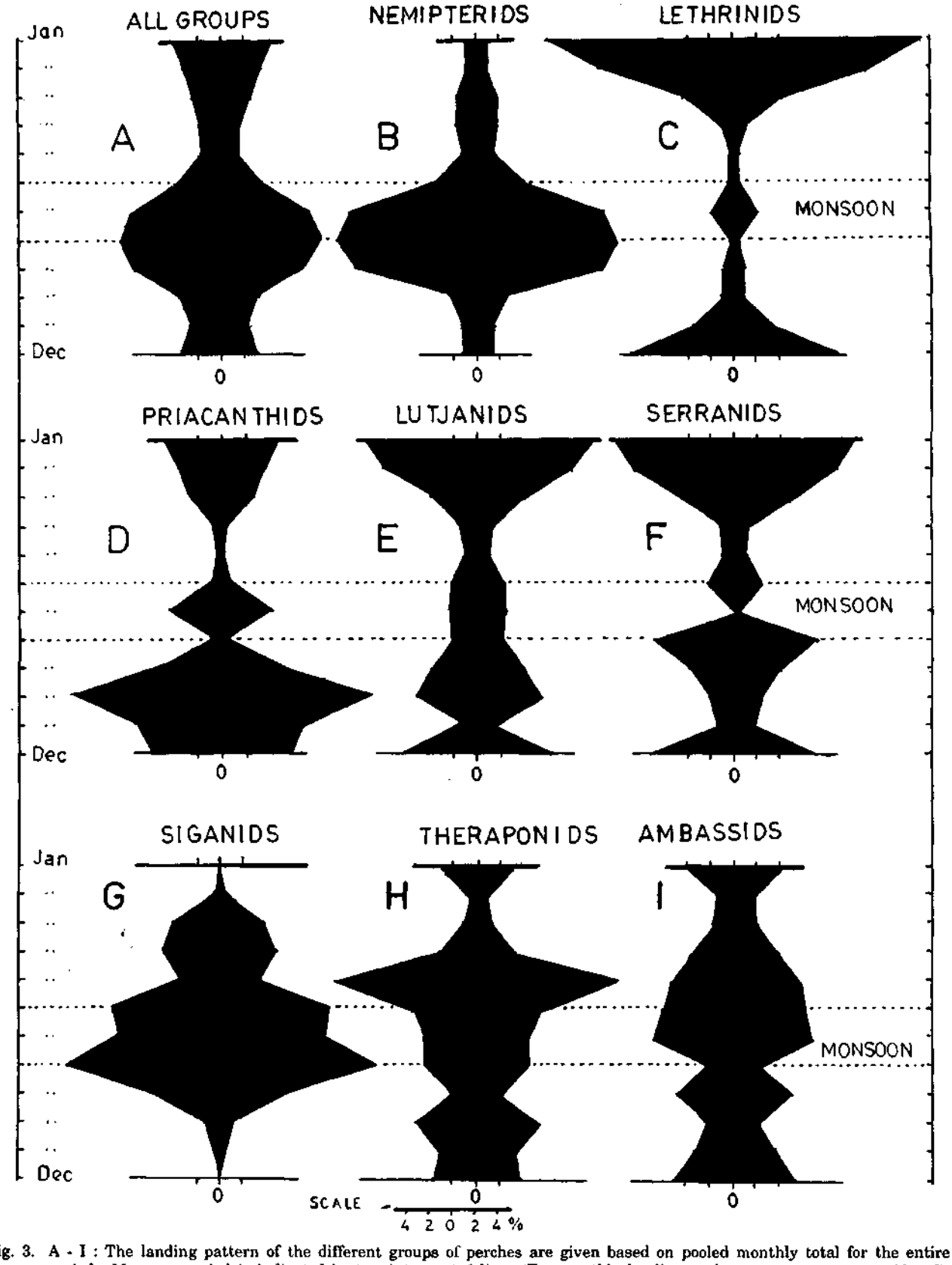


Fig. 3. A - I : The landing pattern of the different groups of perches are given based on pooled monthly total for the entire period. Monsoon period is indicated by two interrupted lines (For monthly landings only percentages are considered).

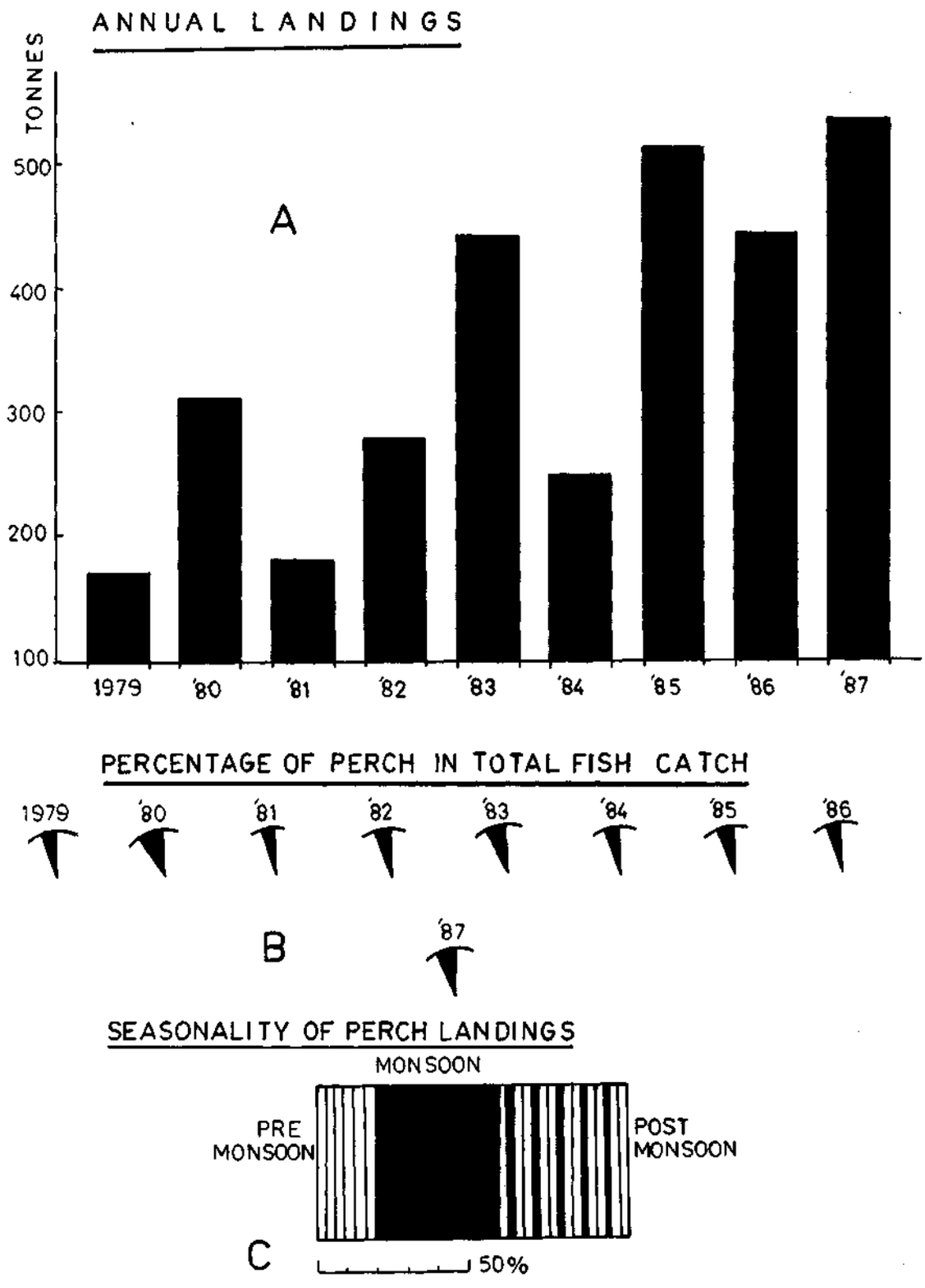


Fig. 4. A. Annual landings, B. Percentage composition and C. Seasonality of perch landings at Vizhinjam for the period 1979 to 1987 ; from pooled data.

to 4th and during 1984 to 1987 was from 6th to 7th. This clearly shows that the dominance of this groups diminished towards the fag end of the period. The seasonal landings fluctuated very little; the maximum was registered during the premonsoon (35.8%) and the minimum in the monsoon (28.6%)

Ambassids : The percentage fluctuated from 0.1% (1967) to 5.4% (1979) and the landings from 0.6 t (1987) to 9.1 t (1979) with the average at 3.6 t (Fig. 5 C). The annual landings were above this average in 1979, 1981 and 1982 with a decreasing trend after 1984.

This group occupied the overall 8th rank in the order of abundance, but it changed to 6th in 1979 and 1981 or to 7th (in 1980 and 1982) position, before being shifted to the last position after 1983.

In general, the landings increased as the period advanced in the case of Nemipterids, Lethrinids, Priacanthids, Siganids and Serranids, while a decreasing trend could be noted for Theraponids, Lutjanids and Ambassids. The probable reasons that govern this trend are discussed in a later section.

GEARWISE PERCH PRODUCTION

Craft : The most important craft employed for fishing in this area is the catamaran and next to it, in importance, comes the canoe. Recently a few mechanised boats have also been introduced on an experimental basis for fishing with traditional Drift nets. A recent trend that has been developed at Vizhinjam is the motorisation of traditional crafts (catamaran and canoe) with 'Yamaha' outboard motors.

Gears : Of the four principal fishing methods used *viz.* by seines, by drift nets, by trawls and by hooks. Fishing by trawls is not popular at Vizhinjam due to the rocky nature of the sea bottom. All the other three methods are now practiced, but among these the most popular is fishing by hooks and line.

Details relating to the various gears, their mode of operation, etc. are available in Nayar (1958) and Sam Bennet (1967).

During the present study 11 types of gears were in operation at Vizhinjam. No gear was specific in the landing of perches, but in each gear a fraction of the catch was perches.

The various gears, their category, total landing for the period, their percentages, position occupied (rank) by each gear in relation to the total landings etc. are given in Table 3.

TABLE 3. *Gearwise landing and their percentage in total landings during 1979 - '87*

Gear	Landing (t)	%
Hooks and line (non mech. Sect)	1365.710	43.44
*Hooks and line (mech. sector)	927.873	29.51
Boat seine	342.728	10.90
*Drift net (mech. sector)	215.107	6.84
Drift net (non mech. sector)	175.587	5.59
Konchu vala (gill net)	82.514	2.63
Achil (Hooks and line)	19.822	0.63 **
Shore seine	9.972	0.32 **
Nandu vala (gill net)	2.574	0.08 **
Trawl	1.303	0.04 **
Chala vala (gill net)	0.507	0.02 **

* Operated from 1983 to 1987.
** Given as 'others' in Fig. 6 A.

The various gears, based on their order of production (rank) are dealt with below:

Hooks and line (Non-mechanised sector)

Crafts that are not fitted with outboard motors and employing Hooks and line (called 'Choonda' in Malayalam) are considered first. This gear was operated allthrough the years 1979 to 1987. The number of units operated annually varied from 5184 (1983) to 71,782 (1984) amounting to 378,262 units with the average at 42,029 nos.

The total units operated during 1979-'87 was 378,262, with a total landing of 1365.710 t and this works out to a CPU of 3.61 kg. The pooled monthly CPU fluctuated considerably from month to month from 1.1 kg (May) to 7.32 kg. (Sept) (Fig. 7 A). The total effort expended in 1984, when mechanisation of traditional crafts was at the initial stage, was the maximum (71,782) and the number of units

started showing a decreasing trend from this year onwards and reached the lowest level (8540) by 1987.

In the pooled total landing, monthly landings (%) of perches by this gear varied considerably from 2.4 % (May) to 20.8 % (Aug.) (Fig. 7 A) with a bimodal pattern in landings. The monsoon peak of August was followed by another in January (8.1%, the postmonsoon peak).

The perch landings by this gear (1365.710 t) constituted 43.44 % of the total perch landings for 1979 to 1987 ranking the first in the order of abundance (Table 3, Fig. 6 A). In the annual landings for the various years the share by this gear in total landings fluctuated between 8.7% (1987) and 85.9% (1980) (Fig. 8) and the annual landings from 39.8 t (1987) to 291.6 t (1983) with the average at 151.7 t.

It could be noted that the contribution by this gear to the total perch landings was at a higher level during 1979 to 1984 [variation 85.9% (1980) to 64.1% (1984)], but later *i.e.* during 1985-87 period, it came down abruptly [variation 20.2% (1985) to 8.7% (1987) (Fig. 8)]. The reason could be the reduction in the effort, as increasing mechanisation of the traditional units by OBM resulted in a drastic cut in fishing by non-mechanised Hooks and lines. The distribution of units for the period 1979 to 1987 was assessed seasonwise from pooled total. This revealed that the maximum number (44.4%) was operated during the postmonsoon and the minimum during the monsoon period (21.4%). Landingwise, the postmonsoon period was the best as 47.2% of the total was landed, while the premonsoon period recorded the minimum (19.2%).

Perches in Hooks and line (Non-mechanised sector)

The total landing 1365.710 tonnes, was composed of the following groups (Fig. 6 B, Table 4).

Landing of individual group

Nemipterids : This group formed the most dominant one in the landings with 948.917 t (69.48%) (Fig. 9 D, inset). The annual landings fluctuated from 27.04 t (1986) to 320.41 t (1980) with an average at 105.435 t. The annual landings registered a downward trend from 1984 onwards and it came down to to 27.04 t by 1986.

TABLE 4. *Perches landed in Hooks and line (non-mechanised sector)*

Groups	Landings (t)	%
Nemipterids	948.917	69.48
Lethrinids	126.804	9.28
Lutjanids	107.169	7.85
Theraponids	73.996	5.42
Serranids	55.596	4.07
Priacanthids	52.330	3.84
Siganids	0.898	0.06

Nemipterids were available in the landings allthrough the different months. In January it contributed to 2.6% of the total while in August, 27.5 % in the pooled landings for the period 1979 to 1987. Two modes in the pooled monthly landings could be noted, the dominant one being that of August (27.5%) followed by another in March (5.3%) (Fig. 9 D). Monsoon was found to be the best season in the landings of Nemipterids by this gear with about 43.5% of the total followed by the postmonsoon (40.2%).

Lethrinids : With 126.804 t forming 9.28% of the total landings by this gear, this group formed the second dominant among the different groups (Fig. 13 D, inset). The annual landings fluctuated from 0.202 t (1987) to 28.7 t (1984) with the average at 14.08 t. Here also an abrupt decrease in the landings could be noted from 1984 onwards and this may be attributed to more and more fishermen resorting to mechanisation.

Lethrinids were caught by this gear throughout the year. In the pooled monthly total landings it fluctuated between 0.3% (July) and 36.0% (Jan.). The bulk of the landings was realised during the postmonsoon period (65.3%) and the minimum in the monsoon period (2.7% of the total) (Fig. 13 D).

Lutjanids : This group constituted 7.85% of the total by this gear accounting to 107.169 t

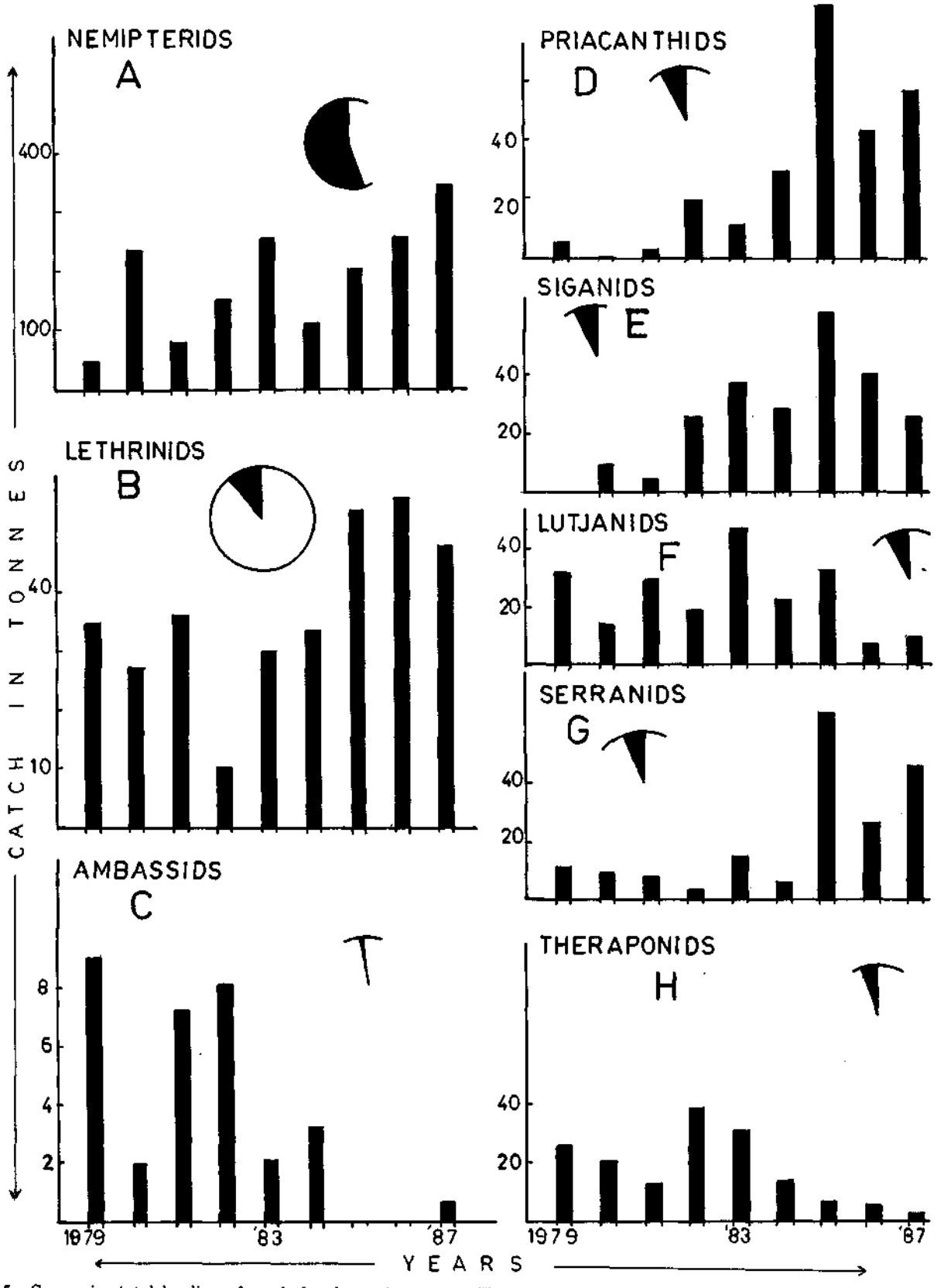


Fig. 5. Groupwise total landing of perch for the various years. The percentage contribution to total landings by each group is given (inset).

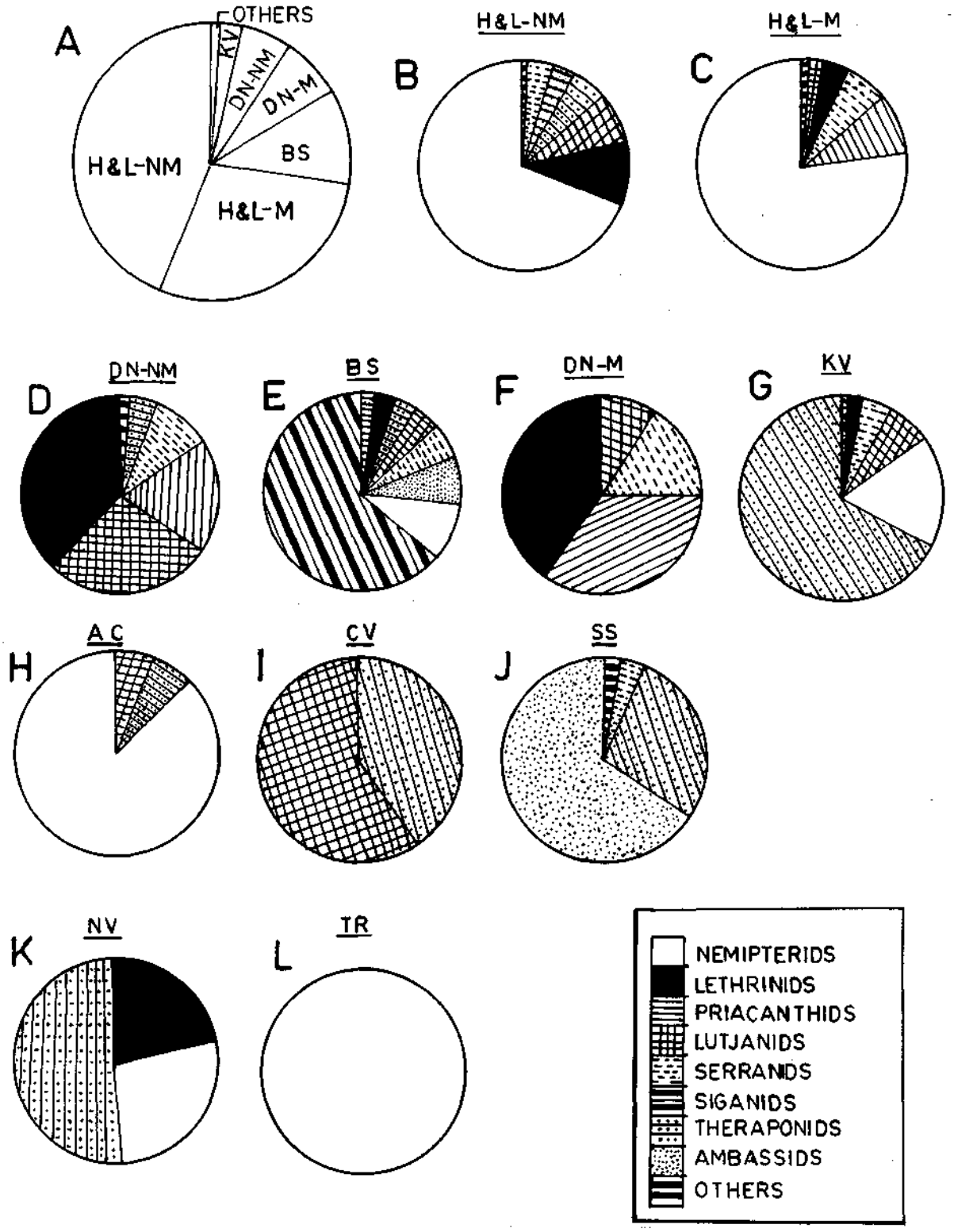


Fig. 6. A. The percentage contribution of each gear to the total perch landings at Vizhinjam (1979 to 1987) (from pooled data). Gears which contributed an insignificant quantity are grouped together under 'others' and B - L : The percentage contribution of each group in various gears.

B. Hooks and line (non-mech. sector), C. Hooks and line (mech. sector), D. Drift net (non-mech. sector), E. Boat seine, F. Drift net (mech. sector), G. Konchuvala, H. Achil, I. Chala vala, J. Shore seine, K. Nandu vala and L. Trawl.

ranking third in the order of abundance (Fig. 12 E, inset). The annual landings varied from 1.39 t (1987) to 25.41 t (1983) with the average at 11.9 t

The landings could be seen spread out in all the months in the pooled total for the entire period, but in separate year's landings, their occurrence was interrupted. The monthly percentage of landings, in the pooled total, fluctuated between 1.8% (April) and 16.3% (Jan.) with two modes; a dominant in January (16.3%) and a minor in September (13.4%, both in the postmonsoon period, Fig. 12 E).

The postmonsoon period formed the best season in the landing of this group by this gear and 59.3% of the total landings was realised during this period. Monsoon period recorded the minimum landings (12.9%).

Here also the landings showed a decreasing trend after 1983 and the reason may be attributed to the conversion on non-mechanised units into mechanised ones.

Theraponids : With a total of 73.996 t (5.42% of the total by this gear), this group ranked 4th in the order of abundance (Fig. 11 D, inset). The annual landings fluctuated from 0.3 t (1987) to 20.12 t (1983) with the average at 8.2 t. The landings of this group showed a decreasing trend after 1983 : there was landing only for a month during 1987 while nil in 1986.

In the pooled total for each month the landings were seen throughout the year and the monthly landings varied from 2.5% (both in February and May) to 16.2% in August (Fig. 11 D). Four peaks in the landings could be noted, the one noted in August formed the dominant (monsoon peak, 16.2%) followed by the next in October (postmonsoon peak). The other two, one in April and the other in December were insignificant.

The best period of Theraponid landings by this gear was the postmonsoon (53.4%) followed by the monsoon (31.2%).

Serranids : The total landings of Serranids by this gear from 1979 to 1987 were estimated at 55.596 t (4.07% of the total) which marked 5th position in the order of abundance (Fig. 10 K, inset). The annual landings fluctuated between 1.3 t (1981) and 11.8 t (1985) with the average at 6.17 t. The landings were never spread allthrough the year in the annual landings, but in the pooled total for each month the landings were found throughout the various months. In the pooled estimations the landings varied considerably from month to month with in a maximum of 25.3% [January and a minimum of 0.09% (July)]. The peak landing, in this case, could be noted in January by this gear (Fig. 10 K).

The best period for Serranids by this gear was the postmonsoon period with 58.7 % of the total landing. The monsoon period registered very poor landings (5.3%).

Priacanthids : The total landings of Priacanthids by this gear was estimated at 52.330 t constituting 3.48% of the total and ranking 6th in the order of abundance (Fig. 10 D, inset). The annual landings, in this case, ranged from 0.31 t (1980) to 13.12 t (1985) with the average at 5.81 t.

Though no landings were registered for several months at a stretch in some years, in the pooled data for the entire period each month indicated some landings; the monthly landings fluctuating from 0.9% (June) to 34.0% (October) with two modes, the higher one in October (34.0%) and a lesser one in June (Fig. 10 D).

The postmonsoon period formed the best period with 82.9% of the total while the monsoon period was the lowest (4.8%).

Siganids : The total landings of Siganids by this gear was only 0.898 t (0.06%) ranking 7th in the order of abundance. The entire quantity was landed during January of 1984 and 1986 (Fig. 12 N).

Hooks and line : (Mechanised sector)

Crafts fitted with outboard motors and fishing by Hooks and line are considered under this section. Though mechanisation of this sort has been initiated by the end of 1982, its impact was felt fully in the landings only from 1983 onwards. Such units increased gradually from

5232 (1983) to 39,873 (1987). It is estimated that the total units employed at Vizhinjam during the period 1983 to 1987 was 122,094 with the average at 24,418. The total quantity of perch landed during the above period was 927.873 t against a total of 122,094 units with a CPU of 7.59 kg. The variation in CPU noted in the pooled total for each month was from 0.5 kg (May) to 23.2 kg (July) (Fig. 7 B).

The total perch landings by this gear accounted for 927.873 t forming 29.51% of the total perch landed at Vizhinjam for the period 1983 to 1987 (Fig. 6 A, Table 3). In the annual landings the share by this gear fluctuated between 52.4 t (1983) and 369.0 t (1987) and from 8.5% (1984) to 68.2% (1987) (Fig. 8). In the pooled total for each month the monthly landings varied from 0.5% (May) to 28.6% (July) (Fig. 7 B). Two peaks in the landings could be noted in the pooled total, the major being in July (monsoon period) followed by the other in December (postmonsoon) (Fig. 7 B).

The best season for this gear was the monsoon and 56.9% of the total was landed during this period. The minimum landing (9.3% of the total by this gear) was registered during the premonsoon.

The distribution of units during the various seasons was found to fluctuate considerably. The maximum number of units was operated during the postmonsoon months (50.26%) followed by the monsoon (26.8%).

Perches landed in Hooks and line (mechanised sector)

The total landing of 927.873 t was by the following groups of perches (Table 5, Fig. 6 C).

TABLE 5. *Perches landed in Hooks and line (Mechanised sector and their percentages)*

Groups	Landings (t)	%
Nemipterids	717.701	77.34
Priacanthids	86.350	9.31
Serranids	60.839	6.56
Lethrinids	38.641	4.16
Lutjanids	20.013	2.16
Theraponids	4.329	0.47

The groups Siganids and Ambassids were not represented in the landings.

Nemipterids : This group ranked first among the perches landed by this gear with a total of 717.701 t (77.34%) of the total landings (Table 5, Fig. 9 E, inset). The landings showed an increasing trend from 36.1 t (1983) to 310.6 t (1987) with an average at 143.57 t.

Nemipterids were present throughout the year and from the pooled monthly total, the best period was found to be June to September (Fig. 9 E). The landing by this gear during January to May was quite negligible, so also for October to December. During the above 8 month duration the monthly landing (in pooled total) seldom gone beyond 2.4%.

Regarding the seasonality of Nemipterid landings by this gear it could be noted that the monsoon was the best period as the landing recorded was 69.8% of the total. The landings in July (in pooled monthly total) formed 35.2%. The premonsoon period recorded only 4.2% of the total landings.

Comparing the landing pattern by this gear with that of non-mechanised Hooks and lines, it may be stated that the pattern was almost similar, the only difference being the period of peak landing: in the latter it was during August.

Priacanthids : With a total landing of 86.35 t (9.31%) for 1983 to 1987 (Table 5, Fig. 10 E, inset) this group formed the second dominant by this gear (This group occupied only the 6th rank in the non-mechanised sector). The annual landings of Priacanthids varied from 0.9 t (1983) to 41.0 t (1985) with the average at 17.3 t. This group was absent for several months at a stretch in various years.

In the pooled total, monthly landings ranged from 0.2% (March) to 17.0% (Nov.) of the total with 4 modes in the distribution and they were in the order of abundance, in November (postmonsoon), July (monsoon), February (premonsoon) and April (premonsoon). A similar trend in the landings, though with some minor changes, could be noted in the case of Hooks and

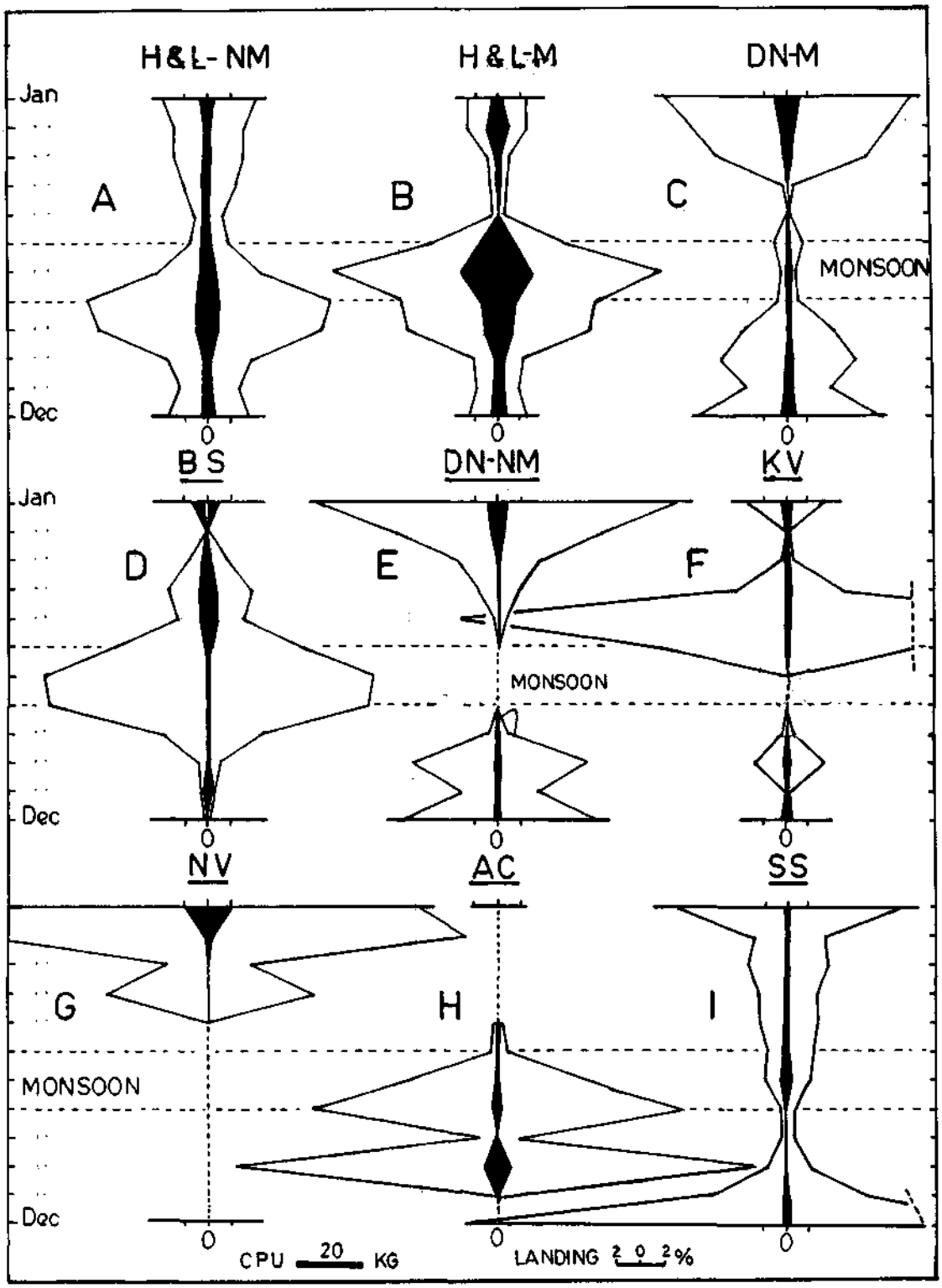
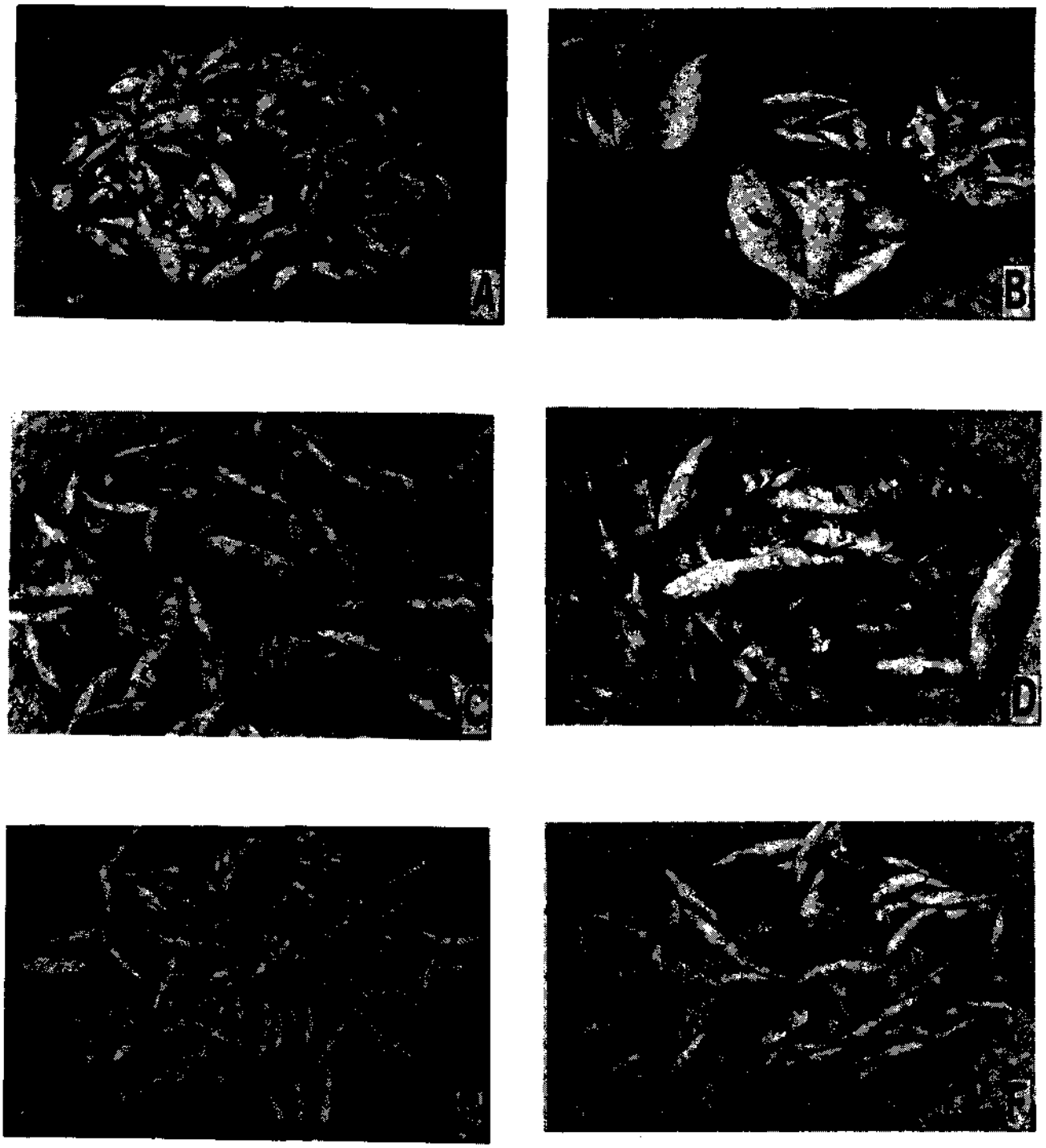


Fig. 7. Gearwise monthly landings (%) of perch at Vizhinjam from 1979 to 1987 and the actual CPU (shaded area) noted during the different months (based on pooled monthly total). The monsoon period is indicated by interrupted lines.

A. Hooks and line (non-mech. sector), B. Hooks and line (mech. sector), C. Drift net (mech. sector), D. Boat seine, E. Drift net (non-mech. sector), F. Konchu vala, G. Nandu vala, H. Achil and I. Shore seine).



A. *Nemipterus metopias*, B. *Larger perches*, C. *Lethrinus nebulosus*, E. *Epinephelus* spp., E. *Therapon jarbua* and F. *Lethrinus lentjan*.

lines operated from non-mechanised crafts also (Fig. 10 E). The postmonsoon registered the maximum landings by this gear (67.0%), followed by the monsoon (18.0%).

Serranids : This group occupied the third position with a total of 60.839 t (6.56%) (Table 5, Fig. 10 L, inset).

The annual landings (1983-1987) showed an increasing trend with an exception in 1984. It fluctuated between 0.36 t (1984) and 19.46 t (1987) with the average at 12.16 t. The landings were either poor or nil during certain months every year and this was reflected in the pooled total landings also (no landings for July and November, poor landings in June).

In the pooled landings the monthly percentage ranged from 0.2% (June) to 24.4% (January) with three modes in landings. The mode noted in January (postmonsoon) was the dominant (24.4%), followed by that of September (12.4%) (postmonsoon) and May (premonsoon) (Fig. 10 L).

The postmonsoon period accounted for the maximum (63.2%) landings followed by the premonsoon period. Comparing the seasonality trend noted in the landings of mechanised and non-mechanised Hooks and line fishery, it may be stated that though the trend was, for the most part similar, the landings during the postmonsoon by the mechanised sector were higher.

Lethrinds : The landing of this group, in this gear, was 4.16% (38.641 t for 1983 to 1987) (Table 5, Fig. 13 E, inset). The annual landings, in this case, varied from 0.2 t (1984) to 15.93 t (1986) with the average at 7.72 t. The landings, as seen from the pooled data, were confined to November - March and also to the monsoon.

The monthly landings in the pooled total were varying between 0.7% (August) and 38.3% (February) with two peaks, the dominant being of February (premonsoon), the other in July (monsoon) (Fig. 13 E).

The maximum landing by this gear was obtained during the postmonsoon (53.3%) and the minimum in the monsoon (7.4%).

The chief difference noted with Lethrinid landings by the gear as compared with those from the mechanised sector is that the landings were not protracted in this case.

Lutjanids : Lutjanids accouted for 23.013 t (2.16%) of the total perches by this gear occupying 5th position (Table 5. Fig.12 F, inset). The annual landings showed a decreasing trend from 7.4 t (1983) to 2.2 t (1987) with the average at 4.9 t.

The landings were never spread throughout the year and in 1984 they were confined to two months. In the pooled monthly total for the entire period the paucity in landings could be noted only for two months (April and November).

In the pooled monthly landings for the entire period, it fluctuated from 0.1% (July) to 38.7% (February) with three modes in landings. The dominant mode was in February (38.7%, premonsoon peak) followed by September (8.2%, postmonsoon peak). The third one or monsoon peak (June, 4.0%) was quite inconspicuous (Fig. 12 F).

The postmonsoon period was the best for Lutjanids by this gear (46.0%) and the monsoon registered very poor landings (10.9%).

This group ranked third in the landings by non-mechanised sector. The landings were also more protracted by non-mechanised sector.

Theraponids : With a total landing of 4.329 t (0.47%) this group occupied 6th rank among the various groups by this gear (Table 5, Fig. 11 E, inset).

Theraponids were rather scarce in the monthly landings from 1983 to 1987 and were confined to 1 or 2 months per year. The annual landings were found to vary between 0.056 t (1983) and 1.9 t (1985) with the average at 0.86 t. The monthly landings fluctuated between 1.3% (November) and 49.4% (June) with two peaks, the dominant one in June (monsoon) followed by the other in October (postmonsoon, Fig. 11 E).

As compared with the present sector the monthly pattern of landing noted in the non-mechanised sector was more protracted.

Boat seine

This gear was in operation allthrough 1979 to 1987. The number of units engaged in the above period was 295,574 with a landing of 324.728 t. This works out to an average of 1.15 kg of perch per unit. The units operated annually were from 22,723 (1980) to 47,763 (1979) with an average of 32,841. Except during 1979, 1981, 1982 and 1985, the units operated annually was below the average. The monsoon period was the best period for this gear with 76.9% of the total number of units. An unusual increase in units noted in this period may be attributed to the migration of fishermen to Vizhinjam from nearby centres. Only 4.2% of the total number of units was operated in the premonsoon.

The landings by this gear for the period was estimated at 342.728 t (10.9% of the total by all gears) ranking third in the order of abundance (Table 3, Fig. 6 A). The annual landings varied from 11.3 t (1979) to 101.25 t (1985) with the average at 38.08 t and from 4.8% (1980, 1987) to 19.7% (1985) of the total (Fig. 8). The annual landings were higher than the average only in 1983, 1985 and 1986. In the pooled total for the various months it is noted that the monthly landings varied from 0.3% (February) to 27.8% (July) (Fig. 7 D), with two modes, the dominant one in July (monsoon) and the next in April (premonsoon peak). The monsoon accounted for the bulk (71.4%) followed by the premonsoon (15.8%).

Monthly CPU estimated was at its peak during January (11.02 kg, Fig. 7 D). After a sudden fall in February, it again went up by April (6.6 kg) and then from June to October it was at a lower level. In November it showed a slight increase (5.71 kg), but came down to 0.8 kg by December. It is interesting to note in this context that the peak period in landing registered lower CPU and vice versa.

Perches in Boat-seine

The total landings of 342.728 t by this gear was shared by 8 groups (Table 6, Fig. 6 E).

Siganids : This group formed the major item in the landings by this gear forming 64.62% (221.468 t). The annual landings ranged from 3.19 t (1981) to 60.15 t (1985) with the average at 24.6 t. The annual landings were well above this average during 1983 to 1987 (Table 6, Fig. 12 K).

TABLE 6. *Perches landed in Boat-seine and their percentages*

Groups	Landings (t)	%
Siganids	221.468	64.62
Nemipterids	28.791	8.40
Ambassids	25.520	7.45
Serranids	19.344	5.65
Theraponids	14.000	4.08
Lutjanids	13.931	4.06
Lethrinids	10.904	3.18
Priacanthids	8.770	2.56

In the monthly landings, March to October was generally with good landings, though nil landings were somewhat regular for some years. In the pooled total for each month, however, nil landings were noted only in January and in other months the landings ranged from 0.06% (February) to 27.9% (August). Three peaks were seen with the dominant one in August (27.9%, monsoon). The other two peaks were in June (15.5%, monsoon) and April (Fig. 12 K).

The monsoon landed the maximum (65.8%) and the postmonsoon period, the minimum (13.9%).

Nemipterids : This group accounted for 28.791 t (8.40% of the catch by this gear) ranking second in the order of abundance (Table 6, Fig. 9 B). The landings were effected during February to October in 1980, but later they were confined to July only. For 5 years (1979, 1981 to 1983 and 1987), there were no landing of Nemipterids by this gear. The annual landings varied from 0.12 t (1984) to 14.2 t (1985) with the average at 7.19 t. The monsoon period accounted for 94.5% of the total by this gear.

Ambassids : This group accounted for 25.52 t forming 7.45 % of the total perch landed by this gear (Table 6, Fig. 13 I). There were no landings of Ambassids during 1980, 1985 and 1986 and for the rest of the period the landings were

irregular with average at 4.2 t. The landings recorded for 1983, 1984 and 1987 were below the average of 4.2 t.

In the pooled total for each month for the entire period, the landings were noted in all months and the monthly landings were from 0.7% (February) to 17.4% (July) (Fig. 13 I). The monsoon accounted for the maximum landings (38.3%) and the premonsoon for the minimum 23.8%).

Serranids : The landing of Serranids by Boat-seine for 1979 to 1987, was estimated at 19.344 t forming 5.65% of the total (Table 6, Fig. 10 H). Out of 9 years investigated this group could be encountered only twice in this gear : July, 1980 (124 kg) and August 1985 (19.2 t). This shows that the representation of this group in this gear is only accidental.

Theraponids : This group occupied 5th position with a total of 14.0 t (4.08%) (Table 6, Fig. 11 A). They landed almost throughout the year during 1979 and 1980, but later became rather scarce, the landings being, at the most, confined to a month or two per year. The annual landings of this group, by this gear, ranged from 0.13 t (1986) to 5.1 t (1979). In pooled monthly total for the entire period, the monthly landings fluctuated between 0.3% (Sept.) and 46.2% (July) (Fig. 11 A). Three peaks were seen : the monsoon peak in July was the dominant one (46.2%) followed by others in April (9.3%, premonsoon) and October (8.4%, postmonsoon). The monsoon accounted for 75.5% of the total, followed by the premonsoon period.

Lutjanids : The landing of this group for 1979 to 1987 by this gear was estimated at 13.931 t and by its 4.06 % contribution, ranked 6th in the order of abundance (Table 6, Fig. 12 B). The catches were nil during 1979, 1982, 1984, 1986 and 1987; and for the rest of the period varied from 0.4 t (1980) to 6.6 t (1985). The landings could be noted only for a month every year, but in the pooled catch data the landings were spread over 4 months from June to September. Two peaks (Fig. 12 B) in the pooled monthly landings could be noted, the dominant one was in August (47.6%).

Lethrinids : The landings of Lethrinids for the period were estimated at 10.904 t (3.18% of the total by this gear). Out of 9 years investigated, this group could be encountered only once (July, 1983) (Table 6, Fig. 13 B).

Priacanthids : With an aggregate of 8.770 t (2.56%) this group ranked 8th in the landings by this gear. There were no landings from 1979 to 1984 and in 1987. Of the two years when they were present, the landings were confined to July - September period only (Fig. 10 B, inset; Table 6).

Drift net (Mechanised sector)

Drift nets operated from mechanised crafts (*i.e.* catamaran and canoe) fitted with OBM are included under this category. Though this type of mechanisation got initiated at Vizhinjam by the end of 1982, the landings of perches by this sector upto 1983 were not at all encouraging. By 1984 the landings started showing distinct upward trend and from 10.7 t (1984) it had gone upto 86.8 t by 1987 (Fig. 6 A).

The total landings by this gear from 1983 to 1987 was estimated at 215.107 t (6.84%) ranking 4th among the various gears that landed perch at Vizhinjam (Table 3). The annual landings by this gear ranged from 2.7 t (1983) to 86.8 t (1987) with the average at 43.02 t. The contribution to the annual landings by this gear varied from 0.6% (1983) to 16.0% (1987) (Fig. 7).

The units operated during 1983 to 1987 was 65,830 against at total landings of 215.107 t and this worked out to an average of 3.26 kg per unit. The overall variation in the annual distribution of units was from 1332 (1983) to 24,208 (1987) with the average at 13166. 58.1% of the total units was employed during the postmonsoon months followed by 30.6% in the premonsoon (Fig. 7 C). The range in the pooled monthly total CPU for the entire period was from 0.3 kg (May) to 8.08 kg (January).

In the pooled catch data the monthly landings ranged from 0.3% (May) to 21.2% (January) with three modes in landings. Of these, two were noted during the postmonsoon (January and October) with 21.2% and 11.4%

respectively and the other in June (monsoon period, 2.7%).

Seasonwise, the postmonsoon period claimed the bulk (64.0%) of the total landings followed by the premonsoon period (30.8%).

Perches in Drift net (Mechanised sector)

The undermentioned 5 groups (Table 7, Fig. 6 F) constituted to total landings of 215.107 t of perches by this gear.

TABLE 7. *Perches landed in Drift net (Mechanised sector) and their percentages*

Groups	Landings (t)	%
Lethrinids	86.861	40.38
Priacanthids	75.372	35.04
Serranids	33.139	15.41
Lutjanids	19.563	9.09
Nemipterids	0.172	0.08

Lethrinids : This group formed the major item with 86.861 t (40.38%) of the total by this gear (Table 7, Fig. 13 A, inset). The annual landings, in this case, were found to vary between 0.19 t (1983) and 33.8 t (1987) with an average at 17.37 t.

Lethrinids were absent in the landings during May to August. Two peaks in the pooled monthly landings were noted and were in January (29.5%) and September (4.8%) (Fig 13 A). Postmonsoon period accounted for 62.9% and the premonsoon period for 37.1% of the total landings.

Priacanthids : The total landings of this group was 75.372 t (35.04 % of the total by this gear) (Table 7, Fig. 10 A). There was no landing in 1983 and in 1984 the landings were poor. The annual landings were fluctuating between 9.9 t (1984) and 25.5 t (1987), the average being 15.07 t. The landings of Priacanthids were not spread through the various months of the years and in the pooled total also the trend was the same. Usually these fishes were not obtained in April, May and August. Four peaks in the landings were seen in the pooled monthly total for the entire period (Fig. 10 A); they were in October (24.5%), March (16.8%), December (15.0%) and June (2.3%). The postmonsoon period accounted for 74.8 % of the total landings and the monsoon for 4.0 % by this gear.

Serranids : This group was third in the order of abundance, with a total of 33.139 t (15.41%) (Table 7, Fig. 10 G). During 1983 and 1984 there were no landings but, for the rest of the period, the annual landings fluctuated from 2.4 t (1986) to 21.6 t (1987). In the pooled monthly total, there were no landings in July and for the rest the monthly landings ranged from 1.5 t (December) to 27.0 (February).

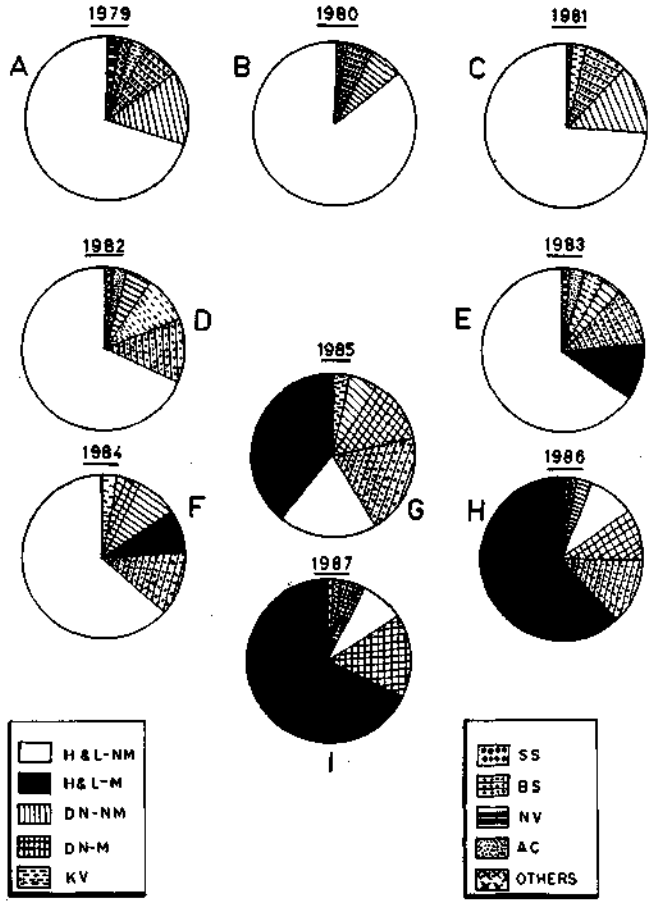


Fig. 8. Percentage contribution by different gears to the total annual landings of perch

Four peaks in the landings, two in the postmonsoon and one each during premonsooon and monsoon periods were noted (Fig. 10 G). Premonsoon peak (February) was the most dominant one (27%) followed by June (13.5%). The other two peaks were insignificant. The landings registered during the post- and

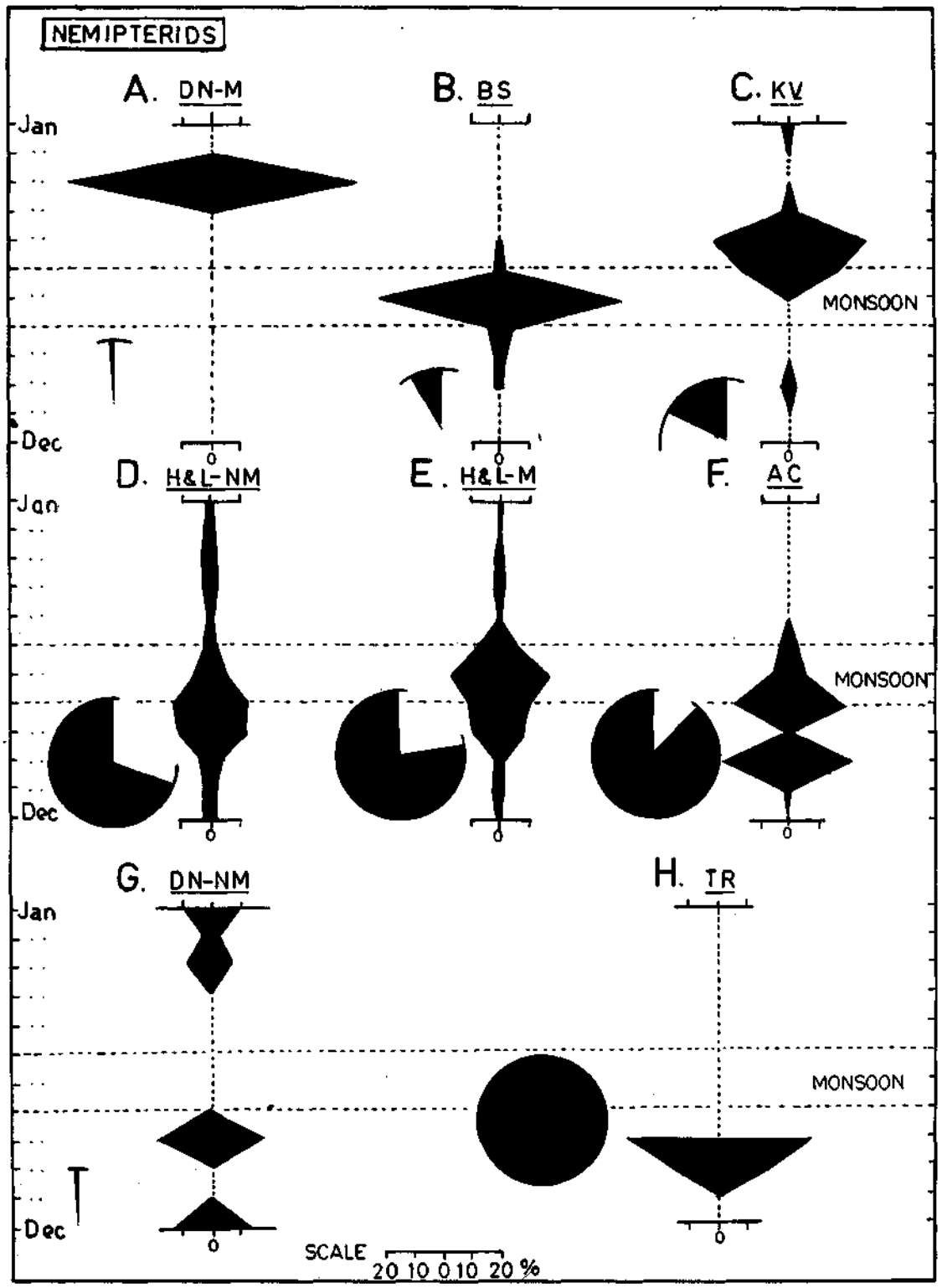


Fig. 9. Landings of Nemipterids by different gears. Monthly landings (%) from pooled (1979 - 1987) for each month are given. Monsoon period is indicated by interrupted lines.

A. Drift net (mech. sector), B. Boat seine, C. Konchu vala, D. Hooks and line (non-mech. sector), E. Hooks and line (mech. sector), F. Achil, G. Drift net (non-mech. sector) and H. Trawl (inset figure shows the percentage contribution of each group by the respective gear).

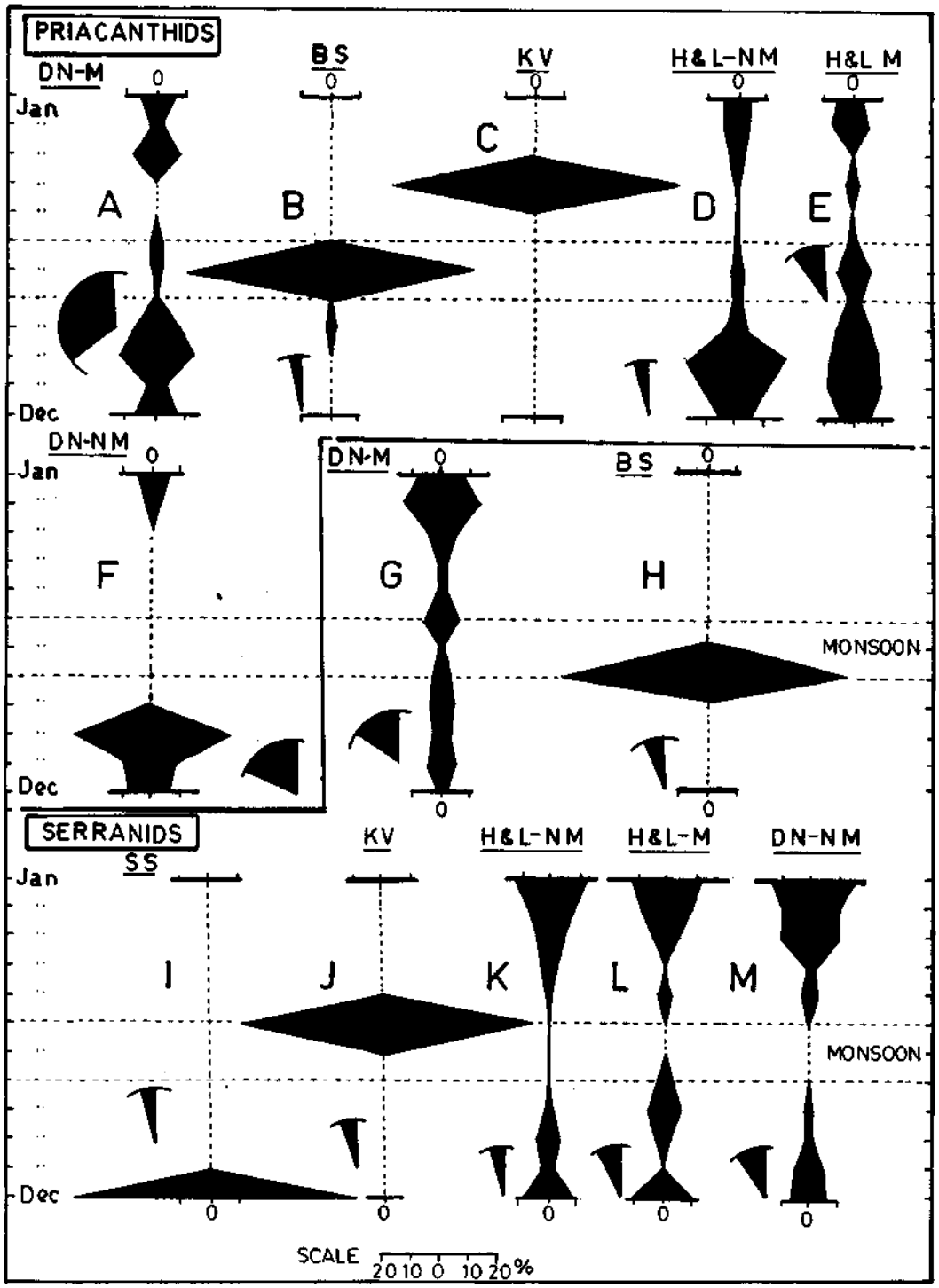


Fig. 10. Landings of Priacanthids and Serranids by different gears. Average monthly landings (%) for each month are given. Monsoon period is indicated by two interrupted lines.

A - F. Priacanthids : A. Drift net (mech. sector), B. Boat seine, C. Konchu vala, D. Hooks and line (non-mech. sector), E. Hooks and line (mech. sector), F. Drift net (non-mech. sector); G - M. Serranids : G. Drift net (mech. sector), H. Boat seine, I. Shore seine, J. Konchu vala, K. Hooks and line (non-mech. sector), L. Hooks and line (mech. sector) and M. Drift net (non-mech. sector) (inset figures shows the percentage contribution of each group by the respective gear).

premonsoon periods were more or less similar quantitatively (41.5% and 41.4% respectively).

Lutjanids : This group with 19.563 t, formed 9.09 % of the total perch landed by this gear (Table 7, Fig. 12 A). The variation noted in the annual landings of this group was from 0.052 t (1984) to 9.1 t (1985) with an average at 3.12 t. The landings were irregular in different months and in 1984 there was only a month's landing. However, in the pooled data the landings were noted from January to April and also from August to October and December, and the monthly landings fluctuated between 0.2% (March) to 27.6% (December) with 4 modes in landings (Fig. 12 A). Of these two were during the postmonsoon (December, dominant; October, 12.8%), one each in monsoon (August, 9.8%) and premonsoon (April, 2.7%). The maximum landing of this group was seen in the postmonsoon period (67.4%) followed by the premonsoon (22.8%).

Nemipterids : Out of 5 years fishing by this gear, Nemipterids occurred only in 1984 (Fig. 9 A) and that too, in small quantities (172 kg in March).

Drift net (Non-mechanised sector)

The contribution by this sector, for the period 1979 to 1987, was 5.59 % (Fig. 6 A) of the total amounting to 175.587 t, ranking 5th in the order of abundance (Table 3).

In the annual landings, the contribution by this gear ranged from 1.7% (1987) to 14.6% (1979) and the landings from 9.1 t (1987) to 20.0 t (1985) with the average at 19.5 t. Landings noted during; the period 1982 to 1987 were below the average except in 1985. The annual landings showed a decreasing trend from 1985 onwards as more and more crafts were mechanised. This gear was not in operation during the monsoon period unlike their counterparts operated from mechanised crafts.

The total units operated during the entire period was 77,395 against a total landing of 175.587 t of perches and this worked out to a CPU of 2.26 kg per unit. The total units operated per year ranged from 1128 in 1987 to 17,573 in 1980, with an average at 8599 units. As noted in landings, there was a decline in the total units operated towards the fag end of the period.

In the pooled total landings for each month, the monthly landings fluctuated considerably, from 0.8% (May) to 30.5 (January) with two peaks in landing. Both these peaks were in the postmonsoon period, the dominant being that of January (30.5%) and the next in October (15%) (Fig. 7 E). CPU also registered a bimodal oscillation, the dominant one was in January (7.6 kg) and the next in October. Seasonwise it is seen that 71% of the total catch was landed in the postmonsoon months as against 61% of the total units engaged.

Perches in Drift net (Non-mechanised sector)

The total of 175.587 t of perches by this gear was shared by the following 7 groups (Table 8, Fig. 6 D).

Lethrinids : With a total of 67.059 t this group formed 38.19% of the total perches landed by this gear, ranking first (Table 8, Fig. 13 F). The annual landings varied from 1.6 t (1982) to 13.7 (1981) with an average at 7.45 t. During 1979 to 1981 and also in 1985 the annual landings were above the average (7.45 t).

The monthly landings by this gear, when examined yearwise, were quite irregular; in 1982 landings were only for two months (November and December) and in 1987 also a similar situation prevailed (January and February).

TABLE 8. *Perches landed in Drift net (Non-mechanised sector) and their percentages*

Groups	Landings (t)	%
Lethrinids	67.059	38.19
Lutjanids	48.244	27.48
Priacanthids	33.403	19.03
Serranids	16.967	9.66
Theraponids	8.014	4.57
Nemipterids	1.200	0.68
Ambassids	0.700	0.39

In the pooled total, it is noted that the landings were confined to November to May only, with one peak in January (41.6%). Landingwise the postmonsoon accounted for 66.8% of the total landings (Fig. 13 F).

Lutjanids : The landing of this group (1979 - 1987) was estimated at 48.244 t forming 27.48% of the total by this gear (Table 8, Fig. 12 I). This group occupied the second rank and in the annual landing this group varied from 0.608 t (1987) to 12.01 t (1979) with the average at 5.36 t. The annual landings had fallen short of the above average during 1982, 1984, 1986 and 1987.

In pooled total the monthly landings fluctuated considerably from 0.4% (September) to 30.5 % (January). The landings could be seen during January to April and also from September to December only. Two peaks could be noted and both of them were in the postmonsoon months, the dominant being that of January (30.5 %) followed by the one in October (14%).

The postmonsoon accounted for 62.1% of the total landings.

Priacanthids : This group ranked third with 33.403 t (19.03%) among the various groups landed by this gear. In some years (1979 and 1987) this group figured in the landings only for two months (Table 8, Fig. 10 F).

This group was caught by this gear only during the postmonsoon months, but in 1979, 1986 and 1987 the fishery got extended to the premonsoon month of February also. The fluctuation in the annual landings was from 0.15 t (1980) to 9.2 t (1984) with the average at 3.7 t. The landings were above this average during 1982, 1984, 1985 and 1987.

In the pooled total landings for each month, the landings could be noted in all months except March to September and the monthly landings were found to vary between 52.9% (October) and 3.9% (February) (Fig. 10 F). The peak landings of this group could be seen during the postmonsoon period (96.1.%).

Serranids : The contribution to the total landings by this gear was 9.7% of the total (16.967 t) ranking 4th in the order of abundance (Table 8, Fig. 10 M). The serranids could be observed allthrough the year in pooled data except during monsoon when the gear was not in operation. But such continuity could not be observed in the landings of any year when taken individually.

The annual landing ranged between 0.303 t (1983) and 5.1 t (1985) with the average at 1.88 t. The annual landings were above this average during the years 1980, 1981, 1985 and 1986.

In the pooled total landing for each month, the monthly landings were found to very from 1.1% (October) to 28.0 (January) with two peaks in landings : the dominant was in Junuary (28%) and the other in May (4.5%) (Fig. 10 M).

Seasonwise it is seen that the postmonsoon registered the maximum landings (52.4%) followed by the premonsoon period.

Theraponids : The total landing of this group, by this gear, was estimated at 8.014 t (4.57%) from 1979 to 1987. This group occupied 5th position among the different groups landed by this gear (Table 8, Fig. 11 H). there was no landings of Theraponids during 1979, 1986 and 1987, while in the other years their landings were irregular. The annual landings varied from 0.19 t (1984) to 3.7 t (1983) with an average at 0.89 t. The annual landings were above this average in 1980 and 1983.

In the pooled total for each month the monthly landings ranged between 1.7% (February) and 30.2% (September) with three peaks in landings (Fig. 11 H). Both the dominant and the next one in landings could be seen during the postmonsoon months of September and January contributing to 30.3% and 26.4% respectively of the total.

The postmonsoon period is the best season for this group by this gear as 93.7% of the total was registered during this period.

Nemipterids : The total quantity landed (1979-1987) was only 1.2 t (0.68%) by this gear (Table 8, Fig. 9 G). The landings were stray and registered for 1 to 2 months per year for 4 years

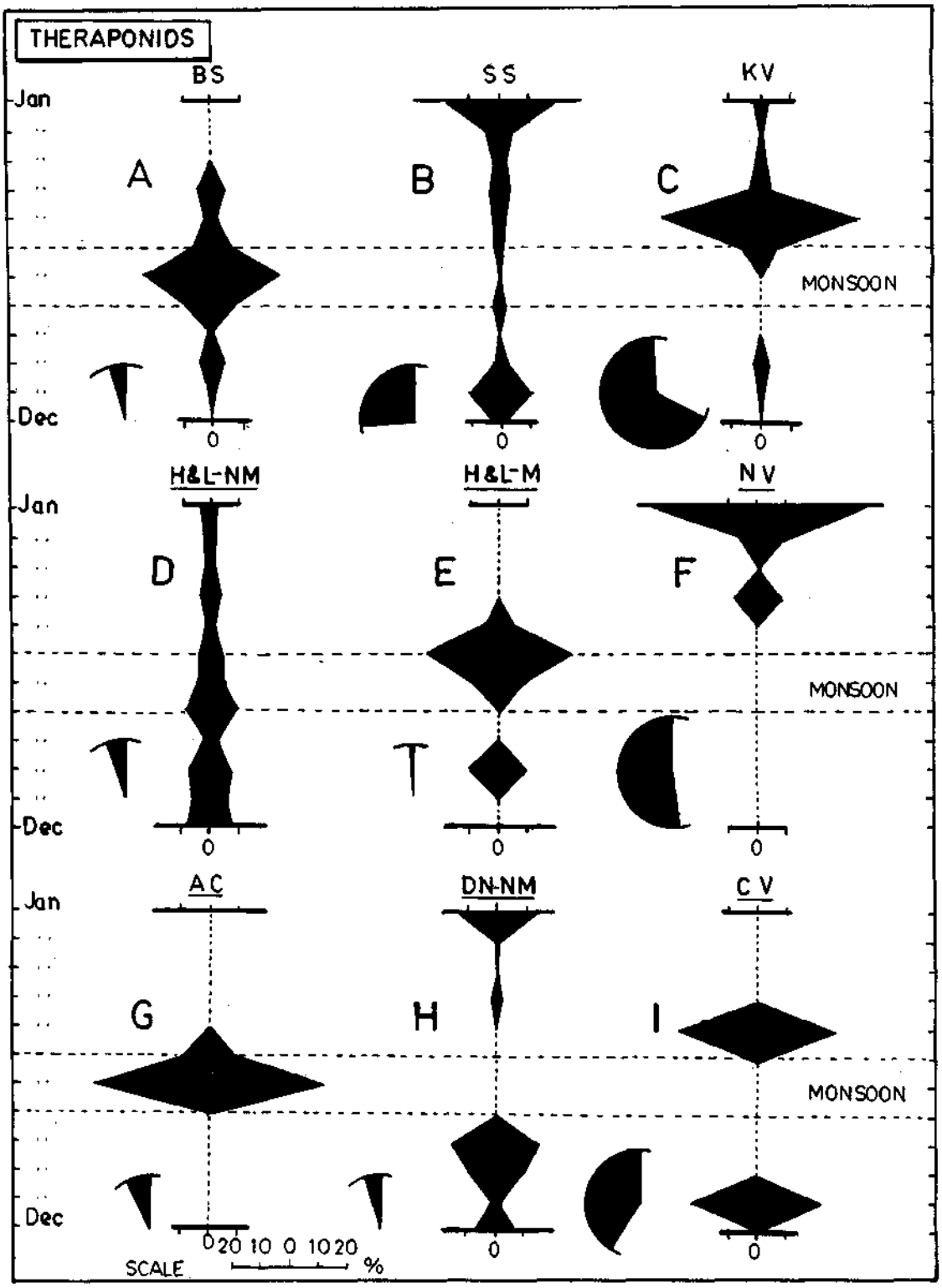


Fig. 11. Landings of Theraponids by different gears. Monthly landings (%) from pooled total for each month are given. Monsoon period is indicated by two interrupted lines : A. Boat seine, B. Shore seine, C. Konchu vala, D. Hooks and line (non-mech. sector), E. Hooks and line (mech. sector), F. Nandu vala, G. Achil, H. Drift net (non-mech. sector) and I. Chala vala (inset figure shows the percentage contribution of each group by the respective gear).

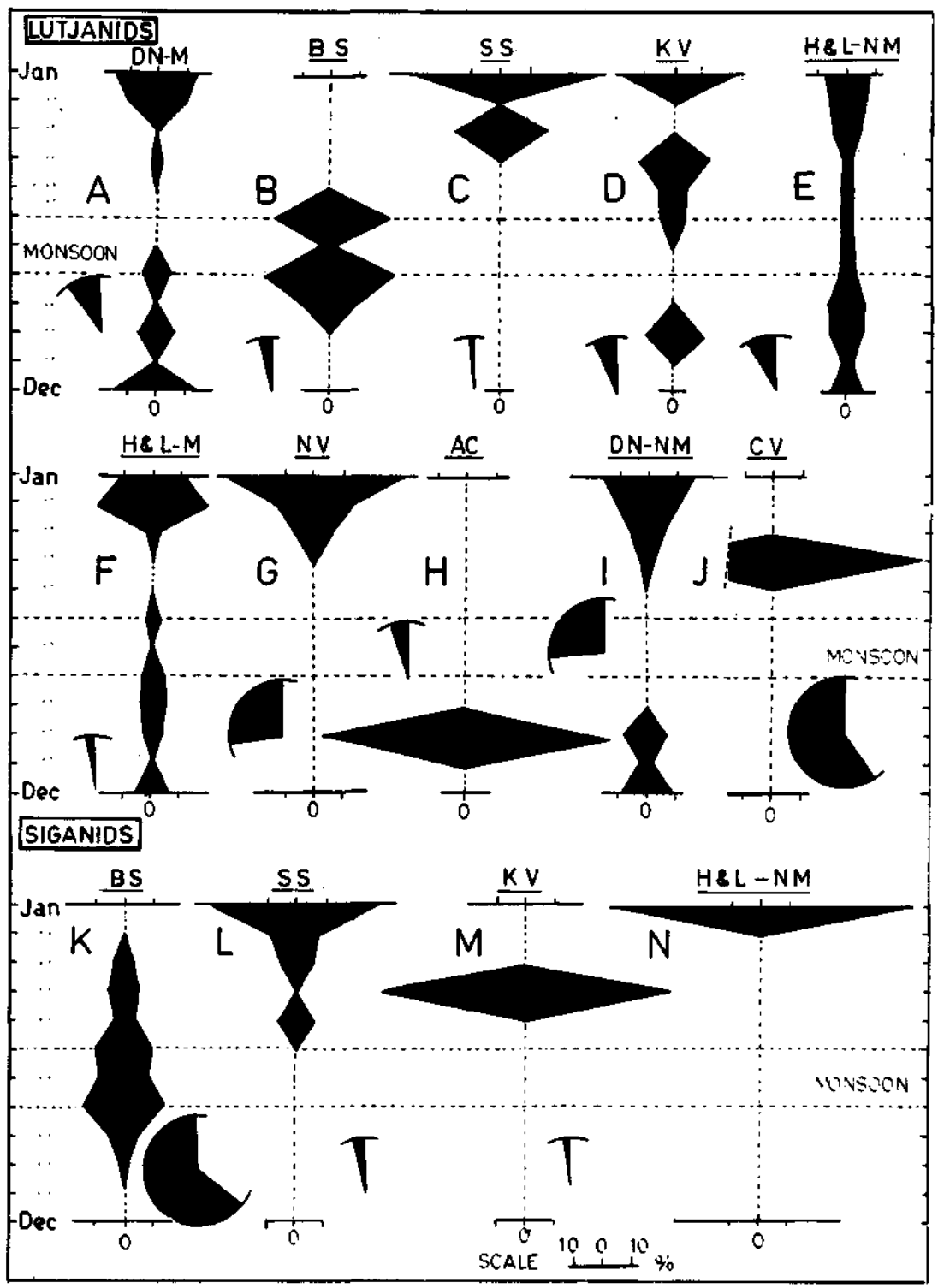


Fig. 12. Landings of Lutjanids and Siganids by different gears. Monthly landings (%) from pooled total for each month are given. Monsoon period is indicated by two iterrupted lines. A - J. Lutjanids and K - N. Siganids. A. Drift net (mech. sector), B. Boat seine, C. Shore seine, D. Konchu vala, E. Hooks and line (non-mech. sector), F. Hooks and line (mech. sector), G. Nandu vala, H. Achil, I. Drift net (non-mech. sector), J. Chala vala, K. Boat seine, L. Shore seine, M. Konchu vala and N. Hooks and line (non-mech. sector) (inset figure shows the percentage contribution of each group by the respective gear).

(1980, 1982, 1984 and 1985) and for the rest of the period this group was not at all present in the landings.

In the pooled total for each month the landings could be noted only against 5 months *viz.* January to March, September and December. Three peaks in the landings could be observed, of which the one in September formed the dominant (36.2%) followed by December (20.9%) (Fig. 9 G). The postmonsoon accounted for 77.8% of the total Nemipterid landings by this gear.

Ambassids : This group accounted for 0.7 t (0.39%) and the entire landing was registered in April, 1982 (Fig. 13 J).

Konchu vala

This gear was in operation for the entire period (1979 to 1987), but the periodicity of operation was restricted to March to June and from October to January. The contribution by this gear to the perch landings accounted for 82.514 t (2.63%) (Fig. 6 A, Table 3). In the annual landings, the percentage contribution by this gear ranged from 0.6 (1987) to 9.3 (1982) and the landings from 3.0 t (1987) to 26.18 t (1982) with an average at 9.16 t (Fig. 8).

The total units operated during the period was 53,317 and the annual variation in the number of units operated was from 1163 (1985) to 13,020 (1979) with the average at 5924. The average production per unit for the period was 1.54 kg. In the pooled total for each month, the monthly landings fluctuated between 0.3% (Sept.) and 56.7% (May) with three peaks in landings. The peak in May (premonsoon period) was the dominant one (56.7%) followed by that of January (6.1%) and of October (6%) (Fig. 7 F).

The CPU, in the pooled total for each month, was found to vary from 4.24 kg (January) to 0.42 kg (December). Three peaks in the distribution of CPU could be noted in the above pooled data. When the landing was the maximum in May, the CPU was only 1.62 kg, and in October, when the last peak occurred, the CPU was higher (3.35 kg) (Fig. 7 F).

The maximum units were employed during the postmonsoon period (64.6% of the total) and in this period 67 % of the total landings was recorded.

Perches in Konchu vala

The total landing of 82.514 t of perches was shared by the following 7 groups (Table 9, Fig. 6 G).

TABLE 9. *Perches landed in Konchu vala and their percentages*

Groups	Landings (t)	%
Theraponids	55.695	67.49
Nemipterids	14.438	17.49
Lutjanids	5.706	6.92
Serranids	3.660	4.44
Lethrinids	1.653	2.01
Siganids	1.282	1.56
Priacanthids	0.080	0.09

Theraponids : Theraponids ranked first with 55.695 t (67.49%) (Table 9, Fig. 11 C). The annual landings ranged from 1.07 t (1987) to 24.89 t (1982) with the average at 6.18 t. The annual landings were well above this average only in 1982 and 1983, but after this period, the landings showed a decreasing trend. No landings in February, July, August and November for all the years. The period from March to June had better landings while September to January witnessed poor landings.

In the pooled total for each month, the monthly landings ranged from 0.6% (December) to 67.4 (May) with three peaks (Fig. 11 C). The dominant peak was seen in May (premonsoon period, 67.4%) followed by October (postmonsoon period, 5.6%) and January (2.8%). 75.8% landing was registered during the premonsoon period while the landing in the postmonsoon period was only 9.6%

Nemipterids : This group ranked second in the total landings by this gear with 14.438 t (17.49%) (Table 9, Fig. 9 C). There were no landings by this gear in 1981 and 1986, and for the other years the landings were either poor or irregular. In the pooled total, the landings

were confined to March to June. In 1983 there were some stray landings in October.

The annual landings ranged beteween 0.5 t (1984) and 5.6 t (1985) with the average at 1.6 t. In general, the annual landings dwindled considerably after 1984. In the pooled monthly total for each month, the landings ranged between 0.7% (March) and 53.0% (May). The mode noted in October 1983 was due to an unusual landing, but in other years no such landing was observed (Fig. 9 C). The premonsoon period accounted for 60.2% of the total landings followed by the monsoon period (34.0%).

Lutjanids : This group figured in landings of 1980, 1983, 1984 and 1985; and that too for one or two months only.

The total landings by this gear accounted for 5.706 t (6.92%) (Table 9, Fig. 12 D), ranking third among seven groups. The annual landings varied from 0.056 t (1984) to 3.6 t (1985).

In the pooled total for each month the landings were seen only during January, April to June and October. Three peaks in the landings were noted, the dominant one in January (39.7%) followed by April and Ocober (24.0% and 19.0% respectively) (Fig. 12 D).

The maximum landing was recorded during the postmonsoon period (58.7%) followed by the premonsoon period.

Serranids : This groups with 3.660 t (or 4.44%), ranked 4th in abundance (Table 9, Fig. 10 J). This group could be fished only during June in 1980 and 1982 by this gear.

Lethrinids : The total landings of Lethrinids, by this gear, was estimated at 1.653 t ranking 5th in the order of abundance (Table 9, Fig. 13 C). This group was generally scarce in the landings and was available only for 1 to 2 months per year for three years (1979, 1980 and 1985). In the pooled total for each month the landings were spread over January, and April to June period (Fig. 13 C), January accounting for 68.8% of the total landings.

Siganids : This group was encountered in the landings by this gear only once (April, 1983) with a total of 1.282 t (1.56% of the total by this gear) (Table 9, Fig. 12 M).

Priacanthids : A small quantity (80 kg) was landed by this gear in April, 1979 (Table 9, Fig. 10 C).

Achil

This gear which is a modified version of Hooks and line, is a hand line with closely set smaller hooks at the end of the line. Out of 9 years studied, this gear was employed only in 1982 and 1983. The total landings, by this gear, were estimated at 19.822 t forming 0.63% of the total perch landings by all gears (Fig. 6 A, under 'others' and Table 3). The contribution by this gear to the annual landings in 1982 was 2.3% of the total, while in 1983 it was 3% (Fig. 8).

The season of operation of this gear also fluctuated considerably: it was operated during June to August in 1982 and from May to November in 1983. The monsoon was the best period in the landings (49.9% of the total) followed by the postmonsoon period (49.4%) (Fig. 7 H).

The total units employed was 12,146. In the pooled total for each month, the monthly CPU varied from 0.09 kg (June) to 10.5 kg (October). Three peaks in the distribution of CPU could be noted in the pooled monthly total, the dominant being that of October (10.5 kg), followed by August (3.09 kg) and May (1.4 kg). Peaks in CPU coincided with the peaks in landings (Fig. 7 H).

The maximum number of units was operated during the monsoon period (81%), but the catch accounted was only 49.9% of the total. The postmonsoon period, on the contrary, engaged only 18.3% of the total number against a landing of 49.4% of the total.

Perches by Achil

The total landings of 19.822 t by this gear, was consisted of 3 groups (Table 10, Fig. 6 H).

Nemipterids : This group dominated with 17.434 t (87.95%) (Table 10, Fig. 9 F). There were landings only in August (1982), but were

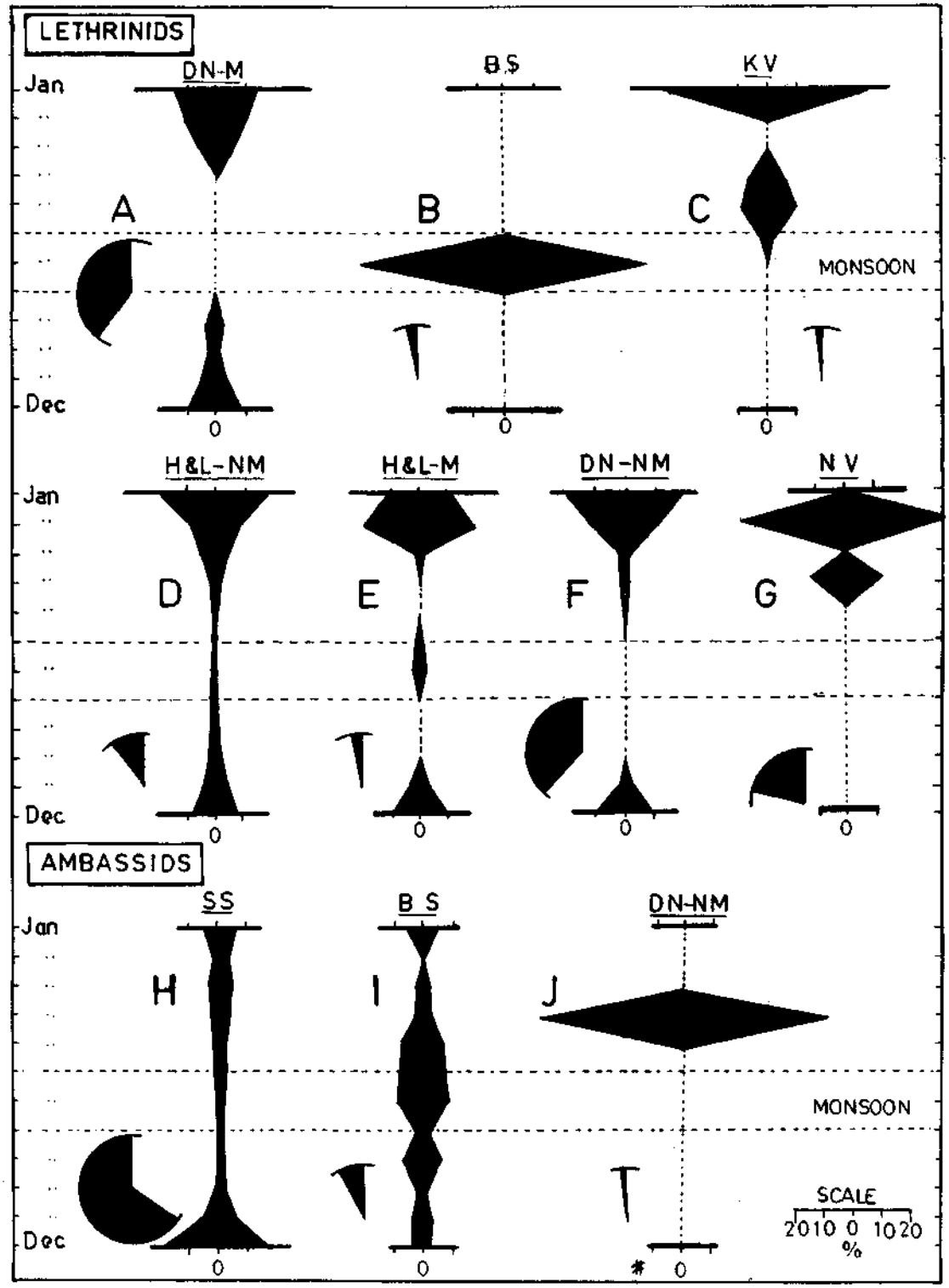


Fig. 13. Landings of Lethrinids and Ambassids by different gears. Monthly landings (%) from pooled total for each month are given. Monsoon period is indicated by two interrupted lines. A - G. Lethrinids : A. Drift net (mech. sector), B. Boat seine, C. Konchu vala, D. Hooks and line (non-mech. sector), E. Hooks and line (mech.sector), F. Drift net (non-mech. sector), G. Nandu vala; H - J. Ambassids : H. Shore seine, I. Boat seine and J. Drift net (non-mech. sector) (inset figure shows the percentage contribution of each group by the respective gear).

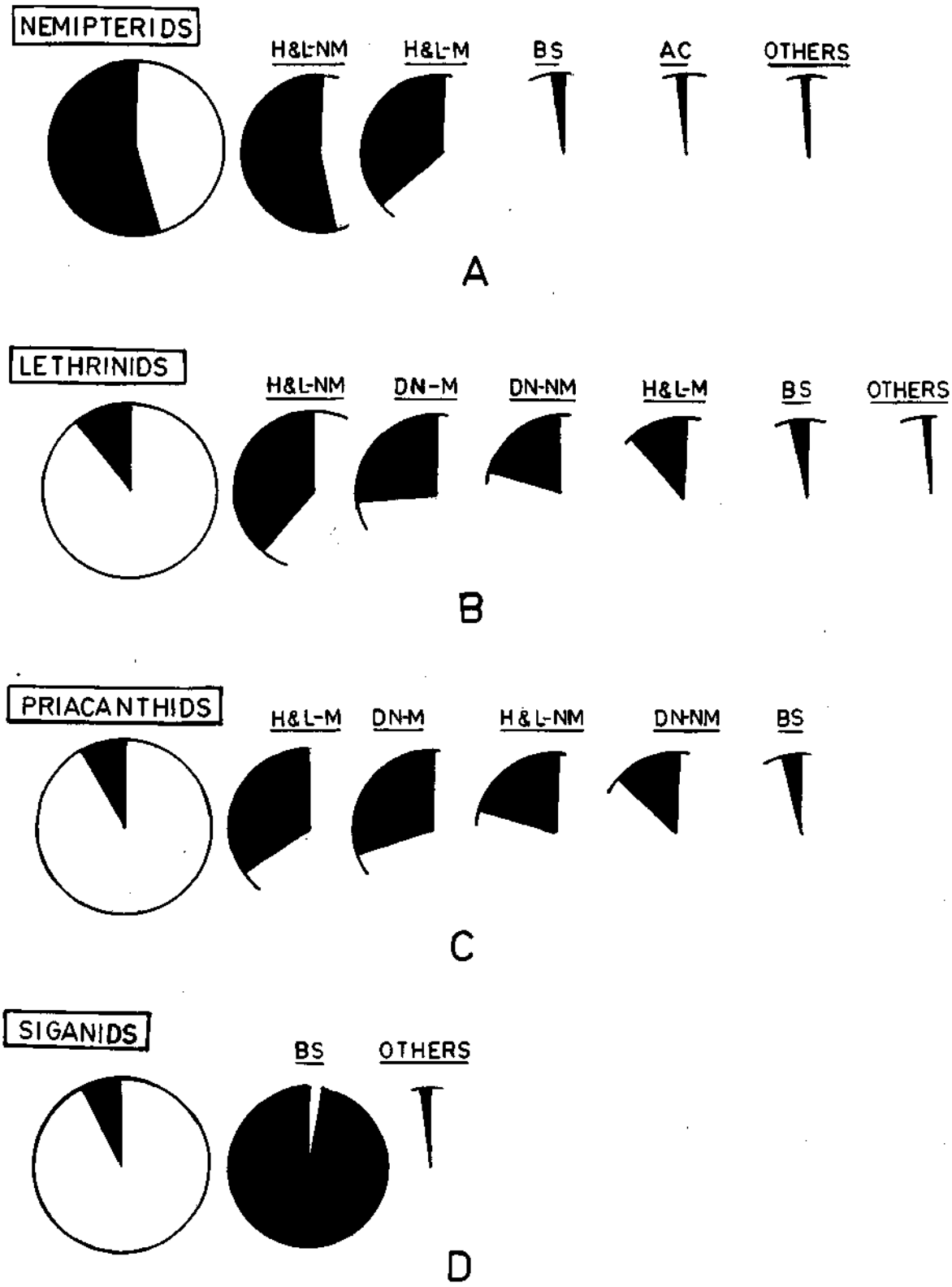


Fig. 14. The percentage share of each group in the total landings of perches at Vizhinjam for 1979 - 1987 and their gearwise contribution.

spread from May to November in 1983. The annual landings noted during 1982 and 1983 were 5.0 t and 12.36 t respectively.

TABLE 10. *Perches landed by Achil and their percentages*

Groups	Landings (t)	%
Nemipterids	17.424	87.95
Theraponids	1.427	7.19
Lutjanids	0.961	4.86

In the pooled total for each month, landings ranged from 0.8% (May) to 4.62% (October) with two peaks (Fig. 9 F). The dominant peak was in October (46.2%) and the other in August (36.8%).

The postmonsoon period may be taken as the best period for this group (50.6%) followed by the monsoon period (48.6%).

Lutjanids : This group was available in the landings by this gear in October, 1983 and the quantity was only 0.961 t (4.86%) (Table 10, Fig. 12 H).

Shore-seine

The landing by this gear was somewhat regular during 1979 to 1981, but later became irregular and sparse; there were landings for three months in 1983, for one month in 1986 and were totally absent in 1984, 1985 and 1987.

The total landings by this gear for the period 1979 to 1987 were at 9.972 t forming 0.32% of the total perch landed by different gears for the period (Table 3, Fig. 6 A, under 'others') ranking 8th in the order of abundance. The contribution by this gear to the annual landings fluctuated between 0.01% (1886) and 2.3% (1979) and the landings from 0.028 t (1986) to 3.967 t (1979) with the average at 1.1 t (Fig. 8).

Only one peak in landings could be noted both in the monthly landings for the individual years and also in the pooled total for each month. This peak invariably occurred during the postmonsoon month (December, 27.9% of the total landings) (Fig. 7 I).

The postmonsoon period accounted for the bulk in landings (67.9%) followed by the premonsoon (23.6%).

The total units operated during 1979 to 1987 was 5619 and the annual variation in number was from 39 (1986) to 2614 (1979) with the average at 624. In the pooled total for each month the CPU fluctuated between 0.8 kg (August) and 6.96 kg (July). Two peaks in CPU was noted in the pooled monthly total, the dominant one in July (6.96) kg) and the next in December (3.0 kg) (Fig. 7 I).

Perches in Shore-seine

The total landings of 9.972 t were shared by the following 5 groups (Table 11, Fig. 6 J).

TABLE 11. *Perches landed in shore-seine and their percentages*

Groups	Landings (t)	%
Ambassids	6.637	66.5
Theraponids	2.652	26.6
Serranids	0.386	3.9
Siganids	0.246	2.5
Lutjanids	0.051	0.5

Ambassids : This group constituted the bulk (66.5%) with 6.637 t in the landings by this gear (Table 11, Fig. 13 H). The landings, though irregular, could be noted only during 1979 to 1983. The quantity landed during the above period fluctuated between 0.294 t (1983) and 2.9 t (1979). In the pooled total for each month the monthly landings varied from 1.7% (September) to 37.1% (December) with a single mode in December (Fig. 13 H). The best season for this group, by this gear, was the postmonsoon (66.1%) followed by the premonsoon (25.2%).

Theraponids : This group ranked second among the five groups with 2.652 t (26.6%) of the total landings by this gear (Table 11, Fig. 11 B). Here also, as seen in the above group, there were no landings after 1983, with the exception in 1986, when a meagre quantity of 28 kg was landed. The annual landings ranged from 0.028 to (1986) to 1.0 t (1979).

In the pooled total for each month, the monthly landings ranged from 0.3% (September) to 38.2% (January) with 4 peaks in landings. The dominant peak was noted in January (38.2%) followed by the next in November (22.5%). The other two peaks were insignificant (Fig. 11 B). The postmonsoon period, with two peaks (in January and November), accounted for the maximum landings (69.2% of the total) followed by the premonsoon (22.9%).

Serranids : This group accounted for 0.386 t (3.9%) of the total landings by this gear (Table 11, Fig. 10 I). Out of 9 years studied, this group occurred only once, *i.e.* in December 1981.

Siganids : The total quantity landed was only 0.246 t (2.5% of the total by this gear). Landings were noted only in 1980, 1981 and 1983. In the pooled total for each month the landings could be seen only during January to June, with two peaks in landings (Fig. 12 L). These peaks were noted in January and May (57.3% and 12.2% respectively).

Lutjanids : During January 1979 and March 1980, this group formed a small fraction in the landings by this gear (5 kg and 0.5 kg respectively) (Table 11, Fig. 12 C).

Nandu vala

Nandu vala, a bottom set gill net, was under operation during 1979 and landed 2.574 t (Table 3, Fig. 6 A, under 'others'). This gear was employed during January to April and the CPU, during this period, fluctuated between 0.45 kg (March) and 16.9 kg (January) (Fig. 7 G).

The number of units operated during 1979 was 1324 with a landing of 2.574 t and this works out to an average of 1.94 kg per unit. 95.8% of units was operated during the premonsoon period.

Perches landed by Nandu vala

The total of 2.574 t was shared by 3 groups of perches (Table 12, Fig. 6 K).

Theraponids : With 1.346 t, this group was the most dominant one in the total landings by this gear (Table 12, Fig. 11 F). The maximum landing of this group occurred in January when 69.3% of the total occurred. The catches then came down to a 16.2% level by April.

TABLE 12. *Perches landed by Nandu vala and their percentages*

Groups	Landings (t)	%
Theraponids	1.346	52.3
Lutjanids	0.686	26.7
Lethrinids	0.542	21.0

Lutjanids : This group was available only during January to April and the total was only 0.686 t (26.7% of the total by this gear). Here also the landings registered a decreasing trend during January to April period (Table 12, Fig. 12 G).

Lethrinids : This group was recorded during February (peak) and April (0.542 t) (Table 12, Fig. 13 G).

Trawl

This gear was in operation only during September and October 1982 and the total landings were 1.303 to (Fig. 6L)

Perches landed by Trawl

The only group represented was Nemipterids and 64.3% of the total was landed during September and the rest in October (Fig. 9 H).

Chala vala

Between 1979 and 1987, this gear was under operation only in 1982, 1986 and 1987 with a total of 0.507 t ranking 11th in abundance (Table 3, Fig. 6 A under 'others').

The contribution by this gear in the total annual landings varied from 0.04% (1982) to 0.1% (1986) and the landings from 94 kg (1987) to 300 kg (1986). The premonsoon period accounted for 81.4% of the total landings. The total units employed was 1785 and landed 0.507 t and this works out to an average of 0.28 kg per unit.

Perches landed in Chala vala

Only Lutjanids and Theraponids shared the total landings (Table 13, Fig. 6 I).

Lutjanids : This group was encountered only once in April 1986 with 59.2% of the total (Table 13, Fig. 12 J).

TABLE 13. *Perches landed by Chala vala and their percentages*

Groups	Landings (t)	%
Lutjanids	0.300	59.2
Theraponids	0.207	40.8

Theraponids : This group was seen in the landings during May and November of 1982 and 1987 respectively. The total was only 0.207 t (Table 13, Fig. 11 I).

to considerable variation both in time and space. The occurrence of perches in different gears during 1979 - '87, is given in Table 14. Some gears were highly seasonal in their operation.

A perusal of Table 14 indicates that Boat-seine is the only gear that lands all the 8 groups of perches dealt with here. Three gears *viz.* Hooks and line (non-mechanised sector), Drift net (nonmechanised sector) and Konchu vala landed 7 groups each; Hooks and line (mechanised sector) landed 6 groups each; Achil and Nandu vala landed 3 groups each; Chala vala landed 2 groups and finally trawl landed only one group.

No group had figured in the landing of all the 11 gears; the maximum noted was 10 gears in the case of Lutjanids. Theraponids figured in the landings by 9 gears; Nemipterids by 8 gears;

TABLE 14. *Group - Gear relationship of perches at Vizhinjam during 1979 - 1987*

Gears	1	2	3	4	5	6	7	8	Number of groups in each gear
Boat seine	X	X	X	X	X	X	X	X	8
Hooks & line (NM)	X	X	X	X	X	-	X	X	7
Shore seine	-	-	X	X	X	X	X	-	5
Drift net (NM)	X	X	X	X	X	X	-	X	7
Konchu vala	X	X	X	X	X	-	X	X	7
Achil	X	-	X	X	-	-	-	-	3
Chala vala	-	-	X	X	-	-	-	-	2
Trawl	X	-	-	-	-	-	-	-	1
Hooks & line (M)	X	X	X	X	X	-	-	X	6
Nandu vala	-	X	X	X	-	-	-	-	3
Drift net (M)	X	X	-	X	X	-	-	X	5
Gears that landed each group	8	7	9	10	7	3	4	6	

NM = Non-mechanised, M = Mechanised
1. Nemipterids, 2. Lethrinids, 3. Theraponids, 4. Lutjanids, 5. Serranids, 6. Ambassids, 7. Siganids and 8. Priacanthids.

GEAR - GROUP INTERACTION IN THE LANDING OF PERCH AT VIZHINJAM

At present 11 types of gears contribute to the perch landings at Vizhinjam, of which none is employed specifically for perches. Some groups of perches were found dominating in certain gears, but this situation was also subject

Lethrinids and Serranids by 7 gears; Priacanthids by 6 gears; Siganids by 4 gears and finally Ambassids in the landings by 3 gears.

Different groups of perches were caught by different gears in different quantities and hence, how the different gears and groups of perches interacted in landings is dealt here.

The details are disussed for each group in the following lines:

Sub Section. 1. How the total landing of each group was apportioned as the catches of different gears and

Sub Section. 2. How much of each gear's catches was contributed to by the particular group discussed in the section.

Nemipterids

1. Among the 8 groups of perches landed at Vizhinijam during the above period, this group formed 55% of the total (1729.956 t) (Fig. 14 A). 8 gears were instrumental in the landing of this group. Hooks and line (non-mechanised sector) accounted for 948.917 t (54.8%) followed by Hooks and line operated from mechanised crafts (717.701 t or 41.5%). It may, hence, be stated that the Hooks and line accounted for about 86.3 % of the total Nemipterid. The rest of the landings, *i.e.* 3.7% (63.3 t) was contributed by 6 different gears in the following order : Boat seine 1.7%, Achil 1%. The contribution by the 4 other gears were negligible (1 %) (Fig. 14 A, under each gear).

2. The share of Nemipterids in the landings of the respective gear is given here. This group constituted the entire landings (100%) only in the case of Trawl net operated during 1982, for two months. In the case of other gears their share is as follows : Hooks and line (non-mechanised sector) 69.4%; Hooks and line (mechanised sector) 77.3%; Achil 87.9%; Konchu vala 17.5% and Boat-seine 8.4%. The share of other gears were negligible (Fig. 9 A-H, under various gears).

Lethrinids

1. The contribution by this group to the total perch landings, as compared to that of the previous group, was less, only 10.6% of the total with 332.464 t. 7 gears contributed their share in the above landings. The percentage contribution by Hooks and line (non-mechanised sector) was the maximum (38.1% or 126.8 t) followed by Drift net (mechanised sector 26.1% or 86.8 t). Drift net operated from non-mechanised crafts accounted for 20.2% or 67.0 t. Hooks and line (mechanised sector) accounted for 11.6% ; Boat-seine 3.3% or 10.9 t; Konchu vala 0.5% or 1.6 t. The contributions from other gears were negligible (Fig. 14 B, under each gear).

2. The composition of Lethrinids in the total landings of each gear indicated that Drift net (mech arised sector) accounted for 40.4%; Drift net (non-mechanised sector) 9.3%; Hooks and line (mechanised sector) 4.2% and Boat-seine 3.2% of the total by this group (Fig. 13 A-G, under various gears).

Priacanthids

1. This group accounted for 8.2% or 265.305 t of the total perch landings for 1979-1987. The percentage contribution was more in the mechanised sector of both Drift net and Hooks and line (29.4% and 33.7 % respectively). Hooks and line operated from non-mechanised craft accounted for the maximum among the non-mechanised gears with a total of 136.57 t. or 20.4% of the toal landings. Drift net (non-mechanised sector) accounted for 13% followed by Boat-seine (3.4%). The contribution by Konchu vala was negligible (Fig. 14 C, under each gear).

2. This group accounted for 35% in the total landings by Drift net (mechanised sector); 19% by Drift net (non-mechanised sector); 9.3% by Hooks and line (mechanised sector); 3.8% by Hooks and line (non-mechanised sector) and 2.6% by Boat seine. Landings of Priacanthids by Konchu vala were negligible (Fig. 10 A-F, under various gears).

Siganids

1. This group formed 7.1% of the total perch landings with 223.894 t and the number of gears that contributed to this total was four. Of these 4 gears, the Boat seine accounted for 98.9% (221.4 t) of the total Siganid landings. The other gears such as Konchu vala, Hooks and line (non-mechanised sector) and Shore seine accounted for 0.6%, 0.4% and 0.1% respectively (Fig. 14 D, under each gear).

2. Among perches landed by the Boat seine the foremost position was occupied by Signaids with 64.4% of the total. This group constituted only 2.5% in the total by Shore seine, 1.6% in the total by Konchu vala; landings by Hooks and

line (non-mechanised sector) were negligible (Fig. 12 K-N, under various gears).

Lutjanids

1. This is the only group landed by 10 different gears. The total landing for the period 1979 to 1987 was estimated at 216.624 t or 6.9% of the total perch landings at Vizhinjam for the above period. Hooks and line (non-mechanised sector) accounted for the maximum landings (107.169 t or 49.5%) followed by that of Drift net (non-mechanised sector) (48.244 t or 22.3%). Contributions by Hooks and line and Drift net (both from mechanised sector) were quite negligible (9.2% and 9% respectively) (Fig. 15 A, under each gear).

2. From the share of Lutjanids in the total landing by different gears, could be noted that 59.2% of Chala vala, 27.4% of the total by Drift net (non-mechanised sector 26.7% by Nandu vala, 9.1% by Drift net (mechanised sector) and 7.8% by Hooks and line (non-mechanised sector). The Lutjanid landing in other gears were negligible (Fig. 12 A-J, under various gears).

Serranids

1. Seven gears landed a total of 189.931 t of Serranids. Hooks and line operated from both mechanised and non-mechanised crafts claimed the major share in the above total (61.3%). Drift net (mechanised sector) accounted for 17.4%, while Hooks and line (non-mechanised sector) for only 8.9%. The serranid landings by Boat seine formed 10.2%, by Konchu vala 1.9% and by Shore seine 0.2% (Fig. 15 B, under each gear).

2. In no gear this group formed the bulk. 15.4% of the total landings by Drift net (mechanised sector) was Serranids and 9.7% of the total by Drift net (non-mechanised sector) was accounted by this group. The percentage occurrence of Serranids in different gears were as follows: 6.6% by Hooks and line (mechanised sector), 4.1% by Hooks and line (non-mechanised sector), 4.4% by Konchu vala, 3.9% by Shore seine and 5.6% by Boat-seine (Fig. 10 G-M, under different gears).

Theraponids

1. This group accounted for 161.666 t (5.1%) in the total perch landings for the period 1979 to 1987 (Fig. 15 C) and was fished by 9 gears at Vizhinjam.

A major share of the total landings (45.8% or 73.99 t) came from Hooks and line operated from non-mechanised crafts. Konchu vala landed 55.695 t (34.5%) and the rest of the landing was shared by gears such as Boat seine (14.0 t or 8.6%, Drift net (non-mechanised 4.9% or 8.014 t), Hooks and line (mechanised, 2.7%, 4.329 t) and Shore seine (1.6% or 2.652 t). The contribution by other gears *viz*. Nandu vala, Achil and Chala vala together formed only 1.8% of the total (Fig. 15 C, under each gear).

2. In some gears the Theraponids formed a major part, while in others only a minor item. In the landings by Konchu vala this group accounted for 67.4% of its total, while in Chala vala only 40.8% or 207 kg. In Shore seine landings 26.6% (2.652 t) was composed of this group and in Nandu vala, 52.3% (1.346 t). The percentage of Theraponids in the landing by other gears were as follows : Boat seine 4.1%, Hooks and line non-mechanised sector 5.4%, Driftnet non-mechanised sector 4.6%, Achil 7.2% and Hooks and line, mechanised sector 0.5% (Fig. 11 A-I, under various gears).

It is seen from the landings that this fish is very common in the inshore waters within the reach of traditional crafts. The mechanised units which were operating in distant and deeper grounds could, however, make no impact in enhancing the production.

Ambassids

1. This group ranked 8th among the different groups with a total of 32.857 t constituting 1% of the total perch landings. Ambassids were landed by 3 gears of which Boat seine accounted for the bulk (77.7% or 25.52 t) followed by Shore seine (20.2% or 6.637 t) and Drift net non-mechanised sector 2.2% (or 0.7 t) (Fig. 15 D, under each gear).

2. Among the 3 gears given above the percentage composition of Ambassids was the highest in Shore seine (66.5%). Boat-seine accounted for only 7.4% of the total by this gear, though the quantity landed was 25.520 t. Drift net (non-mechanised sector) contributed to 0.4% of its total landings (Fig. 13 H-J, under various gears).

IMPACT OF MECHANISATION ON THE PERCH FISHERY

When this work was initiated at Vizhinjam in 1979, the fishermen of the area were operating 9 different types of gears. The craft in vogue were of traditional type *i.e.* catamaran and canoe. Even though they were well aware of the advantages of mechanisation, they were avoiding it on the ground that besides being capital intensive, this might invite big businessmen into the field.

The first attempt to fit a few (approximately 5) traditional crafts with 'Yamaha' outboard motors (Kerosene, Model 8 BE, 7 HP) in September 1982 became an eye opener to many of the fishermen who were always lamenting on the illeffects of mechanisation. The fishermen could reach, at a low cost, distant grounds at 60 to 80 m depth and 20 to 25 km away from the shore, beyond the limits of traditional fishermen (The traditional grounds are within 10 km from the shore, at depths varying between 40 and 50 m). This enabled them to spend more time in fishing. Since these beds were not exploited in the past, the catch per trip was much higher. The mechanisation of traditional crafts thus became acceptable to the fishermen at Vizhinjam and they now consider it a better combination in their search for an 'ideal unit'.

The past experience with mechanisation is that it will, sooner or later, lead to a law and order situation. But as far as the present centre is concerned the transformation from traditional crafts to 'mechanised' ones did not create any problem since the beneficiaries were traditional fishermen themselves.

Initiated with a meagre number of 5 in 1982, the number of OBM fitted traditional crafts has swelled up to 60 within 18 months. The present (1988) estimate is that their number is somewhere between 400 and 500. It is expected that the number may still go up when the Harbour and servicing facilities improve in future.

Details pertaining to improvement in general landing, the major groups where an enhancement in landing was effected due to mechanisation, socio-economic problems akin to mechanisation, etc. have been dealt with by Gopakumar *et al.* (1986).

The total landing effected at Vizhinjam by the mechanised sector (1979 to 1987) through three gears *viz.* Hooks and line, Drift net and Trawl, was 1144.28 t. This is only 36.39% of the total perch landings for the said period. Hence, it is evident that the non-mechanised sector still controlls the bulk in landings.

Since mechanisation effected by fitting OBM on to traditional crafts only comes under the purview of the present study, a small quantity (1.3 t) landed by Trawl net in 1982 is left out while assessing the impact of mechanisation. Hence, the total by the other two gears was reestimated as 1142.98 t or 36.35% of the total. Of this total 927.873 t or 81.19% came from the Drift net landings (Fig. 16 A - I).

No doubt, mechanisation has improved the landings considerably in some groups of perches, while in others a decreasing trend was evident. The impact of mechanisation on the landing and the shift in composition of perch at Vizhinjam are discussed below.

IMPACT OF MECHANISATION ON HOOKS AND LINE FISHERY

Changes in annual percentage composition : Among the various gears employed at Vizhinjam, the most important one that contributed to the bulk in perch landings was the Hooks and line. The contribution by this gear to the total perch landings fluctuated considerably from year to year from 69.4% (1982) to 85.9% (1980) during 1979 to 1982. Since mechanisation got initiated in 1982, this is here reconsidered as relating to two phases *viz.* the pre-mechanisation (1979-'82) and post-mechanisation (1987-1989) periods.

This shows that during the post-mechanisation period, there was a decreasing trend in landings by the non-mechanised sector as the percentage narrowed down from a higher percentage (65.7%) in 1983 to 8.7 in 1987. On the contrary, the contribution to total landings registered a steady increase from 11.8% (1983) to 68.2% (1987) by the Hooks and line operated from mechanised crafts (Fig. 15 A - 1).

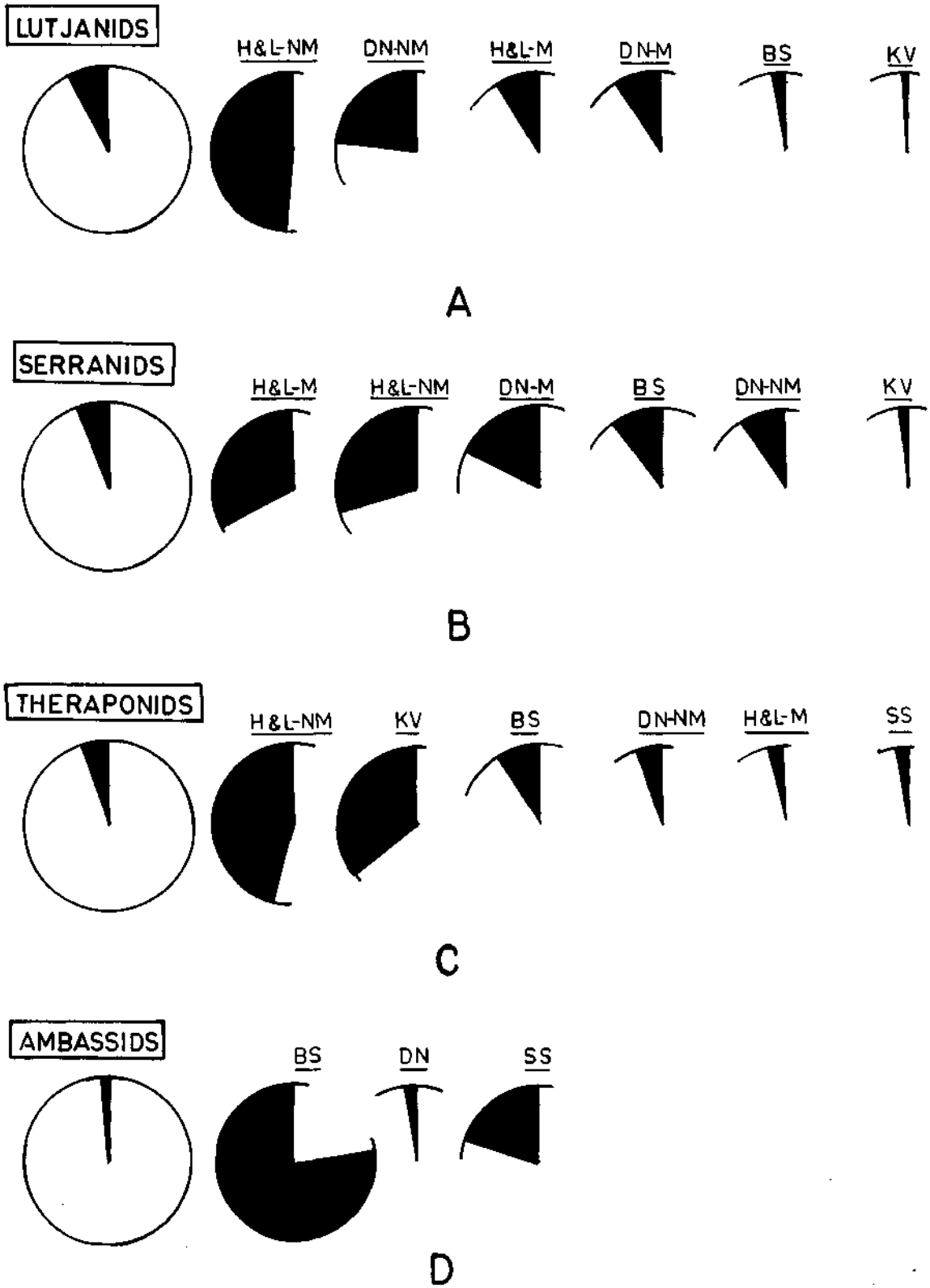


Fig. 15. The percentage of each group in the total landings of perch at Vizhinjam for 1979 - 1987 and their gearwise contribution.

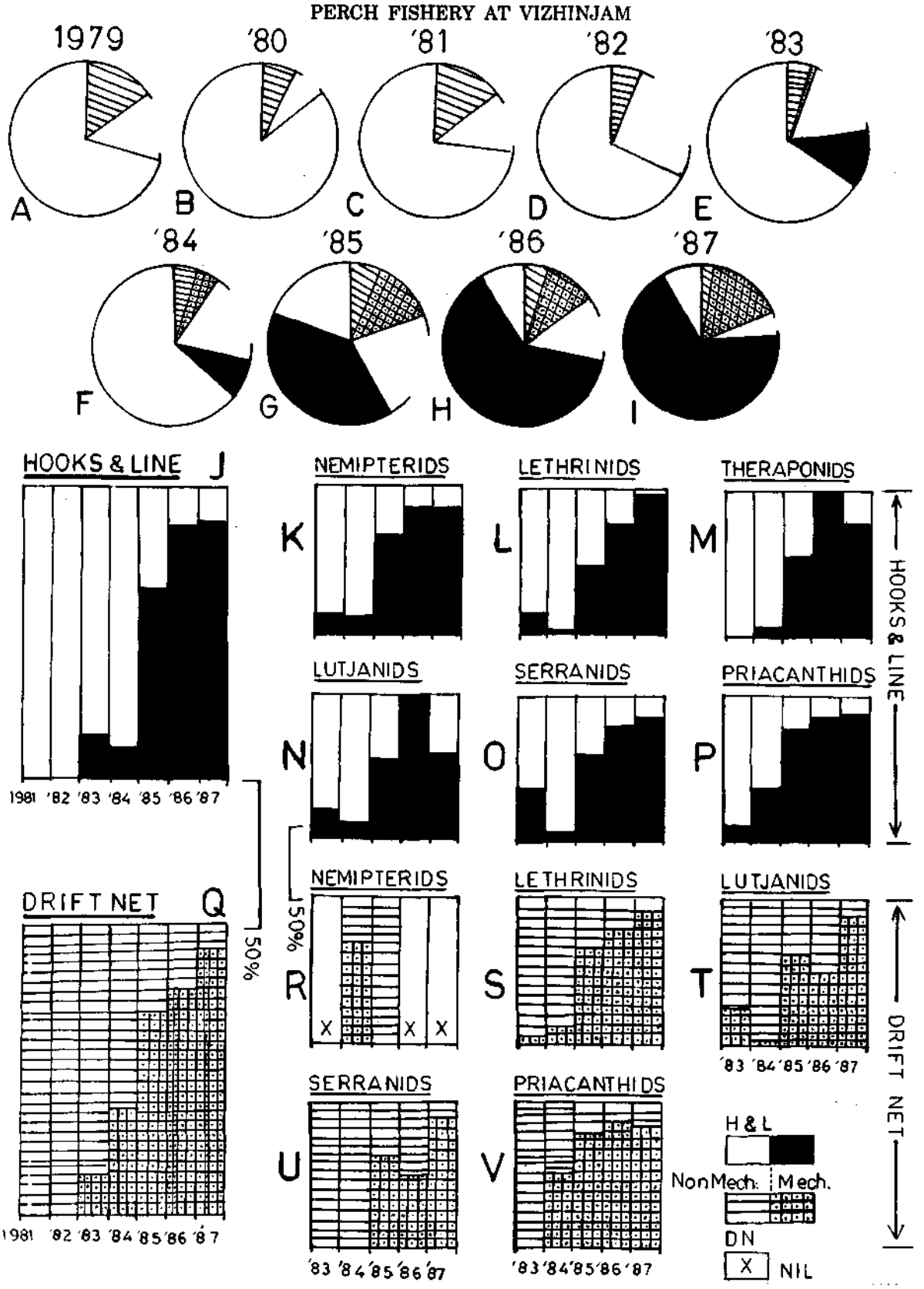


Fig. 16. A - I. Fluctuation in the landings (%) by mechanised and non-mechanised sectors of Hooks and line and Drift net, J. Total landings by both mechanised and non-mechanised sectors of Hooks and line are compared, K - P. Landings of different groups of perches by both sectors of Hooks and line and Q - V. by Drift net.

Quantitative flucuations : The total quantity of perch landed by non-mechanised sector was 1365.71 t (1979 - 1987) and by mechanised sector was 927.873 t (1983 - 1987) (Table 3). Of the total 1365.71 t landed by the non-mechanised sector, the pre-mechanisation period (1979 to 1982) accounted for 722.33 t and the post-mechanisation period for 643.38 t. The annual average landings for the respective period were calculated at 180.583 t and 128.677 t. Likewise, the average for the mechanised sector was calculated at 185.574 t (Table 15). This clearly indicates that mechanisation has helped considerably in imporving the landings.

Nemipterids ranked first in the landings by both sectors. Lethrinids and Lutjanids, which occupied the second and third position respectively in the non-mechanised sector, had very poor representation in the landings by the mechanised sector where they occupied only the 4th and 5th position. The group which was 4th in rank in the non-mechanised sector *viz.* Theraponids was very rare in the landings by the mechanised sector. Serranids and Priacanthids, which occupied the 5th and 6th rank respectively in the non-mechanised sector, ranked 3rd and 2nd respectively in the mechanised sector. The only group which could be seen exclusively in the landings by the non-mechanised sector was

TABLE 15. *Trend in the landings (t) by Hooks and line operated from both mechanised and non-mechanised sectors at Vizhinjam during 1979 to 1987*

Groups	Average landing by non-mech. sector		Average landing by mech. sector	Increase (+) or decrease (-)
	Average for 1979 - '82	Average for 1983 - '87	Average for 1983 to 1987	
Nemipterids	126.474	88.604	143.540	+
Lethrinids	17.398	11.441	7.728	-
Priacanthids	4.446	6.909	12.270	+
Siganids	Nil	0.179	Nil	-
Lutjanids	15.096	9.356	4.002	-
Serranids	5.475	6.739	12.167	+
Theraponids	11.691	5.446	0.865	-
All groups combined	180.583	128.677	185.574	

The percentage contributon of each sector in the total landings was then calculated on an annual basis. Though in the initial years (1983 and 1984) the percentage composition by non-mechanised sector was higher (84.7% and 88.2% respectively). Subsequently the contribution by non-mechanised sector started decreasing : 34.0% (1985), 12.4% (1986) and 11.4% (1987). The loss in landing by this sector was made good by the mechanised sector (Fig. 15 J).

Qualitative fluctuations : Out of 8 groups of perches considered here, 7 were landed by Hooks and line operated by non-menchnised sector and 6 by the mechanised sector. Ambassids were absent to both sectors while Siganids were absent in the mechanised sector. Siganids. Here also, as noted in the case of Theraponids, a preference towards the shallower traditional grounds was evident.

Nemipterids

Landings during the pre- and post-mechanisation periods : The total landings of Nemipterids by Hooks and line (both sectors) for the period 1979 to 1987 was 1666.618 t, of which the contribution by non-mechanised sector was 948.917 t and by mechanised sector 717.701 t. Of the 948.917 t landed by the former sector the landings for the pre-mechanisation period were 505.897 t and for the post-mechanisation period, 443.020 t; the average annual production being 126.474 t and 88.604 t respectively (Table 15). The total landings by the mechanised sector for the post-mechanisation period were estimated at

717.701 t with the average at 143.540 t (Table 15)

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

It is seen that the landings from the mechanised sector increased as years advanced at the expense of the other sector and this trend was noted in the distribution of units also.

It is evident (Fig. 16 K) that in the initial years of mechanisation (1983 and 1984) the landings of this group by non-mechanised sector dominated (85.6% and 87.4% respectively), but later this trend got reversed and the mechanised sector started catching the bulk (66.4% in 1985; 89.4% in 1986 and 89.0% in 1987).

Regarding the seasonality in landings it could be noted that though the monsoon period formed the best period in both cases, more landings were registered (69.8%) by the mechanised sector.

Lethrinids

Landing during the pre- and post-mechanisation periods : The total landings of Lethrinids, by both sectors, were estimated at 165.445 t. Of this, 126.804 t may be accounted by the non-mechanised sector (76.18%) and 38.641 t by the mechanised sector. The former landings were the aggregate for 9 years (1979 to 1987) while the latter were for 5 years (1983 to 1987). The landings by Hooks and line (non-mechanised sector) for the entire period, when calculated on a pre- and post-mechanisation basis, it is found that the annual average for the former period was 17.398 t and for the latter period, 11.441 t (Table 15). It is evident that, as compared to the pre-mechanisation period, there was a cut in the average landing during the post-mechanisation period and this can be due to the conversion of non-mechanised crafts into mechanised crafts.

The average landing by mechanised crafts (1983 to 1987) was only 7.728 t. This shows that mechanisation could produce no effect on the landing of this group probably due to the poor distribution of these fishes in the offshore grounds.

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

For the first three years of mechanisation (1983 to 1985) the landings from the non-mechanised sector accounted for the bulk, *i.e.* 85.0%, 99.2% and 51.7% respectively. But later, *i.e.* from 1986 onwards, the mechanised sector started scoring the bulk in landings, *i.e.* 75.3% in 1986 and 98.2% in 1987 (Fig. 16 L).

The major difference noted with regard to the pattern of landing is that in the non-mechanised sector the landings could be recorded allthrough the year while in the other sector it was rather interrupted. In both cases the postmonsoon period accounted the maximum landings.

Priacanthids

Landings during the pre- and post-mechanisation periods : The total landings (1979 to 1987) were estimated at 138.68 t; of which 52.33 t were contributed by the non-mechanised sector and 86.35 t by the mechanised sector. The average annual landing by this gear for the pre-mechanisation (1979 to 1982) was estimated at 4.446 t and for the post-mechanisation period (1983 to 1987) at 6.909 t (Table 15). This shows that though many of the traditional crafts were converted into mechanised units the landings by the non-mechanised sector still registered an upward trend.

The landings of Priacanthids by the mechanised sector registered an average annual landing of 17.27 t during the period 1983 to 1987 (post-mechanisation period). This shows that the mechanised sector was quite efficient in landing more priacanthids since the total landings (86.35 t) were only for a period of 5 years as against a total of 52.33 t for 9 years by the non-mechanised sector.

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

As seen in other cases, here also the landings for the first two years of mechanisation (1983 and 1984) were dominated by those from the non-mechanised sector. The percentages, by this sector, in the total landings were found to

be 90 in 1983 and 62.3 in 1984 (Fig. 16 P). But from 1985 onwards a reversal in the order of abundance could be noted; the percentages of mechanised sector were 75.8 in 1985, 84.2 in 1986 and 86.7 in 1987.

Comparing the two sectors it is found that while the monsoon landing was slightly better in the mechanised sector with a minor peak in July, the postmonsoon accounted for the bulk in landings in both sectors alike.

Siganids

Though this group ranked 4th in total landings (1979 to 1987), the contribution to the Hook and line fishery (of both sectors) was rather negligible. The total landings estimated were only 0.898 t and the entire landing came from the non-mechanised sector. Hooks and line operated from mechanised crafts in distant grounds did not make any imporvement in the landing of this group.

Lutjanids

Landings during the pre- and post-mechanisation periods : The landings from nonmechanised sector accounted for the bulk (107.169 t), while that from the mechanised sector was only 20.013 t. Out of 107.169 t from the non-mechanised sector, 60.387 t could be accounted for the premechanisation period (1979 to 1982) with the average at 15.096 t and the rest *i.e.* 46.782 t for the post-mechanisation period (1983 to 1987) with the average at 9.356 t (Table 15). This clearly indicates that the landings by the non-mechanised sector dwindled considerably during the post-mechanisation period (1983 to 1987).

The landings registered during 1983 to 1987 period by the mechanised sector were very poor (20.013 t with the average at 4.002 t). This shows that mechanisation has failed to not only help much in enhancing the production, but there was fall in total landings in this group.

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

Here also the effect of mechanisation was evident only from 1985 onwards. During 1983 and 1984 the landings were dominated by those from the non-mechanised sector (Fig. 16 N). But by 1985 a clear change in the pattern of dominance was discernible; the percentage went upto 57.7 in 1985, 100 in 1986 and 61.7 in 1987. In the pooled monthly total for various years, it is noted that the landings were rather protracted upto 1985, but when mechanised sector started gaining momentum this pattern changed altogether and the landings became sparse. This situation prevailed in both sectors alike.

Serranids

Landings during the pre- and post-mechanisation periods : The total landings (1979 - 1987) by Hooks and line (both sectors) were estimated at 116.435 t. Out of this the share by non-mechanised sector was 55.596 t and by the other sector 60.839 t. In the case of non-mechanised sector the total for the period 1979 to 1982 was 21.9 t and for the post-mechanisation period (1983 to 1987) 33.696 t with a corresponding annual average of 5.475 t and 6.739 t (Table 15). This shows that during the post-mechanisation period there mwas marginal increase in the landings of this group.

Assessing the performance of Hooks and line operated from the mecahnised craft it may be stated that the total landings for the period 1983 to 1987 were 60.839 t with the average at 12.167 t. This is an indication that the introduction of mechanised units has considerably improved the Serranid landings.

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

Here also the landings registered during 1983 and 1984 were dominated by those from the non-mechanised sector (63.6% and 92.7% respectively). From 1985 onwards the trend got reversed and the landings dominated by those from the mechanised sector; 59.6% in 1985, 81% in 1986 and 84.78% in 1987 (Fig. 16 O).

The landings registered during June-July were very poor in both sectors, but by August the landings improved. The postmonsoon fishery was very good in both sectors alike.

Theraponids

Landings during the pre- and post-mechanisation periods : By both the sectors for the period 1979 to 1987, landings were estimated at 78.325 t. Of this total, 73.996 t were landed by the non-mechanised sector and 4.329 t by the mechanised sector; or in other words, 94.47% was landed by the former sector. The share of the pre-mechanisation period in the total for the non-mechanised sector was 46.765 t and for the post-mechanisation period, 27.231 t with the averages respectively at 11.691 t and 5.446 t (Table 15). This shows that landings of Theraponids decreased considerably during the postmecahnisation period in the non-mechanised sector.

The total landings for the period 1983 to 1987 by the mechanised sector were only 4.239 t with the average at 0.865 t. So mechanisation made only a decline in the landings of this group in the mechanised sector.

Annual trend in the landings by the mechanised and non-mechanised sectors - a comparison

Here also the first two years (1983 and 1984) did not make any notable change in the production by the mechanised sector and the contributions by the other sector (non-mechanised) were high (99.7% and 92.4% respectively). From 1985 onwards a clear cut dominance in the landings by the mechanised sector could be noted. The contributions for the subsequent years were : 57.5% in 1985; 100% in 1986 and 78.3% in 1987 (Fig. 16 M).

Theraponids were available in the landings throughout the year in the non-mechanised sector, but their occurrence in the other sector was highly seasonal; May to July and also in October and November (pooled landings). While assessing the landings annually it could be seen that the landings by the non-mechanised sector became quite irregular from 1985 onwards when the mechanised sector gained dominance over the landings. There were no landings in 1986 and the landings in 1987 were confined to one month only.

The general pattern of landings noted in both the sectors was interesting. The peaks in monthly landings (pooled data) alternated with each other, *i.e.* the peak landings in the mechanised sector were noted in January and October while the same in the other sector in April, August and December. Monsoon period accounted for the bulk in landings (67.1%) in the case of mechanised sector while the postmonsoon period (53.4%) in the other.

Remarks

In short, it may be stated that in the case of 3 groups (Nemipterids, Priacanthids and Serranids) the average landings were more in the mechanised sector, while in the others these were less (Table 15). While comparing the average landings for both pre- and post-mechanisation periods it is noted that the average was higher in the latter period (1983 to 1987) in the case of groups such as Priacanthids, Siganids and Serranids. The landings of Lethrinids, Lutjanids and Theraponids did not show any improvement. The decrease in landing noted in the non-mechanised sector during 1983 to 1987 may be attributed to the conversion of non-mechanised crafts to mechanised units.

Impact of Mechanisation on the Effort Expended

The units operated in the non-mechanised sector during 1979 to 1987 was 378262. There were only non-mechanised units upto 1982 and for the rest of the period (1983 to 1987) both mechanised and nonmechanised units were in operation. Since many of the traditonal crafts got fitted with OBM, there was drastic cut in the number of non-mechanised units from 1983 onwards.

Out of 378,262 units operated during 1979 to 1987, 246,481 units were operated during 1979 to 1982 (pre-mechanisation period), while 131,781 units during 1983 to 1987 (or post-mechanisation period). In other words, 65.2% of units was operated during 1979 to 1982 and 34.8% during 1983 to 1987.

In the non-mechanised sector the variation in the number of units operated annually in the

pre-mechanisation period was from 51,115 (1979) to 70,854 units (1980), with the average at 61,620 units. And for the post-mechanisation period the same was from 5,184 (1983) to 71,782 units (1984), with the average at 26,356 units. The cut noted in the average as well as in the annual number of units may be attributed to the conversion of non-mechanised units into mechanised units.

As given earlier, the total perch landings for the period 1979 to 1982, by the non-mechanised sector (Hooks and line) were 722.33 t and for 1983 to 1987 were 643.38 t against a total effort of 246,481 units and 131,781 units respectively. These work out to an average CPU of 2.9 kg for the pre-mechanisation period and 4.9 kg for the post-mechanisation period. This indicates that though the effort and landing dwindled as a result of mechanisation, the CPU showed an increase as against that noted in the pre-mechanisation period.

With reference to the mechanised sector there was slight hike (50.2 %) in the total units operated in 1983 as against that in the non-mechanised sector, but during 1984 and 1985 the number of units operated was far less (12.1 % and 48.1 % respectively) than that in the other sector. From 1986 onwards the non-mechanised sector's landing started decreasing as the mechanised sector's percentages increased : 74.6% in 1986 and 82.4 % in 1987.

The total units operated from 1983 to 1987 by the mechanised sector was 122,094 with the average at 24,418 units. The total landings, by this sector, was 927.873 t (Table 3) and this works out to an average CPU of 7.6 kg for the period. This indicates that the CPU in mechanised sector was higher as compared to the other sector.

While examining the pooled monthly CPU for the entire period it could be noted that in the non-mechanised sector CPU showed two ranges in its distribution. It was at a higher range during July-September period and at a lower range during December - January period. In the former period the fluctuation noted was from 5 to 7.32 kg while in the latter, it was from 3 to 4.18 kg. In the mechanised sector the higher range could be noted during June to September when the fluctuation noted was between 10 and 23 kg. The lower range, in this case, was noted from December to February when the variation was from 4 to 7 kg.

Maximum effort was expended during the postmonsoon period and this was rather similar for both sectors.

TABLE 16. *Trend in the landings (t) by Drift net operated from both mechanised and non-mechanised crafts at Vizhinjam during 1979 - 1987*

Groups	Average landing by non-mech. sector		Average landing by mech. sector	Increase (+) or decrease (-)
	Average for 1979 to '82	Average for 1983 to '87	Average for 1983 to '87	
Nemipterids	0.233	0.053	0.034	-
Lethrinids	9.703	5.649	17.372	+
Priacanthids	2.363	4.790	15.074	+
Lutjanids	7.112	3.959	3.912	-
Serranids	1.459	2.226	6.627	+
Theraponids	0.856	0.918	Nil	-
Ambassids	0.175	Nil	Nil	-
All groups combined	21.902	17.595	43.021	+

IMPACT OF MECHANISATION ON DRIFT NET FISHERY

Changes in the annual percentage composition

Drift net was in operation throughout the 9 years covered under the present study. During

the pre-mechanisation period (1979 - 1982) the contribution to total landings by this gear fluctuated between 5.6% (1982) and 14.6% (1979). In the post-mechanisation period (1983 - 1987) the contribution to the annual landings by non-mechanised sector fluctuated between 1.7% (1987) and 7.6% (1984) while that of mechanised sector was from 0.6% (1983) to 16.0% (1987).

Fluctuations in landing

With the total of 175.587 t the Drift net operated from non-mechanised sector ranked 5th among the various gears that landed perch during 1979 to 1987 (Table 3). Of this total, 87.608 t were landed during the pre-mechanisation period (1979 - 1982) and the rest *i.e.* 87.979 t during the post-mechanisation period (1983 to 1987). Percentage-wise, the former came to 49.9% and the latter 50.1% which indicated that there was not much variation in the landings of the pre- and post-mechanisation periods. The average landing for the respective period was calculated at 21.902 t and 17.595 t (Table 16).

Drift net operated from the mechanised crafts accounted for 215.107 t (Table 3) for 1983 to 1987 with the average at 43.021 t (Table 16). This shows that mechanisation helped much in improving the landings.

The percentrage contribution by Drift net to the total annual landing revealed that, as in Hooks and line, here also the effect of mechanisation was not much spectacular in the initial stages (*i.e.* 1983 and 1984). For these two years the contribution by the non-mechanised sector was comparatively at a higher level, say 86.2% and 63.7% respectively. By 1985 the trend reversed and percentage contribution from mechanised sector gained dominance; 69.7 % in 1985, 77.9% in 1986 and 90.5% in 1987 (Fig. 16 Q).

Fluctuations in groups

Groups of perches represented were only 5 in the mechanised sector as against 7 noted in the non-mechanised sector.

Regarding the abundance of various groups in the landings by these two sectors, it could be noted that Lethrinids ranked first in both sectors. Lutjanids occupied 4th rank in the mechanised sector, but the 2nd position in the non-mechanised sector. Priacanthids occupied the third position in the non-mechanised sector, but 2nd in the other. Serranids occupied the 3rd position in the landings by the mechanised sector, but its position was 4th in the non-mechanised sector. Nemipterids formed the least in the order of abundance in the mechanised sector with negligible composition (0.08%) as in the non-mechanised sector (6th rank, 0.39% of the total).

Nemipterids

Landings during the pre- and post-mechanisation periods : The total lanidngs from both sectors were only 1.372 t, of which 1.2 t came from non-mechanised sector and the rest (0.172 t) from mechanised sector. Of this 1.2 t, 0.933 t was from the pre-mechanisation and 0.267 t from the post-mechanisation periods. The respective average for the above periods were at 0.233 t and 0.053 t (Table 16).

The total landings by the mechanised sector (1983 to 1987) came to 0.172 t with the average at 0.034 t. This shows that mechanisation had no beneficial effect on the landings of this group.

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

Landings on Nemipterids were confined to 1984 and 1985 in the non-mechanised sector; only for 1984 in the other sector. In 1984, the mechanised sector accounted for 70.2% of the total. In 1985, there were landings only from the non-mechanised sector (Fig. 16 R).

Lethrinids

Landings during the pre- and post-mechanisation periods : This group ranked first in the landings by both sectors alike. The total landings of Lethrinids were estimated at 153.92 t. The contribution from mechanised sector (86.861 t or 56.4%) was for a period of 5 years while that by non-mechanised sector (67.059 t or 43.6 %) accounted for a period of 9 years.

Out of 67.059 t landed during the non-mechanised sector, 38.813 t were landed during the pre-mechanisation period and 28.246 t in the

post-mechanisation period with the respective average at 9.703 t and 5.649 t (Table 16).

As mentioned earlier, the total landings by mechanised sector came to 86.861 t (1983 to 1987), the average being 17.372 t. This shows that mechanisation has helped much in enhancing the production of this group.

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

Here also the effect of mechanisation was quite negligible upto 1984 (6.6% in 1983 and 12.1% in 1984) in the landings by the mechanised sector. From 1985 onwards, landing by the mechanised sector showed an upward trend : 67.6% in 1985; 80.2% in 1985 and 92.0% in 1987 (Fig. 13 S).

In both sectors there were no landings during May to September and for the rest of the year (in pooled data) the landings were almost of the same pattern, the only difference being that the mechanised sector registered comparatively better landings during September and October.

Priacanthids

Landings during the pre- and post-mechanisation periods : The total landings (1979 - 1987) by this gear were estimated at 108.775 t, of which 33.403 t were by the non-mechanised sector and 75.372 t by the mechanised sector. This landing showed that 69.3% of the total was landed by the mechanised sector.

Of the total of 33.403 t landed for 9 years by the non-mechanised sector, the pre-mechanisation period accounted for 9.452 t and the post-mechanisation period, for 23.951 t. This is an indication that though the mechanised sector attracted more crafts into its fold, the landings by the non-mechanised sector were still on the increase. The landings of non-mechanised sector for the pre- and post-mechanisation periods indicate an average of 2.363 t for the former and 4.79 t for the latter periods (Table 16). The average for the mechanised sector, similarly, was estimated at 15.074 t. This indicates that irrespective of the sector there was an increase in the landings of Priacanthids during 1983 to 1987.

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

In 1983 there were no landings by the mechanised sector and in 1984, this sector contributed 51.6% of the total. Thereafter the contribution by this sector was steadily on the increase; 80.5% in 1985; 88.1% in 1986 and 86.8% in 1987 (Fig. 16 V).

Drift net was not operated by the non-mechanised sector during monsoon period, but this was not the case with the mechanised sector. There were appreciably good landings of this group during June - July by the mechanised sector. The postmonsoon period registered the maximum landings in both sectors alike.

Serranids

Landings during the pre- and post-mechanisation periods : The total landings (1979 - 1987) of Serranids by this gear, amounted to 50.106 t, of which 33.139 t or 66.1% were contributed by the mechanised sector and 16.976 t or 33.9% by the non-mechanised sector. Of the above total of 16. 976 t, 5.837 t were landed during 1979 to 1982 and 11.130 t during 1983 to 1987; the average being 1.459 t and 2.226 t respectively (Table 16). This shows that though many of the conventional crafts were converted into mechanised units, the landings in the post-mechanisation period were on the increase. In the case of mechanised sector, the average landing for the post-mechanisation period was 6.627 t clearly indicating that mechanisation had helped in improving the landings.

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

During the first two years of mechanisation (1983 and 1984) there were no landings by the mechanised sector. From 1985 onwards the trend changed and the landings by mechanised sector started dominating except during 1986, when the contribution had decreased to 49.8% level. For the other two years the contribution by the mechanised sector were 63.8% (1985) and 92.5% (1987) (Fig. 16 U).

In the mechanised sector there were landings in all months except in July, while in the other sector, there were landings allthrough

the monsoon months. The postmonsoon period registered the maximum landings followed by the premonsoon; the difference in the percentage being very insignificant.

Theraponids

Landings during the pre- and post-mechanisation periods : The total quantity landed by this gear was 8.014 t and there were no landings by the mechanised sector. The average landings for the pre- and post-mechanisation periods were at 0.856 t and 0.918 t respectively. This clearly indicate that the landings of the group were retained at almost the same level though many of the traditional crafts got converted into mechanised ones (Table 16).

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

Out of 9 years investigated the presence of this group in this gear was noted only from 1980 to 1985. In the pooled monthly landings, however, the landings could be noted during September to February and also in April. The postmonsoon period accounted for the bulk in landings (93.7%).

Lutjanids

Landings during the pre- and post-mechanisation periods : The total landings (1979 - 1987) by this gear, were estimated at 67.807 t. The non-mechanised sector accounted for the bulk (48.244 t or 71.1 %) in landings. The average landing by this sector for the pre-mechanisation period was 7.112 t and for the post-mechanisation period, 3.95 t (Table 16). The sharp decline in the average landing for the latter period may indicate two possibilities : (1) that mechanisation has affected the landing in the other sector and (2) Lutjanids have sparse distribution in distant areas. The findings from Hooks and line landings (of mechanised sector) also suggest a similar possibility.

Annual trend in the landings by mechanised and non-mechanised sectors - a comparison

Here also, as seen in other groups, the effect of mechanisation was slowly felt in its initial phase. The contributions from non-mechanised sector were 75.5% and 98.5% respectively of the total landings in 1983 and 1984. In 1986, there was slight fall in the percentage contribution by the mechanised sector (48.9%; Fig. 16 T). For the other years the percentages were 62.1 (1985) and 90.5 (1987).

In both sectors there were no landings during May - July period. The landings for the rest of the months, were regular in the initial years, but later became sparse in the mechanised sector. The postmonsoon period registered the maximum landings in both sectors alike.

Ambassids

Landing during the pre- and post-mecchansiation periods : Ambassids were caught only once by the non-mechanised sector (1982) and the mechanised sector totally failed to land this group.

Remarks

In conclusion, the landing trend noted in both sectors of the Drift net showed that more groups of perches were represented in the traditional grounds that are frequented by the traditional fishermen. No doubt, the mechanisation has increased the landings in some groups, but it had affected the landings of some other groups for two reasons : (1) More and more fishermen were adopting mechanisation and it made a notable cut in the number of units which were previously exploiting the stocks in the conventional grounds and (2) only some groups of perches enjoy an extensive distribution and hence, the landings in such groups only could be augmented by increasing the area of operation through mechanisation.

It may be seen from Table 16 that 3 groups *viz*. Ambassids, Siganids and Theraponids, failed to figure in the landings by the mechanised sector of Drift net and 2 groups *viz*. Ambassids and Siganids, in the landings by the same sector of Hooks and line (Table 15). While evaluating the abundance of the above groups in different gears, it is noted that Theraponids constituted 67.4% of the total landings by Konchu vala which is a gill net; 40.8 % by Chala vala which

is a gill net; 52.3% in Nandu vala which is a bottom set gill net; Hooks and line (non-mechanised sector); Shore seine, etc. Siganids, similarly, are caught by 4 different types of gears such as Boat seine, Shore seine, Konchu vala, etc. This shows that this group dominates in the near shore areas. A similar behaviour may be noted in the case of Ambassids also.

The other groups represented may be divided into 2 categories based on their landing in the mechanised sector : (1) Those which showed an increase in their average landings during the period of mechanisation and (2) those which showed a decrease in their average landings during the period of mechanisation (Table 16).

The various groups represented in the landings by Drift net may be arranged as follows :

a. Those with increased production : Lethrinids, Priacanthids, Serranids and landings as whole.

b. Those with decreased production : Nemipterids, Lutjanids, Theraponids and Ambassids.

The various groups represented in the landings by Hooks and line may be arranged as follows.

a. Those with increased production : Nemipterids, Priacanthids, Serranids and landings as a whole.

b. Those with decreased production : Lethrinids, Siganids, Lutjanids and Theraponids.

It may, hence, be concluded that mechanisation has helped much in improving the landings of Nemipterids, Priacanthids, Serranids and Lethrinids.

Impact of Mechanisation on the Effort Expended

The total number of units (both sectors) operated at Vizhinjam during 1979 to 1987 was 143,225, of which 77,395 units belonged to the nonmechanised sector and 65,830 units to the mechanised sector. In other words, 54.03% of the total was claimed by the non-mechanised sector.

Of the total 77,359 units employed by the non-mechanised sector, 42,296 were operated during the pre-mechanisation period and 30,099 during the post-mechanisation period, the average being 11,824 and 6,019 units respectively. Percentage-wise, the former is 61.1 and the latter 38.9. This clearly indicates that there was a cut in the number of non-mechanised units operated during the post-mechanisation period.

Since both mechanised and non-mechanised units were operated during the post-mechanisation period (1983 to 1987) and many of the traditional crafts had been fitted with OBM, there was a cut in the number of units of the latter sector subsequently. Hence, the number of units operated by both sectors were 95,929. The percentage for the mecahnised sector was found to be more (68.6%) and this indicates that the mechanised units increased numerically in the post-mechanisation period.

The above paragraphs give only a general idea on the trend of mechanisation at Vizhinjam after 1982, but it throws no light on the annual variation in landings. Hence, the percentage fluctuations in the landing by both sectors were calculated year-wise. Though mechanisation was initiated in 1982, its effects were seldom felt in the landings both in 1983 and 1984. Of a total of 9,297 units operated in 1983, 85.7% belonged to the non-mechanised sector. A similar condition prevailed in 1984 also as the percentage composition of the non-mechanised sector was 70.4. From 1985 onwards the situation reversed and landing in the mechanised sector increased to 70.5% in 1985, 77.8% in 1986 and 95.5% in 1987.

The total landings registered by the non-mechanised sector (Drift net) during 1979 to 1987 were 175.587 t (Table 3) of which 87.608 t were landed during pre-mechanisation and 87.979 t during the post-mechanisation periods. This indicates that the hike in landings registered during the latter period was rather negligible. The number of units operated during the pre-mechanisation period was 47,296, while

TABLE 17. *Summary of monthwise peak landing of each group and the gears used during the present study at Vizhinjam*

Groups	Months of peak landing	Gears used and sector	Remarks
Nemipterids	March	Drift net (MS)	Certain gears were seasonal.
	May	Konchu vala	Boat seine, Achil, Konchu vala
	July	Boat seine, Hooks & line (MS)	and Drift net (MS) registered
	August	Hooks & line (NMS)	low landings.
	September	Drift net (NMS),	
	October	Achil	
Lethrinids	January	Konchu vala, Hooks & line (NMS) Drift net (NMS and MS)	Konchu vala, Nandu vala and Boat seine registered low landings.
	February	Hooks & line (MS), Nandu vala	Other gears were seasonal.
	July	Boat seine	
Priacanthids	April	Konchu vala	Boat seine and Konchu vala
	July	Boat seine	registered low landings.
	October	Hooks & line (NMS), Drift net (NM & MS)	
	November	Hooks & line (MS)	
Lutjanids	January	Shore seine, Hooks & line (NMS); Drift net (NMS & MS); Konchu vala; Nandu vala	Achil, Nandu vala, Chala vala and Shore seine recorded low landings. Certain gears were seasonal.
	February	Hooks & line (MS)	
	April	Chala vala	
	August	Boat seine	
	October	Achil	
Serranids	January	Hooks & line (NMS & MS), Drift net (MS)	Konchu vala, Shore seine and Boat seine registered low landings.
	February	Drift net (MS)	Some gears were seasonal.
	June	Konchu vala	
	August	Boat seine	
	December	Shore seine	
Siganids	January	Shore seine and Hooks & line (NMS)	Except Boat seine all the other gears
	April	Konchu vala	recorded poor catches during the
	August	Boat seine	peak period.
Theraporids	January	Shore seine and Nandu vala	Nandu vala, Achil and Chala vala
	May	Konchu vala and Chala vala	registered low landings. Some gears
	June	Hooks & line (MS)	were seasonal.
	July	Boat seine and Achil	
	August	Hooks & line (NMS)	
	September	Drift net (NMS)	
Ambassids	April	Drift net (NMS)	Drift net (NMS) and Boat seine
	July	Boat seine	recorded low landings.
	December	Shore seine	

MS = Mechanised Sector; NMS = Non-mechanised Sector.

that for the post-mechanisation period 30,097. From this the average CPU for the respective period may be calculated at 1.8 kg and 2.9 kg. This shows that inspite of a reduction in the number of units in the non-mechanised sector, there was an increase in CPU during the post-mechanisation period.

The total landings by the mechanised sector, for 1983 to 1987 were 215.107 t (Table 3) and this was landed against a total effort of 65,830 units with an average CPU of 3.26 kg indicating better production by this sector.

In the pooled monthly total of CPU for the entire period, it is seen that the monthly CPU for the non-mechanised sector fluctuated between 0.23 kg (May) and 7.6 kg (January). The CPU was at a higher range from December to February (with peak in January). 61% of the total units was operated during the postmonsoon period and 31% in the premonsoon period. There were no landings during the monsoon period by this sector unlike their mechanised counterparts.

In the mechanised sector the monthly fluctuation in CPU was from 0.3 kg (May) to 8.08 kg (January). The CPU was at a higher range from November to March with a peak in January. While comparing the CPU noted in both sectors it may be stated that in the mechanised sector the period with higher CPU was more protracted (5 months) while in the other, it was only for 3 months. The monsoon operation was characteristic only of the mechanised sector.

Conclusions and Recommendations

1. The southwest coast of India with characteristic rocky outcrops and offshore 'Kalava' grounds situated at a depth range of 75 to 100 m provides congenial conditions for many a perch to dwell in. Vizhinjam, a fishing centre situated right on this coast, hence, is an important centre for any study pertaining to this group of fishes.

2. The percentage of perch in total fish landings at Vizhinjam varied from 3.78 (1979) to 8.37 (1980) during the period of the present study (1979 to 1987). The total landings, at this centre for the above period fluctuated between 169.9 t (1979) and 542.2 t (1987) registering an upward trend.

3. Under the present conditions it was possible only to evaluate the landings of perch on a family-basis. Attempts to study the biology of a few common species failed on account of the nonavailability of statistically sound sampling throughout the year. It is hoped that in future, when mechanised vessels bring in more landings from the offshore areas, the condition might improve to make biological investigations more meaningful. More studies on the qualitative and quantitative aspects of landings will have to be made.

4. The period 1983 to 1987 represents a new phase in the fisheries of the area since many of the traditional crafts (catamaran and canoe) got fitted with OBM, which resulted in notable enhancement in the catch per trip of such mechanised units. The advantages of such mechanisation, the quantitative and qualitative changes that took place in landings, the effect of mechanisation on the number of non-mechanised units, etc. could be studied carefully for a period of 5 years (1983 to 1987). Hence, the present study may serve as a basic work for the said period and major changes, if any, that might take place in future will have to be evaluated by comparing with the results presently reported.

5. The fishermen themselves adopted mechanisation and as there was no compulsion or coercion from any outside agency in doing so and as the beneficiaries were the fishermen themselves, no law and order situation emanated in this process. From a meagre number of 5, in September 1982, the number of such units has gone up to nearly 500 in 1988.

6. It is sure that completion of the Fishing Harbour at Vizhinjam will give more thrust to the mechanised sector at the expense of the non-mechanised, which now claims the bulk in landings (63.65%). At this stage, an influx of big business houses to Vizhinjam will become inevitable and their profit-oriented operations

might relegate the artisanal sector to an insignificant entity. Many of the distant fishing grounds that are profitably fished at present by OBM fitted traditional crafts will no longer be their monopoly. Hence, these OBM fitted crafts, in turn, may try to encroach upon the inshore realms for better returns. This might ignite any law and order situation unless proper precautionary measures are adopted in the beginning itself.

7. The distant grounds now covered by such OBM fitted traditional crafts are quite productive due to their virgin nature. But in future, when fishing pressure increases in an unbridled manner there is every likelihood that these grounds also may become less productive. Hence, it is quite essential to limit the operation of such units in these offshore realms. The needed fishing restrictions, then, will have to be arrived at based on more precise knowledge about the resource availability in these grounds. Hence, more investigations will have to be undertaken to recommend measures for their rational exploitation.

8. More studies on the breeding, fecundity and recruitment patterns will have to be initiated atleast in a few of the more common species of perches. Such studies will have to be intensified as it might throw some light on the recruitment patterns in perches.

9. Mechanisation of traditional crafts has so far resulted in increasing the landings in 4 groups only *viz*. Nemipterids, Priacanthids, Serranids and Lethrinids, while in the case of the other 4 a decreasing trend was discernible. The reason is that the fishing pressure decreased considerably in the inshore areas as more and more traditional crafts have resorted to mechanisation. The 4 groups, in which a decreasing trend in production was evident, were those which were being caught in plenty in gears that were operated in the nearshore areas.

10. As seen from the present account, different groups of perches are fished throughout the year by different gears. The period of their peak landings also vary from month to month as well as from gear to gear. Hence, to increase their production it would be worthwhile attempting (i) any alternate gear to fish any group in such months (periods) when it does not form a peak in any gear and (ii) to intensify the operation of the gear in the month in which any particular group forms a peak (Table 17).

Though with the completion of the Fishing Harbour and the availability of other attendant facilities for large trawlers and gill netters, the nature of the fisheries at Vizhinjam is likely to change, till such a situation arises, for some years to come, the transitional phase of indigenous crafts getting fitted with OBM and small mechanised vessels competing with country crafts in the same coastal grounds is likely to continue and some effort to regularise the fishing operation by different gears would be necessary. It is hoped that the information on catch and effort with reference to fish landed, the gears used and effort expended, given above would be helpful in arriving at some of these decisions for a rational exploitation.

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AN APPRAISAL OF THE PERCH FISHERY AT MUTTOM AREA IN TAMIL NADU

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ABSTRACT

The fishery of the perch fishes at Muttom has been studied and discussed based on the data collected during 1987 and 1988. Perches form 33.3% of the local fish catch amounting to an annual average of 222 tonnes. November to April is the best season for perch fishery at Muttom with peak in January. Lethrinids, Lutjanids and Nemipterids formed respectively 64.5%, 16.4% and 13.0% of the perch landings. The remaining quantity was constituted by Serranids, Sparids and Siganids. Hooks and line contributed to 86.0% of the catch which is followed by Traps (11.2%) and Gill nets (2.8%). Distribution of sizes of important species in the fishery are given along with suggestions for improving the catch.

INTRODUCTON

Muttom (77° 20' E, 08° 10' N) is one of the important fish landing centres in the southwest coast of India for artisanal fisheries (Fig. 1). The Wadge Bank known for its perch fishery is at its close proximity. Inshore region of Muttom is sandy sterwn with rocky beds. Chain of rocks found on the shore as well as on the sea bottom harbour good concentration of rock dwelling demersal fishes mainly perch fishes. Hitherto there is no exclusive account available on this group from this area. Muttom fishing village may be divided into two regions - Keezhamuttom and Melamuttom. Since perches are landded only at Melamuttom landing centre the present observations are confined to this centre only.

Catch date collected by fortnightly observations spread over two years from January 1987 to December 1988 are utilised for the present study. The term 'Perches' given in this account relates to the percoid fishes of the families Lethrinidae, Lutjanidae, Serranidae, Nemipteridae, Siganidae and Sparidae. The method of raising the sample value to catch as described by Sekharan (1965) was followed for obtaining the monthly estimates of total catch of each species and for the number of fish in each length group. Catch per unit of effort was also calculated separately following the above author.

CRAFT AND GEAR

Catamarans numbering about 200 are the main craft at Melamuttom for the perch fishery.

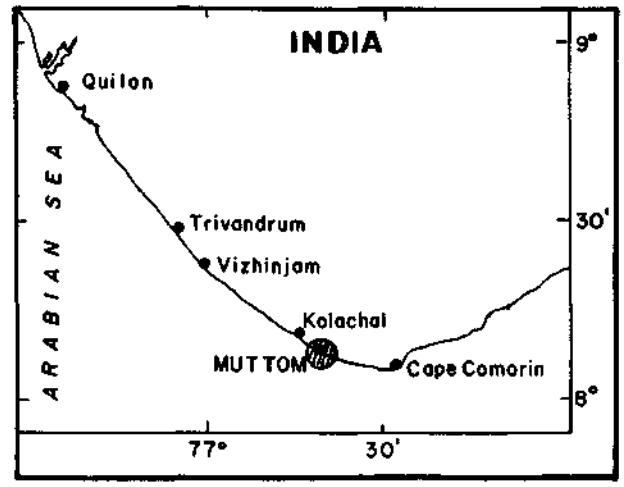

Fig. 1. Location of Muttom and its landing centres.

Out of this, 30 are now motorised (7 HP). Hooks and line and Traps, locally called Choonda and Koodu respectively are the main gears operated for perches here. While Traps are primarily intended to fish percoid fishes which abound in localities with hard bottom formed of rocks and corals, the Hooks and line are meant for fishing a variety of forms including perches. Handlines and longlines are the two types in use at

Muttom. At times perches are also caught by a variety of gill nets such as Thathu vala, Podi vala, Vali vala and Disco vala.

The perch Traps that are in use in the Palk Bay and the Gulf of Mannar (Pearson, 1922; Hornell, 1950; Prabhu, 1954) have one to five entrances. But the Trap used at Muttom has only opne entrance and is made of the main rachis of wild palm locally knows as Yeenthal. For lacing the joints and the entrance funnel fiber of palmyrah leaf stalk and nylon are used. The Trap is almost rectangular in shape with a concave entrance side and a convex posterior side (Fig. 2 A and B).

kept inside as bait. The Traps are placed at the bottom of the sea at places nearer to the rocks without any floats. Every time one of the fishermen dives down with the Trap and leaves it at the bottom. Similar diving is resorted to when the catches are removed. The entraped fishes are removed in the morning. Like at Muttom, Traps are being used for perches at places like Kadiapattinam, Colachel, Kodimunai, Vaniakkudi, Kurumbanai and Enayam along this coast. Next to Muttom, Traps are more common at Kadiapattinam. Here, in addition to the above type, those made of metal frame, nylon netting and entrance funnel made of palmyrah leaf fibre also are used (Fig. 2 C and D).

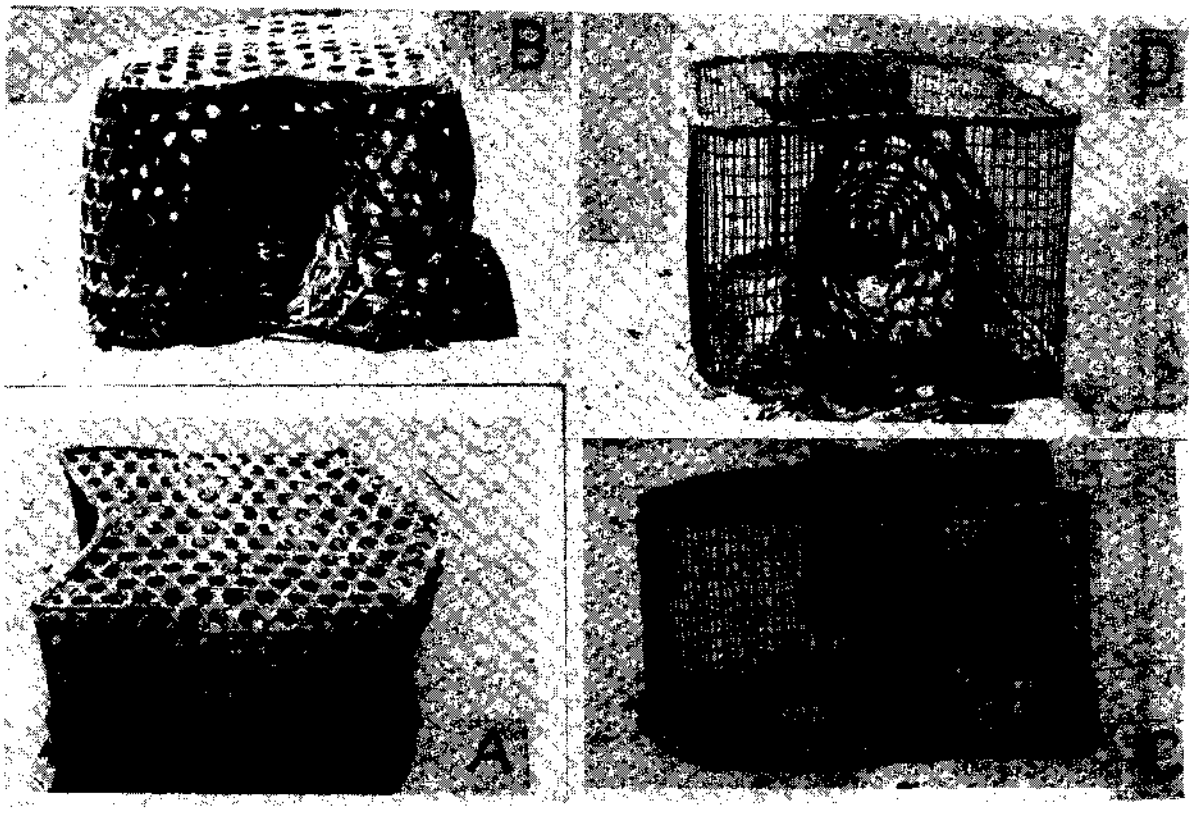

Fig. 2. Perch Traps used at Muttom and Kadiapattinam : A, B = Trap used at Muttom (A = Lateral veiw, B = Entrance view) and C, D = Trap used at Kadiapattinam (C = Lateral view, D = Entrance view).

The season for Trap fishing in this area is from December to April. Four to five fishermen jointly operate three to four Traps by using a Catamaran. Stone weights are kept inside at the corners of the Trap to enable it to sink easily. A bunch of brown mussel is also

FISHERY

Trend of the fishery

The annual perch landings at Muttom ranged from 78.3 t to 365.7 t during the two

years of observation with the average at 222.0 t (Fig. 3). The average monthly landings varied between 1.0 t in August and 91.7 t in January with an overall monthly average of 18.5 t. Landings higher than this monthly average were obtained during November to April, when nearly 88% of the annual catch was landed. This group's representation to local fisheries touched a lower level of 0.7% during August in the lean season and 41.3% during January in the peak season (Fig. 4). In general it amounts to 33.3% of the local fish catch at

TABLE 1. *Annual landings (kg) of different groups of perches at Muttom*

Family	Species	1987	1988	Total	Average
Lethrinidae	*L. nebulosus*	107439	28406	135845	67922.5
	L. Lentjan	122037	21964	144001	72001.0
	L. harak	1750	3008	4758	2379.0
	L. elongatus	2000	-	2000	1000.0
Lutjanidae	*L. fulvus*	41113	2215	43328	21664.0
	L. bigutatus	22518	-	21518	112559.0
	L. malabaricus	6980	-	6980	3490.0
Nemipteridae	*N. bleekeri*	45931	6240	52171	26085.5
	N. japonicus	-	6435	6435	3217.5
Siganidae	*Siganus.* sp.	1820	-	1820	910.0
Serranidae	*Epinephelus* sp.	14151	8680	22831	11415.5
Sparidae	*Rhabdosargus sarba*	-	1345	1345	672.5

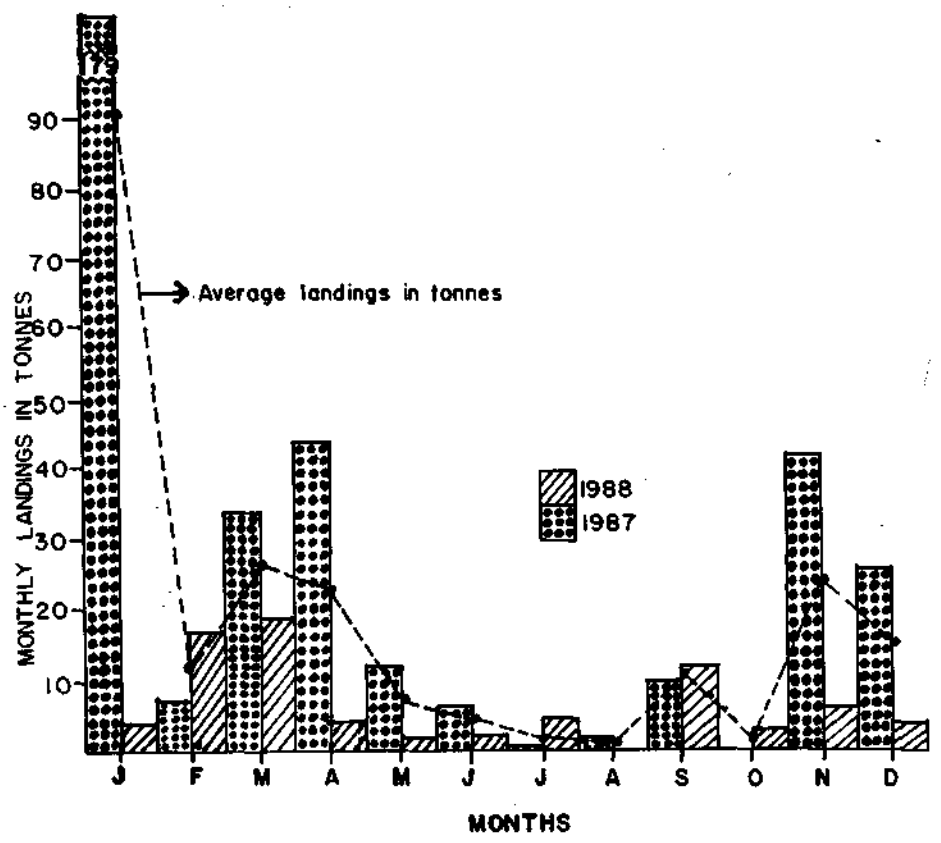

Fig. 3. Monthly landings of perches at Muttom during 1987 and 1988.

Muttom (Fig. 5 A). The highest landings of all fish as well as perches noted during January for perches with best returns in January at the Muttom area. However, the general fishery

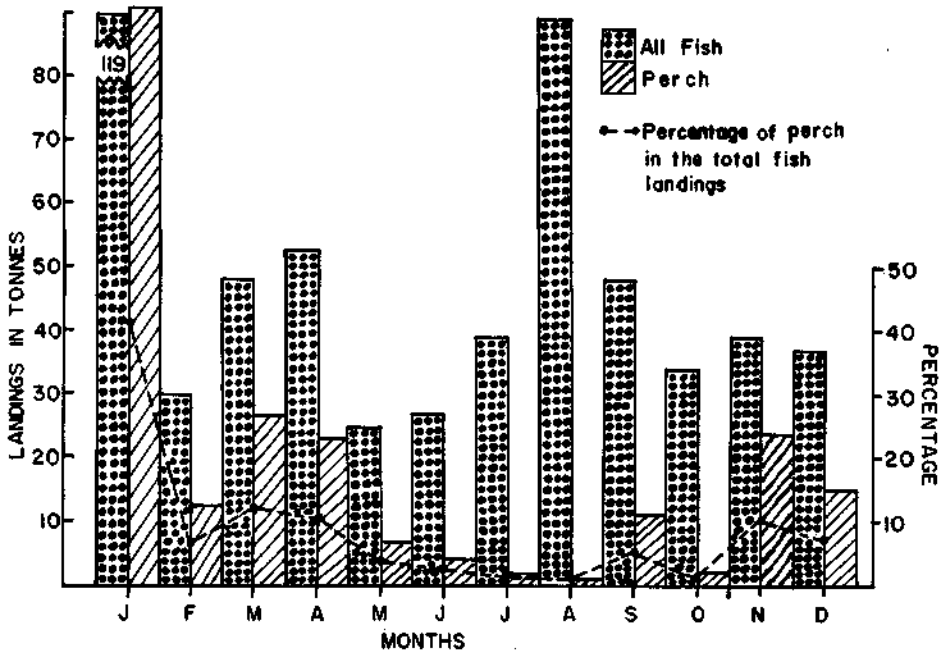

Fig. 4. Average monthly landings of perches and other fishes at Muttom.

was due to the highest number (8100) of Hooks and line units operated during January 1987. From the foregoing trend it may be stated that November to April represents the main season extended throughout the year with two peaks, one in January fetching 20.2% of the annual catch and the other in August amounting to 15.2% of the annual catch (Fig. 4).

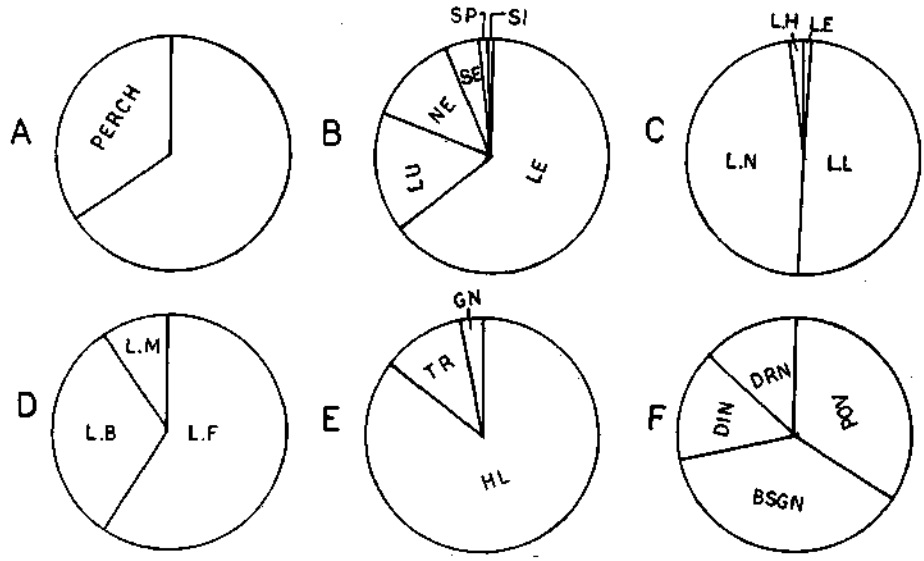

Fig. 5. A. Percentage of perches in the local landings at Muttom, B. Different groups of perches forming the fishery at Muttom (LU = Lutjanids, NE = Nemipterids, SE = Serranids, SP = Sparids, SI = Siganids, LE = Lethrinids), C. Species of the genus *Lethrinus* forming the fishery at Muttom (LN = *Lethrinus nebulosus*, LL = *L. lentjan*, LH = *L. harak*, LE = *L. elongatus*), D. Species of the genus *Lutjanus* forming the fishery at Muttom (LF = *Lutjanus fulvus*, LB = *L. biguttatus*, LM = *L. malabaricus*), E. Gearwise contribution of perches at Muttom (HL = Hooks and line, TR = Trap, GN = Gill net) and F. Contribution by the various types of gill nets to the perch fishery at Muttom (BSGN = Bottom set gill net, POV = Podi vala, DRN = Drift net, DIN = Disco net).

Species composition

Fishes of the families Lethrinidae, Lutjanidae, Nemipteridae, Serranidae, Sparidae and Siganidae formed the perch fishery at Muttom forming respectively 64.45%, 16.39%, 13.00 %, 5.14%, 0.61%, 0.41% of the total catch (Fig. 5 B). The annual landings of different species of perches are given in Table 1. Lethrinids ranked first among perches landed at Muttom. Bulk of Lethrinid catch was constituted by two species namely *Lethrinus lentjan* (50.2%) and *L. nebulosus* (47.4%). The other two species *L. harak* and *L. elongatus* formed respectively 1.7% and 0.7% of the catch (Fig. 5 C). The fishery for *L. lentjan* started by November and lasted upto June/July with a peak during January to April forming about 79% of the annual catch. Annual landings ranged between 22.0 t and 122.0 t with the average at 72.0 t. *L. nebulosus* appeared in the landings almost throughout the year except during August and October with a peak during November to April accounting to 90% of the total annual catch (Fig. 5 C). Annual landings for these two years ranged from 28.4 t 107.4 t with the average at 67.9 t. Unlike the case of other two species the fishery for *L. harak* and *L. elongatus* lasted only for a shorter period : November to March for the former and November for the latter species contributing respectively 2.4 t and 1.0 t annually.

Three species of Lutjanids *viz. Lutjanus fulvus, L. biguttatus* and *L. malabaricus* contributed to the fishery. First one formed 59.5% while the other two formed respectively 30.9% and 9.6% of the Lutjanid catch (Fig. 5 D). Only *L. fulvus* under this group has a fishery of appre- ciable magnitude and its annual catch ranged between 2.2 t and 41.1 t with an average at 21.7 t. Fishery started by November and lasted upto July with peak in January accounting to 74% of the total annual catch. *Lutjanus biguttatus* and *L. malabaricus* recorded respectively a total of 11.3 t and 3.5 t annualy forming a fishery during December - January period.

Nemipterus bleekeri and *N. japonicus* with a percentage composition of 89.0 and 11.0 were the two species recorded under Nemipterids from Muttom and their contribution could be estimated at 26.0 t and 3.2 t respectively. *N. bleekeri* has two fishery seasons at Muttom, one from November to June and the other in September, while for *N. japonicus* there is only one season lasting for two months from September.

Serranids form the next important group with annual average landings of 11.4 t accounting to 5.1% of the total perch catch. *Epinephelus septemfasciatus* (50.0%), *E. malabaricus* (35.0%) and *E. tauvina* (15.0%) were the three species forming the perch fishery at Muttom. These fishes landed from April to December with fairly good quantities during April (20.5%) and November (22.0%).

Fishes of the families Sparidae and Siganidae were encountered rarely in the fishery and they accounted for about 0.6% and 0.4% respectively of the total perch catch. Siganids occurred during September and Sparids in January to March period.

Gearwise production

As mentioned already three main types of gears are in vogue at Muttom to exploit the perch resources. They are Hooks and line, Trap and Gill nets. Hooks and lines (Longline and Handline) contribute to the bulk (86.0%) of the total landings (Fig. 5 E) followed by Trap (11.2%) and Gill net (2.8%). Out of the total Gill net catch the Thathu vala and Podi vala have the major share, each contributing 38.0% and 33.8% respectively of the total (Fig. 5 F). The remaining quantity was shared by Disco vala (15.1%) and Vali vala (13.1%).

TABLE 2. *Annual average CPUE (kg) of perch at Muttom by the different gears*

Gear		CPUE (kg)
Hooks and line		10.4
Trap		12.9
Disco net	Gill net	2.0
Thathu vala	Gill net	0.6
Vali vala	Gill net	0.9
Podi vala	Gill net	10.8

Hooks and line was in operation in both the years of study. Annual effort ranged from

31,592 units in 1988 to 33,715 units in 1987 with the average at 32,654 units. Total catch ranged from 59.8 t in 1988 to 349.7 t in 1987 with the average at 204. 7 t. The annual catch per unit of effort varied from 1.9 kg in 1988 to 10.4 kg in 1987 (Table 2). Fishing by this gear is in vogue throughout the year, but is more intense during November to May period. Almost all groups of perches are landed by this gear.

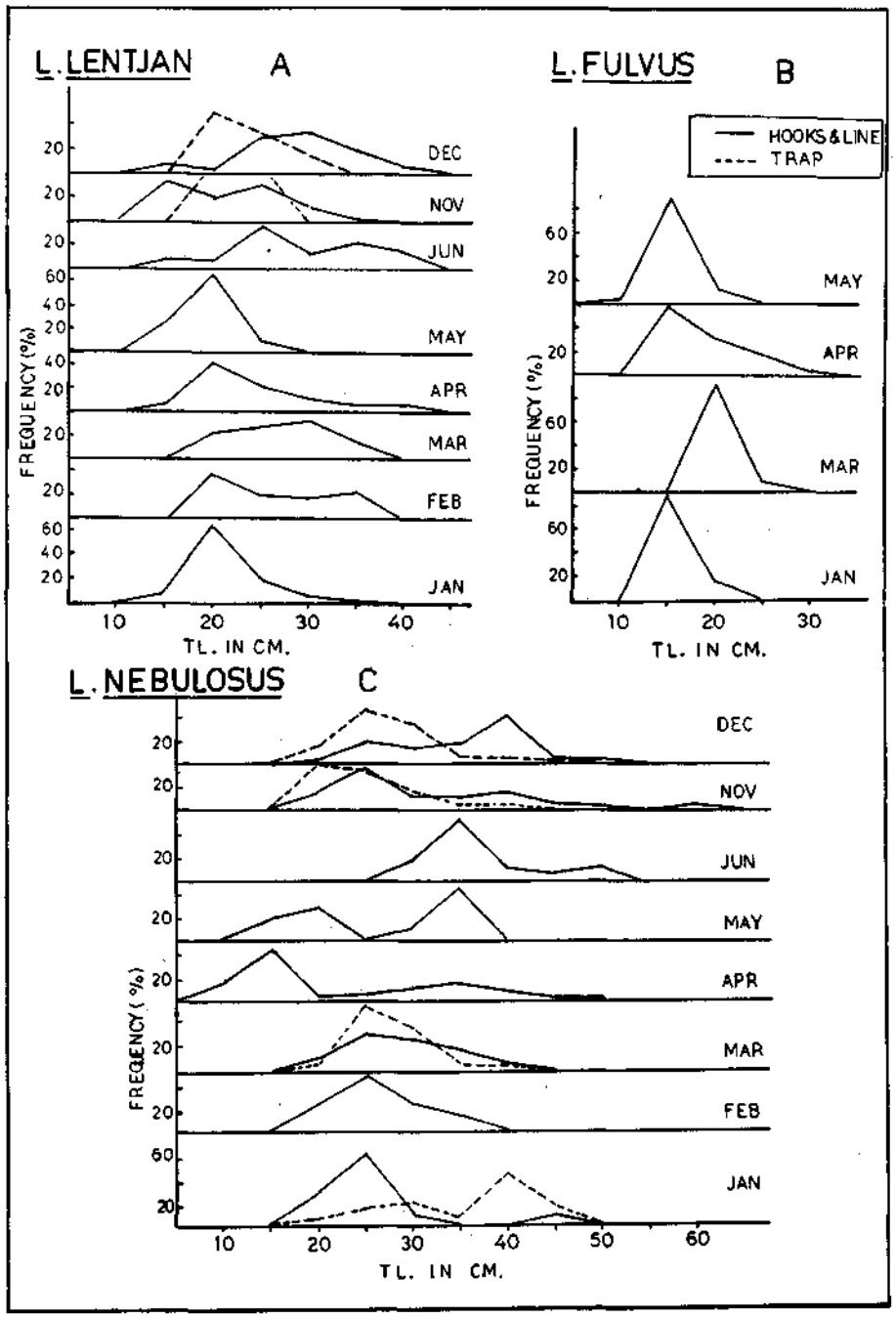

Fig. 6. Length frequency distribution of different species of perches (A = *Lethrinus lentjan*, B = *Lutjanus fulvus* and C. *Lethrinus nebulosus*).

An estimated total of 273 Trap units were operated during 1987 and 1306 during 1988 and

they brought respectively 2.6 t and 16.9 t of perch at the rate of 9.6 kg and 12.9 kg per Trap respectively. This gear is operated for five months from November every year. Medium sized *Lethrinus nebulosus* and *L. lentjan* were the two main species caught by this gear. Occassionally small sized *Lethrinus harak* and *Lutjanus fulvus* were also landed in lesser quantities. It is mainly a selecitve gear and fish between 20 and 45 cm size were only caught.

Among gill nets only the bottom set ones (Thathu vala) were operated in both years of observation and they contributed 594 kg during 1987 (C/E 0.5 kg) and 1612 kg during 1988 (C/E 0.6 kg). The period of their operation was between May and July. Other types of gill nets such as *Disco vala, Podi vala* and *Vali vala* were operated only during 1987 and they brought respectively 3120 kg (C/E 2.0 kg), 2705 kg (C/E 0.9 kg) and 7020 kg (C/E 10.8 kg) of perches. These nets were operated from June to September months.

Size Distribution of Important Species

Lethrinus nebuloses : Fish landed by Traps had a narrow size range, normally from 20 cm to 45 cm with modes at 30 cm and 40 cm during January, at 25 cm during March, at 20 cm during November and at 25 cm during December. But in Hooks and line wider size ranges (from 10 cm to 60 cm) with two modes in most of the months were found (Fig. 6 C). The smaller size range observed for the Trap catches was due to the small size of the Trap opening.

Lethrinus lentjan : When compared to *L. nebulosus* only smaller specimens of this species dominated the catch by hooks and line at Muttom. The size ranged form 15 to 40 cm with modes at 20 cm during January, February, April and May. During March and December the prominant mode was found at 30 cm size guoup. During June and November, the distribution was bimodal (Fig. 6 A) with a common mode at 25 cm size group. The other modes were at 35 cm during June and 15 cm during November. This species caught by traps ranged in size from 20 to 30 cm with mode at 20 cm.

Lutjanus fulvus : Normally fish from 10 to 30 cm sizes occurred in the catches (mainly by Hooks and lines) with prominant mode either at 15 cm size group or at 20 cm size group (Fig. 6 B).

Marketing and Utilization

Perches are usually auctioned at Muttom on the beach itself soon after landing. They are transported to nearby markets by headloads and to interior markets by bicycles, buses and trucks. Transport buses specially designed to lift fresh fish to Nagercoil market are also in operation now. Quantities exceeding the local demand are iced and sent to distant markets in Kerala. Recently because of their good export demand, they are being weighed in the beach itself and sold to merchants on pre-fixed rate just like that for shellfish and cuttlefish. The rate varies from Rs.12 to Rs.18 per kg depending upon demand as well as quality of the fish. Fish caught by traps fetch higher rate than that caught by other gears. Frozen perches are exported to foreign countries.

Remarks

There is vast scope for improving the perch fishery at Muttom. Now mostly non-motorised Catamarans are empolyed to exploit this resource. If outboard motors are provided to the Catamarans, they can cover distant beds and thereby catches could be increased. Motorisation of Catamaran was first introduced at Muttom on a trial basis in the sixties by the Indo-Belgium Project (Pelzer, 1971), but that did not attract the fishermen much, because there was no facility for repair or for replacement of parts (Lazarus and Joel, 1979). Now the situation has changed and these facilities are available in all important fishing centres, and the fishermen have developed a liking towards motorising the Catamaran because of its many advantages. An important point in favour of motorization is that it almost eliminates the physical strain of rowing and increases leisure time so that the fishermen will have better health and social life. With the introduction of outboard motors the younger generation in Kerala has showed an enthusiastic inclination towards the fishing profession (Balan *et al.*, 1989).

Attempts should also be made to exploit the vast Kalava resource available in the Wadge Bank area from Muttom by introducing Dorry

fishing or Mothership operation (Gopinath, 1954). Accounts on the traditional Handline fishing for perches in the Wadge Bank appear in the works of Hornell (1916) and Gulland (1971). Silas (1969) during the cruises of R. V. *VARUNA* has observed line fishing by indigenous crafts on the Wadge Bank. He has also mentioned about the existence of a trawl ground for perches on the Wadge Bank itself. Thangal fishing for perches in the Wadge Bank area by fishermen from Kanyakumari District has been reported by Lazarus and Joel (1979).

Joseph and John (1986) have recorded a catch rate of 67 kg/hr for perches from Wadge Bank area. They have also located a highly productive perch ground yielding on an average 94.26 kg/hr southeast off Cape Comorin in 50 m depth. The catch rates of perches obtained by them from this area during July - September was 153.4 kg/hr and in April - June 130.7 kg/hr. This conspicuous seasonal variation in yield pattern was attributed to the presence of two stocks, *viz.* the resident stock which is present on the fishing ground throughout the year and the migrant stock that appears on the Bank during the southwest monsoon period (Sivalingam and Medcof, 1957; Silvalingam, 1969).

ACKNOWLEDGEMENTS

The authors wish to express their sincere thanks to Dr. P.S.B.R. James, Director, C.M.F.R Institute and to Shri P. Sam Bennet, Project Leader for their encouragement shown in this study.

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THE PERCH FISHERY BY TRADITIONAL TRAPS AT KILAKARAI (GULF OF MANNAR) AND SOME ASPECTS OF BIOLOGY OF *LETHRINUS NEBULOSUS* (FORSKÅL)

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ABSTRACT

Exploitation of perch resources off Kilakarai in the Gulf of Mannar, by traditional traps is studied. The increase in perch landings and the change in succession of species are attributed to the change in mode of operation, area of operation and increase in the usage of prawn peelings predominantly as baits in place of traditional baits. The biology of the dominant species *Lethrinus nebulosus* is studied. The age and growth of this species is described from the length frequency data collected from the landings of perch traps. The length-weight relationship and food and feeding are dealt in detail. The mortality coefficient namely natural (M), total (Z) and fishing (F), exploitation rate (U) and yield per recruit in relation to different F, M/K ratios keeping the age at first capture constantly at the prevailing level (0.2913 yr) have been estimated to assess the present status of the fishery of this species. It is inferred that this species is exposed to higher fishing intensity by the perch trap units as the prevailing fishing mortality coefficients are higher than the F_{max} which can bring about the yield max for the prevailing M/K ratio. This finding is attributed as one of the possible reasons for the continued decline in the percentage composition of *L. nebulosus* in the perch trap landings since 1950s.

INTRODUCTION

Perch fishery in India is sustained by a large number of species belonging to thirty seven genera and the perch production by mechanised units have been assessed to be higher (72.4%) than the non-mechanised units (Kasim *et al.*, 1989). On exploitation of this resource by traditional gear only a few accounts by Prabhu (1954), Lal Mohan (1985) and others are available. Among the traditional gear, the trap of Kilakarai centre is unique in exploiting the perches in the Gulf of Mannar. Initially the perch-traps have been described in detail by Hornell (1950) followed by Prabhu (1954) and the latter has given not only on the fabrication and mode of operation of the traps, but fairly a good account on the fishery also. There had been a subtle change in the mode of operation and consequently a change in the catch composition also in 1970s (Lal Mohan, 1985). Present account deals not only with the mode of fishing, area of fishing, catch statistics, species composition, but also the growth, food and feeding and some aspects of population dynamics of *Lethrinus nebulosus* which is the dominant species among the perches landed by trap fishing units at Kilakarai.

MATERIAL AND METHODS

Weekly observations were made at Kilakarai (09° 14' N, 78° 47' E) fish landing centre and data on catch, effort and species composition were collected during 1983 - 1985. The catch estimate on the sampling day was obtained by raising the observed catch to total number of trap fishing units operated on that day. Subsequently, the monthly catch and effort estimates were obtained by raising the sampling days catch and effort to the total number of fishing days in that respective month. Length frequency of the dominant species *Lethrinus nebulosus* was also collected on the sampling days and samples of this species were obtained for biological studies whenever possible.

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FISHERY

Mode and area of fishing : There has been no change in the structural design and material used for the fabrication of perch traps at Kilakarai from that described by Hornell (1950) and Prabhu (1954). During 1970s, consequent to the installation of prawn processing plants in and around Mandapam area, the perch trap fishermen started using the prawn peels and heads as the dominant baits in traps in addition to the traditional baits like the cephalopods, crabs, holothurians, clupeid fishes and jellyfishes. Lal Mohan (1985) has attributed the increase in the catch in traps in the Gulf of Mannar when compared to the Palk Bay to the use of prawn peels and prawn heads as bait in the traps since early 1970s. It appears from the account of Prabhu (1954) the area of operation of perch traps were limited to near shore waters and the distance of operation varied from 20 to 300 m from shore where the bottom is sandy and it was 600 to 800 m where the bottom is rocky. Now the operation of the perch traps is not near shore, but located around the nearby islands namely Anai Par, Valiamunai, Kilinjan Par, Appa Island, Valai Island and Mulli Island which are about 8 - 10 km away from Kilakarai (Fig. 1).

Catch statistics : As seen from the data on estimated fishing effort of trap fishing units and catch of perches by traps at Kilakarai given in Table 1, the catch increased in subsequent years from 1983 to 1985 not only due to the increase in the effort input, but also due to the increase in the abundance of perches in subsequent years as indicated by the catch per unit effort which increased from 7.26 kg/unit in 1983 to 9.00 kg/unit in 1984 and then to 9.64 kg/unit in 1985. During 1983, it is seen from the catch rate, the abundance of perch was good in January, March, April, October and November whereas the catch was better in all the months except in February, May, July and September. In 1984, the catch was good in almost all the months, but the abundance was good only in January, April, May, August, October, November and December. On the other hand the catch was good in all the months in 1985 except in January and the abundance was good in March, May to september and December (Table 1). During the period of this study on an average 267 trap fishing units were operated and 2327 kg of perch were landed at the catch rate of 8.59 kg/unit in a month.

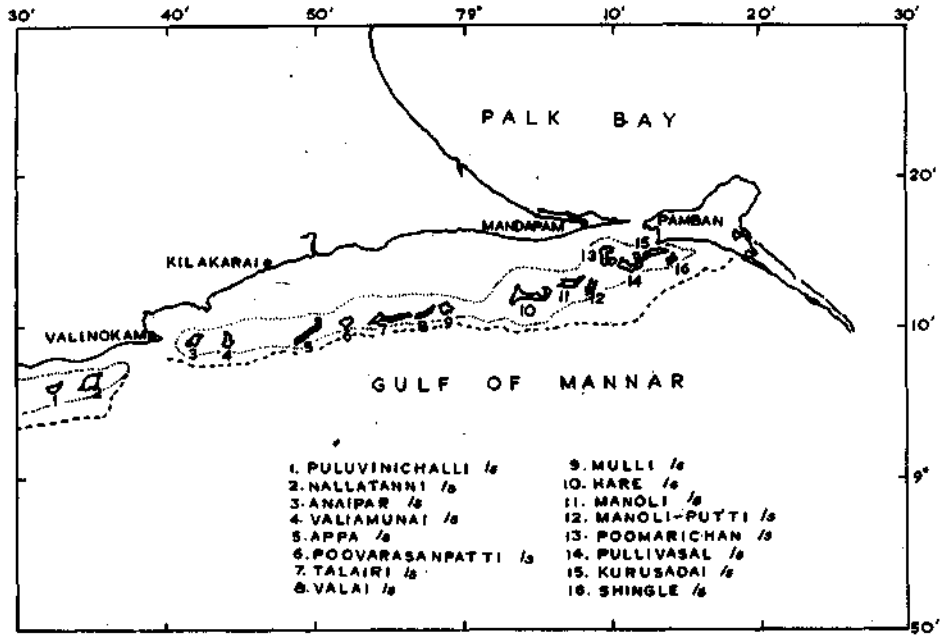

Fig. 1. Location of Kilakarai in the Gulf of Mannar and the area of trap fishing in the nearby islands such as Anai par, Valiamunai, Appa Island, Mulli Island and other islands.

Species composition : There appears to be a perceptible change in the species composition in

the catches by perch traps at Kilakarai since 1950s, when Prabhu (1954) reported that composition of *L. nebulosus* (45%) and *C. ghobban* (10%) whereas *Siganus canaliculatus*

TABLE 1. *Estimated effort of perch trap units, catch in kg of perch and catch per unit of effort in kg of perches landed at Kilakarai in the Gulf of Mannar during 1983 - 1985*

	1983			1984			1985		
	E	C	C/E	E	C	C/E	E	C	C/E
January	300	3120	10.4	260	2706	10.4	208	1248	6.0
February	280	960	3.4	230	1736	7.5	286	2470	8.6
March	264	2753	10.4	234	1521	6.5	338	3425	10.0
April	248	2769	11.2	210	3120	14.8	286	2418	8.4
May	300	832	2.7	312	2890	9.2	312	4708	15.0
June	338	2080	6.0	364	2908	8.0	288	3424	11.9
July	182	773	4.2	286	1978	6.9	338	3458	10.2
August	156	1125	7.2	208	1898	9.0	364	3454	9.5
September	130	734	5.6	260	1872	7.2	286	2550	9.0
October	156	1508	9.6	234	2319	9.9	286	2064	7.2
November	286	2600	9.1	286	2662	9.3	275	2408	8.7
December	208	1430	6.9	260	2704	10.4	340	3146	9.2
Total	2848	20684	-	3144	28314	-	3607	34773	-
(Mean)	(237)	(1724)	(7.26)	(262)	(2360)	(9.00)	(301)	(2898)	(9.64)

Lethrinus nebulosus (*L. cinereus*) formed 56.8%, *Callyodon ghobban* 25.9% and *Teuthis* constituted 26.2% of the perch trap catches during early 1970s. During the period of this

TABLE 2. *Average annual catch of perches (kg) caught by Traps (Koodu) at Kilakarai in the Gulf of Mannar during 1983 - 1985*

	Lethrinus nebulosus	*Lutjanus* spp.	*Epinephelus* spp.	*Siganus* spp.	*Callyodon ghobban*	*Plectorhynchus* spp.	Other fishes	Total
January	1449	228	118	180	48	-	335	2358
February	761	103	139	204	219	9	287	1722
March	929	208	193	464	299	39	434	2566
April	1095	204	317	438	407	-	308	2769
May	537	173	247	741	465	52	595	2810
June	511	52	417	1025	512	22	265	2804
July	355	113	226	749	300	67	260	2070
August	377	152	286	709	230	80	325	2159
September	461	81	149	535	241	69	183	1719
October	784	182	152	507	151	-	188	1964
November	1138	270	170	514	162	63	240	2557
December	1426	247	182	225	69	18	260	2427
Total	9823	2013	2596	6291	3103	419	3680	27925
%	35.18	7.21	9.30	22.53	11.11	1.50	13.18	-

marmorata 1.9%. Subsequently, Lal Mohan (1985) observed a decline in the percentage study (1983 - 85) *L. nebulosus* continued to be the dominant species among the 30 species

which supported the perch trap fishery at Kilakarai. There was further decline in the

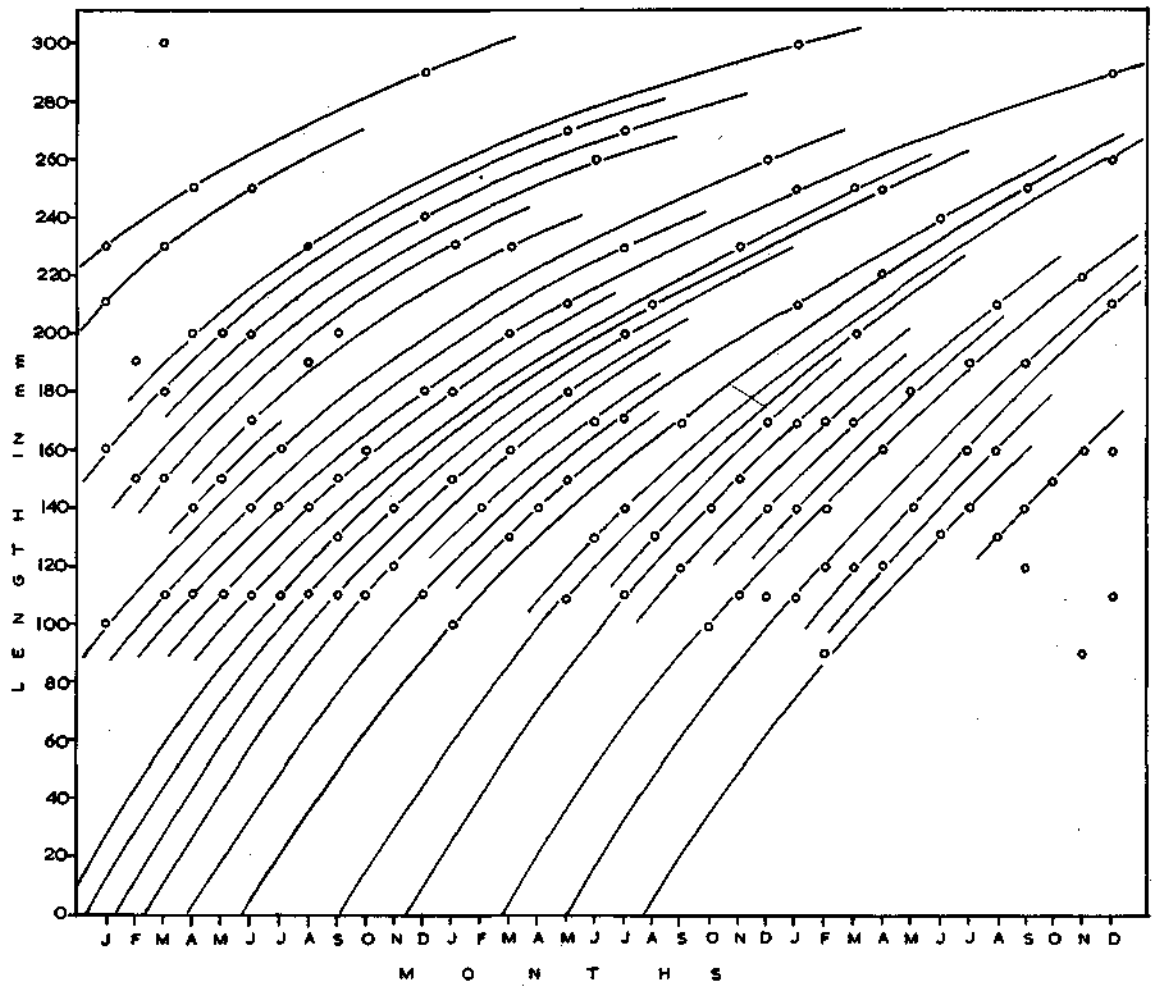

Fig. 2. Tracing the progression of different modes in relation to time as per the integrated method (Pauly, 1980).

percentage composition of *L. nebulosus* (35.18%) comparatively, *S. canaliculatus* constituted the second place (22.53%), *C. ghobban* occupied the third place (11.11%) and *Lutjanus* spp., *Epinephelus* spp., constituted 7.21% and 9.30% respectively (Table 2). The rest of the catch was constituted by *Plectorhynchus* spp., *Diagramma* spp., *Upeneus* spp., *Plotosus* spp., *Psammoperca waigiensis*, *Therapon* spp., *Serranus* spp., *Chaetodon* spp., *Acanthurus* spp., etc.

BILOGY OF *LETHRINUS NEBULOSUS*

Food and feeding : Gut content analysis of *Lethrinus nebulosus* ranging in size from 80 to 200 mm in total length reveals that fishes with empty stomach were dominant forming 61.1%, followed by fishes with little quantity of food (22.2%). Fishes with gorged, full and 3/4 full stomach were totally absent, indicating that either the fishes which are always in search of food enter the traps and get caught or as the fishes remain alive in the traps for longer duration of time, may be 24 hours, the food in the stomach gets digested. The average volume of the food content in the stomach was 1.0 ml in 1/2 full, 0.4 ml in 1/4 full and 0.15 ml in stomachs containing little quantity of food items.

The qualitative analysis of gut content revealed that prawn appendages formed the major items and it constituted 57.14% followed by digested matter (28.57%), partly digested fish (7.15%) and coral stone bits (7.14%). The

occurrence of higher percentage of prawn appendages in the stomach content indicates that more and more prawn peelings are being used predominantly as baits and the usage of traditional baits such as holothurians, crabs, fishes, jellyfishes, etc. in the perch traps (Prabhu, 1954) is on the decline.

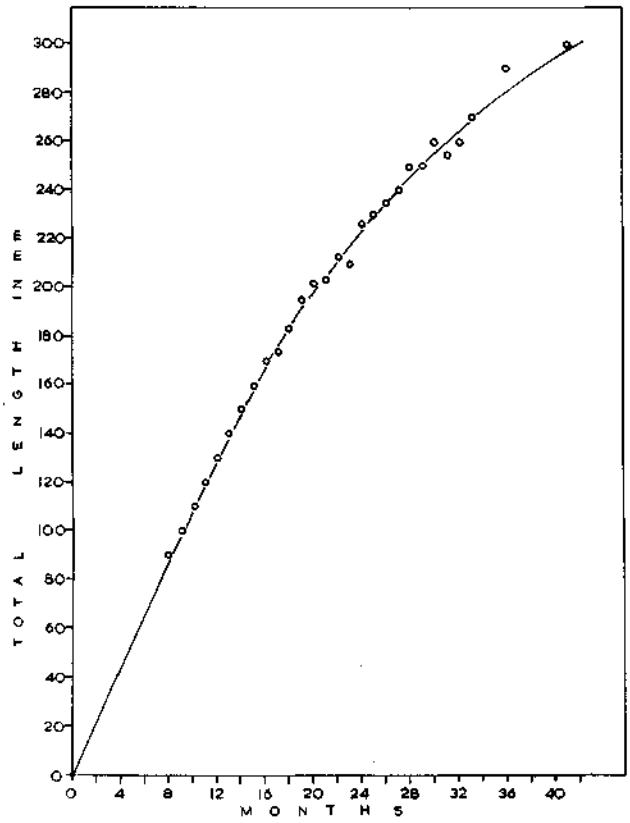

Fig. 3. Empirical growth curve of *Lethrinus nebulosus* obtained by plotting the average sizes attained by this species, estimated as per George and Banerji (1968) against their respective months.

Age and growth : The growth of *L. nebulosus* has been studied by plotting the modes available in different month as scatter diagram. The progression of the modes in relation to time was traced as per Pauly (1980) as shown in Fig. 2. The average sizes attained by this species were estimated as per George and Banerji (1968) which were plotted on an arithmatic graph against respective months and an empirical growth curve was obtained by fitting a free hand curve through the plots (Fig. 3). Based on this curve a series of another set of growth values were obtained which were subjected to further analysis to obtain the growth parameters L_∞, K and t_o as per Bagenal (1955) and the estimates are L_∞ = 400.2 mm, K = 0.3994 and t_o = -0.0204. Kasim *et al.* (1989) have also studied the growth of *L. nebulosus* in the Gulf of Mannar from Tuticorin and the estimates obtained by them are L_∞ = 968 mm, K = 0.4172 and t_o = -0.0716. The estimates K and t_o do not differ much in these studies whereas the L_∞ is estimated to be lower in the present study than the estimate of Kasim *et al.* (1989). This is mainly due to occurrence of smaller size ranges in the perch trap fishery *i. e.* to 300 mm whereas Kasim *et al.* (1989) have recorded a size range of 60 to 760 mm at Tuticorin. Since the maximum size attainable by this species is much more higher than 400 mm, the L_∞ estimate obtained by Kasim *et al.* (1989) is taken into account for further studies on mortality rates and yeild per recruitment substituting 968 mm as L_∞ the growth in length of this species may be expressed as per von Bertalanffy growth equation $L_t = 968\ (1\text{-}e^{-0.3994\ (t + 0.0204)})$. Based on this estimate *L. nebulosus* attains 324, 536, 678, 774 and 838 mm in 1st, 2nd, 3rd, 4th and 5th year and this estimate is in close agreement with Kasim *et al.* (1989).

Length-weight relationship : The length weight relationship of this species has been obtained as per the least squares method (Snedecor, 1961) from the data on the log length (mm) and log weight (g) and the same may be expressed as per the regression equation Log W = -4.5364 + 2.9078 Log L, with r value 0.9672. Prabhu (1954) has described the length weight relationship of this species by the equation Log W = -2.0830 + 3.1901 Log L from Mandapam waters in the Gulf of Manner and Kasim *et al.* (1989) by the equation Log W = -1.6846 + 2.9551 Log L from Tuticorin waters. There appears to be a very limited variation in the length weight relationship described by Prabhu (1954), Kasim *et al.* (1989) and the present study and all these three equations describe the relationship adequately well (Fig. 4). However, the equation proposed by Kasim *et al.* (1989) indicates a marginal faster weight gain and the equation of Prabhu (1954) a slower increase in weight than that prosped in this study. Based on this length weight relationship the W_∞ is estimated to be 13.993 kg.

Mortality rates : The natural mortality coefficient (M) is estimated from the life span (T_{max}) of the species as per Sekharan (1974). The T_{max} is

estimated to be 7.5 year from the relation T_{max} = 3/K (Pauly, 1980). Assuming 99% of the population die by the time they reach 7.5 years, if there is no fishing, we get an estimate of 0.61 as M, as per the relation M = 1/7.5 Log $e^{0.01}$ (Alagaraja, 1984) and the M/K ratio is 1.53. The total mortality coefficient (Z) is estimated by the length converted catch curve method (Pauly, 1983) and the estimates are 9.4, 10.2 and 8.0 in 1983, 1984 and 1985 respectively. Fishing mortality coefficient (F) were obtained by deducting M from Z and the F is estimated to be 8.79, 9.59 and 7.39 during 1983, 1984 and 1985 respectively.

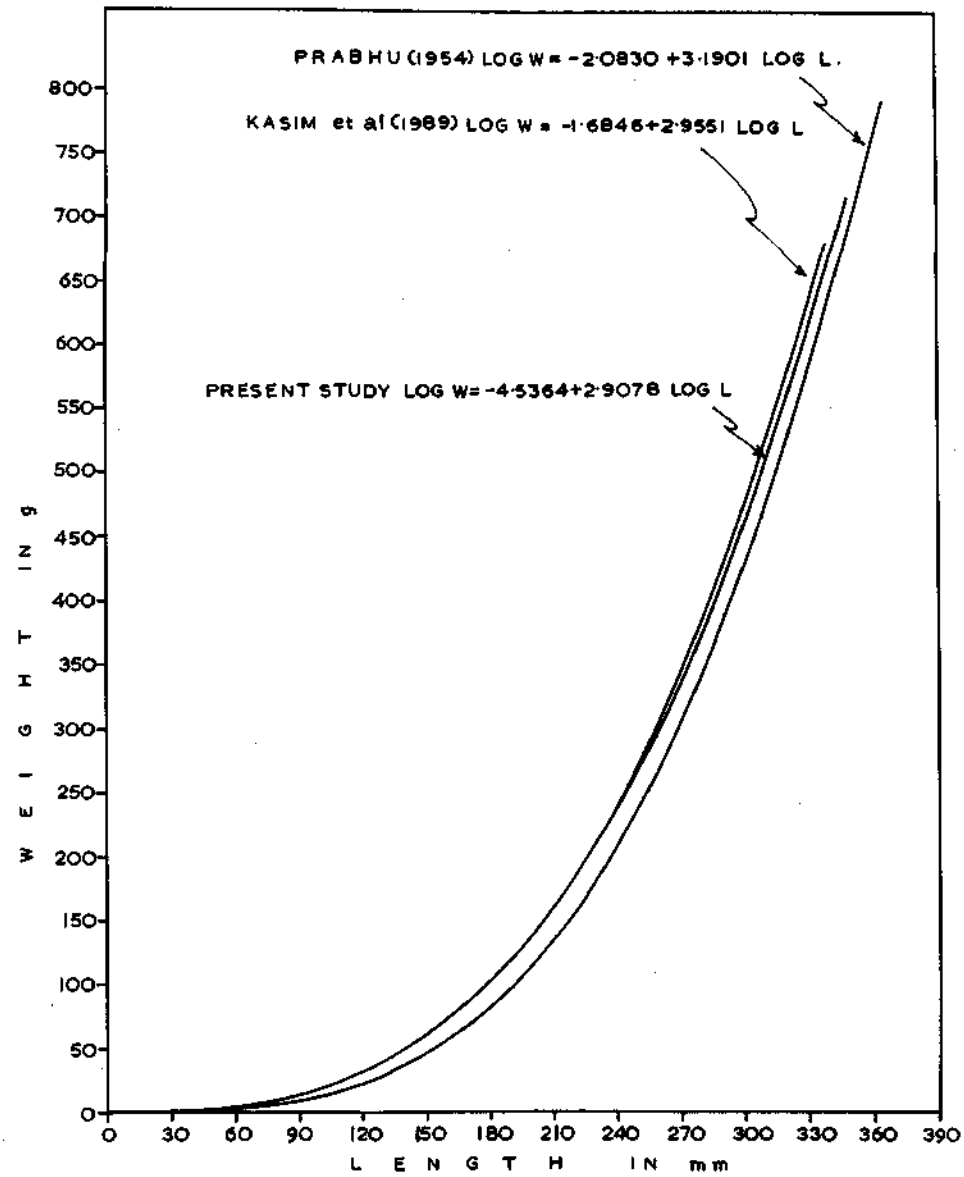

Fig. 4. Length-weight relationship curves drawn as per the equations of Prabhu (1954), Kasim *et al.* (1989) and the present study.

Exploitation rate : The exploitation rate 'U' is estimated from the relation U= F/Z (1 - e^{-Z}) and the estimates are 0.94, 0.94 and 0.92 in 1983, 1984 and 1985 respectively.

Yield per recruitment : Yield per recruit in g estimated as functions of different fishing mortality rates, keeping the age at first capture constant at prevailing level of 0.2913 yr and

varying the M/K ratio as per the method of Beverton and Holt (1957) simplified by Ricker (1958) are shown in Fig. 5. The yield per recruit increases with increase in fishing mortality rate to a certain level in all the M/K ratios and then it tends to decline in higher F. The fishing

Discussion

There has been a gradual increase in the total catch since 1950s (Prabhu, 1954) owing to the change in the mode of operation and probably due to the use of prawn peelings as bait

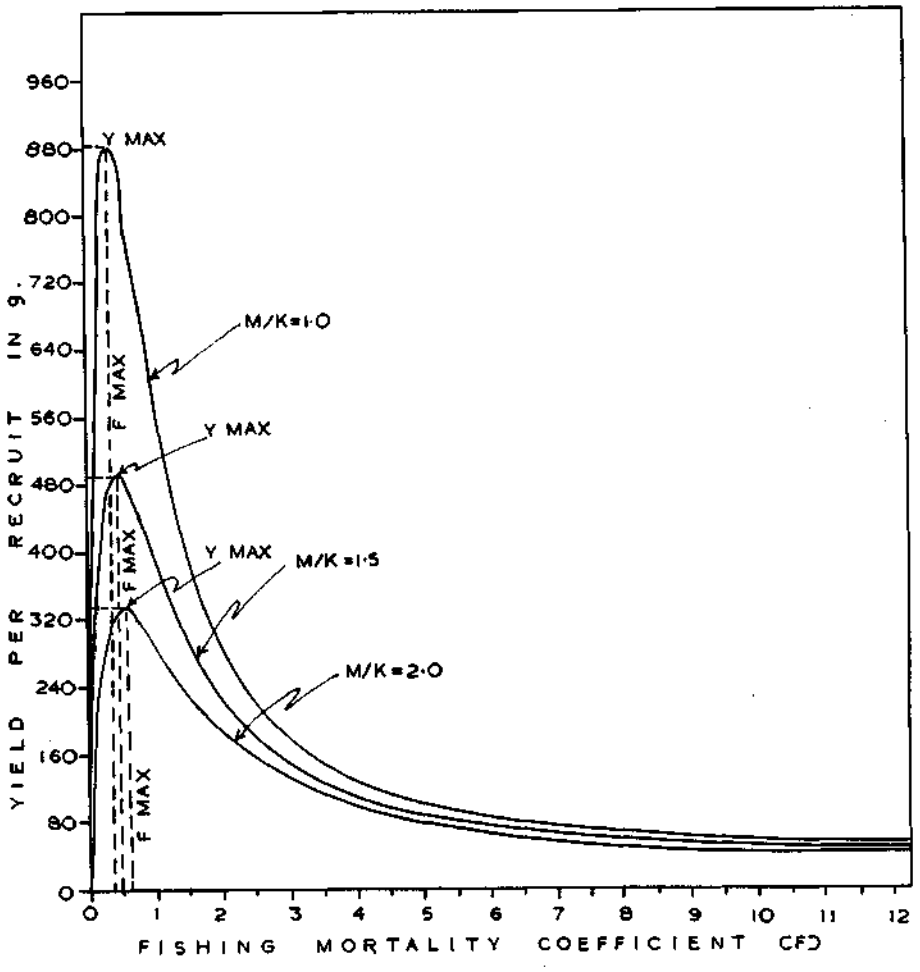

Fig. 5. Yield per recruitment in g of *Lethrinus nebulosus* at different fishing mortality coefficients (F), keeping the age at first capture for 3 different M/K ratios with their respective Y_{max} and F_{max}.

mortality rate which can produce the highest yield (Y_{max}) in each M/K ratio is called as the F_{max}. The F_{max} tends to increase with the increase in M/K ratio whereas the Y_{max} declines with the increase in M/K ratio. Considering the prevailing M/K ratio 1.53, the F_{max} which can produce an Y_{max} of 497.0 g is 0.445 whereas the prevailing average F is 8.59 during 1983-85 indicating higher rate of exploitation. The other two M/K ratios 1.0 and 2.0 are also indicating similar situation (Fig. 5).

in the traps (Lal Mohan, 1985). The change in the succession of species and quantum of landing is attributed not only to the introduction of prawn peelings as bait, but also due to the shifting of fishing area from near shore waters to the nearby island areas. Though there was an increase in the abundance of different species, *L. nebulosus* continued to remain as the dominant species. However, there was a gradual decline in the percentage composition of this species since 1950s.

The studies on the mortality rates, exploitation rate and yield per recruitment reveal that *L. nebulosus* is exposed to higher fishing intensity by perch traps as the prevailing fishing mortality rates are higher in all the 3 years than the F_{max} which can produce the highest yield. Kasim *et al.* (1989) have also reported that this species is being exposed to higher fishing pressure by almost all the gears operated off Tuticorin and the intensity of exploitation is in the order of Podivalai (drift gill net with mesh size 50-70 mm), Olai valai (shore-seine), hooks and line, Paruvalai (drift gill net with mesh size 100-170 mm) and trawl net. The length frequency studies on this species landed by perch traps reveal that only juvenlies and pre-adults measuring 60 - 300 mm are being exploited by these traps and thus generating a high exploitation rate. The selective nature of this gear depends mainly on the oval shape of the entrance of the traps and the length of the entrance varies from 15 to 20 cm depending on the dimension of the traps. In general, considering all exploitation parameters, it appears that perch traps are not a favourable gear for proper exploitation of *L. nebulosus* unless suitable provisions are made in traps to exploit larger specimens also.

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EXPLOITATION OF PERCH FISHERY RESOURCE OFF TUTICORIN BY SMALL MECHANISED TRAWLERS WITH AN ACCOUNT ON THE BIOLOGY OF *SCOLOPSIS BIMACULATUS* RÜPPELL

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ABSTRACT

Annual average perch production was 2541.2 tonnes at the catch rate of 88.8 kg/unit by average effort of 28612 units of small mechanised trawlers measuring 14 m and below. Peak periods of perch fishery were during June-September and a minor peak during December-February. Inspite of the comparative decline in the catch rate of perch, there is a scope for further increase in perch production provided the effort is increased. The age and growth of *Scolopsis bimaculatus* is described by the von Bertalanffy growth equation *i.e.* $1_t = 322\ (1\text{-}e^{-1.4146\ (t+0.0018)})$. This species attains a size of 163.6, 243.9, 283.5 and 303.0 mm in 0.5, 1.0, 1.5 and 2.0 years. Length - weight relationship of this species is defined by the equation Log W = -5.6848 + 3.3699 Log L and the W_∞ is 584 g. The natural mortality coefficient (M) is estimated to be 2.2, the total mortality coefficient (Z) is 3.2 and the fishing mortality rate (F) is 1.0. Yield per recruit of this species indicates that for the prevailing M/K ratio 1.56 and age at first capture 0.4353 the F_{max} which can produce the Y_{max} of 52.3 g is 4.5 and suggests that the fishing effort may be increased further from the present level to enhance the yield of this species as in the case of *L. nebulosus* and *N. delagoae*. The fish is a carnivore feeding on fishes, amphipods, *Squilla* spp., brittle stars, prawns, cuttlefish, polychaetes and molluscs.

INTRODUCTION

Systematic and planned intensive surveys carried out in areas beyond the traditional coastal fishing grounds have indicated the existence of a few potential fishery resources. Among them perches and perch-like fishes have gained enviable importance in view of the dominant emergence of a few species specially belonging to the genera *Priacanthus, Psenes, Centrolophus*, etc. This has lead to an increase in perch production from 59215.6 t during 1982-85 (Kasim *et al.*, 1989) to 89,031.8 t during 1985-89. Perches are exploited by different types of gears operated by both mechansied and non-machanised crafts in which the mechanised commercial trawlers alone lands 42% of perch catch.

In view of the intensive and extensive exploitation by mechanised trawlers along both east and west coasts of India, it was felt essential to monitor the trawl net operations from selected centres along east and west coast by the Central Marine Fisheries Research Institute. Accordingly, observations of small mechanised trawlers below 14 m size was carried out at Tuticorin, an age old fishing port situated in the Gulf of Manner in southeast coast of India from 1985 onwards. Exploitation of perches off Tuticorin is presented here with a special account on the biology of *Scolopsis bimaculatus* since information on the biology of this species is very rare from Indian waters.

OBSERVATIONS

Data on the effort of mechanised trawler, qualitative and quantitative catch composition of different fishery resorces landed by trawlers, species composition of perches and length frequency of *Scolopsis bimaculatus* were collected by systematically observing the landing at Tuticorin Fishing Harbour once in a week. The data obtained on the sampling days were initially raised to the sampling days and then to the month by the respective raising factors.

FISHERY

Catch statistics : The strength of small mechanised trawlers continued to increase from 150 in 1984-85 to 210 in 1991-92. The catch statistics obtained during 1989-92 are presented in Table 1. The monthwise effort expended by small mechanised trawlers was observed to be uniformly good during 1989-90 and it moderately declined in general in subsequent two years as the total annual effort declined from 31,757 units in 1989-90 to 26,732 units in 1990-91 and it further declined moderately to 24,280 units in 1991-92. On the other hand the perch production increased from 1970.5 t in 1989-90 to 2889.0 t in 1990-91 and then it declined moderately to 2634.4 t in 1991-92. The decline in the annual perch production is not due to the decline in the

TABLE 1. *Estimated fishing effort, catch and CPUE of perches landed by trawl net at Tuticorin fishing harbour during 1989 - 1992*

Months	1989-90			1990-91			1991-92		
	E (Units)	C (t)	C/E (kg)	E (Units)	C (t)	C/E (kg)	E (Units)	C (t)	C/E (kg)
April	2262	95.5	42.2	858	48.6	56.6	1372	126.3	92.1
May	4165	157.7	37.9	2655	157.7	59.4	1822	179.2	98.4
June	3600	94.9	26.4	3515	291.8	83.0	2600	460.9	177.3
July	4347	285.4	65.7	3800	846.4	222.7	3367	541.8	160.9
August	3796	373.5	98.4	4306	641.4	148.9	3133	208.3	66.5
September	2470	239.5	96.9	3500	281.0	80.3	2714	260.2	95.9
October	1040	120.3	115.7	2641	134.8	51.0	2220	161.1	72.6
November	1536	64.7	42.1	-	-	-	-	-	-
December	1980	164.3	82.9	2200	166.6	75.7	2877	205.0	71.3
January	3017	101.6	33.7	1365	146.7	107.5	1595	158.1	99.1
February	2424	167.6	69.1	980	91.1	92.9	1700	189.8	111.6
March	1100	105.5	95.9	912	82.9	90.9	880	143.7	163.2
Total	3175 7	1970.5	62.1	26732	2889.0	108.1	24280	2634.4	108.5
Mean	2646	164.2	62.1	2228	240.8	108.1	2023	219.5	108.5

TABLE 2. *Estimated monthwise average catch, effort and CPUE of perches landed by trawl net at Tuticorin fishing harbour during 1989 - 1992*

Months	Effort (Units)	Perch catch (t)	CPUE (kg)	Other fishes (t)	Total catch (t)
April	1497	90.1	60.18	282.96	373.06
May	2887	164.9	57.12	509.19	674.09
June	3238	282.5	87.25	1305.90	1588.40
July	3838	557.8	145.34	1667.37	2225.17
August	3745	407.8	108.89	735.53	1143.33
September	2895	260.3	89.91	750.97	1011.27
October	1967	138.8	70.56	528.73	667.53
November	1536	64.7	42.12	339.64	404.34
December	2352	178.7	75.98	922.14	1100.84
January	1992	135.5	68.02	753.06	888.56
February	1701	149.5	87.89	537.39	686.89
March	964	110.6	114.73	378.56	489.16
Total	28612	2541.2	88.82	9485.01	12026.21
Mean	2384	211.8	88.84	790.42	1002.22

abundance of perch resource as the annual catch rate continued to increase from 62.1 kg/unit in 1989-90 to 108.1 kg/unit in 1990-91 and then to 108.5 kg/unit in 1991-92, but due to decline in the effort expended during 1991-92 (Table 1).

bimaculatus (15.37%), *Lutjanus* spp. (6.38%), *Diagramma* spp. (5.31%), *Epinephelus* spp. (4.94%), *L. miniatus* (3.19%), *Serranus* spp. (3.08%), *Siganus* spp. (1.43%) and *N. japonicus* (0.82%).

TABLE 3. *Estimated species catch (t) composition of perches landed by trawl net at Tuticorin fishing harbour during 1989 - 1992*

Year	*Lethrinus nebulosus*	*Lethrinus miniatus*	*Lutjanus* spp.	*Epinephelus* spp.	*Serranus* spp.	*Diagramma* spp.	*Siganus* spp.	*Scolopsis bimaculatus*	*Nemipterus delagoae*	*Nemipterus japonicus*	Total catch of perches
1989-90	668.4	107.1	118.6	108.0	41.1	117.7	38.8	256.9	513.9	-	1970.5
1990-91	923.6	79.5	160.6	93.0	64.4	103.2	49.3	456.4	959.1	-	2889.1
1991-92	818.4	52.7	198.7	169.5	125.2	176.7	19.4	438.8	573.6	61.5	2634.5
Total	2410.4	239.3	477.9	370.5	230.7	397.6	107.5	1152.1	2046.6	61.5	7494.1
Mean	803.5	79.8	159.3	123.5	76.9	132.5	35.8	384.03	682.2	61.5	2498.0
%	32.16	3.19	6.38	4.94	3.08	5.31	1.43	15.37	27.31	0.82	-

The monthwise average perch production, effort expenditure and catch rate are given along with other fish catch and total fish catch during 1989-92. On an average 12,026.21 t of fish were landed by 28,612 units of small mechanised trawlers in which the perch constituted 2541.2 t which were landed at the catch rate of 88.82 kg/unit. In all fish catch perch constituted on an average 21.1% during 1989-92. In a month, on an average 211.8 t of perches were landed by 2384 units of small mechanised trawlers at the catch rate of 88.84 kg/unit. Monthwise average perch production indicates that the landings varied from 64.7 t in November to 557.8 t in July. The average monthly catch rate increased from 60.18 kg/unit in April to 145.34 kg unit in July, then declined to 42.12 kg/unit in November and then increased to 114.73 kg/unit in March. Inspite of comparatively higher catch rate in March the catch was only 110.6 t due to poor effort input. In general a peak period of perch production is identified during summer *i.e.* June - September and a secondary peak in winter *i.e.* December - February (Table 2).

Species composition : Annual species composition of perches landed during 1989 - 92 is given in Table 3. A variety of species constituted the perch fishery. Among them the pigface bream *Lethrinus nebulosus* was the dominant species forming 32.11% followed by the threadfin-bream *Nemipterus delagoae* (27.31%), *Scoloposis*

In Addition to the two dominant species *L. nebulosus* and *N. delagoae* studied in detail, *Scolopsis bimuculatus* also constitutes a sizable portion of the perch landings and commands considerable commercial importance among perches. Hence, the age and growth, mortality rates, yield per recruit and stock assessment of this species has been studied and reported here under.

BIOLOGY OF *SCOLOPSIS BIMACULATUS*

Sex, maturity and food : A total of 113 specimens of *Scolopsis bimaculatus* in the size range of 106 - 262 mm in total length were collected from the trawl catches at Tuticorin Fishing Harbour and examined for sex, maturity food and feeding habits.

Out of the 113 specimens examined, 58.09% were females followed by indeterminates (33.)%) and males (9.0%). Fishes with maturity stages I -VI were recorded during the period of study. Ripe females (Stages IV - VI) occurred more during July - September.

Of the 113 stomachs examined, empty stomachs constituted 25.0%, stomachs with little food 35.22%, 1/4 full 18.20%, 3/4 full 10.22%, full 7.94% and 1/2 full 3.42%. A qualitative analysis of the stomach contents of *S. bimaculatus* revealed that fishes (small perches, red-bait

Dipterygonotus leucogrammicus, 49-72 mm), amphipods, *Squilla* spp., brittle stars (Amphiurid ophiuroid), small prawns (*Metapenaeus* spp.), cuttlefish (*Sepia* spp.), polychaetes and molluscs were found to be the food of this species. The volume of the stomach contents varied from 0.05 ml to 6.25 ml.

Age and growth : Length frequency data of *S. bimaculatus* collected from the trawl net landings at Tuticorin indicate the presence of multimodes in each month showing the recruitment of different broods into the fishery. The progression of these modes in subsequent months due to growth of the broods were traced (Fig. 1) by plotting these modes against the respective month in the form of a scatter diagram as per Pauly (1980). These growth curves were transformed into a tabular form and the average size attained by this species in subsequent months was obtained as per George and Banerji (1968). These average sizes were plotted on an arithmatic graph and an empirical growth curve was fitted through these plots (Fig. 2). A new set of average sizes were obtained from this empirical growth curve and used for the estimation of the growth parameters for this species to define the age and growth of this species. Accordingly the asymptotic growth *i.e.* L_∞ of this species is estimated to be 322 mm, growth constant K is 1.4146 year and the age at 0 length t_0 is - 0.0018 year as per Begenal (1955) method. The growth of this species may be defined as per von Bertalanffy growth equation as shown below.

$$l_t = 322\ (1\text{-}e^{-1.4146\ (t\ +\ 0.0018)})$$

The data used for the estimation of above said growth factors and the estimated age and growth of this species are given in Table 4. This species is estimated to grow to a size of 163.6, 243.9, 283.5 and 303.0 mm at the end of 0.5, 1.0, 1.5 and 2.0 years respectively.

Length - weight relationship : Total length in mm and wet weight in g of 113 specimens of both the sexes of this species were examined to study the langth-weight relationship of this species. The length-weight relationship of this species may be described by the following formula.

Log W = -5.6848 + 3.3699 log L (r = 0.9340).

Based on this equation the asymptotic weight *i. e.* W_∞ of this species is estimated to be 584 g.

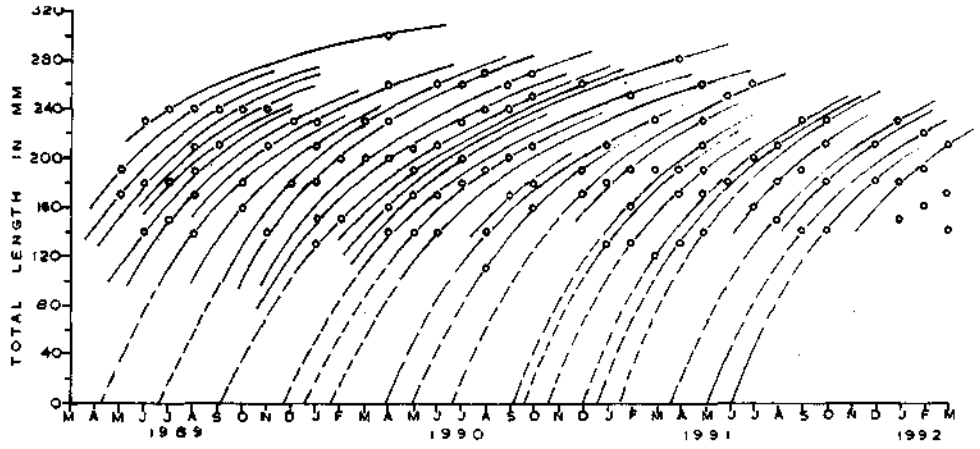

Fig. 1. Modal progression of *S. bimaculatuas* in subsequent month obtained from length frequency data collected from trawl landings at Tuticorin during 1989-'92.

Size and age at first capture : The size at first capture (l_c) of this species during 1989 - 92 has been estimated from the length frequency to be 143.0 mm, 152.6 mm and 15.0 mm respectively in 1989-90, 1990-91 and 1991-92 with an average l_c of 148.5 mm as per the catch curve method of Pauly (1984). Corresponding average age at first capture (t_c) is 0.4353 yr.

Average size : The average size ($\bar{l}$) obtained from the length frequency above the size at first capture are 200.2, 205.9 and 199.8 mm in 1989 - 90, 1990 - 91 and 1991 - 92 respectively.

Size and age at recruitment : The smallest size which suffered mortality by the trawlnet is 110 mm which is taken as the size at recruitment (l_r) into the fishery and the corresponding age at recruitment (t_r) is 0.2937 yr.

TABLE 4. *Average size obtained from the empirical growth curve shown in Fig. 2 used for the estimation of growth parameters and the estimated size at ages based on the growth parameters as per von Bertalanffy growth equation*

Age in months	Average size (mm)	Estimated size (mm)
1	45.0	36.5
2	80.0	68.3
3	109.0	96.5
4	131.0	121.5
5	150.0	143.8
6	166.0	163.6
7	182.0	181.2
8	197.0	196.9
9	210.0	210.8
10	222.0	223.2
11	233.0	234.1
12	242.0	243.9
13	251.0	252.6
14	259.0	260.3
15	266.0	267.2
16	273.0	273.3
17	278.5	278.7
18	284.0	283.5
19	289.0	287.8
20	293.5	291.6
21	297.5	295.0
22	301.0	298.0
23	-	300.6
24	-	303.0
25	-	305.1
26	-	307.0
27	-	308.7

Mortality rates : The natural mortality coefficient (M) is estimated to be 2.2 as per Sekharan (1974) method. The total mortality coefficient (Z) is estimated to be 3.01, 3.08 and 3.47 in 1989-90, 1990-91 and 1991-92 respectively as per Beverton and Holt (1956) method. The fishing mortality coefficient (F) is derived from the relation F = Z - M and the estimates are 0.81, 0.88 and 1.27 during these 3 years respectively. The average total and fishing mortality rates are 3.2 and 1.0 respectively.

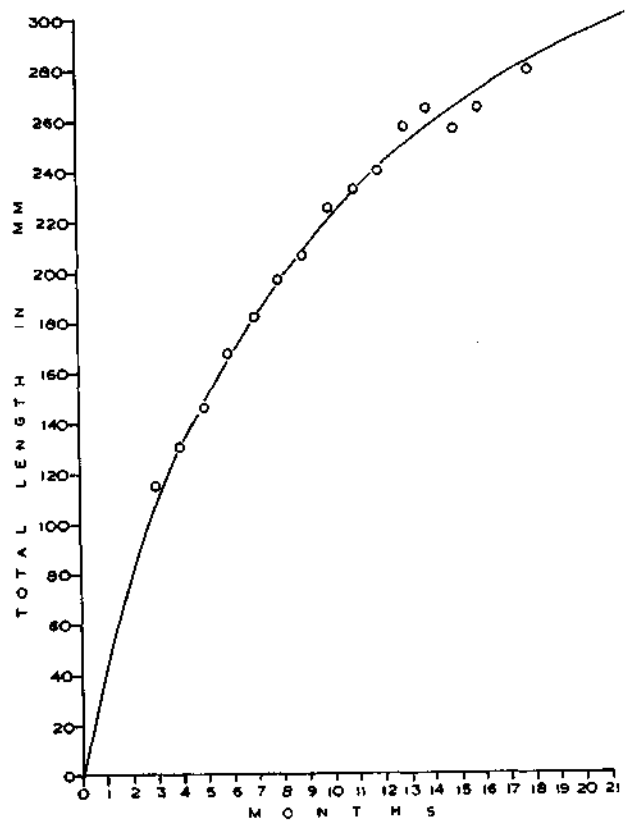

Fig. 2. Empirical growth curve of *S. bimaculatus* estimated from the modal progression analysis as shown in Fig. 1.

Exploitation rate : The exploitation rate (U) is estimated from the relation $K = F/Z (1 - e^{-Z})$ and the estimates are 0.26, 0.27, and 0.36 in 1989 - 90, 1990 - 91 and 1991 - 92 respectively. The average exploitation rate is 0.30.

Yield per recruit : Keeping the age at first capture (t_c) as constant at the prevailing level of 0.4353, the yield per recruit of *S. bimaculatus* has been estimated at different varying fishing mortality rates for 3 M/K ratios and the yield per recruit curves are given in Fig. 3. As seen from these curves the yield increases with an increase in F to attain a maximum and then tends to decline at higher F. The fishing mortality rate which produces the highest yield is known as the F_{max} corresponding yield as Y_{max}. The F_{max} and Y_{max} are 2.5 and 75 g at M/K ratio 1.0, at M/K ratio 1.56 they are 4.5 and 52.3 g

and at M/K ratio 2.0 they are 10.5 and 46.8 g. For the prevailing M/K ratio, present F expended by the trawl net units at Tuticorin is lower by 1.5 than the F_{max} suggesting a scope for further increase in the trawlnet effort input.

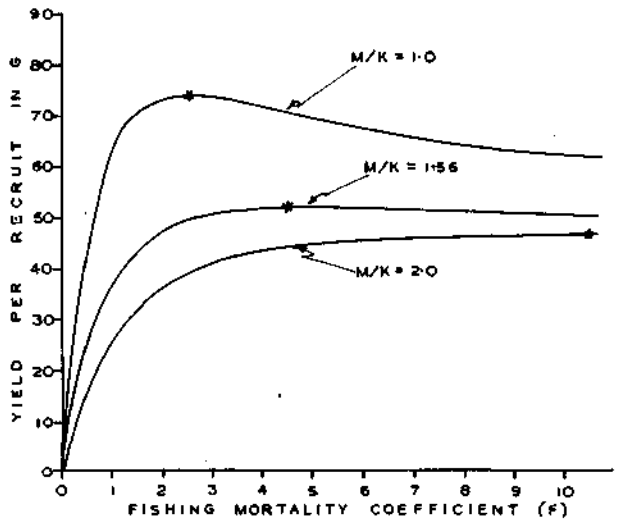

Fig. 3. Yield per recruit in g of *S. bimaculatus* at prevailing age at first capture, three different M/K ratios and at different fishing mortality rates. The asterisk indicates the F_{max} and Y_{max} for the respective M/K ratios.

Stock assessment : The annual standing stock of *S. bimaculatus* is estimated to be 316.7, 518.6 and 345.5 t in 1989 - 90, 1990 - 91 and 1991 - 92 respectively. The annual total stock is estimated to be 988.1, 1690.4 and 1218.9 t during the above said three years respectively. The annual average standing stock of this species off Tuticorin is 393.6 t and the annual average total stock is 1299.1 t.

DISCUSSION

Three fold increase in all India perch production from 1969 to 1982 - 85 has been adequately explained by Kasim *et al.* (1989) and they have suggested a further increase in perch landings which has come true that in subsequent years ending 1986 - 90 all India perch production has increased from 59,215.6 t to 89031.8 t. This has been possible due to continued mechanisation, introduction of efficient gears and modernization of fishing fleet through various development programmes such as Bay of Bengal programme funded by Sweedish International Development Authority and other FAO sponsored programmes for developing countries.

Kasim *et al.* (1989) have reported an increase in annual perch production in Tuticorin from 1369.1 t in 1984-85 to 5588.4 t in 1986-87. However, during 1989-92 the perch landing in Tuticorin is estimated to be on an average 2541.2 t which is less than half of the perch production reported during 1986-87. The decline in the landing is not only due to poor abundance of perch as the annual average catch rate during 1989-92 was lower (88.8 kg/unit) than the catch rate reported in1986-87 (114.9 kg/unit), but also due to apparent reduction in the effort expenditure also as the effort in 1986-87 was nearly 100% higher (48,631 units). Further, the effort obtained in 1986-87 include the effort of pair trawlers also, whereas the present effort reported for the period 1989-92 does not include the pair trawlers effort as the aim of the project was to monitor the commercial small mechanised trawlers measuring 14 m in length and below. Therefore present study indicates that **there is scope for the increase in perch production provided the effort is increased further from present level inspite of the decline in the catch rate.**

The yield per recruit of *S. bimaculatus* also indicated that there is scope for further increase in the effort of trawlnet as the F_{max} which can generate the highest yield of 52.3 g for the prevailing age at first capture 0.4353 yr and M/K ratio 1.56 is 4.5 which is higher than the prevailing F (0.99). Similar observation has been made by Kasim *et al.* (1989) for *L. nebulosus* during 1985-86 as the F was 0.64 which was lower than the F_{max} 0.75 suggesting an increase in the effort of trawl net. Hamsa *et al.* (MS) have also reported a similar observation for the threadfin-bream *N. delagoae* which also suggest an increase in the trawlers effort. All these three studies on the three dominant species of perch resource indicate a further increase in perch production by increasing the effort of trawlnet from present level.

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The authors are immensely thankful to Dr. P. S. B. R. James, Director, C.M.F.R.I., Cochin for his constant interest and encouragement shown on this study.

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THE FISHERY, BIOLOGY AND STOCK ASSESSMENT OF *NEMIPTERUS DELAGOAE* SMITH OFF TUTICORIN, GULF OF MANNAR

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ABSTRACT

Nemipterus delagoae is the dominant threadfin-bream landed at Tuticorin. An estimated 158.15 t and 226.9 t were landed by trawl net at the catch rate of 6.31 and 10.13 kg/unit in 1987 and 1988 respectively constituting on an average 3.6% of the total catch by trawl net. The peak period of fishing season is during September - December. The estimated growth parameters from length frequency data are $L\infty$ = 362.0 mm, K = 1.0586 (annual) and t_0 = -0.0087 yr. The sexwise length-weight relationship did not exhibit any significant difference and hence a common length-weight relationship is proposed. Fishes (25.6%), prawns (21.9%), crabs (14.3%) formed the dominant food items of this species in addition to brittle-stars, cuttlefishes, gastropods, bivalves, *Squilla*, polychaetes, alphids, isopods and amphipods. The natural mortality coefficient (M) is 1.625 and the average annual total mortality coefficient (Z) is 3.29 by trawl net. The yield per recruit studies indicate that the prevailing F *i.e.* 1.665 by trawl net which is well below the F_{max} which can produce the highest yield (Y_{max}) for the prevailing age at first capture 0.4687 yr for the M/K ratio 1.535. This indicate that the fishery of *N. delagoae* is not exposed to higher fishing pressure and there is scope for further increase in the fishing effort of trawl net.

INTRODUCTION

Among perches, threadfin-bream is considered as a commercially very important resource as this constitutes more than 50% of the total perch landings in India (Kasim *et al.*, 1989). The fishery and biology of different species of threadfin-breams have been studied by Krishnamoorthi (1971, 1973, 1976), Murty (1982, 1983, 1984), Muthiah and Krishna Pillai (1979) and Vinci and Kesavan Nair (1974). However, the fishery, biology and stock assessment of *Nemipterus delagoae* Smith is being reported from Tuticorin, Gulf of Mannar for the first time in India. The fishery of threadfin-breams in Tuticorin is sustained by mostly *Nemipterus delagoae* and the occurrence of other species was very much limited. The predominant occurrence, commercial and economic importance of *N. delagoae* have prompted to initiate a detailed study on this species at Tuticorin and the present account deals with the fishery by trawl net, some aspects of biology such as the length - weight relationship, food and feeding, maturity, age and growth, mortality rates, yield per recruitment and stock assessment of *N. delagoae*.

OBSERVATIONS

Due to non-maintenance of fishing log by the fishing units, weekly obsevations were made and data on the gearwise catch, effort and length frequency of *N. delagoae* were collected by sampling at random a minimum of 10% of the fishing units on each observation day. The length-weight relationship was studied by simple regression and co-variance analysis (Snedecor, 1961). To estimate the growth parameters initially the length frequency data were processed as per integrated method (Pauly, 1980) as shown in Fig. 1. Then the average size attained by this species in subsequent month was obtained as per George and Banerji (1968) from this figure and these data were used to obtain the $L\infty$, K and t_0 by the method of Alagarja (1984). The natural mortality coefficient (M) was estimated from the life span (T_{max}) according to Sekharan (1974), the total mortality coefficient (Z) by Beverton and Holt (1956) method, the gear selection factor by the catch curve method (Pauly, 1984) and the yield per recruitment by the method of Beverton and Holt (1957) simplified by Ricker (1958). The optimum

age of exploitation and potential yield per recruit were estimated as per Krishnan Kutty and Qasim (1968).

to higher effort expended (Table 1). The effort expended being not commensurate with better abundance of this species in most of the months

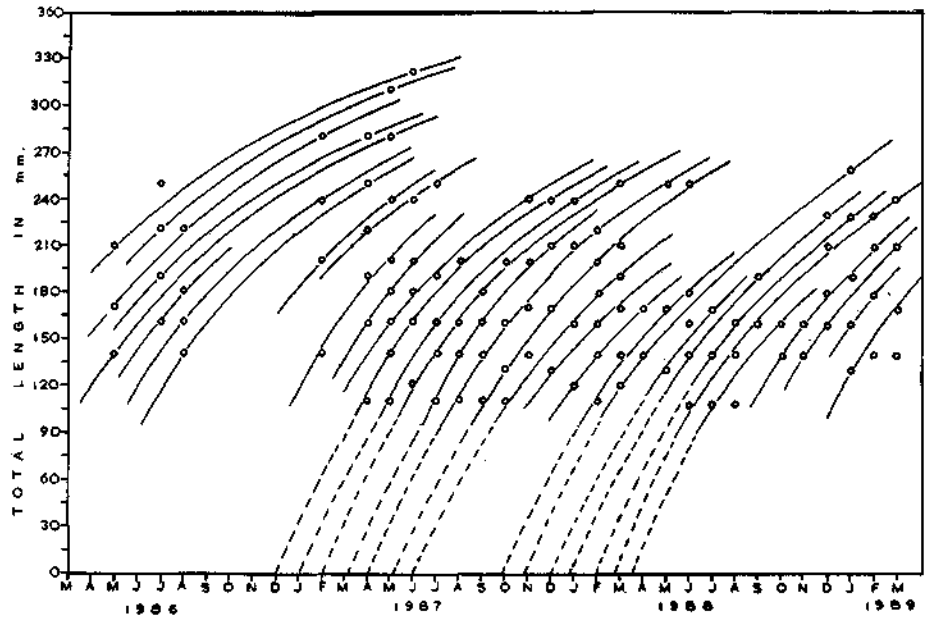

Fig. 1. Tracing the progression of different modes in relation to time and back tracing (broken lines) to find out the time of origin of different broods in *N. delagoae* as per the integrated method (Pauly, 1980).

FISHERY

Annual landing of threadfin-breams is estimated to be 158.15 t and 226.9 t in 1987 and 1988 by trawlers and the annual catch rate was 6.31 kg and 10.13 kg per unit respectively (Table 1). On an average the threadfin-breams constituted 3.6% of the total catch by trawl net in a year. As indicated by the monthly catch rate, the abundance of threadfin-bream was good during January - March and August - December in both the years. However, the effort input decreased while the abundance increased during January - March 1987 registering a decline in the catch whereas during August - December 1987 the effort input increased from 1250 units to 3250 units when the abundance was also good which resulted in better landings during September - December. Almost similar trend was observed in 1988 also with an exception that the effort input did not coincide with better abundance during November and December 1988 whereas the catch was good during these two months due to better abundance. Though the catch rate was low (3.88 Kg/unit) in June 1988, the landing was good due during 1987 - '88 was mainly due to the reason that the trawl fishery is not aimed at exploiting *Nemipterus* alone, but some other resources also. Hence the deviation from the usual expolitation strategy *i.e.* when the abundance is more, effort is also increased to realise more catches.

BIOLOGY

Age and Growth : A sample of 4087 specimens of *Nemipterus delagoae* were measured from both trawl net and hook and line landings for length frequency studies in which 2296 were studied from trawl net landings during 1986 - 1988 and 1791 specimens from hook and line during 1987 - '88. Combined length frequency data base was used for age and growth studies as this resource is being exploited from the same ground by these two gears. The average size attained by *Nemipterus delagoae* in subsequent months, derived from Fig. 1 were plotted against respective month on an arthmatic graph and a curve was fitted through the plots by free hand as shown in Fig. 2. This curve may be considered as an empirical growth curve of this species.

As per this growth curve, this species attains 87, 155, 205, 241, 268.5, 291 and 309 mm in 0.25, 0.5, 0.75, 1.0, 1.25, 1.5 and 1.75 years respectively. Based on this growth data the growth parameters have been estimated to be $L\infty$ = 362 mm, K = 1.0586 (annual) and t_0 = -0.0087 yr by Alagaraja (1984) method.

According to von Bertlanffy growth equation, $1_t = 362\ (1\text{-}e^{-1.0586\ (t\ +\ 0.0087)})$, this species is estimated to grow 237.6, 318.8 and 347.0 mm in 1st, 2nd and 3rd year. The life span (T_{max}) of this may be 2.83 years as per the relation T_{max} = 3/K (Pauly, 1980). The fishery of *Nemipterus delagoae* is sustained by mostly one year old

TABLE 1. *Estimated fishing effort (units), catch (kg) and Catch per effort (kg) of* Nemipterus delagoae *by trawl nets at Tuticorin Fishing Harbour during 1987 and 1988*

	1987			1988		
	E	C	C/E	E	C	C/E
January	1430	7757	5.42	2250	18800	8.36
February	828	5302	6.40	1540	13970	9.07
March	754	6049	8.02	1620	22275	13.75
April	1820	6240	3.42	1456	9750	6.69
May	1690	8540	5.05	2262	9672	4.27
June	2252	2300	1.02	2600	10088	3.88
July	2530	4007	1.58	1950	17592	9.02
August	1250	7205	5.62	1820	28470	15.64
September	2470	28340	11.47	2236	33690	15.06
October	2700	28850	10.68	2522	31161	12.35
November	3000	19688	6.56	1612	16367	10.15
December	3250	34060	10.48	1134	15120	13.33
Total	23974	158158	-	23002	226955	-
Mean	1998	13180	6.31	1917	18913	10.13

TABLE 2. *Monthly percentage frequency of the intensity of feeding of* N. delagoae *caught by trawl nets and hooks and lines during 1987 and 1988*

	Gorged	Full	3/4 Full	½ Full	¼ Full	Little	Empty
January	10.27	10.27	12.50	6.25	13.39	6.25	41.07
February	-	18.60	10.53	25.09	15.27	2.63	27.90
March	12.70	14.29	22.22	28.97	9.13	-	12.70
April	11.44	16.67	5.56	2.94	2.94	46.08	14.38
May	33.34	22.92	6.25	6.25	25.00	6.25	-
June	-	38.89	-	27.78	5.56	5.56	22.22
July	-	24.09	10.00	15.00	4.55	5.00	41.36
August	19.30	29.89	2.18	6.52	10.87	-	31.25
September	31.25	39.59	8.34	8.34	12.50	-	-
October	10.53	42.11	10.53	26.32	10.53	-	-
November	6.25	6.25	18.75	25.00	12.50	18.75	12.50
December	-	6.25	-	12.50	12.50	12.50	56.25
Mean	11.26	22.49	8.91	15.91	11.23	8.59	21.64

individuals and to a limited extent by two year old individuals in trawl net and hooks and line.

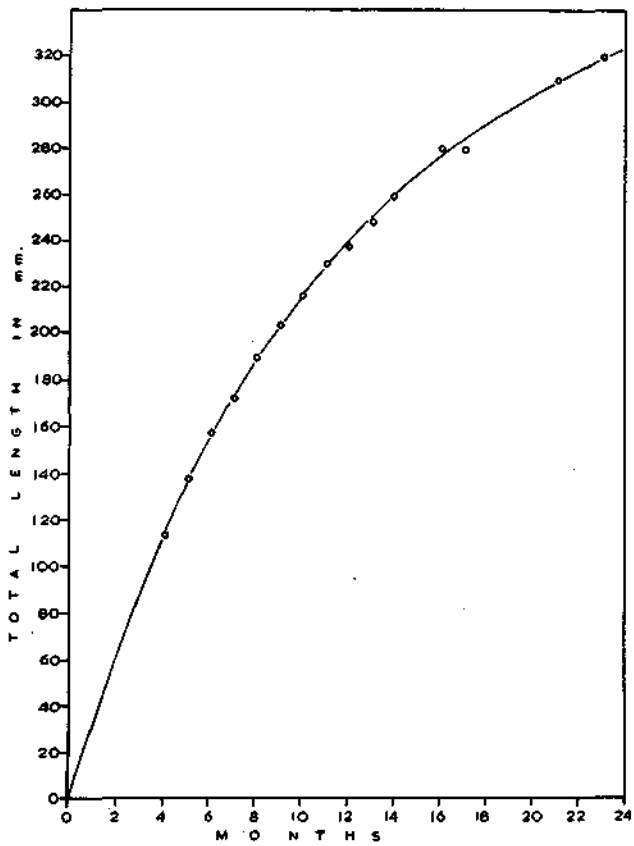

Fig. 2. Empirical growth curve of *N. delagoae* obtained by plotting the average size attained by this species against respective months.

Length - weight relationship : The sexwise length-weight relationship may be described by the equations :

Male : log W = -5.6909 + 3.3249 Log L (r = 9327) and

Female : Log W = -4.9269 + 2.9962 Log L (r = 0.9569)

However, the analysis of covariance carried out to test the difference in significance between the values of regression coefficient (b) for male and female has yielded an F ratio 2.54, f = 1.255 indicating that there is no significant difference in the length weight relationship between male and female. Therefore, a combined equation Log w = -5.0547 + 3.0508 Log L (r = 0.9088) is proposed to describe the length-weight relationship of *N. delagoae*. Muthiah and Krishna Pillai (1979) have also suggested a single equation to describe the length-weight relationship of this species from Bombay waters on the west coast as there was no significance in the length-weight relationship of male and female.

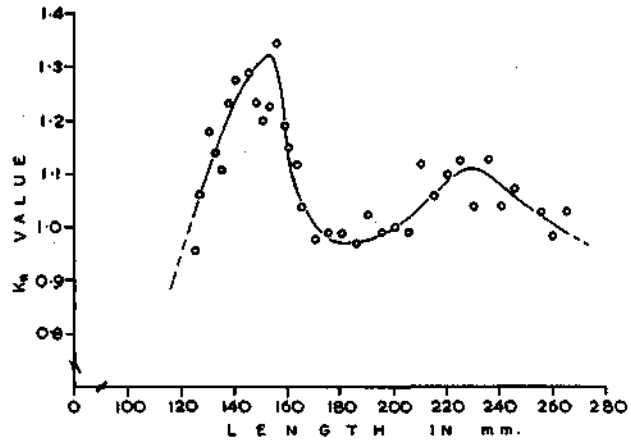

Fig. 3. Variation in the relative condition factor (K_n) in relation to different size ranges in *N. delagoae* in Tuticorin waters.

Feeding intensity : In all 273 stomachs of *N. delagoae* have been examined to study the food and feeding of this species. The intensity of feeding was determined for each fish based on the distension of its stomach and the amount of food contained in the stomach was classified by eye estimation as gorged, full, 3/4 full, 1/2 full, 1/4 full, little and empty (Pillay, 1952). The total and individual volume of different food and their number of occurrence were recorded qualitatively. The monthwise percentage frequency of the intensity of feeding (Table 2) indicates that this species appears to be an active feeder as the gorged, full and 3/4 full individuals constituted 11.26%, 22.49% and 8.91% respectively and fishes with empty stomach were only 21.64%. Further, it is observed that this species exhibits active feeding particularly during March - May and August - October (Table 2). There appears to be no relation between the intensity of feeding and size of the fish except that fishes with empty stomach were available in all sizes except in 250 - 269 mm, the gorged and full stomach fishes were observed from 140 - 249 mm and the gorged stomach in 260 - 269 mm also. In general the feeding intensity was observed to be better to some extent in higher size ranges. The average volume of stomach in various degrees of fullness varied between 4.11 ml in gorged, 1.52 ml in full, 1.06 ml in 3/4 full, 0.91 ml in 1/2 full, 0.55 ml in 1/4 full and 0.2 ml in little (Table 3).

Food composition : The qualitative analysis of food reveals that the diet of *N. delagoae* is constituted by prawns, crabs, fish, brittle stars, cuttlefish, bivalves, gastropods, *Squilla* spp., polychaetes, alphids, isopods and amphipods in which the first three items have been recorded to be the most dominant items constituting on an average 21.9%, 14.3% and 25.6% respectively and these 3 items occurred in all the months in the diet of this species (Table 4). The occurrence of brittle star was observed in all the months except in January, July, August and December and of cuttlefish also in all the months except in January, May and October - December. The rest of the items have occurred higly irregular manner (Table 4). The percentage occurrence of different food items in the stomachs of different size ranges of *N. delagoae* indicates that the bivalves, gastropods, *Squilla* spp., polychaetes, alphids, isopods and amphipods occurred mostly in lower size ranges from 130 - 199 mm whereas the other items occurred in almost all the size ranges and perhaps more in the higher size ranges.

Index of preponderance : The degree of preference of different food items by *N. delagoae* has been studied by estimating the 'index of preponderance' as per the method of Natarajan and Jhingran (1961). It is clearly discernible from the index of preponderance that the order of preference of different food items by *N. delagoae* is fishes such as *Stolephorus* spp., *Leiognathus* spp., young ones of different perches and clupeids (37.02), prawns constituted by *Metapenaeus* spp., *Penaeus indicus*, etc. (30.8), juvenile crabs of *Charybdis, Portunus pelagicus* and spider crab (15.4), brittle star mostly Amphiurids (10.4), cuttlefish *i.e. Sepia* spp. (1.03), followed by *Squilla* spp. (0.5), gastropods and bivalves (0.3), amphipods (0.03), isopods (0.02), alphids (0.02) and polychaetes (0.01). Animal flesh (2.9) and partially or fully digested matter (1.7) which could not be related to any of the above said food items were also present.

Stages of maturity : Immature specimens belonging stage I occurred throughout the year

TABLE 3. *Percentage frequency occurrence of stomachs in various degrees of fullness and the average volume of food per fish of different size ranges in* N. delagoae *caught by trawl nets and hooks and lines during 1987 and 1988*

Size group (TL/mm)	Number of stomachs observed in degrees of fullness						
	Gorged	Full	3/4 Full	½ Full	¼ Full	Little	Empty
120 - 129	-	-	-	-	-	50.00	50.00
130 -	-	-	18.18	27.27	9.10	18.18	27.27
140 -	5.88	23.53	11.76	23.53	5.88	11.76	17.65
150 -	10.71	25.00	10.71	28.57	10.71	7.14	7.14
160 -	5.56	30.56	8.33	11.11	11.11	16.67	16.67
170 -	5.88	20.59	11.76	17.56	11.76	8.82	23.53
180 -	4.76	38.10	11.90	14.29	14.29	-	16.67
190 -	18.42	15.79	7.89	10.53	10.53	15.79	21.05
200 -	13.33	13.33	20.00	20.00	13.33	-	20.00
210 -	8.33	33.33	-	8.33	8.33	-	41.67
220 -	33.33	13.33	-	20.00	6.67	-	26.67
230 -	12.50	37.50	12.50	-	25.00	-	12.50
240 -	36.36	27.27	-	-	-	18.18	18.18
250 -	-	-	-	100.00	-	-	-
260 - 269	50.00	-	-	-	50.00	-	-
Mean	13.67	18.56	7.54	18.75	11.78	9.77	19.93
Average volume of food per fish in ml	4.11	1.52	1.06	0.91	0.55	0.20	0.00

in highest percentage followed by stage II specimens in almost all the months except in January. Females with developing ovaries (stage III) occurred during January - April and July-October and females with developed ovaries (stage IV) were observed in March - April and also during July - August. Specimens with ripening ovaries (stage V) occurred in February, March and July and females with fully ripened ovaries (stage VI) were observed in February, August, October and December. There appears to be two spawning seasons in a year - the first one in July and August and the second one, may be a prolonged one from October to February (Table 5). This is being supported by the occurrence of young ones in the trawl net catches (Fig. 1).

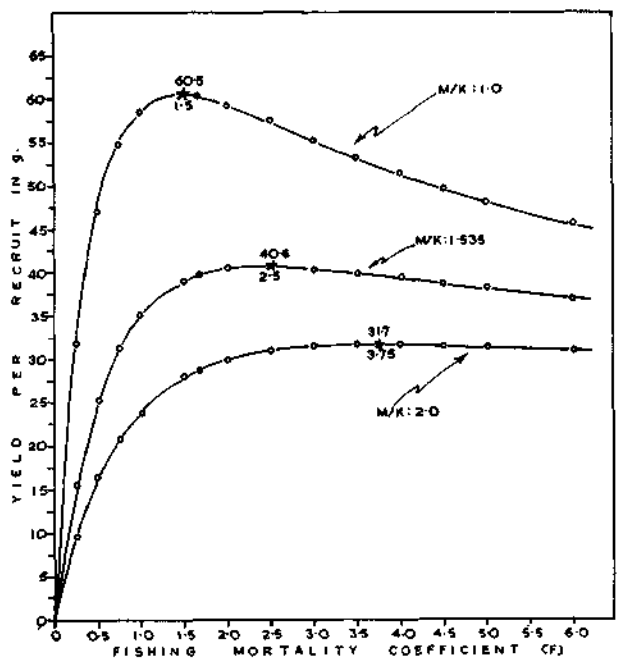

Fig. 4. Yield per recruitment (Y=W/R) in g of *N. delagoae* at different fishing mortality coefficients (F) for the prevailing age at first capture and for 3 different M/K ratios with their respective Y_{max} and F_{max}. The prevailing F is indicated by closed circles.

Size at first maturity : The occurrence of different stages of maturity in different size ranges (Table 6) reveals that the specimens measuring upto 140 mm were all immature and mature specimens were observed in size ranges above 150 mm suggesting that size at first maturity may be above this size. The relative condition factor (K_n) estimated from the relation

TABLE 4. *Monthly percentage occurrence of food components in* N. delagoae *caught by trawl nets, and hooks and lines during 1987 and 1988*

	Size Group (TL/mm)	No of fishes	Prawn and prawn append-ages	Crab and crab append-ages	Fish and fish remains	Brittle-star	Cuttle-fish	Molluscs (with shellbits)	*Squilla* spp.	Poly-chaete	Alphid	Isopod	Amphi-pod	Animal flesh	Partly/ fully digested matter
January	134 - 245	23	21.67	26.05	28.56	-	-	4.41	-	-	0.44	0.88	-	0.88	17.11
February	140 - 240	34	40.53	18.80	12.67	0.79	8.06	4.07	3.23	-	-	0.33	-	8.26	3.10
March	150 - 256	23	28.03	34.40	5.39	4.17	7.92	6.03	-	-	-	-	-	10.53	3.54
April	140 - 228	26	20.31	6.79	38.00	3.66	3.57	-	-	-	-	-	-	3.57	24.11
May	153 - 265	14	58.33	9.81	15.49	1.77	-	0.59	10.33	0.30	-	-	-	3.39	-
June	129 - 210	18	33.64	10.71	34.14	13.93	0.71	-	-	-	-	0.43	-	-	6.43
July	135 - 217	21	4.17	5.00	41.67	-	32.50	-	-	-	-	-	-	16.67	-
August	142 - 232	31	25.55	37.43	23.95	-	8.92	-	-	-	-	-	-	-	4.17
September	135 - 265	32	2.86	5.00	39.79	22.40	1.88	5.84	0.21	1.67	-	-	-	10.17	10.21
October	155 - 199	19	16.05	13.84	22.11	4.74	-	5.63	4.21	1.32	0.53	0.26	-	18.68	12.63
November	138 - 204	16	2.14	20.93	17.14	8.57	-	2.86	2.50	-	4.28	-	4.21	7.86	29.50
December	128 - 216	16	20.41	8.16	35.71	-	-	-	-	-	-	-	-	23.47	12.24

$K_n = w/\hat{w}$ where W is the observed weight and $\hat{W}$ is the calculated weight of a specimen

a highly pronounced first one around 150 mm and another near 230 mm. The initial peak may

TABLE 5. *Percentage frequency distribution of maturity stages in* N. delagoae *landed at Tuticorin by trawl nets, and hooks and lines during 1987 and 1988*

	No. of fishes examined	Maturity Stages (Females)					
		I	II	III	IV	V	VI
January	21	52.4	-	47.6	-	-	-
February	34	41.2	23.5	23.5	-	5.9	5.9
March	22	36.4	31.8	13.6	9.1	9.1	-
April	23	65.2	17.4	13.0	4.4	-	-
May	9	77.8	22.2	-	-	-	-
June	17	47.1	52.9	-	-	-	-
July	13	46.2	30.8	7.7	7.7	7.7	-
August	28	42.9	28.6	17.9	3.6	-	7.1
September	28	50.0	42.9	7.1	-	-	-
October	17	52.9	35.3	5.9	-	-	11.8
November	4	50.0	50.0	-	-	-	-
December	11	18.2	63.6	-	-	-	18.2

TABLE 6. *Percentage frequency distribution of maturity stages in different size groups in* N. delagoae *landed at Tuticorin by trawl nets, and hooks and lines during 1987 and 1988*

Size range (TL/mm)	No. of fish examined	Maturity Stages (Females)					
		I	II	III	IV	V	VI
120 - 129	2	50.0	50.0	-	-	-	-
130 -	9	55.6	11.1	33.3	-	-	-
140 -	12	66.7	16.7	16.7	-	-	-
150 -	25	44.0	44.0	8.0	4.0	-	-
160 -	33	42.4	48.5	6.1	-	-	3.0
170 -	34	38.2	32.4	17.7	2.9	-	8.8
180 -	34	35.3	26.5	17.7	5.9	5.9	8.8
190 -	25	56.0	16.0	16.0	4.0	4.0	4.0
200 -	11	72.7	-	18.2	-	9.1	-
210 -	8	87.5	12.5	-	-	-	-
220 -	11	54.6	18.2	18.2	-	9.0	-
230 -	8	62.5	25.0	12.5	-	-	-
240 -	11	27.2	54.6	18.2	-	-	-
250 -	2	-	100.0	-	-	-	-
260 - 269	2	50.0	-	50.0	-	-	-
Total	227	108	68	33	5	5	8
%	-	47.6	30.0	14.5	2.2	2.2	3.5

measuring particular size, were plotted against respective sizes (Fig. 3) exhibits two peaks *i.e.* be taken as to reflect the attaining of maturity by this species for the first time. Further,

running specimens were observed to occur in the size range 160 - 169 mm onwards. Therefore the minimum size at first maturity may be around

F_{max} which can produce the highest yield (Y_{max}) are 1.5, 2.5 and 3.75 for M/K ratios 1.0, 1.535 and 2.0 respectively in which the F_{max} of the

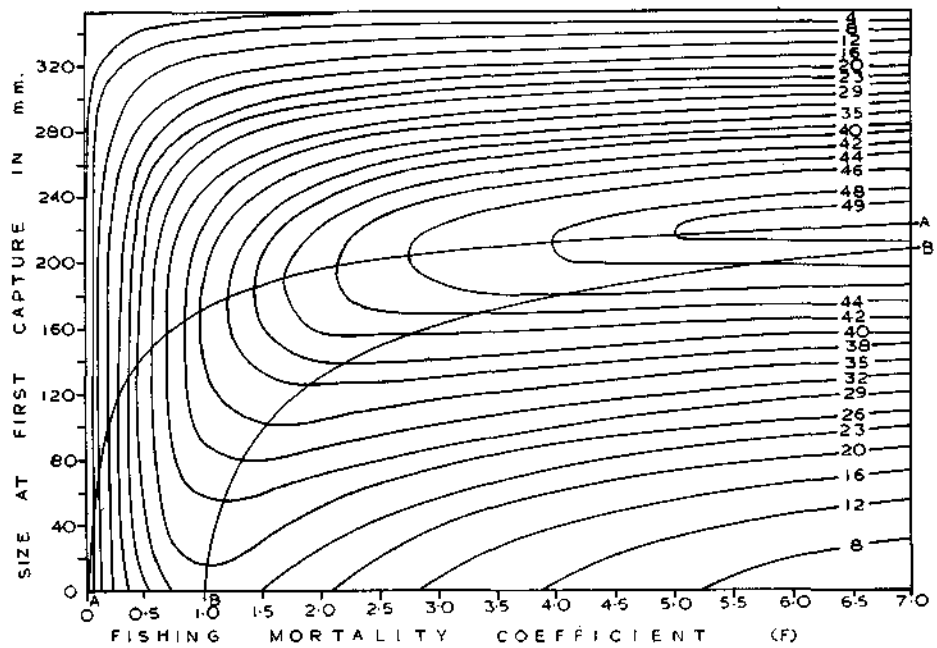

Fig. 5. Isopleth diagram of yield per recruit in g of *N. delagoae* population in Tuticorin waters. The eumetric fishing curve (line A - A), maximum sustainable yield curve (line B - B) and potential yield per recruit are indicated.

160 - 169 mm. Occurrence of two peaks at 150 mm and 230 mm in the K_n value indicates that this species may spawn twice in its life span.

Population Dynamics

Mortality rates : The natural mortality coefficient (M) is estimated to be 1.625 and the annual total mortality coefficient (Z) is 3.11 and 3.49 by trawl net in 1987 and 1988 respectively. The fishing mortality coefficient (F) is estimated to be 1.48 and 1.87 in 1987 and 1988 by trawl net. The annual average Z and F by trawl net is 3.29 and 1.665 respectively.

Exploitation rate : The exploitation rate (U) estimated from the relation $U=F/Z\ (1-e^{-z})$ is 0.46 and 0.52 in 1987 and 1988 by trawl net. The annual average exploitation rate by trawl net is 0.49.

Yield per recruitment : The yield per recruitment estimated for the prevailing average age at first capture (0.4687 yr) and M/K ratio 1.0, 1.535 and 2.0 (Fig. 4) indicate that the latter two M/K ratios are higher than the prevailing F by trawl net 1.665. This indicates a scope for further increase in the fishing effort by trawl net.

The yield isopleth drawn from the estimates of yield per recruitment by varying the age at first capture and fishing mortality coefficient for the prevailing M/K ratio 1.535 is given in Fig. 5 wherein the line A - A indicates the eumetric fishing curve and line B - B the maximum sustainable yield curve. The optimum age of exploitation is estimated to be 1.0251 yr and the potential yield per recruit 49.8 g which is indicated in the yield isopleth diagram where both the eumetric fishing curve and MSY curve tend to meet.

Stock Assessment : The annual standing stock is estimated to be 343.9 and 436.5 t in 1987 and 1988 in the trawling grounds off Tuticorin and the average is 390.2 t. The average standing stock is estimated to be 106.9 and 121.4 t in 1987 and 1988 and the average is 114.2 t.

Maximum sustainable yield (MSY) : This can be estimated from the relation MSY = M x 0.5 x B, where M is the natural mortality coefficient and B is the annual standing stock. The average MSY is estimated to be 317.0 t.

DISCUSSION

Among threadfin-breams, the growth of *N. delagoae* is estimated to be faster than the growth of *N. japonicus* (Krishnamoorthi, 1971; Murty, 1984; Kasim *et al.*, 1989). The K value obtained for *N. delagoae* is 1.0586 whereas Krishnamoorthi (1971) has reported a K value of 0.2941 to 0.648 for *N. japonicus* from Andhra Coast, Murty's (1984) estimate was 0.75142 from Kakinada waters and Kasim *et al.* (1989) have estimated the K to be 0.8606 for *N. japonicus*. Owing to its ability to grow faster than *N. japonicus*, this species attains 237.6, 318.8 and 347.0 mm in 1st, 2nd and 3rd year respectively. The food and feeding studies reveal that this species is a voracious carnivore and it actively feeds on fishes, crustaceans, molluscs and echinoderms unlike *N. japonicus* which feeds mainly on crustaceans, molluscs, annelids and echinoderms (Krishnamoorthi, 1971). There appears to be similarity in maturity and spawning of this species and *N. japonicus* as the minimum size at maturity is around 160 - 169 mm for both species and this species also spawns for the second time when it attains 230 mm as in the case of *N. japonicus* (Krishnamoorthi, 1971). However, there appears to be two spawning seasons, the first one in July and August and the second, a prolonged one from October to February.

The exploitation rates generated by trawl net are lower than the optimum exploitation rate and it roughly indicates that *N. delagoae* is under exploited. The yield per recruitment in weight also shows that the F_{max} which can generate the highest yield (Y_{max}) is higher than the present F for the prevailing M/K ratio 1.535 and above, indicating that there is scope for further increase in the effort of trawl net which can enhance the production of *N. delagoae*. The age at first capture by trawl net is 0.4687 per year which is lower than the optimum age of exploitation *i.e.* 1.0251 yr and even at this prevailing low age at first capture *N. delagoae* is exposed to low fishing pressure. Similar state of under exploitation has been reported for *N. japonicus* by Krishnamoorthi, (1976), Murty (1983) and Kasim *et al.* (1989) suggesting that, in general, there is scope for increasing the production of threadfin-breams by increased effort input.

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FISHERY, AGE, GROWTH, MORTALITY AND STOCK ASSESSMENT OF *PRIACANTHUS HAMRUR* FORSKÅL FROM BOMBAY WATERS

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ABSTRACT

Perches form an important marine fisheries resources from the coast of India. During 1969 - 81 period the average catch of perch was 27,184 tonnes. The annual average catch of perch during 1983 - 85 period in Maharashtra was 6508 t contributing 11% of the all India perch catch. The annual average catch of this resource at New Ferry Wharf and Sassoon Dock landing centres of Greater Bombay during 1980 - 88 period was 1791.6 t with New Ferry Wharf contributing 83.87% and Sassoon Dock 16.13%. Fitting of quadratic equation to the catch at both the landing centres indicated increasing trend.

Age and growth study on *Priacanthus hamrur* Forskål shows that this species grows to 193, 283 and 323 mm at the end of I, II and III years of its life. The von Bertalanffy's growth parameters in length were estimated as follows : L_∞ = 360 mm, K = 0.736 (annual) and t_0 = -0.009116 years. The total, natural and fishing mortality for 1989 - 90 period were calculated as : Z = 3.08, M = 1.52 and F = 1.56. The exploitation ratio (E) and exploitation rate (U) were calculated as 0.506 and 0.482 respectively. The standing stock (Y/F) and total stock (Y/U) were estimated as 331.92 t and 1074.28 t respectively as compared to the present combined yield of 517.81 t from New Ferry Wharf and Sassoon Docks. The MSY was estimated as 201.8 t.

INTRODUCTION

The perches form an important fishery, but the exploitation of this resource is limited to the narrow belt of the continental shelf of about 50 m depth covering an area of 1,80,539 km. Annually on an average 59,215 t of perches are landed by different types of gears, both by mechanised and non-mechanised vessels along the east and west coasts of India (Jones and Banerjee, 1973; Anon., 1981, 1983, 1986). During 1969-81 period an average of 27,184 t to of perches were landed in India with fluctuations from 12,865 t in 1969 to 49,312 t in 1978 (Kasim *et al.*, 1989). During 1982-85 period the total catch of perches in Maharashtra was 6508 t contributing 11% of the all India catch of perches.

Perches are landed as by-catch of shrimp trawl and the area of operation, types of boats, etc. have been discussed by Chakraborty *et al.* (1983).

The total catch of New Ferry Wharf and Sassoon Dock during 1980 - 88 period was 16,124.8 t by an estimated 4,10,652 units. The contribution of New Ferry Wharf being 13,523.5 t and that of Sassoon Dock 2601.3 t. Percentage-wise New Ferry Wharf and Sassoon Docks contributed 83.87 and 16.13 respectively.

Priacanthids are widely distributed in the Indian seas. The five species of priacanthids found in Indian waters are *Priacanthus hamrur* Forskål, *P. blochii* Bleeker, *P. tayenus* Richardson, *P. macracanthus* Cuvier and *P. cruneatus* Lacepede. Of these five species, the most dominant species occurring in the Bombay waters is *P. hamrur*. This species is distributed in the east coast of Africa, seas of India to Malay Archipelago. In the present communication, based on eighteen months data from February 1989 to July 1990, the von Bertalanffy's growth parameters in length, mortality estimates, exploitation rate and ratio and stock assessment of *P. hamrur* are reported.

From Indian waters work on the biology of *P. macracanthus* has been done by Rao (1984). Age, growth and mortality estimates of *P. hamrur* have been done by Birader *et al.* (MS).

Stock assessment of *P. hamrur* and priacanthids has been done by Birader (1989) and John and Sudarsan (1988) respectively.

Most of the studies on the biology, growth and mortality parameters of priacanthids are restricted to southeast Asian countries. *P. macracanthus* has been worked out by Nugroho and Rusmadji (1983). Chomjurai (1970) and Ingles and Pauly (1984) have worked on Samar Seas and the Gulf of Thailand materials. Dwiponggo *et al.* (1986) have worked on *P. macracanthus* from Java Sea.

Material and Methods

The catch and effort data were collected for the respective landing centres by the field staff. Apart from this, the data on catch composition and length frequency were collected once in a week at the landing centre.

In order to determine the trend of fishery the following quadratic equation was fitted $Y = a+b+ct^2$ where Y = annual yield, t = year with base year 1980 as t_0 and a, b and c are constants. This equation was worked out following Snedecor (1940).

Total length from the tip of the snout to the tip of the tail was taken. The length data obtained were raised to day's catch and the same were raised for the month. The length data obtained were raised to day's catch after grouping them in 10 mm groups for the growth study. Scatter diagram technique of Devaraj (1982) was employed in the present study. The growth was expressed using von Bertalanffy's (1983) equation given as

$$L_t = L_\infty \ (1-e^{-K\,(t-t_0)})$$

Where L_∞ is the asymptotic length, 'K' is the growth coefficient and 't_0' the theoretical age at which length is zero. 'L_∞' and 'K' were estimated by Ford-Walford plot (Ford, 1933; Walford, 1946) of L_t against L_t+1 on monthly basis and 't_0' was estimated by Gulland and Holt's (1959) plot.

The instantaneous rate of total mortality 'Z' was calculated by length converted catch curve method of Pauly (1982).

The natural mortality coefficient was estimated by the method of Cushing (1968). Here, in the unexploited state, if the number of one year olds are taken as 100 and the number surviving to maximum age (T_{max}) as 1 then the formula could be written as

$$M = \frac{1}{T_{max}^{-1}} . \log e \frac{100}{1}$$

The largest fish recorded during the present study was 341 mm. By using VBGF the age at this length was estimated as 4.02 years.

The instantaneous rate of fishing mortality 'F' was obtained by substracting M from Z.

The exploitation ratio (E) and exploitation rate (U) were calculated by the formula

$$E = \frac{F}{F+M} \text{ and } U = \frac{F}{Z} (1-e^{-z})$$

The total and standing stocks were estimated by using the relationship Y/U and Y/F in the usual notations. Maximum sustainable yield (MSY) was estimated by Gulland's (1971) formula

$$MSY = 0.4 \times M.Bv.$$

Instead of 0.5 as a multiplicative factor 0.4 was used. Here 'M' is the natural mortality coefficient and Bv is the virgin biomass.

Results

Catch statistics

The average annual catch of perhces at New Ferry Wharf and Sassoon Dock during 1980 - 88 period was 1791.6 t of which 1502.6 t and 289.0 t are respective shares of the former and latter landing centres respectively. The highest catch at Sassoon Dock was 907 t in 1988 whereas at New Ferry Wharf the highest catch of 6170 t was recorded in 1987. The lowest catch at both the centres was recorded in 1981 *i.e.* 23.25 t for Sassoon Dock and 40.3 t for New Ferry Wharf.

The lowest catch per boat of 38.4 kg was recorded in 1981 whereas the highest catch per

boat of 198.95 kg was recorded in 1987 for New Ferry Wharf. The lowest catch per boat at both places was in 1981 *i.e.* 1.05 kg for Sassoon Dock and 2.12 kg for New Ferry Wharf (Fig. 1). The percentage contribution of perch to the total fish catch at New Ferry Wharf varied from 0.33% in 1980 to 12.05% in 1987 and the same for Sassoon Dock varied from 0.12% in 1987 to 2.03% in 1988.

Monthwise average catch of 1980-88 shows that highest catch of 2569 t with CPUE of 109.54 Kg was obtained in November at New Ferry Wharf contributing 5.7% to the total fish catch.

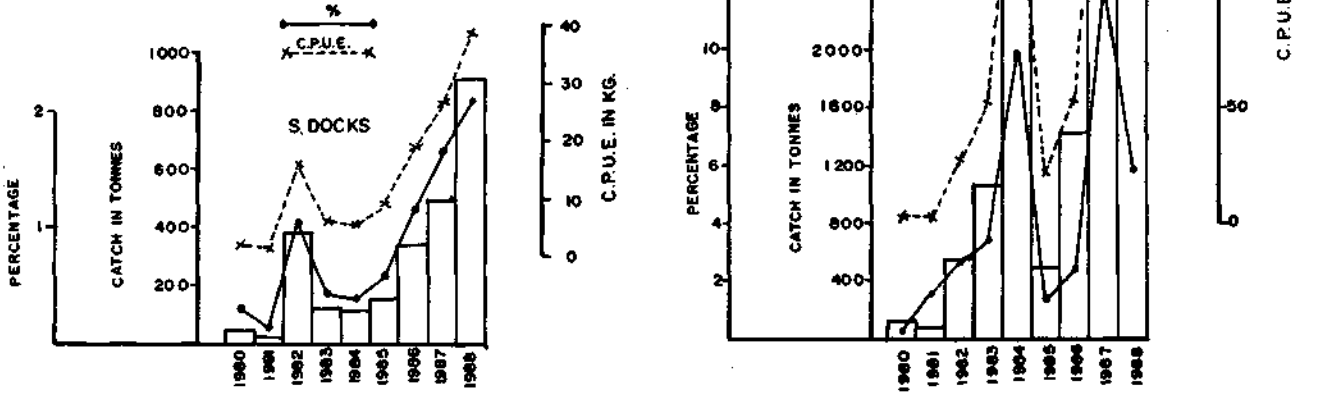

Fig. 1. Annual catch, CPUE and percentage of perch in total fish catch at Sasoon Dock and New Ferry Wharf during 1980-'88.

This was followed by 1836 t in December with CPUE of 73.49 kg and contributing 3.7% to the total fish catch. Poorest catch of 11.61 t with CPUE of 4.89 kg was obtained in July contributing only 0.43% to the total fish catch. October - December appears to be the peak season for these perches at this landing centre (Fig. 2).

At Sassoon Dock also the highest CPUE of 19.41 kg was recorded in November with a catch of 328 t and it contributed 1.33% to the total fish catch at this landing centre.

Percentagewise highest contribution was obtained in September (7.91) at New Ferry Wharf and 1.36 in May at Sassoon Dock. At Sassoon Dock November - January appears to be the best season for perches.

Fitting of the quadratic for the catch of Sassoon Dock and New Ferry Wharf separately and Sassoon Dock and New Ferry Wharf catches pooled indicated an increasing trend (Fig. 3, 4 and 5). The equations obtained are given below.

Sassoon Dock : $Y = 227.5798 + -107.577\ t + 18.926\ t^2$ ($r^2 = 0.79231$)

New Ferry Wharf : $Y = 402.1339 + -81.483\ t + 295.967\ t^2$ ($r^2 = 0.69368$)

New Ferry Wharf and Sassoon Dock : $Y = 629.7137 + -403.545 + 100.412\ t^2$ ($r^2 = 0.651660$)

The increasing trend in the perch catch is already indicated at New Ferry Wharf and Sassoon Docks. At New Ferry Wharf from a catch 40.36 t in 1981 the catches have gone upto 6170 t in 1987. At Sassoon Dock too from 23 t in 1981 the catches have gone upto 907.29 t in 1988.

Age and growth

A total of 2507 specimens in the size range of 150-341 mm were measured for length

frequency studies during February 1989 to July 1990. By connecting maximum number of modes

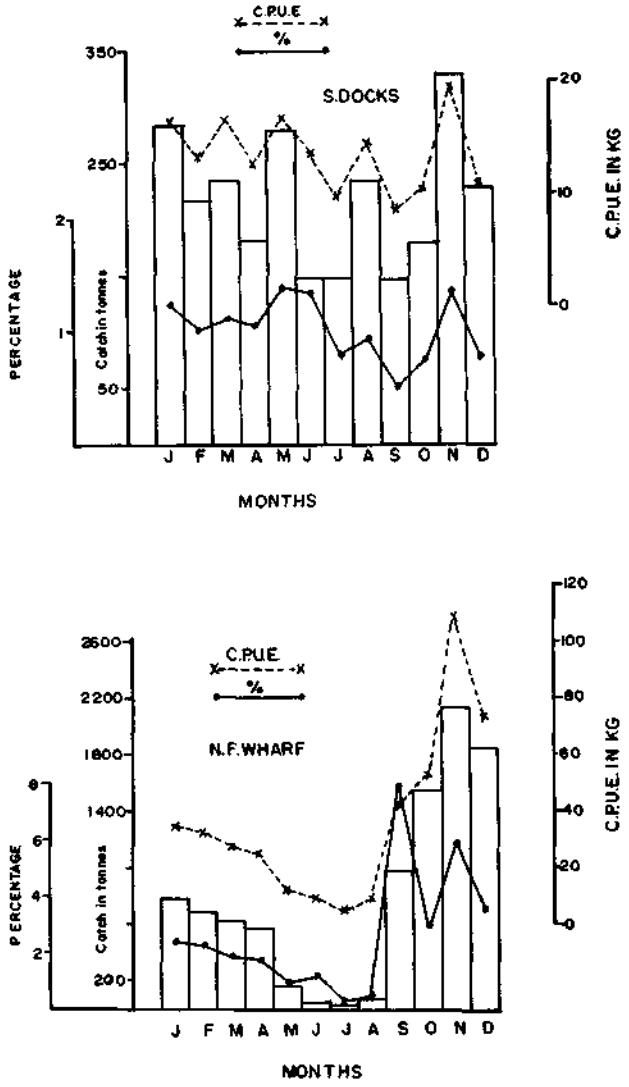

Fig. 2. Monthwise catch, CPUE and percentage of perch in total fish catch.

in the scatter diagram it was possible to obtain ten growth curves of almost identical shapes (Fig. 6). The average length at monthly interval were read and the same were used for the Ford-Walford plot. The growth coefficient, K was estimated as 0.736 on annual basis and the asymptotic length as 360 mm. The 't_0' was estimated as -0.009116 years. This species grows to 193, 283 and 323 mm at the age of I to III years of its life. The Ford-Walford plot and growth curve of this species is presented in Fig. 7 and 8 respectively. The $L\infty$ of 360 mm is close to largest speciman of 341 mm obtained in the population during the present study. Using the VBGF formula the age at 431 mm was calculated as 4.02 years. The VBGF for this species could thus be written as

$$L_t = 360\ (1\text{-}e^{-0.736\ (t+0.009116)})$$

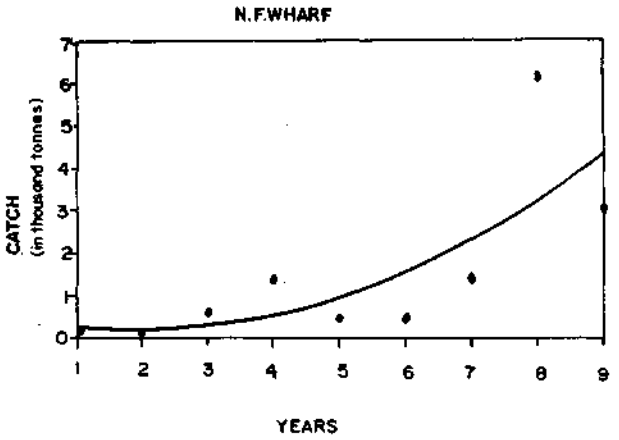

Fig. 3. Trend of perch fishery at N.F. Wharf as indicated by fitting of quadratic equation.

Mortality rates

Using the length converted catch curve method the total mortality coefficient 'Z' for this species for the year 1989-90 was estimated as 3.08 (Fig. 9). The natural mortality coefficient 'M' is estimated to be 1.52. The fishing mortality is obtained by substracting M from Z and it is 1.56. The exploitation ratio (E) and exploitation rate (U) were obtained as 0.505 and 0.482 respectively.

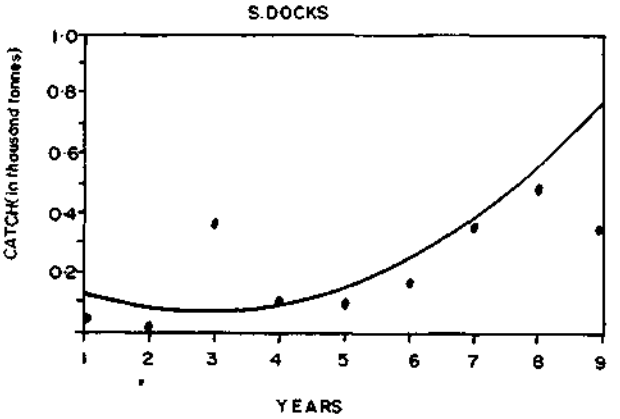

Fig. 4. Trend of perch fishery at S. Dock as indicated by fitting of quadratic equation.

Stock assessment

The total and standing stock of *P. hamrur* obtained from the combined catch of New Ferry

Wharf and Sassoon Dock were estimated as 1074.28 and 331.92 t respectively. The MSY was estimated as 201.80 t.

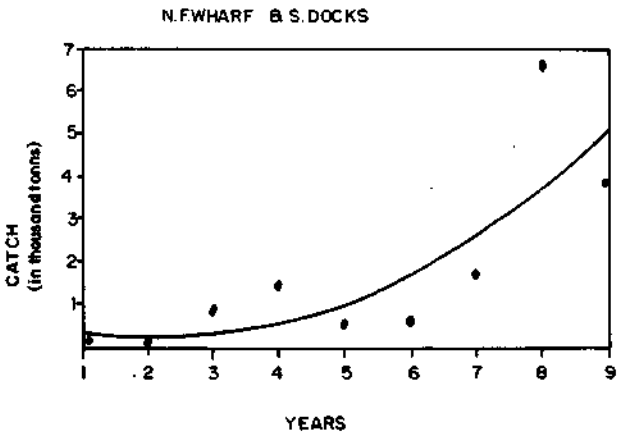

Fig. 5. Trend of perch fishery at N.F. Wharf & S. Dock as indicated by fitting of quadratic equation.

DISCUSSION

The catches of perch show fluctuating trend. The lowest catch of 23.45 t and 40.36 t at Sassoon Dock and New Ferry Wharf respectively in 1981 increased to 907 t and 6170 t in 1988 and 1987 in these respective centres. The catches at New Ferry Wharf went up from 1413 t in 1986 to 6170 in 1987, but then again went down to 3043 t in 1988. At Sassoon Dock a steady increase in the catch from 362 t in 1986 to 907 t in 1988 was observed. From the overall catch of perch it is obvious that the contribution of New Ferry Wharf is higher *i.e.* 83.87% as compared to 16.13% by Sassoon Dock. The monthwise catch indicated that the catches of perch at New Ferry Wharf was better in October - December period, while the same was true in the months of November - January for Sassoon Dock.

The increasing trend of the catch at both the landing centres is clearly indicated by the resultant graph obtained by fitting of the quadratic equation. From the Andhra Coast, Rao (1984) reported that *P. macracanthus* grows at the rate of 10 mm/month for specimen measuring 140-240 mm. Apart from this there is no published account on the age and growth studies of priacanthids from the Indian waters.

Chomjurai (1970) observed a monthly growth rate of 2 mm for *P. tayenus* from Samar Sea. Nugroho and Rusmadji (1983) reported $L\infty$ and K of *P. macracanthus* as 26.0 cm and 1.36 respectively. Ingles and Pauly (1984) reported that the $L\infty$ and 'K' of *P. tayenus* as 29 cm and 1.25 respectively. Working on *P. macracanthus* Dwiponggo *et al.* (1986) reported the asymptotic length and growth coefficient to be 23.8 and 1.30, and 23.0 and 1.15 based on the data of 1977-78 and 1978-79.

In the present investigation however, the $L\infty$ of *P. hamrur* was estimated as 36 cm and the annual growth coefficient as 0.736. This species grows to 193, 283 and 323 mm at the end of I, II and III years of its life in Bombay waters. As the growth coefficientis inversely proportional to the asymptotic length it is obvious that the higher 'K' obtained by workers of southeast Asian countries is related to the smaller sizes the respective species attain there.

There is a wide variation in the estimates of mortality rates of *Priacanthus* spp. Ingles and Pauly (1984) reported 'M' of 8.09 for *P. tayenus* from Samar Sea. Nugroho and Rusmadji (1983) estimated 'M' of 3.45 for *P. macracanthus* whereas Dwiponggo *et al.* (1986) the 'M' as 2.13 and 2.28. John and Sudarsan (1988) calculated the 'M' of *Priacanthus* spp. using Pauly's (1979) empirical formula utilizing the $L\infty$ and K of priacanthids from Southeast Asian countries. The 'M' thus obtained ranged from 1.7 to 1.9 and for their study on the stock assessment they assumed the 'M' of priacanthids of the Indian waters as 1.75. Birader *et al* (MS) estimated the 'M' of *P. hamrur* as 1.0.

The M estimated by Ingles and Pauly (1984) and Nugroho (1983) are obviously over estimate and as it does give a proper M/K ratio which should fall between 1 - 2.5 (Beverton and Holt, 1959). The estimates of John and Sudarsan (1988) also appear to be on the higher side as the calculations are based on the growth parameters of Java and Samar Seas where depending on the species the $L\infty$ varied from 23-29 cm and K 1.15 - 1.36. Birader *et al.* (MS) obtained a 'M' of 1.0 which is lower than the present study of 1.52. But we must give due consideration to the fact that Birader *et al.* (MS) have recorded specimens of *P. hamrur* upto 36.0 cm whereas the largest specimen obtained during the present

study is only 34.1 cm. The chief reason for obtaining larger specimens in the former and small in the latter is due to the fact that the data by Birader *et al.* (MS) is collected from M. V. *Saraswati* which could venture into the deeper waters as compared to data collected from commercial trawlers in the present study which carry out fishing operations upto a depth of 70 m only.

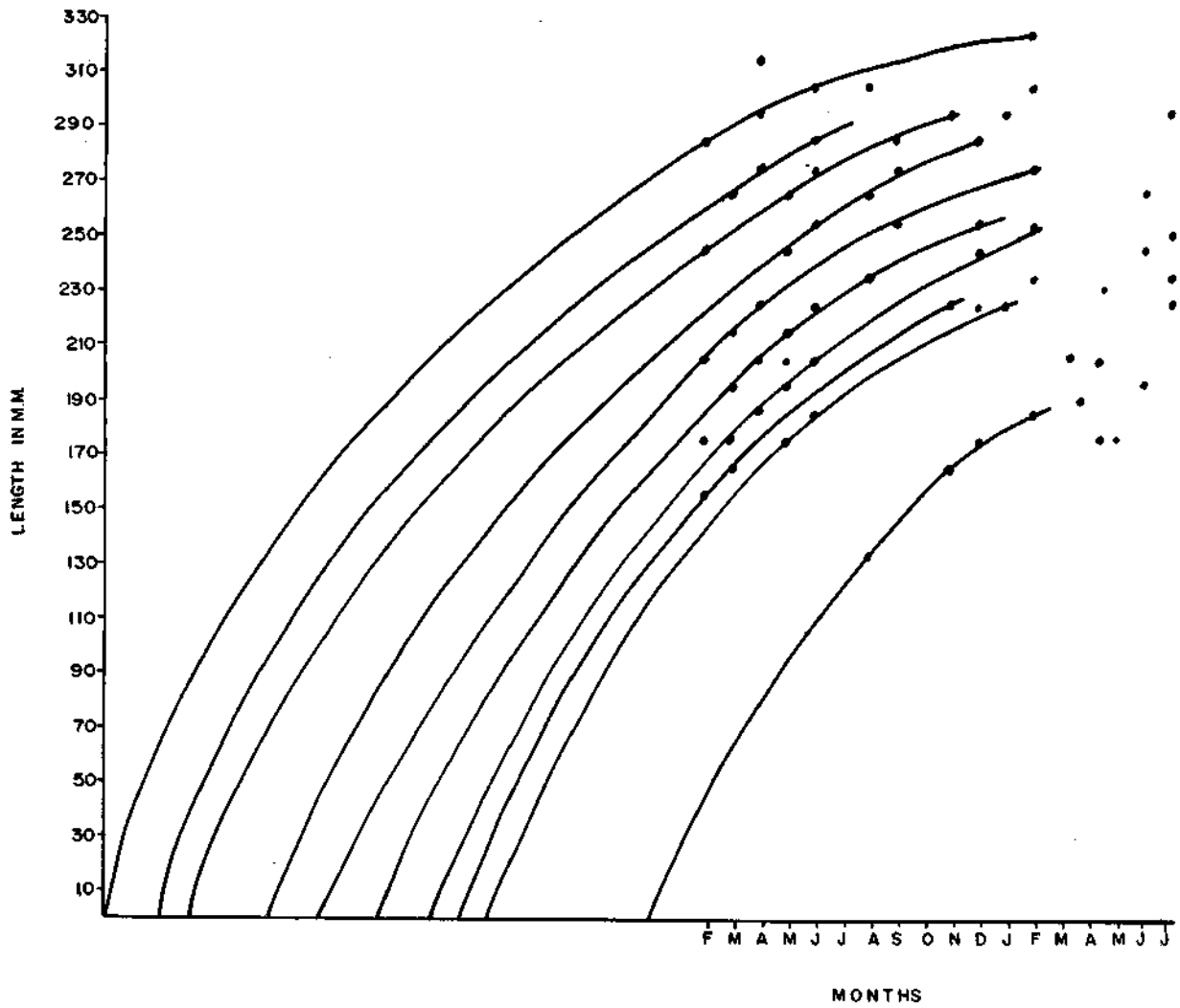

Fig. 6. Scatter diagram of modal length for *P. hamrur*.

The natural mortality of fishes vary with age (Boiko, 1964) and most probably with predator abundance (Pauly, 1980 a, 1982; Munro, 1982; Jones, 1982). Natural mortality should be related to size since larger fish as a rule would have lesser predators. Since 'M' is related to longevity, its relation to growth coefficient is obvious. This could be the chief reason for a higher 'K' and 'M' obtained for Priacanthids by workers from Java and Samar Seas while the reverse is true from the study of *P. hamrur* by Birader *et al.* (MS) from Indian waters. The 'M' of 1.52 thus obtained in the present study appears to be very reasonable.

The total stock and standing stock for this species based on the data collected from New Ferry Wharf and Sassoon Dock landing centre of Greater Bombay for the period 1989-90 comes to 1074.28 t and 331.92 t as compared to the present yield of 517.81 t. Taking 0.4 as the

multiplier, the MSY was estimated as 201.8 t. According to Gulland (1971) MSY = 0.5 MBv where M is the natural mortality and Bv is the

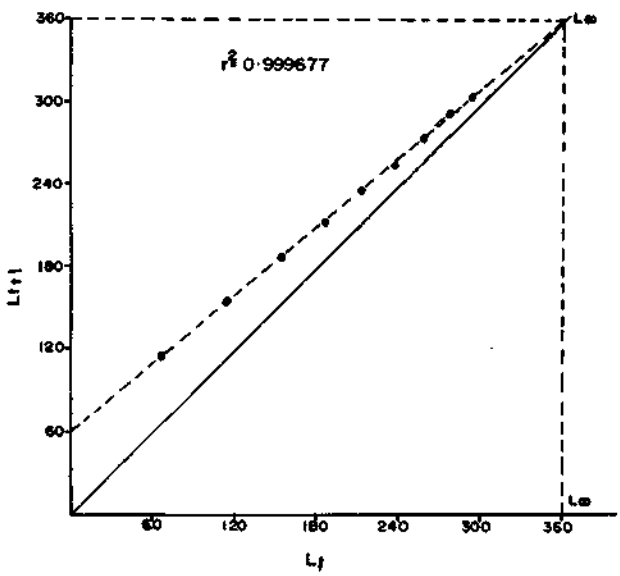

Fig. 7. Ford-Walford plot for *P. hamrur.*

virgin biomass. The use of 0.5 as the multiplication factor has been criticised by many

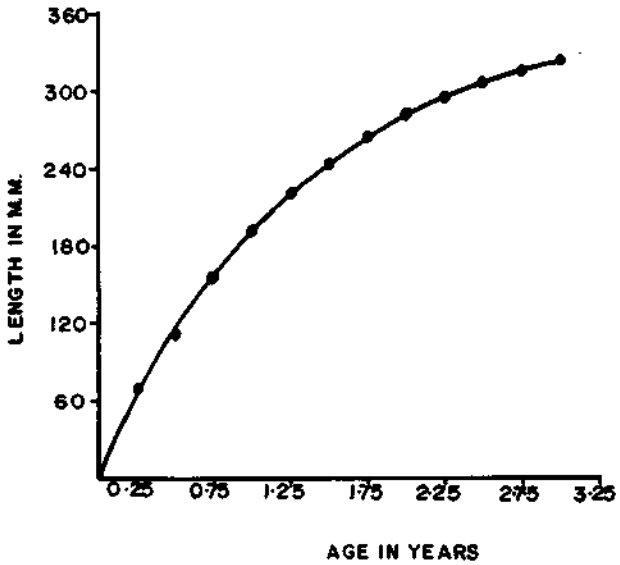

Fig. 8. Growth curve of *P. hamrur.*

authors (Francis, 1974; Buddington and Cooke, 1983; Caddy and Csirke, 1983; Garcia *et al.*, 1987). Garcia and Le Reste (1981) used value ranging from 0.32 to 0.44. John and Sudarsan (1988) used 0.4 as the multiplication factor. Sparre (1988) suggested a factor of 0.2 to be more appropriate. Thus there is no hard and fast rule for taking the multiplication factor and the estimates arrived at could be subjective.

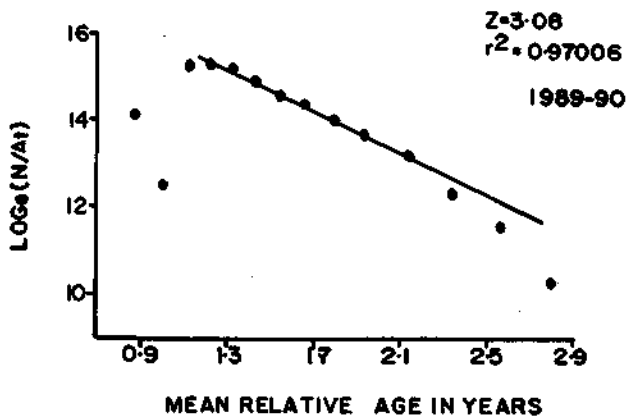

Fig. 9. Length converted catch curve for *P. hamrur.*

Priacanthus spp. from the Waltair Coast is consumed both in fresh and dried condition and is very popular with the poorer section of the people (Rao, 1984). Priacanthids compare favourably as far as the nutritive value of other popular table fishes. Studies on the meat characteristics reveal that it is of high nutritional value with 17.5% protein and 5.1% fat (John and Sudarsan, 1988). They have a good international market as priacanthids are highly priced in Southeast Asian countries. The comment that the big-eye snappers are being exploited only by chartered vessels (John and Sudarsan, 1988) is not correct as the present study is based, exclusively on the data of the commercial trawlers operating upto a depth of 70 m. In the present days of paucity of fish protein it would be very useful to popularise the Priacanthids in the domestic as well as international markets.

ACKNOWLEDGEMENT

The author wishes to express his sincere thanks to Dr. P. S. B. R. James, Director, CMFRI and Shri P. Sam Bennet, Project Leader for effectively persuading to write the present communication. The technical assistance rendered by S/Shri A.D. Sawant and B.B. Chavan is gratefully acknowledged.

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LENGTH - WEIGHT RELATIONSHIP OF *LUTJANUS RIVULATUS* OFF TUTICORIN, GULF OF MANNAR

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ABSTRACT

Length - weight relationship of *Lutjanus rivulatus* exhibits isometric growth since its regression coefficient did not significantly differ from 3. The relative condition factor K_n indicates that the older specimens measuring above 420 mm were more healthy and robust than the younger individuals.

INTRODUCTION

Length - weight relationship of *Lutjanus rivulatus* a perch which constitutes a fishery of considerable magnitude off Turicorin is presented here with a view that this information will be of immense use for various biological purposes such as estimation of asymptotic growth in weight, computation of yield per recruit as per the classical model of stock assessment (Beverton and Holt, 1957) and in the estimation of optimum age of exploitation and potential yield per recruit as per Krishnan Kutty and Qasim (1968), which are essential parameters for proper exploitation and management of any resource.

MATERIAL AND METHODS

Total length in mm and wet weight in gram of 279 specimens of *L. rivulatus* ranging in size from 110 mm to 760 mm have been collected from commercial trawl net landings at Tuticorin. Logarithmic values of total length and wet weight were computed as per the Least squares method (Snedecor and Cochran, 1967). The regression coefficient 'b' was subjected to 't' test to find out whether the b value differs from the theoretical value of 3, as this value is supposed to be around 3 when the growth of the fish is isometric.

RESULTS AND DISCUSSION

Based on the above said method the length - weight relationship of *L. rivulatus* is described by the following equation and depicted in Fig. 1.

$$\text{Log } W = -4.6821 + 2.9562 \text{ Log } L \quad (r = 0.9620)$$

Unchanging body form and specific gravity of a fish are supposed to yield a regression

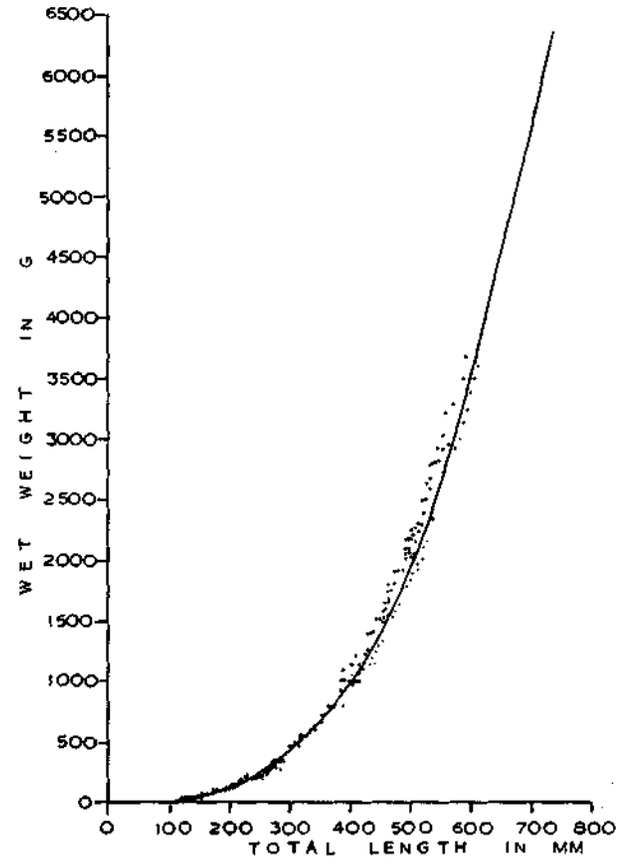

Fig. 1. Length - weight relationship of *L. rivulatus* obtained from trawl net landings at Tuticorin.

coefficient value of 3 which means that the fish exhibits an isometric growth. A large number of

species possess isometric growth following the cube law. Whereas some of the species exhibit allometric growth due to the change in the specific gravity and body form. The b value of *L. rivulatus* was subjected to 't' test and the test revealed that this species exhibits isometric growth since its b value did not significantly differ from the theoretical value of 3. Vivekanandan and James (1984) have observed that both the sexes of the threadfin-breams *Nemipterus tolu, N. delagoae* and *N. luteus* to exhibit isometric growth in Madras waters whereas the b value of the females of *N. mesoprion* was significantly different from 3 indicating an allometric growth.

The relative condition factor Kn obtained from the relation K_n = W/w where W is the observed weight and w is the estimated weight, could be expected to indicate the well being of the fish, its relative robustness, suitability of habitat and to some extent the size at first maturity and peak period of spawning. The K_n factor obtained for *L. rivulatus* is given in Table 1 and it indicates that the K_n factor is around or less than one in the lower size ranges from 110 to 410 mm. Whereas above 420 mm the K_n factor is higher than 1.0 indicating that the larger specimens of this species were more healthy and robust than the smaller young ones. Similar observation was made by Fawzy and Soliman (1984) in a smaller perch *Upeneus sulphureus* in Safaga Bay of the Red Sea.

TABLE 1. *Relative condition factor K_n of* L. rivulatus *at different sizes obtained at Tuticorin*

Total length (mm)	No. of fish	Kn	Total length (mm)	No. of fish	Kn
110-119	2	0.80	360-369	5	1.04
120-129	6	1.04	370-379	4	1.06
130-139	3	0.96	380-389	7	1.06
140-149	5	0.82	390-399	5	0.99
150-159	3	0.90	400-409	7	0.98
160-169	6	0.93	410-419	4	0.97
170-179	7	1.05	420-429	8	1.00
180-189	3	0.97	430-439	3	1.08
190-199	7	0.92	440-449	5	1.04
200-209	6	1.02	450-459	7	1.02
210-219	9	1.07	460-469	9	1.09
220-229	6	1.00	470-479	8	1.08
230-239	6	0.92	480-489	8	1.07
240-249	5	0.92	490-499	9	1.11
250-259	6	0.85	500-509	5	1.10
260-269	9	0.95	510-519	4	1.09
270-279	9	0.97	520-529	3	1.13
280-289	5	0.87	530-539	5	1.10
290-299	5	1.03	540-549	3	1.12
300-309	13	1.00	550-559	3	1.16
310-319	12	0.98	560-569	1	1.20
320-329	9	0.96	570-579	1	1.12
330-339	9	1.02	580-589	1	1.11
340-349	3	0.95	590-599	1	1.14
350-359	8	1.01	600-609	1	1.13
			720-729	1	1.03

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AGE, GROWTH, MORTALITY AND STOCK ASSESSMENT OF *EPINEPHELUS DIACANTHUS* (VALENCIENNES) FROM BOMBAY WATERS

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ABSTRACT

The age, growth, mortality, yield and stock estimates of *Epinephelus diacanthus* is reported in this communication. Using the length frequency data 1989 to 1992, the $L\infty$ was estimated as 502 mm and K as 0.16 on annual basis. This species grows to 229, 354, 421, 458, 478 mm at the end of I - V years of its life span. The total, natural and fishing mortality coefficients were estimated as 1.94, 1.15 and 0.79 respectively. The exploitation rate and ratio was found to be 0.3486 and 0.4072 respectively. The total and standing stocks were estimated as 1815.54 and 801.13 t and MSY 368.5 t as compared to the present yield of 632.9 t.

The age at first recruitment (t_r) and the age at first capture worked out to be 0.4054 and 0.67 years respectively. The $W\infty$ was estimated as 1870 gm. The yield per recruit was estimated as 84.25 gm at the present level of F = 0.79. The yield per recruit study indicate that the 'F' can almost be doubled to 1.46 to get an Y_w/R of 91.906 gm. But as the gain in Y_w/R would be only 7.45 gm increasing the fishing efforts to that level is not advisable.

INTRODUCTION

Perches are one of the most important resources on the Northwest coast of India. Occurring as by-catch of shrimp trawl, the exploitation of this resources is restricted upto the depth of 70 m. During 1982 - 85 the total catch from Maharashtra Coast was 6508 t contributing 11% in the all-India perch catch. Species of the family Serranidae are widely distributed in the Indian Seas. At Bombay amongst the roughly half a dozen species of *Epinephelus, E. diacanthus* is the most dominant and occurs regularly in catch atleast for nine months barring the monsoon months of June - August.

The work on the age, growth and stock assessment on the members of the family from Indian waters is perhaps very scanty. From other places work on this family has been done - *Diacanthus labrax* from Southern Ireland by Holden and William (1974), *E. guttatus, E. striatus*, *Cephalopholis fulva* and *Mycteroperca veneosa* by Thompson and Munro (1977) from Jamaican Reefs and *E. sexfaciatus* from Visayansca by Ingles and Pauly (1984).

In the present communication the age, growth, mortality yield and stock parameters of *Epinephelus diacanthus* (Valenciennes) is reported.

MATERIAL AND METHODS

Weekly length frequency, catch and effort data were collected from Sassoon Dock and New Ferry Wharf landing centres of Greater Bombay from 1989 to 1992. After grouping them in 10 mm class intervals, the length frequencies in each length groups were raised for the day and subsequently for the month using the method of Sekharan (1962). The growth parameters were estimated Elefan programme (Gayanilo *et al.*, 1988). This method does not give an estimate of t_0. The instantaneous rate of total mortality Z was calculated by length converted catch curve method of Pauly (1982) using the relationship.

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$$\text{Log } e\ (N/\Delta t) = a + b.t$$

Where "Δ t" is the time taken to grow from the lower limit to the upper limit in each length class and N is the numbers caught in each length group, a is the Y-axis intercept, b = Z with the sign changed and t is the mid point in each length group. Here only the descending right limb of the curve is taken for the estimation of Z. The length frequency distribution was smoothened by a three point moving averages in each length groups. The natural mortality coefficient (M) was estimated by Cushing's (1968) formula. Here in the unexploited state if the number of one year olds are taken as 100 and numbers surviving to maximum age (T_{max}) as one, then the formula could be written as

$$M = \frac{1}{T_{max} - 1.} \log e \frac{100}{1}$$

The largest fish observed in the catch in the present study was 478 mm. Using VBGF the age of that fish was determined as 4.98 years. By taking this as T_{max} the M was estimated as

$$M = \frac{1}{4.98 - 1.} \log e \frac{100}{1} = 1.15$$

$$E = \frac{F}{F + M} \text{ and } U = \frac{E}{Z} (1-e^{-Z})$$

as given by Beverton and Holt (1957).

The smallest fish observed in the present study was 110 mm. Using VBGF the age of this fish was calculated as 0.4406 year. This was taken as age at first recruitment (t_r). The age at first capture (t_r) was estimated by plotting cumulative percentages as the mesh selection operates in fishes whose size is lower than the first mode (Beverton and Holt, 1957). Using the length - weight formula the W_∞ at L_∞ of 502 mm was calculated as 1870 gm. The per recruit was calculated by using the formula.

$$Y = F.Rw_\infty e^{-M(tc - tr)} \left[\frac{1}{F+M} - \frac{3eK^{(tc - tr)}}{F+M+K} + \frac{3e^{-2K(t_c - t_0)}}{F+M+2K} - \frac{e^{-3K(t_c - t_0)}}{F+M+3} \right]$$

as given by Beverton and Holt (1957) and Gulland (1956, 1969). This calculation was done on computor using LFSA programme as given by Sparre (1987). The maximum sustainable yield was estimated by Gulland's (1971) formula given as MSY = 0.4 x M.Bv. Here 0.4 was used as multiplier instead of 0.5.

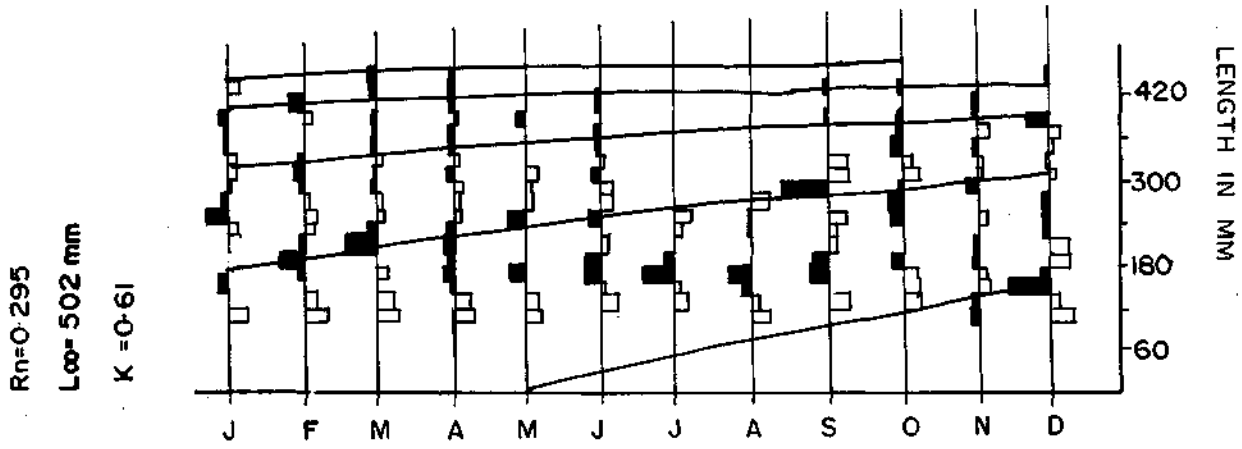

Fig. 1. Growth curve of *E. diacanthus* as estimated using Elefan programme.

The instantaneous rate of fishing mortality F was obtaind by substracting M from Z given as F = Z - M. The exploitation ratio E and exploitation rate U were calculated by the formulae

Results and Discussion

Using Elefan method the L_∞ and K for *E. diacanthus* were estimated as 502 mm and 0.61 on annual basis (R_n = 0.295) (Fig. 1). This

species in Bombay waters grows to 229, 354, 421, 458 and 478 mm at the end of I-V years of its life. The L_∞ of 502 mm is close to the largest fish of 478 mm observed in the catch.

The VBGF growth formula in length for this species could thus be written as

$$L_t = 502\ (1^{-e\ 0.61\ (t-0)})$$

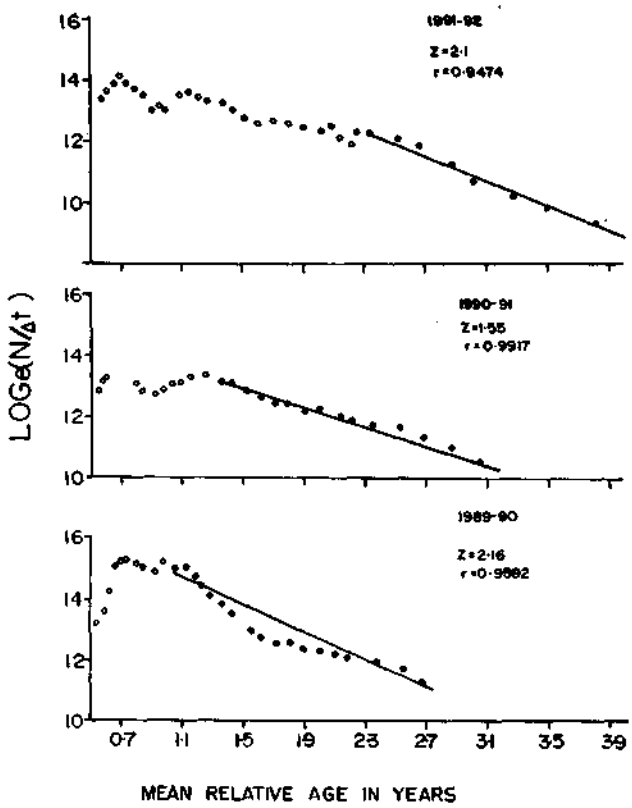

Fig. 2. Length converted catch curve for the estimation of Z for *E. diacanthus*.

The total mortality coefficient varied from 1.55 in 1990 - 91 to 2.16 in 1989 - 90 (Fig. 2). The average Z for three years being 1.94 (Table 1). The natural mortality coefficient was estimated as 1.15 and the fishing mortality coefficient as 0.79.

TABLE 1. *The mortality, yield and stock parameters for* E. diacanthus

Year	Z	M	F	U	E	Yield in tonnes	Total stock	Standing stock	MSY
1989-90	2.16	1.15	1.01	0.4135	0.4675	768.15	1643.1	760.54	349.84
1990-91	1.55	1.15	0.40	0.2032	0.258	435.99	2145.62	1089.97	501.38
1991-92	2.10	1.15	0.95	0.3969	0.4523	694.57	1749.98	1842.08	847.35
Average	1.94	1.15	0.79	0.3486	0.4072	632.9	1815.54	801.13	368.51

The exploitation ratio (E) and exploitation rate (U) were calculated as 0.4072 and 0.3486 respectively.

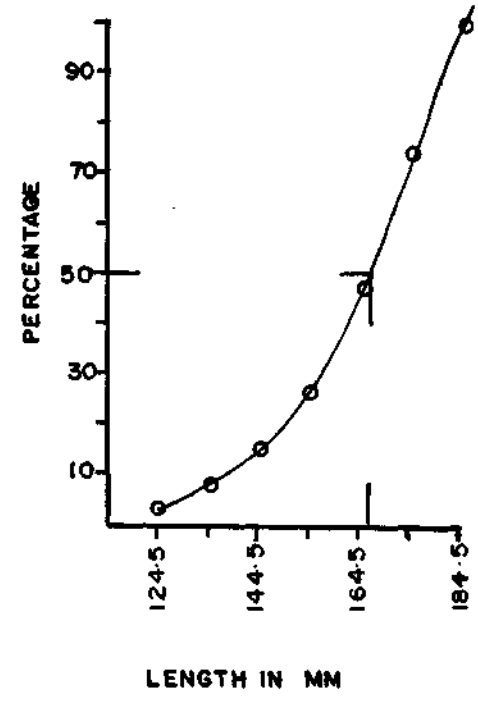

Fig. 3. Selection curve to determine at first capture.

The total and standing stocks were estimated as 1815 and 801 t as compared to present average yield of 632.9 t, the combined yield of Sassoon Dock and New Ferry Wharf taken together (Table 1). The MSY was estimated as 368.51. Using the length-weight relationship the W_∞ at L_∞ of 502 mm was calculated as 1870 gm. By applying VBGF, the age at recruitment (t_r) and capture (t_c) were estimated as 0.4406 and 0.67 year respectively (Fig. 3). The yield per recruitment is given in Fig. 4.

The Yw/R at the present level of F 0.79 is 84.45 gm as compared to 91.9 gm at F_{max} of 1.46. But a steady decline in the biomass per recruit is observed.

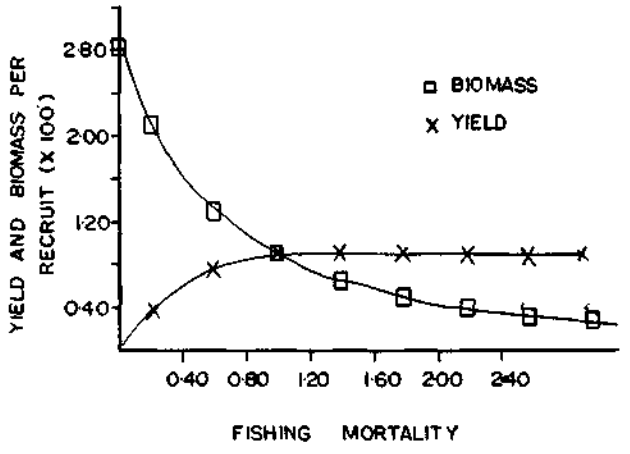

Fig. 4. Yield and biomss per recruit for *E. diacanthus*.

Published account on the age, growth and stock studies on this speices from Bombay wateres is not available for comparison with work done by other workers on this species. For *E. guttatus* reported by Thompson and Munro (1977) from Jamaican Reefs the L_{∞} is 520 mm, K = 0.24, M = 0.68 and W_{∞} is 1880 gm. While the length and weight infinites obtained are comparable to that obtained in the present study, the M and K appear to be on the lower side. As the other species of Serranidae worked out either grows much smaller or larger than *E. diacanthus* of Bombay, the parameters cannot be compared. FAO (1984) reports that *E. diacanthus* grows to a maximum size of 520 mm which is well within the limits of L_{∞} of 502 mm and largest fish of 478 mm observed in the catch.

The total mortality coefficint Z was found to be low in 1990-91 wheres in the other two years *viz*. 1989-90 and 1991-92 it was more or less same. The chief reason for low value of Z may be declined in the catch in 1990-91 (Table 1).

The estimate of natural mortality in tropical multispecies, multigear system presents a large number of problems. As this species is highly carnivorous, growing to large size, having a broad girth and strong dorsal spine, the possibility of this being predated upon by other species is rare. The M of 1.15 appears to be reasonable.

The MSY of 368.5 t was estimated taking a miltiplication factor of 0.4. Gulland (1971) has suggested the use of 0.5 as the multiplier. But the usage of 0.5 as multiplier has been criticised by many authors (Francis, 1974; Buddington and Cooke, 1983; Caddy and Crsike, 1983; Garcia *et al.*, 1987). Garcia and Le Reste (1981) used values ranging form 0.32 to 0.44. Sparre (1988) suggested a factor of 0.2. Thus the estimate of MSY arrived at is subjective and there is no hard and fast rule on the multiplicative factor.

The yield per recruit study shows that the fishing efforts could be nearly doubled to 1.46 from the present 0.79 to Yw/R of 91.9 gm. However, by doubling the efforts the Yw/R would increase only by 7.45 gm which would not give much economic returns. The optimum value of exploitation ratio (E opt.) is about roughly equal to 0.5 (Gulland, 1971). This gives a rough idea if the stock of a fish is optimally exploited or not. For *E. diacanthus* the exploitation ratio appears well bellow the E opt. So there appears to be no threat as to the depletion of stock for this species. At present the fishing operation of most of the commercial trawlers is restricted to the depth of 70 m. Joseph and John (1986) have suggested good grounds of perches in 75-225 m range along NW coast and along upper east coast. They have also computed that perches have an estimated potential of around 2.5 lakh tonnes and the present production of perch is only 26% of that. Thus increase of this resource could be achieved by going for fishing beyond 70 m.

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