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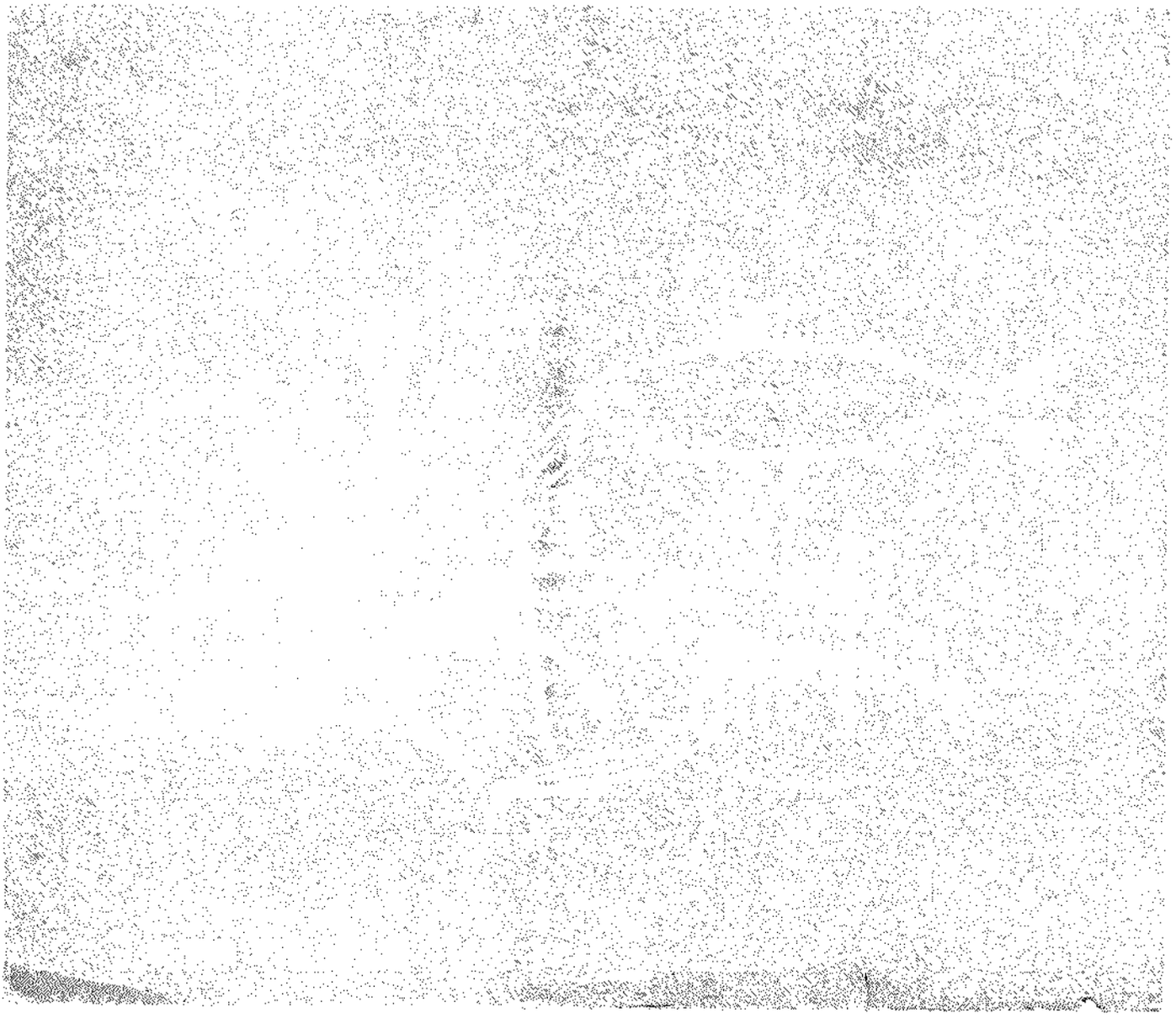

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ON THE CAT-FISH RESOURCES OF THE COASTS OF ANDHRA PRADESH, ORISSA AND WEST BENGAL

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ABSTRACT

Cat-fishes form 3–11% of the annual fish catches on the north-east coast of India (comprising the coasts of Andhra Pradesh, Orissa and West Bengal). The commercial cat-fish fishery is confined to grounds < 50 m. deep, the important fishing units being boat-seines with catamarans and hooks and lines with catamarans. The important species represented in the fishery are *Tachysurus thalassinus* (Rüpp.) and *T. tenuispinis* (Day). The fishery has three peaks in a year, in March, May-June and September-October. In exploratory bottom trawling undertaken up to 100 m. in the area between Kakinada and Sand Heads from 1964 to 1967, cat-fishes formed 28% of the catches. *T. thalassinus* comprised 38·2% and *T. thenuispinis* 60·7% of the cat-fish catches. On an annual average, *T. thalassinus* is more abundant in the zones around 17° 40′ and 19° 40′ N Lat., and *T. tenuispinis* in the zones around 17° 40′ and 19° 10′ N Lat., than in others. Each species has three periods of peak abundance in a year, falling in February-April, May-July and October-December (that is, roughly in the same periods as in the inshore fishery). *T. thalassinus* of the size-range 6–80 cm. and *T. tenuispinis* of the size-range 6–60 cm. are landed commercially; the exploratory trawl catches consisted mostly of 12–55 cm. of the former and 12–45 cm. of the latter species. It is estimated that in commercial trawling with Visakhapatnam as the base, a 25 m. side-trawler with 15 m. trawl should be able to land a minimum of 53–82 m. tons, a 14 m. stern-trawler with a 14 m otter trawl a minimum of 14–37 m. tons, and a 13·7 m. stern-trawler with 12 m. otter trawl, a minimum of 12–20 m. tons of cat-fishes per year from the area. The expected catches of the two species are also estimated. It is also shown that the average expected catch per day, of all cat-fishes, of the smallest of the trawlers considered would be about 3 times that realised by non-powered boats in the commercial fishery at present.

INTRODUCTION

CAT-FISHES of the genus *Tachysurus* form an important fisheries resource of the seas around India forming 2–3% of the annual fish landings on the Indian coast (*Annual Reports of the Central Marine Fisheries Research Institute*, Mandapam Camp). Of the 24 species described from this region (Day, 1878; Chandy, 1953), *Tachysurus thalassinus* (Rupp.), is commercially abundant along both the east coast and the west coast while the others have more restricted commercial abundance. In the north-western Bay of Bengal, the cat-fish catches are composed almost exclusively of *T. thalassinus* and *T. tenuispinis* (Day), the latter being the more important of the two. The latter species has also been recorded from Bombay (Day, 1878; Chandy, 1953) but the extent of its commercial importance there is not known. The present account deals with the relative abundance of these two species off the coasts of Andhra Pradesh, Orissa and West Bengal during the period 1964–67. Sekharan *et al.* (1968) have discussed the relative abundance of cat-fishes as a group in the area, based on the catch data of exploratory trawlers from 1961 to 1965. The percentage of cat-fishes in the total catches of the exploratory trawlers from different regions of this area in 1960 have been given by Sheriff (1961) and Poliakov (1961).

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Material and Methods

The present account is based on data from two sources: (1) the statistics of marine fish landings maintained by the Fishery Survey Division of the Central Marine Fisheries Research Institute (*see* Nair and Banerji, 1968, for details regarding the survey of marine fish catches in India), and (2) the results of exploratory trawling conducted by the Government of India Offshore Fishing Station, Visakhapatnam, off the coasts of Andhra Pradesh, Orissa and West Bengal. The area explored by the trawlers, the division of the area into squares and zones, the sampling method and the methods of analysis of the trawler data have been described by Sekharan *et al.* (1968). During 1964–67, three trawlers took part in exploratory work here, *viz.*, m.t. *Ashok*, m.v. *Champa* and m.v. *Sea Horse* (*see* Sekharan *et al.*, 1968 for details of the vessels and gear). m.t. *Ashok* could stay out at sea for ten days at a time. It fished throughout the area proposed for the survey (from Kakinada to Sand Heads); hence its results gave a good picture of both spatial and temporal variations in the relative abundance of demersal fishes. The other two trawlers undertook daily voyages and fished in the region around Visakhapatnam.

The log entries of the trawlers refer to cat-fishes as a group but not to the species. The quantity of each species landed was estimated by the author from: (1) ship-board observations on haul-wise species composition of the catches of cat-fishes and other fishes undertaken by the Central Marine Fisheries Research Unit, Waltair, and (2) observations at the jetty at the time of unloading, in respect of those voyages for which ship-board observations could not be undertaken. During these observations estimates were made of the percentage of each species among cat-fishes; these were used to convert the log entries into haul-wise and area-wise catches of each species.

Commercial Fishery of Cat-Fishes

As stated already, the information on the present status of the commercial fishery is based on the statistics maintained by the Central Marine Fisheries Research Institute.

Area Exploited Commercially at Present

At present only a narrow coastal zone up to about 25 km. from shore and 50 m. in depth is commercially fished for cat-fishes. Most of the fishing is done in waters < 40 m deep, especially during the rough season from April to November.

Craft and Gear Operated for Cat-Fishes

The main types of craft and gear operated for cat-fishes are given in Table I.

Among indigenous gear, hook and line and boat seine are the most important ones in the cat-fish fishery, accounting for the greater bulk of the catches; their relative importance varies from place to place. Sardines, anchovies and other small fishes are used as bait in hooks and lines. Mechanised boats with trawls and gill nets came into operation only recently.

Annual Catch Trends

The present annual catches of marine cat-fishes in West Bengal, Orissa and Andhra Pradesh are of the order of 2,500–9,000 m. tons, forming 3–11 % of the total marine fish landings (Table II). The percentage of cat-fishes in the total catches in West Bengal and Orissa is very low compared to that in Andhra Pradesh. From the point of view of total catch also, it may be seen that the cat-fish fishery is more important in Andhra than in West Bengal and Orissa.

Seasons of the Cat-Fish Fishery

The main periods when cat-fishes are caught by the different gear are referred to in Table I. The monthly catch trends in West Bengal and Orissa and Andhra Pradesh in 1964 are indicated in

Fig. 1. The trends in other years are also similar and hence are not represented in the figure. It may be seen that on the north-east coast of India the cat-fish fishery has three peaks in a year: in March, May-June and September-October. The period of the best catches is March-June.

TABLE 1

Craft and gear operated for cat-fishes

States	Net/boat	Operational range	Main period of operation	Average catch per day (Kg)
West Bengal & Orissa	Hook & line/1 catamaran	up to 20 km. from shore	Jan.-April	2–10
	Drift net/1 catamaran	up to 10 km. from shore	April-Sept.	3–10
	Boat-seine/2 catamarans	up to 10 km. from shore	March-Sept.	1–10
	Madavala/4 catamarans	up to 10 km. from shore	October-March	5–15
	Shore-seine/1 Masula boat & 2–3 auxiliary catamarans	up to 1 km. from shore	Nov.-March	5–20
	Gill-net/Mechanised boat	up to 20 km. from shore	Throughout the year	5–20
Andhra Pradesh	Hook & line/1 catamaran	up to 25 km. from shore	Throughou the year	2–20
	Boat-seine/2 catamarans or drug-outs	up to 15 km. from shore	April-October	1–15
	Shore-seine/1 Masula boat & 2–3 auxiliary catamarans	up to 1 km. from shore	October-April	5–20
	Gill net/1 catamaran or dug out.	up to 15 km. from shore	October-April	5–10
	Gill net/mechanised boat	up to 20 km. from shore.	October-April	10–15
	Otter trawl/mechanised boat	up to 25 km. from shore	Throughout the year	20–150

The Species Entering the Commercial Fishery

The commercial fishery on the north-east coast is supported mainly by two species: *Tachysurus thalassinus* (Rüpp.) and *T. tenuispinis* (Day). Sufficient data on their percentage in the cat-fish catches are not available; they will have to the estimated in future studies.

EXPLORATORY TRAWLING

The area explored by the trawlers during the years 1964–67 was the shelf between Kakinada and Sand Heads (Fig. 2). About 23,600 sq. km. of the shelf was covered during the survey, but as is only to be expected, all-the squares could not be sampled equally. Similarly, although the maximum depth-trawled was 130 m., the gear did not work satisfactorily beyond 100 m, and hence the various averages calculated here may be regarded as valid only for grounds up to 100 m. deep. It has also to be mentioned that the bulk of the effort was spent in grounds < 80 m. in depth (*see* also Sekharan *et al.*, 1968, for the distribution of effort according to depth in 1961–65; a similar pattern obtained in 1966 and 1967 also). The distribution of effort according to zones in 1964–65 has been referred to by Sekharan *et al.* (1968), where it has been shown that the bulk of the effort was spent in the 17° 40′ zone. Of the total effort of the trawlers during the four years considered here, about 79% was spent in the 17° 40′ zone,

The Annual Effort and Catches of Cat-Fishes of the Trawlers

Table III gives the annual effort and cat-fish catches of the trawlers. As is only to be expected, with increase in the size of the trawlers, the catch per hour also increased, although not directly. The importance of cat-fishes among demersal fishes in the area may also be seen from the fact that they formed 17–34% of the annual catches of the trawlers. Cat-fishes (genus *Tachysurus*) in fact constituted the largest single generic group in the trawl catches.

TABLE II

Annual catches of cat-fishes and their percentages in the catches on all fishes of the coasts on Andhra Pradesh, West Bengal and Orrissa

States	Year	Annual catch of cat fishes (m. tons)	% of cat-fishes in the catches of all fishes
Andhra Pradesh	1964	8,617	12·0
	1965	4,635	6·1
	1966	2,369	3·0
	1967	3,657	4·8
TOTAL	(1964–67)	19,278	6·3
West Bengal and Orissa	1964	400	3·8
	1965	201	1·6
	1966	174	1·7
	1967	182	1·0
TOTAL	(1964–67)	957	1·8
Total for the three States	1964	9,017	10·9
	1965	4,836	5·5
	1966	2,543	2·8
	1967	3,839	4·0
TOTAL	(1964–67)	20,235	5·7
Average for the three States ..	(1964–67)	5,059	5·7

Annual Catch Per Hour of Cat-Fishes and Their Percentage in the Total Catches from Different Zones

The depth-ranges fished in different years are indicated in Tables V-VII. The annual catch per hour of cat-fishes and their percentages in the total catches of the trawlers from different zones are presented in Table IV. Taking into account the zones which were fished for 6 months or more per year, it may be seen that the relative abundance of cat-fishes is higher, on an annual average in the 17° 40′ and 19° 10′ zones than in other zones; between the 17°40′ and 19°10′ zones, the latter shows a greater abundance of cat-fishes (*see* also Sekharan *et al.*, 1968) for annual catch-per-hour of cat-fishes in different zones during the period 1961–65).

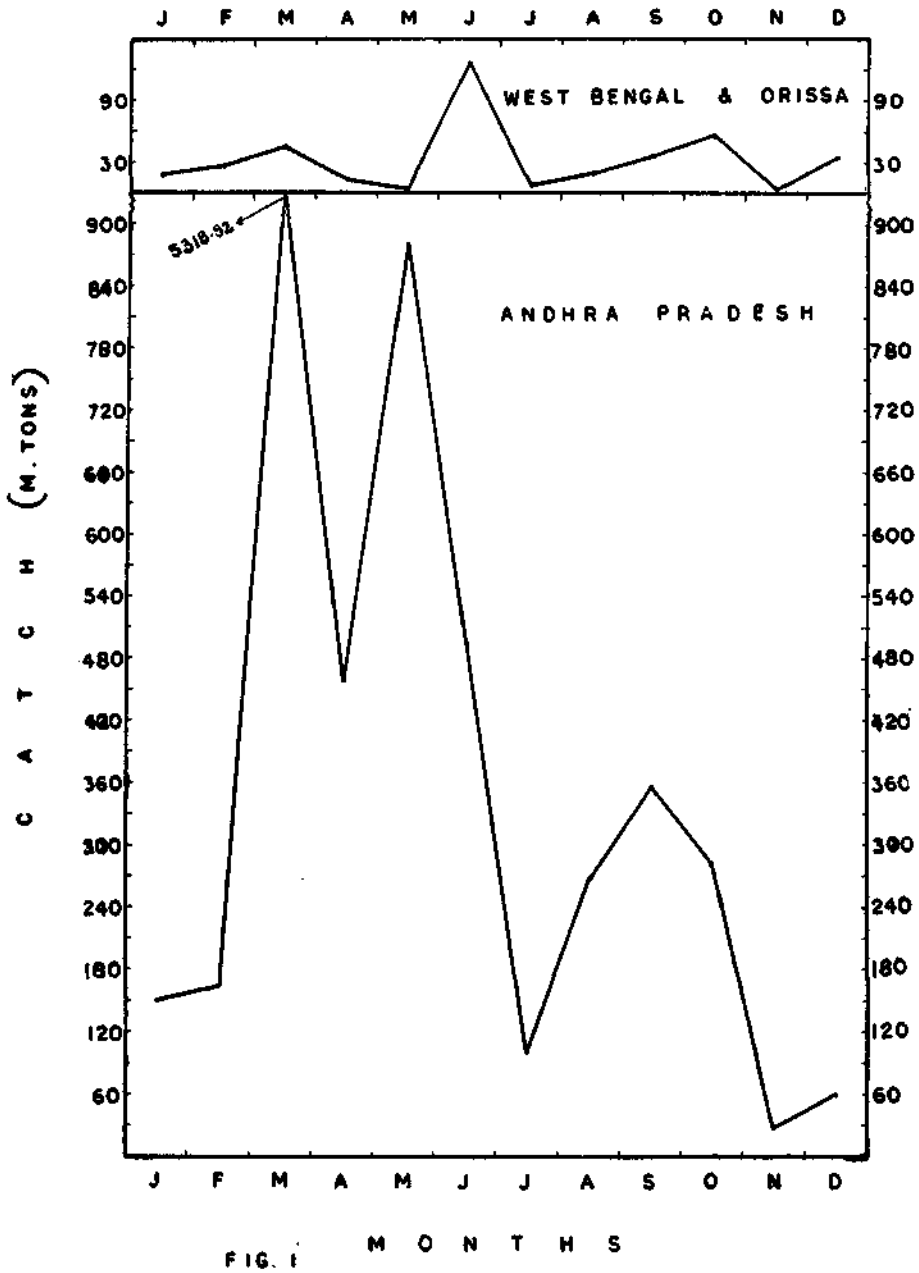

FIG. 1. The monthly commercial catch of cat-fishes on the coast of Andhra Pradesh and West Bengal and Orissa in 1964.

TABLE III

Annual effort, annual catch and catch per hour of cat-fishes and the percentage of each species of cat-fish in the total catch of all fishes, recorded by the trawlers from 1964 to 1967

Trawler	mt. t. *Ashok*				
Year	1964	1965	1966	1967	Total (1964–67)
Effort (hrs.)	796·18	451·75	930·56	463·46	2,641·95
Catch of cat-fishes (Kg.)	47,614	17,498	29,973	23,693·5	1,187,78·5
c.p.h. ,, ,, (Kg.)	59·8	38·7	32·2	51·1	45·0
% of cat-fishes in the total catch	34·1	30·1	31·7	29·1	32·8
% of *T. thalassinus* in the total catch	12·7	24·6	10·1	10·4	13·5
% of *T. tenuispinis* in the total catch	21·2	3·9	21·4	23·2	18·8
% of *T. thalassinus* among cat-fishes	37·4	81·8	31·9	30·3	41·2
% of *T. tenuispinis* among cat-fishes	62·2	12·9	67·7	67·5	57·4
Zones fished:	17° 10′–20° 40′	16° 40′–21° 10′	16° 40′–18° 10′	17° 40′ & 18° 10′	

TABLE III (Continued)

Annual effort, annual catch and catch per hour of cat-fishes and the percentage of each species of cat-fish in the total catch of all fishes, recorded by the trawlers from 1964 to 1967

	m. v. *Champa*					m. v. *Sea Horse*		
Trawler / Year	1964	1965	1966	1967	Total 1964-67	1964	1965	Total 1964–65
Effort (hrs)	447·83	866·90	826·51	622·52	2,763·76	504·47	342·39	846·86
Catch of cat-fishes (Kg.)	7,719	12,992	15,018·5	10,190·5	45,920	8,435	4,835	13,239·5
c.p.h. ,, ,, (Kg.)	17·2	15·0	18·2	16·4	16·6	16·7	14·0	15·6
% of cat-fishes in the total catch	16·7	23·8	23·3	19·3	21·1	27·4	25·2	26·5
% of *T. thallassinus* in the total catch	7·8	8·9	6·3	4·9	6·9	8·5	7·1	7·9
% of *T. tenuispinis* in the total catch	8·9	14·9	16·9	14·3	14·1	18·8	18·0	18·5
% of *T. thalassinus* among cat-fishes	46·6	37·4	27·0	25·5	32·9	30·9	28·2	29·9
% of *T. tenuispinis* among cat-fishes	53·2	62·5	72·3	74·5	66·8	68·8	71·6	69·8
Zones fished:	17° 40′ and 18°10′	17° 40′ and 18° 10′ and 21 10′	17° 40′ and 18° 10′	17° 40′		17° 40′ and 18° 10′	17° 40′ and 18..10′	

Percentage of *T. thallassinus* in the total catches of all trawlers from 1964–67 = 10·8
,, *T. tenuispinis* ,, ,, ,, = 17·2
,, *T. thalassinus* in the catches of cat-fishes ,, ,, = 38·2
,, *T. tenuispinis* ,, ,, ,, = 60·7

The Percentages of Tachysurus thalassinus *and* T. tenuispinis *in Annual Catches of the Trawlers*

The data are given in Table III. In the catches of all trawlers *T. tenuispinis* was the dominant species. It formed 17·2% of the total catch of all the trawlers from 1964 to 1967 and 60·7% of the cat-fish catches, the corresponding percentages of *T. thalassinus* being 10·8 and 38·2 (only 1% of the total cat-fish catches of the period were composed of other species).

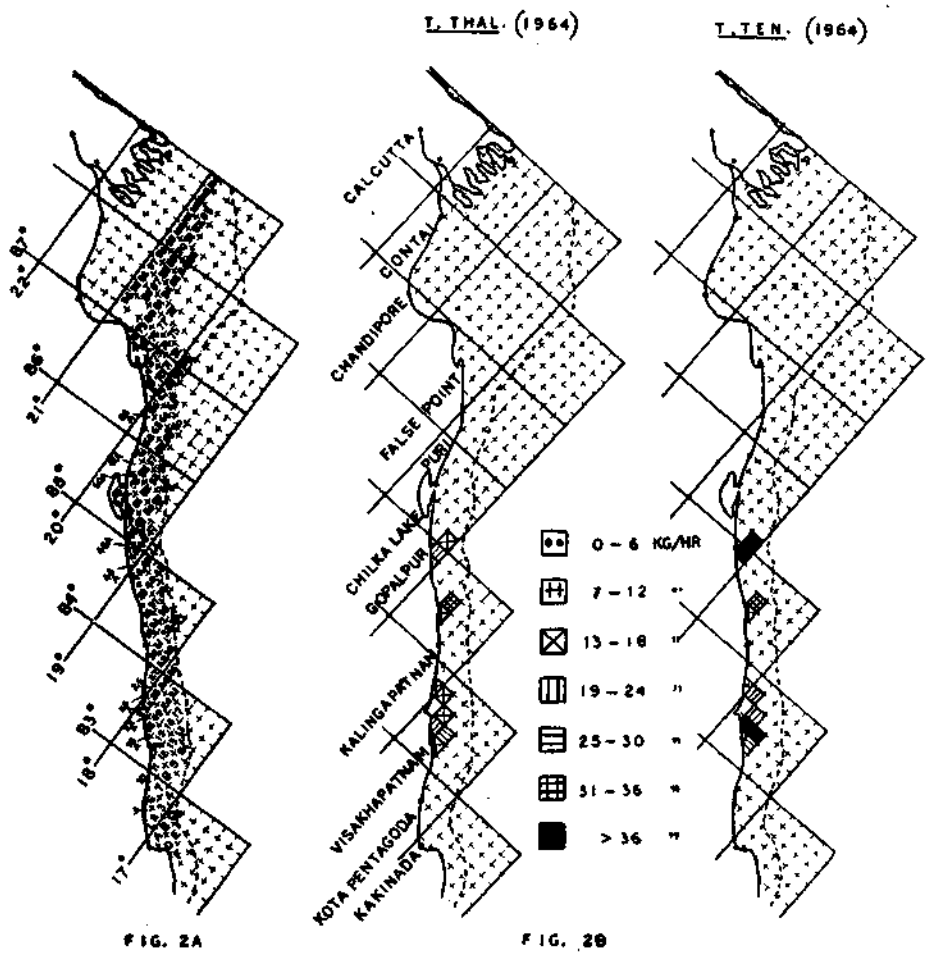

FIG. 2A. Area fished by the exploratory trawlers from 1964–67 (The area is divided into squares 10 × 10 miles each; the squares are numbered serially).

FIG. 2B. Annual c.p.h. of *T. thalassinus* and *T. tenuispinis* in squares fished for 6 months or more each by m.t. *Ashok* in 1964.

Annual Catch per Hour of the Two Species in Various Squares

The squares were divided into two categories for this purpose (*see* Sekharan *et al.*, 1968): (1) those which were fished for 6 months or more each per year, and (2) those which were fished for less than 6 months each per year. From the exploratory point of view, the results based on fishing for more than 6 months may be considered to give a fairly adequate index of the

TABLE IV

Annual catch per hour (y/g, in Kg.) and percentage (%) of cat-fishes in the total catches of all fishes, recorded by the trawlers from different Zones during 1964–67

n.f = No fishing

Year		Zones										
		16°40′	17°10′	17° 40′	18° 10′	18° 40′	19°10′	19°40′,	20°10″	20°40′	21°10′	All Zones
						m. t. *Ashok*						
1964	y/g	n.f		21·7	58·2	44·2	47·7	94·8	82·1	25·4	17·2	..	59·8
	%			34·2	48·3	31·0	33·9	31·9	29·2	7·5	29·1	n.f	34·1
1965	y/g	96·7	33·1	44·7	53·7	84·3	26·9	5·1	27·1	8·8	25·1	38·7	
	%	38·0	23·7	50·8	40·5	40·1	18·7	4·1	20·4	11·3	12·2	30·1	
1966	y/g	42·1	22·1	30·8	45·7	n.f	n.f	n.f	n.f	n.f	n.f	32·2	
	%	8·4	19·5	34·3	41·2							31·7	
1967	y/g	n.f	n.f	51·2	30·8	n.f	n.f	n.f	n.f	n.f	n.f	51·1	
	%			34·4	31·0							29·1	
						m. v. *Champa*						
1964	y/g	n.f	n.f	10·5	50·9	n.f	n.f	n.f	n.f	n.f	n.f	17·2	
	%			11·0	36·4							16·7	
1965	y/g	n.f	n.f	15·2	13·9	n.f	n.f	n.f	n.f	n.f	9·5	15·0	
	%			24·8	17·7						35·6	23·8	
1966	y/g	n.f	n.f	18·2	16·6	n.f	n.f	n.f	n.f	n.f	n.f	18·2	
	%			23·9	14·1							23·3	
1967	y/g	n.f	n.f	16·4	n.f	n.f	n.f	n.f	n.f	n.f	n.f	16·4	
	%			19·3								19·3	
						m. v. *Sea Horse*						
1964	y/g	n.f	n.f	16·4	24·2	n.f	n.f	n.f	n.f	n.f	n.f	16·7	
	%			27·7	22·6							27·4	
1965	y/g	n.f	n.f	14·8	7·8	n.f	n.f	n.f	n.f	n.f	n.f	14·0	
	%			26·0	17·3							25·2	

annual relative abundance of a species in that square. The results of *Ashok*, *Champa* and *Sea Horse* are dealt with separately. (*a*) *m.t. Ashok* (Figs. 2-5).—The square-wise annual catch per hour ranges in respect of each species are marked in Figs. 2-5. The number of squares falling in the different catch per hour ranges are given below.

Annual c.p.h. range (Kg)	*T. thalassinus*				*T. tennispinis*			
	1964	1965	1966	1967	1964	1965	1966	1967
	Squares fished for less than 6 months each							
0–6	6	25	8	2	12	59	11	1
7–12	4	8	2	1	4	2	4	1
13–18	6	7	4	2	2	3	1	..
19–24	7	2	2	..	1	1	..	1
25–30	4	5	2	..	3	2	..	1
31–36	2	3	..	..	3	2	..	..
>36	3	22	1	..	7	3	3	1
TOTAL ..	32	72	19	5	32	72	19	5
	Squares fished for 6 months or more each							
0– 6	0	0	1	0	0	0	0	0
7–12	0	0	1	0	1	0	0	0
13–18	6	0	0	1	1	0	1	0
19–24	1	0	0	0	1	0	0	0
35–30	2	0	0	0	2	0	0	1
31–36	1	0	0	0	1	0	1	0
>36	0	0	0	0	4	0	0	0
TOTAL	10	..	2	1	10	..	2	1

Figures 2-5 show that there are good grounds for both species off Visakhapatnam, Calingapatnam, Gopalpur and Chilka Lake. *T. tenuispinis* appears to be poorly represented, compared to *T. thalassinus*, in the Kakinada and Sand Heads region, but since these grounds were fished for less than 6 months per year, more fishing will have to be undertaken to confirm it.

The annual cat per hour of the vessels m.v. *Champa* and m.v. *Sea Horse* (Tables V and VI) show that *T. tenuispinis* in the more abundant species in the Visakhapatnam region than *T. thalassinus* (as also shown by the data of *Ashok*).

Annual Catch Per Hour in Different Latitude Zones

The squares were grouped into half-degree latitude zones and the annual catch per hour in each zone calculated. Like the squares the zones were also grouped into two categories: those which were fished for 6 months or more per year each and those which were fished for less periods. Both species were recorded in all the depth-ranges fished (*i.e.*, up to 100 m, for, as stated already, the gear used did not work satisfactorily in deeper grounds).

(*a*) *Ashok* (Table VII).—The data of 1964 are more satisfactory than those of other years in regard to the determination of spatial variation in the relative abundance of fishes, 5 zones having been fished for 6 months or more each during that year. From Table VII two zones of abundance

TABLE V

Annual catch per hour (Kg.) of T. thalassinus (T. th.) *and* T. tenuispinis (*T. ten.*) *recorded from different squares by m. v.* Champa

Square	Catch per hour in								Arithemtic average of annual of c.p.h. from 1964 to 1967	
	1964		1965		1966		1967			
	T. th	T. ten	T. th	T. ten	T. th	T. ten	T. th	T. ten	T. th	T. ten
11	n.f		6·5	12·1	2·8	0·0	n.f		9·7	6·1
12	n.f		2·0	4·1	13·7	6·4	0·0	2·0	5·2	4·2
13	0·0	18·8	2·0	8·0	n.f		n.f		1·0	13·4
14	0·5	2·5	2·1	8·1	3·3	15·5	3·4	15·0	2·3	10·4
15	4·8	4·6	12·9	4·5	6·0	15·5	1·2	13·6	6·2	9·6
16	2·4	17·3	15·8	24·8	5·4	2·6	n.f		5·9	14·9
18	5·0	4·8	2·6	10·7	5·5	11·5	5·0	10·1	4·5	9·3
19	5·8	8·4	3·3	5·7	5·5	10·7	2·8	5·0	4·4	7·5
20	0·0	0·0	n.f		n.f		n.f		0·0	0·0
22A	n.f		0·0	0·0	n.f		n.f		0·0	0·0
22	28·0	10·4	3·6	3·7	6·2	9·4	n.f		12·6	7·8
23	26·8	106·1	6·3	25·2	11·7	14·3	n.f		14·9	48·5
26	28·9	0·1	0·0	0·0	n.f		n.f		14·5	0·1
27	35·2	46·5	0·0	0·0	n.f		n.f		17·6	23·3
28	3·6	7·6	0·0	0·0	n.f		n.f		1·8	3·8
99	n.f		7·0	0·0	n.f		n.f		7·0	0·0
100	n.f		9·8	0·2	n.f		n.f		9·8	0·2
Annual Average c.p.h.	8·0	9·2	5·6	9·4	4·9	13·1	4·2	12·2	5·7	11·0

Note: (1) The squares 14 and 18 were fished for 6 months or more per year in all years, 15 in 1964, 1965 and 1966, 19 in 1964 and 1966, 22 in 1964 and 1965 and 23 in 1965. The others were fished for < 6 months per year in all years.

(2) The depth-ranges fished were 10–99 m. in 1964 and 1965 10–69 m. in 1966 and 10–59 m. in 1967.

may be recognised for both species: the first one is 17° 40′ for both; but the other one is 19° 40′ for *T. thalassinus* and 19° 10′ for *T. tenuispinis*. This difference may of course be expected on biological considerations, although it may also arise due to sampling error. The data show that in the two southernmost (16° 40′ and 17° 10′) and the three northernmost (20° 10—21° 10′) zones, *T. thalassinus* is the dominant species, whereas in the middle zones (17° 40′—19° 40′), *T. tenuispinis* in the dominant species. But then these southernmost and northernmost zones were fished for less than 6 months each per year; moreover they were fished mostly during the December-April period

TABLE VI

Annual catch per hour (Kg.) of T. thalassinus *(T. th.) and* T. tenuispinis *(T. ten.) recorded from different squares by m. v.* Sea Herse

Squares	Catch per hour in 1964		1965		Arithemetic average of annual c.p.h. in 1964 and 1965	
	T. th	T.ten	T. th	T. ten	T. th	T. ten
11	n.f		0·0	0·0	0·0	0·0
12	0·0	2·0	0·0	22·4	0·0	12·2
13	1·7	1·4	4·1	14·0	2·9	7·7
14A	n.f		4·6	12·8	4·6	12·8
14	1·6	3·5	4·8	12·7	3·2	8·1
15	5·3	8·2	3·0	26·5	4·2	17·4
16	5·5	5·7	n.f		5·5	5·7
18A	n.f		0·6	11·7	0·6	11·7
18	4·9	12·0	2·8	6·9	3·9	9·5
19	7·2	27·7	5·9	0·6	6·6	14·2
20	n.f		5·6	0·0	5·6	0·0
21	n.f		2·8	0·0	2·8	0·0
22	19·9	8·4	9·6	0·0	14·8	4·2
23	15·5	4·2	4·5	5·8	10·0	5·0
24	n.f		0·0	0·0	0·0	0·0
25	n.f		0·0	0·0	0·0	0·0
26	n.f		0·0	0·0	0·0	0·0
27	n.f		0·0	0·0	0·0	0·0
28	n.f		0·0	0·0	0·0	0·0
Annual average c.p.h.	5·2	11·5	4·0	10·0	4·6	10·8

Note: (1) The following squares were each fished for 6 months or more per year: 14 in 1964 in 1965; 15, 16, 18 and 19 in 1964 and 1965.

(2) The depth-ranges fished were 10–79 m. in 1964 and 19–89 min 1965.

when even in the middle zones *T. thalassinus* attains dominance over the other species (as will be shown below). Hence the apparent dominance of the former in the southernmost and northernmost zones could be a result attributable to inadequacy of sampling.

(*b*) *Champa and Sea Horse.*—In Tables V and VI the squares 11-20 belong to the 17° 40′ zone, 22A-28 to the 18° 10′ zone and 99 and 100 to the 21° 10′ zone. These data also indicate *T. tenuispinis* to be the dominant species of cat-fishes in the 17° 40′ and 18° 10′ zones.

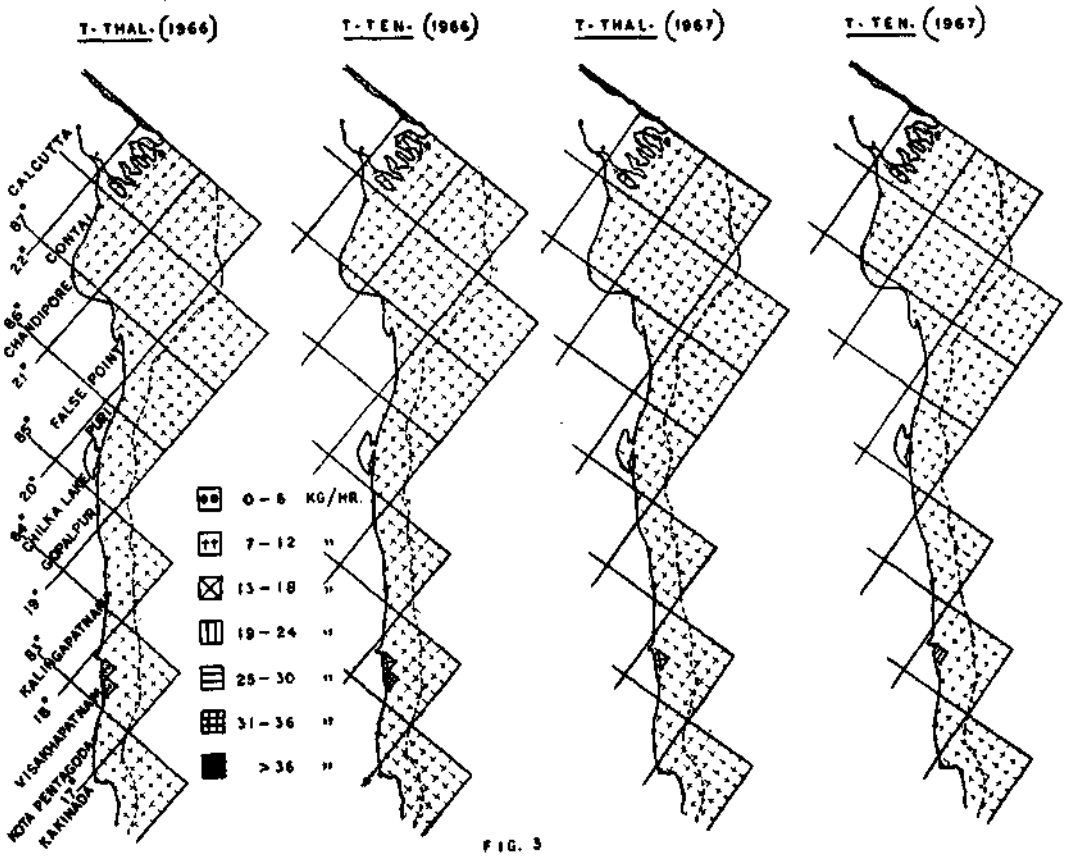

FIG. 3. Annual c.p.h. of *T. thalassinus* and *T. tenuispinis* in squares fished for 6 months or more each by m.t. *Ashok* in 1966 and 1967.

Seasonal Variations in the Abundance of the Two Species in the Zones

The data of the trawlers were also analysed in order to study the variations in the relative abundance of the two species in various months. The discussion below is confined mainly to the zones fished for 6 months or more each per year.

(*a*) *m.t. Ashok* (Fig. 6).—For *T. thalassinus*, generally three peaks are seen in the monthly catch per hour in a year, which in the various zones fall roughly in the periods February-April, May-July and October-November. The highest catch per hour is obtained during the first period in the 17° 40′ and 18° 10′ zones, but during the second period in the zones farther north (18° 40′-19° in the figure for 1964). The possibility of a south to north time-lag in the occurrence of peaks is also indicated by the data of March-June in the 17° 40′-19°10′ zones in 1964, but it could not be investigated in other years because of inadequacy of data.

Three peaks in the monthly catch per hour are observed for *T. tenuispinis* also, which in the various zones fall in the periods February-April, May-July, and October-December. However all

the three peaks are apparent only in the three southern zones, 17° 40′-18° 40′, but not in the two northern zones, 19° 10′ and 19° 40′, possibly because these latter were fished for > 6 months only in one year.

TABLE VII

Annual catch per hour (in Kg.) of T. thalassinus (*T. th.*) *and* (T. tenuispinis (*T. ten.*) *recorded from different Latitude Zones by m.t.* Ashok. n.f = not finished

Sl. No.	Zones	Catch per hour in 1964		1965		1966		1967		Arithmetic average of annual c.p.h. from 1964 to 1967	
		T. th	T. ten	T. th	T. ten	T. th	T. ten	T. th	T. ten	T. th	T. ten
1	16° 40′	n.f		70·2	26·5	42·1	0·0	n.f		56·2	13·3
2	17°10′	11·5	10·3	16·6	6·5	19·3	2·8	n.f		19·1	6·5
3	17° 40′	24·3	33·8	41·3	3·4	9·4	21·3	15·5	34·6	22·6	23·3
4	18° 10′	21·6	22·5	34·7	6·5	6·6	39·2	21·2	9·6	21·3	19·5
5	18° 40′	21·6	26·1	57·7	26·6	n.f		n.f		39·7	26·4
6	19° 10′	20·9	73·3	26·5	0·4	n.f		n.f		23·7	36·9
7	19° 40′	27·6	53·9	5·0	0·1	n.f		n.f		16·3	27·0
8	20° 10′	20·2	5·2	31·3	0·8	n.f		n.f		25·8	3·0
9	20° 40′	17·2	0·0	8·7	0·1	n.f		n.f		13·0	0·1
10	21° 10′	n.f		24·2	0·9	n.f		n.f		24·2	0·9
Annual average c.p.h.		22·6	37·2	31·7	5·0	10·3	21·8	15·5	34·5	20·0	24·6

Note: (1) The following Zones were fished for 6 months or more per year: Zones 3–7 in 1964, 4 in 1965 and 3 in 1966 and 1967. The other Zones were fished for < 6 months per year each.

(2) The depth-ranges covered were 20–99 m. in 1964, 10–129 m. in 1965 and 20–69 m. in 1966 and 1967.

Figure 7 gives the monthly catch per hour of the twc species in zones fished for < 6 months each per year. Both species have peaks in February in the 20° 10′–21° 10′ zones. For the 16° 40′ and 17° 10′ zones the data are not enough to indicate catch per hour peaks.

(*b*) *m.v. Champa* (Fig. 8).—The trends of the monthly variations in catch per hour generally agree with those observed from the data of *Ashok*. But certain minor variations are also apparent. In the 17° 40′ and 18° 10′ zones the first peak for *T. thalassinus* as shown by the *Ashok* data is in February-April, but it may occur any time between January and May as shown by the data of *Champa*. Similarly for *T. tenuispinis* the first peak in the 17° 40′ and 18° 10′ zones is in February-April, as seen from the data of *Ashok* but in March-May, as seen from the data of *Champa*.

(*c*) *m.v. Sea Horse* (Fig. 9).—All the three peaks for the two species shown by data of other vessels are not apparent in the data of this trawler, possibly because it stopped fishing after June 1965. However, the peaks indicated generally correspond to those seen from the data of the other vessels.

The Difference in the Peodris of Abundance of the Two Species

No marked displacement in time of the peaks in the catch per hour of one species in relation to that of the other is observed. However Figs. 6–9 show another important feature: that from March to September in 17° 40′-19°40′ zones, *T. tenuispinis* is the dominant species and that in other months *T. thalassinus* is the dominant species. But March-September being the main period of abundance of cat-fishes as a group, it is apparent that the magnitude of annual cat-fish catches would be determined more by the relative abundance of *T. tenuispinis* than by that of *T. thalassinus*. In the 16° 40′-17° 10′ and 20° 1′-21° 10′ zones there was inadequate fishing during the March-September period, as already stated.

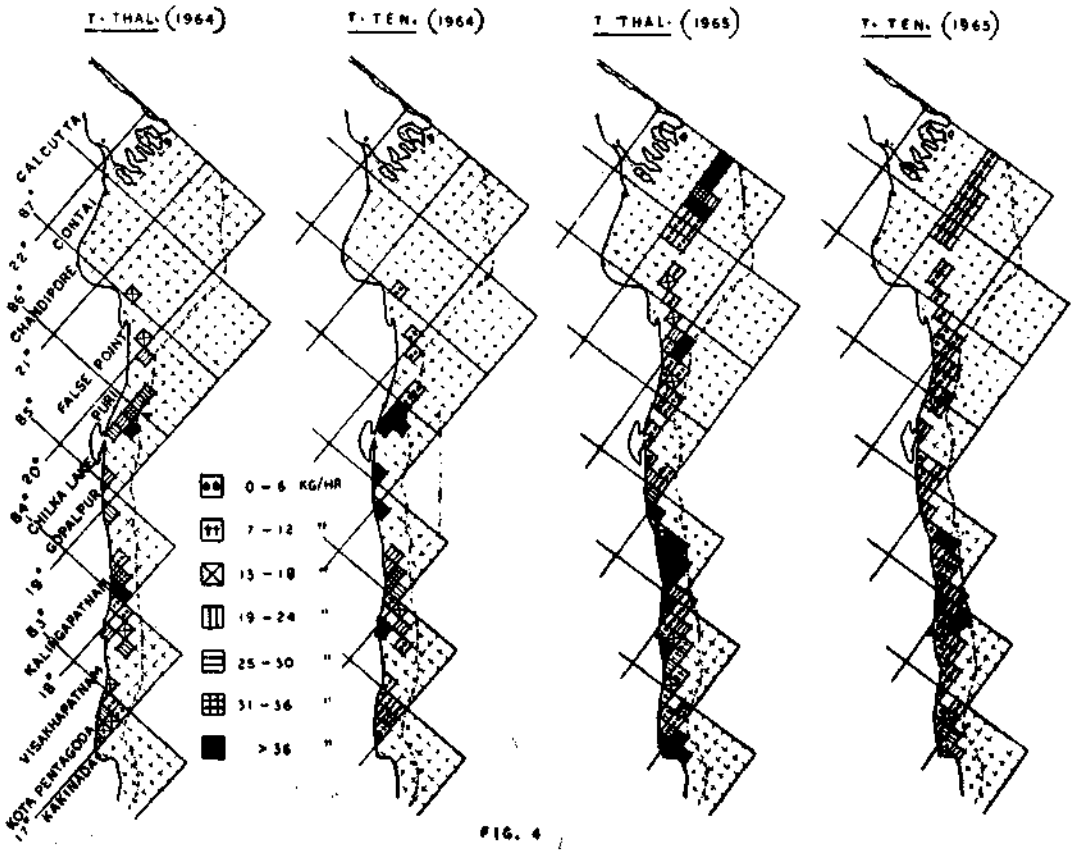

FIG. 4. Annual c.p.h. of *T. thalassinus* and *T. tenuispinis* in squares fished for less than 6 months each by m.t. *Ashok* in 1964 and 1965.

Cat-Fishes in Relation to Other Groups of Fishes

Cat-fishes form the dominant category of fishes in grounds > 30 m. deep from March-June and in December-January (Sekharan *et al.*, 1968), From what has been stated already the March-June dominance may be attributed mainly to *T. tenuispinis* and the December-January dominance mainly to *T. thalassinus*.

Size-Groups Caught

Tachysurus thalassinus of the size-range 6-80 cm. are represented in the inshore commercial fishery; fish above 50 cm. in length are landed mainly by hooks and lines. In regard to *T. tenuispinis* the

size-range in the inshore commercial catches is 6-60 cm., fish above 45 cm. long being caught mainly by hooks and lines. In exploratory trawls, the catches of *T. thalassinus* consisted mostly of the size-range 12-55 cm. and of *T. tenuispinis* of 12-45 cm.; larger fishes were recorded only rarely.

Price Structure

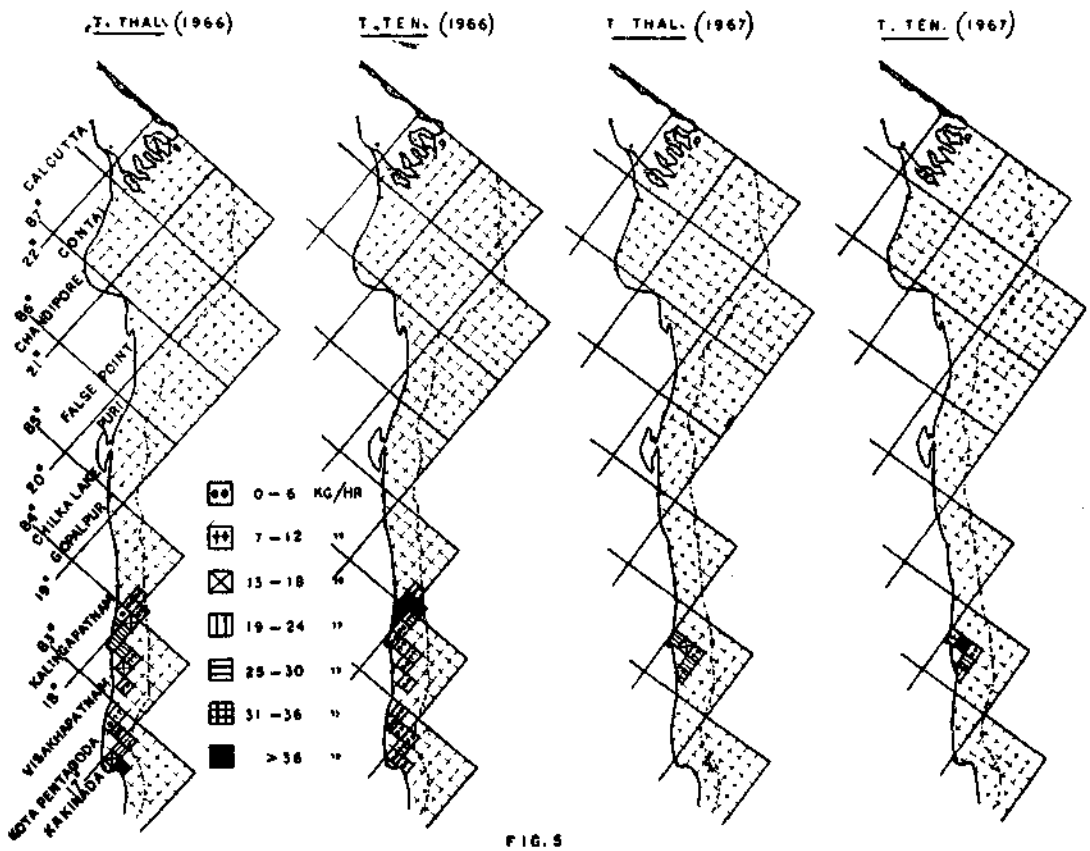

FIG. 5. Annual c.p.h. of *T. thalassinus* and *T. tenuispinis* in squares fished for less than 6 months each by m.t. *Ashok* in 1966 and 1967.

T. thalassinus is the more esteemed of the two species and sells at Rs. 0·50-1·25 per kg. in retail. The price of the other species varies from Rs. 0·35-0·75 per kg. in retail.

Mode of Utilisation

Cat-fishes are mostly consumed in the fresh condition and are only rarely preserved in ice or dried. The air-bladder is used in the preparation of ising glass.

DISCUSSION

Tachysurus thalassinus grows to more than 90 cm. in the Indian region (Devanesan and Chidambaram, 1953). There is no record of the maximum size attained by the other species; the largest fish observed by the present author was 60 cm. in length. But sizes above 55 cm. of the former and above 45 cm. of the latter are only rarely landed by the trawlers; they are landed mainly

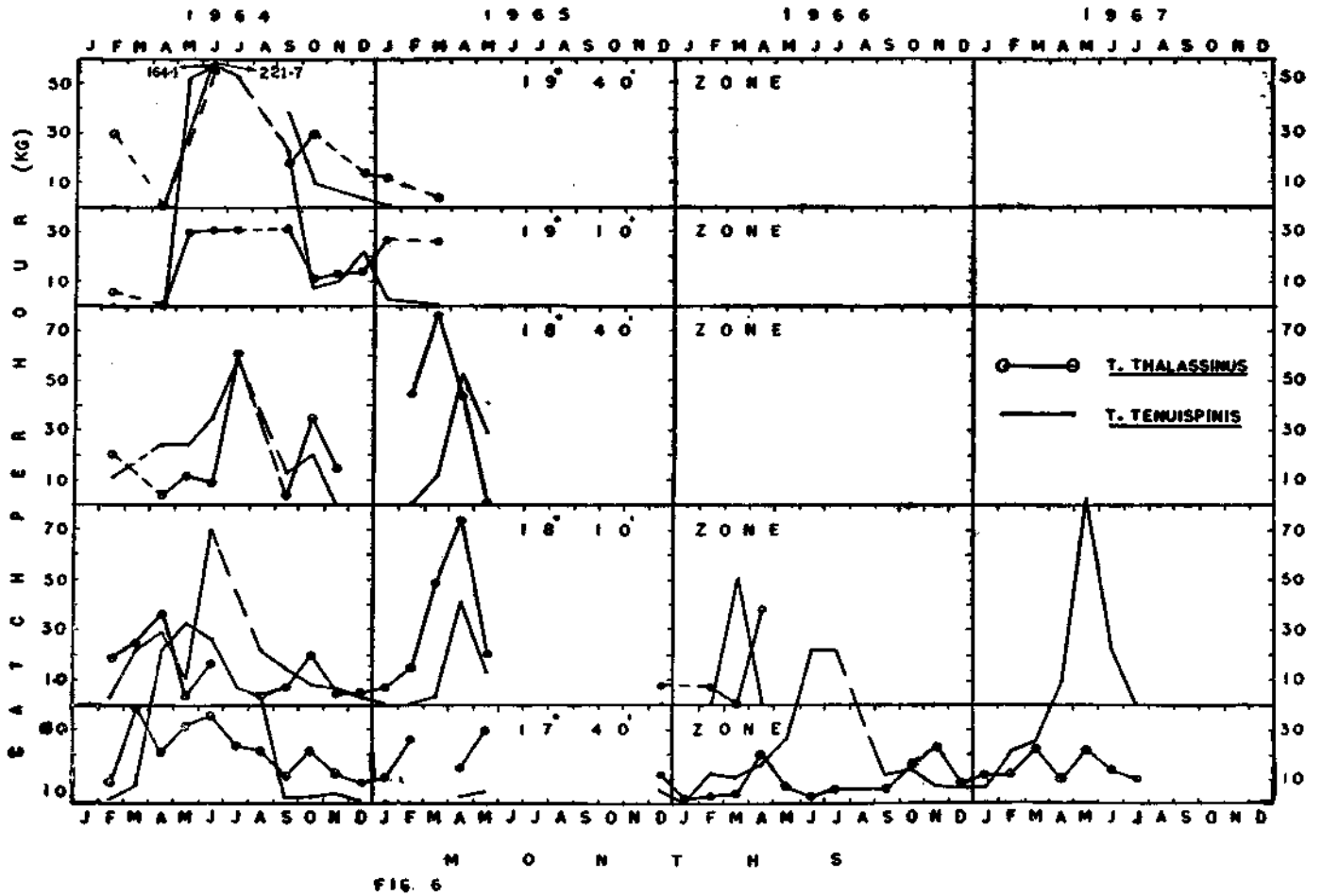

FIG. 6

FIG. 6. Monthly c.p.h. of *T. thalassinus* and *T. tenuispinis*, as recorded by m.t. *Ashok* from the zones 17° 40′ – 19° 40′.

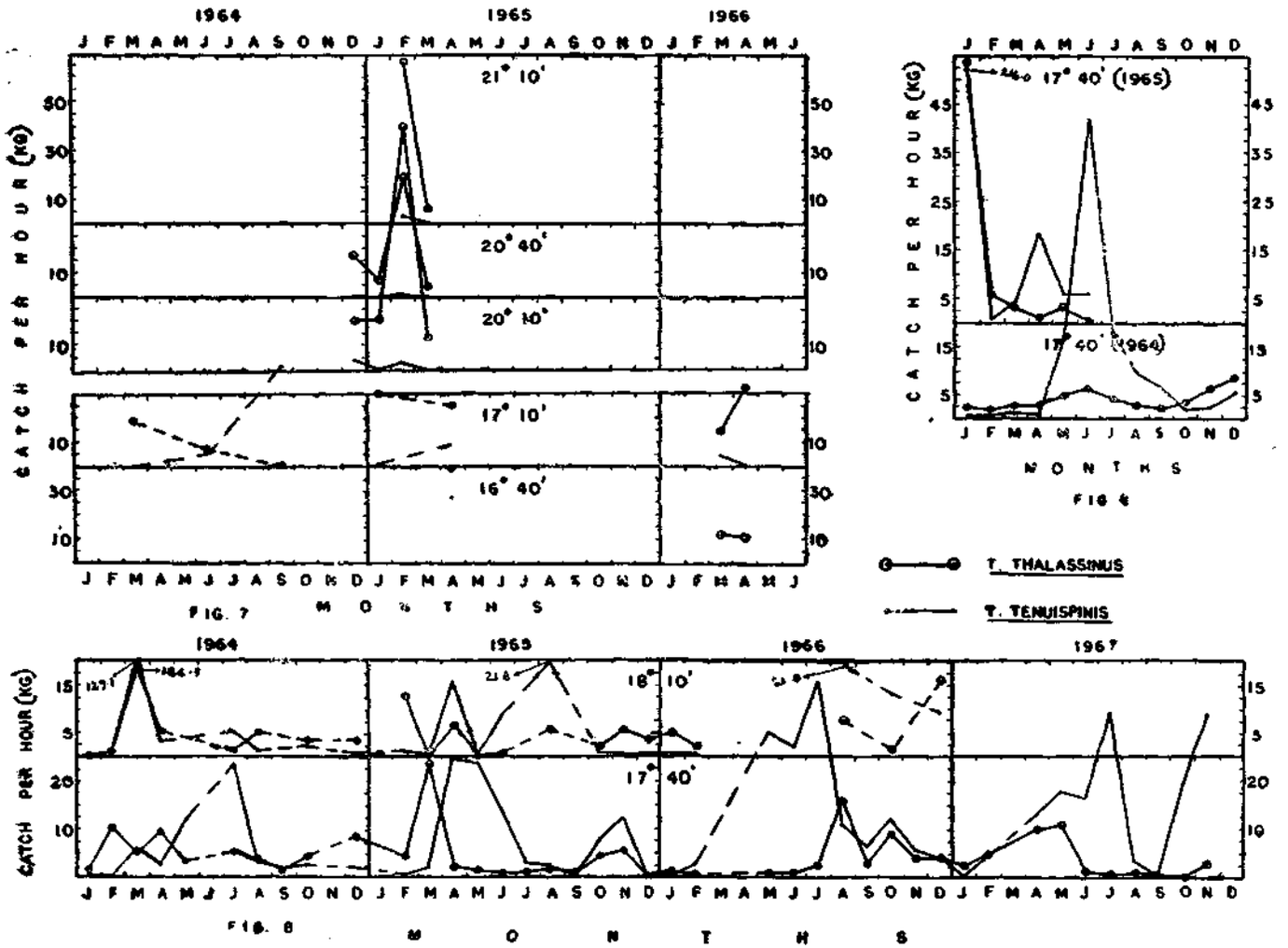

FIG. 7 MONTHS

FIG. 6

FIG. 8 MONTHS

FIG. 7. Monthly c.p.h. of *T. thalassinus* and *T. tenuispinis*, as recorded by m.t. *Ashok* from the zones 16° 40, 17° 10′ and 20° 1 0′–21° 10′.

FIG. 8. Mont hly c.p.h. of *T. thalassinus* and *T. tenuispinis*, as recorded by m.v. *Champa* from 17° 40′ and 18° 10′ zones.

FIG. 9. Monthly c.p.h of *T. thalassinus* and *T. tenuispi is*, as recorded by m.v. *Sea Horse* from the 17°40′ zone.

by hooks and lines. Whether changes in the trawling method would be effective in catching large cat-fishes would have to be investigated in future.

The present study shows that on an annual average cat-fishes as a group are relatively more abundant in the 17° 40′ and 19° 10′ zones than in others. This is in agreement with the observations on the abundance of cat-fishes made by Sekharan *et al.* (1968), based on the study of the exploratory trawl data for 1961-65, and by Sheriff (1961) and Polikov (1961), based on the analysis of the exploratory trawl data for 1960 in the area. The species composition of the cat-fish catches in the area has however not been studied before.

For *T. thalassinus* considered together with another species *T. dussumeri* on the coasts of Andhra Pradesh and Madras, Devanesan and Chidambaram (1953) found two periods of peak catches in a year: in February-March and September. According to them, shoals of these fishes occur off the Malabar coast (on the west coast of India) during August-March. The present study of trawl data shows that off the north-east coast of India, *T. thalassinus* and *T. tenuispinis* each have three periods of peak abundance in a year: March-May, May-July and October-December. These are also the periods of peaks in the commercial fishery of cat-fishes (of non-powered boats). But the patterns of seasonal abundance described here are based on monthly data obtained without reference to the depth-ranges. Sekharan *et al.* (1968) have shown that during February-April and October-December, the inshore regions (< 50 m. in depth) have greater abundance of cat-fishes than the deeper regions (> 50 m. in depth), and in July-September, the latter regions have greater abundance. Obviously non-powered boats would not be able to exploit effectively the deeper regions during July-September, especially because the sea is rough during that period.

Although *T. thalassinus*, the more esteemed of the two species dominates the cat-fish catches from October to March, its highest catch per hour may not be obtained in these months, but may in fact be obtained during the other months, as in the case of *T. tenuispinis*. In other words, the March-September increase in the relative abundance of cat-fishes in the area explored is the result of increased abundance of both species in that period, compared to the other periods.

The present study covers grounds up to 100 m. in depth for both species off the north-east coast of India; the data obtained on their relative abundance in the area is obviously only partial and will have to be supplemented by trawling in deeper grounds in future. What is however important to note is that at present commercial fishing does not extend beyond 50 m. depth. On the other hand, in grounds > 30 m. deep cat-fishes are the dominant category of fishes in March-June and December-January (Sekharan *et al.*, 1968). These considerations would indicate that the cat-fish catches off the north-east coast of India can be stepped up considerably. From the data given by Sekharan *et al.* (1968) for the estimation of the minimum annual catches that may be expected by commercial trawlers stationed at Visakhapatnam and operating in the north-western Bay of Bengal, the minimum expected annual catches of cat-fishes may also be calculated. (According to Sekharan *et al.*, about 21% of total catches would be composed of cat-fishes. This percentage is used here). From the results of the present study, the expected share of the two species may also be calculated. (*T. thalassinus* may be expected to comprise 38·2% and *T. tenuispinis* 60·7% of the cat-fish catches, *see* Table III).

		Classes of trawlers		
		Side-trawler	Stern trawlers	
		Ashok 25 m; 91·7 tons (gross); 240 HP 15 m. Otter trawl	*Champa* 14 m. 34·53 tons (gross); 165 HP 14 m. Otter trawl	*Sea Horse.* 13·7 m; 26 tons (gross); 56 HP 12 m. Otter trawl
1. Minimum expected no. of days per year out of port		189	235	235
2. Total minimum expected annual effort (hrs.)		1,890	1,060	1,000
3. Annual minimum Total catches expected (m tons)	Range	250–390	67–174	56–94
	Average	283	125	76
4. Annual minimum catfishes catches expected (m tons)	Range	53–82	14–37	12–20
	Average	59	26	16
5. Annual minimum expected catch of *T. thalassinus* (m. tons)	Range	20–31	5–14	5–8
	Average	23	10	6
6. Annual minimum expected catch of *T. tenuispinis* (m. tons)	Range	32–50	8–22	7–12
	Average	35·8	15·8	9·7
7. Expected average catch per day out of port (of all cat-fishes) (Kg).	Range	280–434	60–157	51–85
	Average	312	111	68

The average expected catch per day, of all cat-fishes, of the smallest of the trawlers considered is about 3 times that realised by non-powered boats at present—an indication of the superiority of trawling over other methods now in vogue for catching cat-fishes.

Summary

Hooks and lines with catamarans, boat-seines with catamarans, shore-seines with masula boats, and drift-nets and gill nets with catamarans are the important fishing units used in the commercial fishery for cat-fishes along the northern section of the east coast of India, comprising the coasts of Andhra Pradesh, Orissa and West Bengal. The present annual catches of cat-fishes in the area are of the order of 2,500-9,000 m. tons, forming 3-11% of the catches of all fishes. The fishery has peaks in March, May-June and September-October. The important species represented in the fishery are *Tachysurus thalassinus* (Rüpp) and *T. tenuispinis* (Day). At present the fishery is confined to grounds < 50 m. deep.

The catch data of exploratory trawlers from 1964-67 were also analysed to study the relative abundance of cat-fishes in the area between Kakinada and Sand Heads. Cat-fishes comprised 28% of the catches of the trawlers during the period. *T. thalassinus* formed 38·2% and *T. tenuispinis* 60·7% of the cat-fish catches. On annual average, *T. thalassinus* is more abundant in the zones around 17° 40′ N and 19° 40′ N and *T. tenuispinis* in the zones around 17° 40′ N and 19° 10′ N Lat. than in others. Each species has three periods of peak abundance in a year, falling roughly in February-April, May-July and October-December

T. thalassinus of the size-range 6-80 cm and *T. tenuispinis* of the size-range 6-60 cm. are landed commercially; in exploratory trawls, the catches consisted mostly of 12-55 cm. of the former and 15-45 cm. of the latter species.

It is estimated that in commercial trawling in the area with Visakhapatnam as the base, a 25 m. side-trawler with 15 m. otter trawl should be able to land 53—82m. tons, a 14 m. stern trawler with 14 m. otter trawl 14-37 m. tons, and 13·7 m. stern trawler with 12 m. otter trawl 12-20 m. tons catfishes per year. The expected minimum annual catches of the two species are also estimated. It is shown that the expected catch per day, of all cat-fishes, of the smallest trawler considered would be about 3 times that realised by non-powered boats in the commercial fishery at present.

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