

EXPLORATORY TRAWL FISHING IN BOMBAY-SAURASHTRA WATERS DURING 1968-70

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ABSTRACT

The paper deals with the exploratory trawl fishing conducted in Bombay-Saurashtra waters by the Bombay-based vessels of the now Exploratory Fisheries Project, Government of India, during 1968-70. The detailed study is based on the trawling data in respect of M. T. KALYANI IV and M. T. KALYANI V, as these vessels have done extensive fishing, covering larger number of areas from Goa to Dwaraka, used the same type of gear and have identical specifications. The areawise abundance and seasonal distribution of 10 categories of fishes in 8 major areas, where a fishing effort of more than 100 h each was expended, are examined. The monthly variation in abundance and depthwise distribution of 5 groups of quality fishes in two most intensively fished areas (18-72 and 19-71) and in one area (22-68) rich in these fishes are studied. The results of these studies are compared with, and discussed in the light of the earlier findings.

INTRODUCTION

Eversince the first attempt in trawl fishing in Indian waters by about the turn of this century, the northeastern part of the Arabian Sea bordering the Bombay-Saurashtra regions has been in prominence, because of its being frequently fished by governmental and private agencies alike. A historical account of these operations has been given by Jayaraman *et al* (1959). Based on the operations of two pairs of bull-trawlers commissioned by the New India Fisheries Company which started functioning in Bombay in 1956, Rao *et al* (1966) established the relative potentiality of different regions and furnished additional information on the distribution of different groups of demersal fish. The exploratory fishing by the Government of India vessels from 1961 to 1967 was dealt with by Rao *et al* (1972). In the present paper an attempt is made to study the relative abundance of major groups of demersal fish and their seasonal and depthwise distribution. This covers the subsequent trawling operations from Bombay base by the vessels of the now Exploratory Fisheries Project, Government of India, in Bombay-Saurashtra waters during 1968-70.

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VESSELS, AREAS OF OPERATION AND CATCH COMPOSITION

Six vessels, viz. M. T. KALYANI IV, M. T. KALYANI V, M. T. MATSYAVIGYANI, M. V. MEENAKHOJINI, M. V. MEENAPRAYAS and M. V. SAGARKUMARI, operated from Bombay base, the operational details of which are given in Table 1. All the 6 vessels together covered 173 subareas spread over in 17 major areas from 15-73 in the south (off Goa) to 22-68 in the north (off Dwaraka). In 1968 there was fishing only for the first 6 months covering 12 major areas. In the next year, though more areas were covered and the fishing effort increased by about two and half times, the increase in catch was only marginal, as a result of lower catch rates. Six areas were covered in 1970 and the yield was the lowest in 3 years. Of the 17 major areas fished, only 5 were covered in all the years, accounting for 54% of the total catch and 68% of the total fishing effort. Amongst the 6 vessels, the KALYANI type alone did extensive fishing, covering all the major areas; together they spent about 90% of the total fishing effort put in by all the vessels, realising 97% of the catch. Because of this and also their identical specifications, the data in respect of these two vessels only are taken into consideration for detailed investigation.

In Figure 1 the subareas fished during the entire period are shown, and are graded according to the catch-per-hour returns obtained during the 3-year period. The 10 main categories of fishes, as hitherto followed in earlier works, ('Ghol' — *Pseudosciaena diacanthus*, 'Koth' — *Otolithoides brunneus*, 'Dhoma'

TABLE 1. Operational details of Government of India vessels at Bombay base during 1968-70.

Vessels	Horse Power	Nos. of days absent from port	No. of fishing days	Gear used	Fishing effort (hours)	Catch (kg)	Catch per hour (kg)
M. T. Matsyavigyani	578	2	2	45-meter trawl	16.32	2,538	155.51
M. T. Kalyani IV	300	220	192	28,30,35,45,50, 53 & 55-m trawl	1,190.90	347,241	291.58
M. T. Kalyani V	300	168	119	30,35,45 & 50-m trawl	1,964.23	510,137	259.71
M.F.V.Meenakhajini	200	22	27	24 & 26-m trawl	93.20	11,731	125.88
M.F.V.Meenaprayas	200	11	7	26-m trawl	63.68	5,657	88.83
M. L. Sagarkumari	42	35	35	12-m trawl	160.16	3,061	19.11

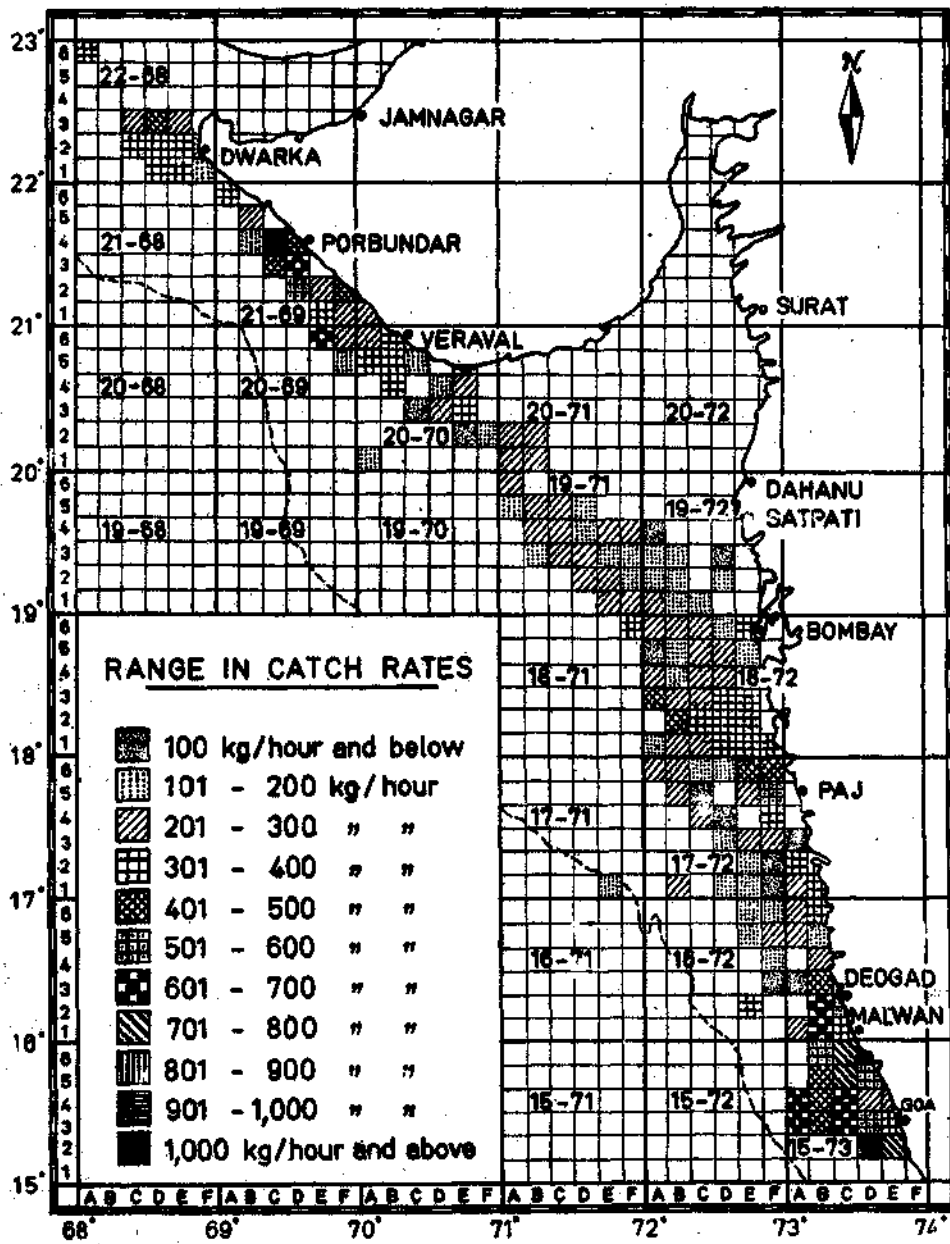


FIG. 1. Subareawise production of demersal fish, based on the average catch per hour during 1968-70. (Areas 22-67|2E, 6E, 6D & 6C which gave less than 400 kg/h each are not shown).

TABLE 2. Yearwise catch particulars of 10 categories of fishes. (Pooled data in respect of all the 6 vessels given in brackets).

	1968*		1969		1970		Total	
Fishing effort (Hrs.)	790		1,708.72 (1,884.40)		656.41 (814.10)		3,155.13 3,488.50	
Categories of fish	Catch (kg)	Percentage	Catch (kg)	Percentage	Catch (kg)	Percentage	Catch (kg)	Percentage
Ghol	10,419	3.10	44,529	11.28	7,719	6.08	62,667	7.32
	..	..	(44,584)	(11.16)	(8,314)	(5.74)	(63,317)	(7.20)
Koth	925	0.27	20,112	5.10	1,540	1.22	22,577	2.63
	..	..	(20,147)	(5.05)	(1,865)	(1.28)	(22,937)	(2.60)
Dhoma	150,725	44.86	54,651	13.85	18,190	14.33	223,566	26.07
	..	..	(57,122)	(14.30)	(19,632)	(13.55)	(227,479)	(25.84)
Dara	570	0.17	24,846	6.30	787	0.62	26,203	3.05
	..	..	(24,846)	(6.22)	(787)	(0.54)	(26,203)	(2.98)
Karkara	3,201	0.95	17,562	4.45	2,401	1.90	23,164	2.70
	..	..	(17,628)	(4.42)	(2,858)	(1.97)	(23,687)	(2.70)
Wam	3,490	1.05	72,425	18.36	15,811	12.46	91,726	10.70
	..	..	(72,437)	(18.13)	(19,069)	(13.16)	(94,996)	(10.80)
Catfish	39,935	11.88	39,997	10.14	24,728	19.48	104,660	12.20
	..	..	(40,087)	(10.03)	(25,888)	(17.86)	(105,910)	(12.02)
Prawns	3,464	1.03	1,621	0.42	394	0.32	5,479	0.65
	..	..	(1,784)	(0.45)	(474)	(0.33)	(5,722)	(0.65)
Elasmobranchs	83,918	24.97	55,572	14.08	34,435	27.13	173,925	20.28
	..	..	(56,633)	(14.18)	(42,395)	(29.25)	(182,946)	(20.78)
Miscellaneous	39,357	11.72	63,165	16.02	20,889	16.46	123,411	14.40
	..	..	(64,166)	(16.06)	(23,645)	(16.32)	(127,168)	(14.43)
Total	336,004	100.00	394,480	100.00	126,894	100.00	857,378	100.00
			(399,434)	(100.00)	(144,927)	(100.00)	(880,365)	(100.00)

* In 1968 the smaller vessels did not operate.

— lesser sciaenids, 'Dara' — *Palydactylus indicus*, 'Karkara' — *Pomadasys hasta*, 'Wam' — *Muraenesox talabonoides*, catfishes, prawns, elasmobranchs and miscellaneous fishes) are listed and their annual catch and percentage from all the areas are given in Table 2; the pooled data in respect of all the 6 vessels also are given for comparison.

AREAWISE, DEPTHWISE AND SEASONAL DISTRIBUTION OF FISH

The fishing effort spent in each of the 17 major areas was not the same but varied from 5 h (area 17-71) to 780.16 h (area 19-71). But, in order to obtain a realistic picture of the relative abundance and seasonal distribution of different categories of fishes, the areas where less than 100 fishing hours were put in during the entire period are not included in the purview of this investigation. Thus only 8 areas, viz. 15-73, 17-72, 18-72, 19-71, 19-72, 20-70, 21-69 and 22-68 have been considered here. Table 3 gives the seasonal distribution pattern of 10 categories of fishes in these areas, as also the total effort, catch, and catch per hour in each of the areas; since there was no continuous fishing in all the months throughout the period, the quarterly values for 3 years were pooled together and are presented in the Table. Most of the fishing operations were carried out in the first two quarters, and almost suspended in the third quarter because of the monsoon. In the fourth quarter fishing was not as intense as in the first two quarters, though the catch rates from some areas were slightly better. The yearwise catch-per-hour values of different categories of fishes obtained from the 8 major areas are shown in Figures 2, 3 and 4; the average values for the 3-year period are also shown for comparison. Since 18-72 and 19-71 were the most intensively and frequently fished areas, these two have been chosen for studying the monthly fluctuations in abundance of 5 groups of quality fish ('Ghol', 'Koth', 'Dara', 'Karkara' and 'Wam'); the area 22-68 was also included because of its richness in these fishes (Figures 5 and 6).

In order to study the depthwise distribution of fish, the entire fishing ground has been divided into 10-meter ranges. There was no fishing up to 10 meters and beyond 90 meters and thus the depth ranges recognised were 11-20, 21-30, 31-40, 41-50, 51-60, 61-70, 71-80 and 81-90 meters. The first and the last mentioned depth ranges were insignificant because the fishing effort expended there was very meagre, just over 1%. Table 4 gives the depthwise abundance of fish in the areas 18-72, 19-71 and 22-68. As regards the seasonal depthwise distribution of the 5 groups of quality fish, the quarterly fluctuations in the catch rates of 'Ghol', 'Koth', 'Karkara' and 'Wam' in the 6 main depth ranges in the 3 areas are shown in Figure 7, and those of 'Dara' in Figure 8.

GENERAL DISCUSSION AND CONCLUSIONS

Though the earlier trawling operations in Bombay-Saurashtra waters have provided some preliminary information on the potential fishing grounds,

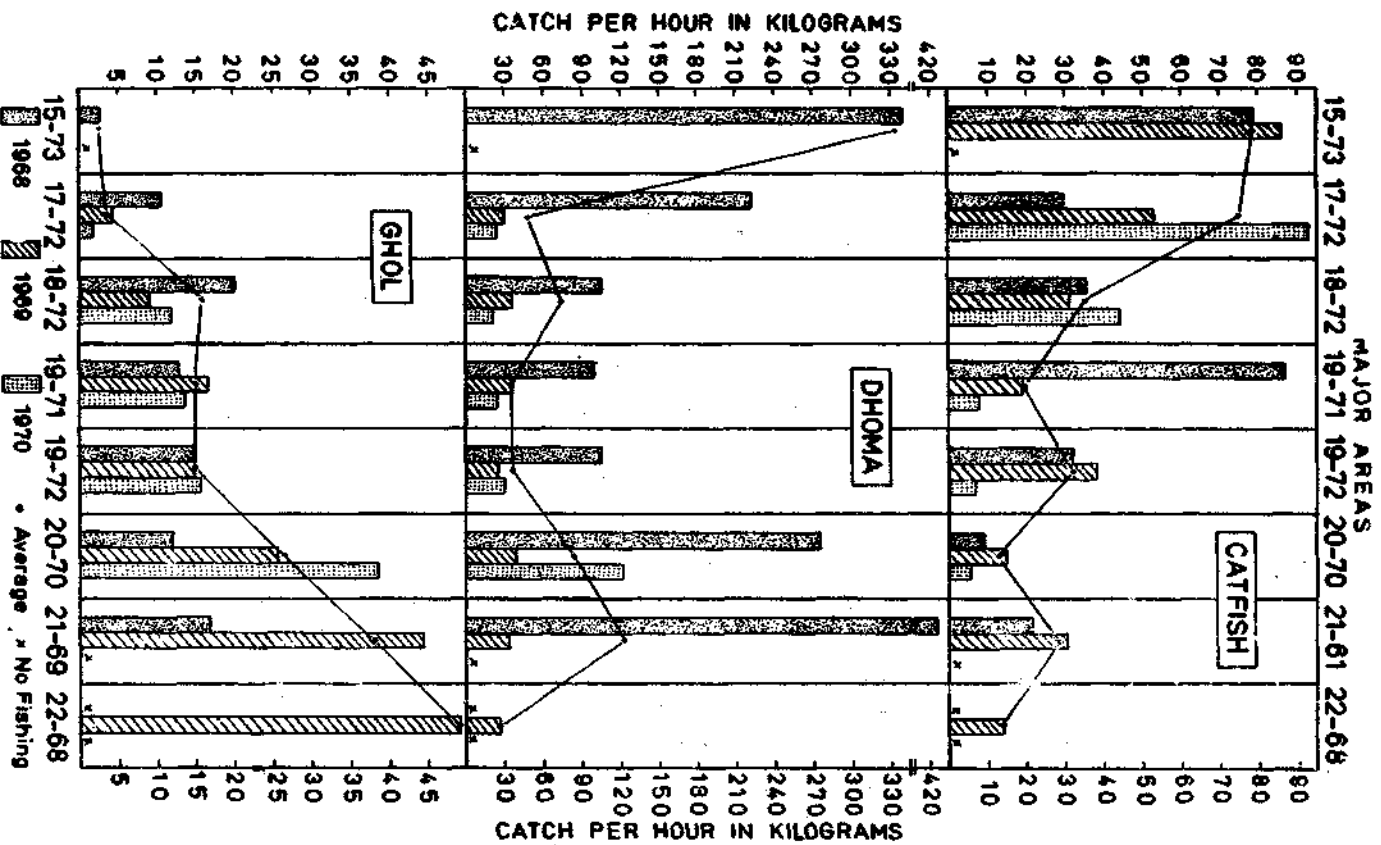


FIG. 2. Yearwise average catch per hour of Ghol, Dhoma and catfish from 8 major areas during 1968-70.

TABLE 3. *Areawise seasonal catch trends (quarterly values for 3 years are pooled together); effort in hours, catch and catch-per-hour (in brackets) in kg; '—' no operation; '...' no catch.*

	Quarter	Area	15—73	17—72	18—72	19—71	19—72	20—70	21—69	22—68
Effort	1st		109.75	117.50	172.50	412.92	39.25	45.75	50.08	218.70
	2nd		84.25	88.75	346.40	316.75	160.25	71.25	76.75	268.30
	3rd		—	—	26.50	—	—	—	—	—
	4th		3.00	79.25	60.75	50.50	21.00	20.75	—	—
	Total		197.00	285.50	606.25	780.17	220.50	137.75	126.83	487.00
Gbol.	1st		190 (1.73)	265 (1.55)	3,288 (19.06)	5,539 (13.41)	640 (16.31)	1,240 (27.10)	567 (11.32)	14,850 (67.90)
	2nd		325 (3.86)	425 (4.80)	6,158 (17.78)	6,300 (20.00)	2,438 (15.21)	2,353 (33.02)	4,273 (55.67)	9,150 (34.10)
	3rd		—	—	148 (5.58)	—	—	—	—	—
	4th		..	320 (4.04)	45 (0.75)	150 (2.97)	260 (12.38)	60 (2.90)	—	—
	Total		515 (2.61)	1,010 (3.54)	9,639 (15.90)	11,989 (15.37)	3,338 (15.14)	3,653 (26.52)	4,840 (38.16)	24,000 (49.28)
Koth	1st		..	..	350 (2.03)	1,245 (3.01)	435 (11.08)	..	..	6,029 (27.57)
	2nd		..	195 (2.20)	699 (2.02)	495 (1.56)	228 (1.42)	40 (0.56)	..	12,846 (47.88)
	3rd		—	—	..	—	—	—	—	—
	4th		..	..	..	15 (0.30)	..	..	—	—
	Total		..	195 (0.68)	1,049 (1.73)	1,755 (2.25)	663 (3.01)	40 (0.30)	..	18,875 (38.76)

Dhoma	1st	38,180 (347.88)	4,240 (24.64)	10,020 (58.08)	20,014 (48.47)	2,375 (60.51)	8,055 (176.08)	12,925 (258.08)	4,074 (18.63)
	2nd	27,615 (327.77)	7,115 (80.17)	31,598 (91.22)	6,347 (20.40)	4,028 (25.13)	2,994 (42.02)	2,765 (36.02)	9,120 (34.00)
	3rd	—	—	185 (6.98)	—	—	—	—	—
	4th	..	2,410 (30.41)	2,980 (49.05)	1,515 (30.00)	1,510 (71.90)	440 (21.20)	—	—
	Total	65,795 (333.98)	13,765 (48.21)	44,783 (73.88)	27,876 (35.73)	7,913 (35.88)	11,489 (163.26)	15,690 (123.71)	13,194 (27.10)
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Dara	1st	..	10 (0.06)	80 (0.46)	857 (2.07)	10 (2.25)	420 (9.18)	..	9,004 (41.17)
	2nd	15 (0.18)	320 (3.60)	292 (0.84)	425 (1.34)	137 (0.85)	15 (0.22)	..	14,598 (54.41)
	3rd	—	—	..	—	—	—	—	—
	4th	20 (0.92)	..	—	—
	Total	15 (0.07)	330 (1.15)	372 (0.61)	1,282 (1.64)	167 (0.76)	435 (3.16)	..	23,602 (48.46)
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Karkara	1st	241 (2.20)	833 (4.80)	460 (2.67)	1,585 (3.85)	174 (4.43)	60 (1.32)	396 (7.92)	4,724 (21.60)
	2nd	100 (1.18)	102 (1.15)	1,955 (5.64)	932 (2.94)	167 (1.04)	61 (0.85)	194 (2.53)	6,092 (22.70)
	3rd	—	—	45 (1.70)	—	—	—	—	—
	4th	20 (6.67)	1,152 (14.53)	1,355 (22.30)	46 (0.90)	104 (4.95)	20 (0.96)	—	—
	Total	361 (1.83)	2,087 (7.31)	3,815 (6.30)	2,563 (3.28)	445 (2.02)	141 (1.02)	590 (4.65)	10,816 (22.21)

TABLE 3. (Continued)

Quarter Area	15-73	17-72	18-72	19-71	17-72	20-71	21-69	22-68	
Wam	1st	..	40 (0.23)	1,230 (7.13)	34,410 (83.33)	935 (22.82)	330 (7.22)	631 (12.60)	13,652 (62.42)
	2nd	15 (0.18)	15 (0.17)	3,629 (10.48)	12,140 (38.33)	5,703 (35.60)	695 (9.75)	2,250 (29.32)	9,809 (36.56)
	3rd	—	—	5 (0.20)	—	—	—	—	—
	4th	..	..	..	779 (15.42)	708 (33.71)	342 (16.48)	—	—
	Total	15 (0.07)	55 (0.20)	4,864 (8.02)	47,329 (60.66)	7,346 (33.31)	1,367 (9.92)	2,881 (22.71)	23,461 (48.17)
Catfish	1st	8,145 (74.21)	12,975 (75.40)	8,221 (47.67)	6,065 (14.70)	725 (18.47)	315 (6.88)	770 (15.37)	4,515 (20.64)
	2nd	7,135 (84.70)	4,125 (46.48)	11,388 (32.87)	9,020 (28.47)	5,993 (37.40)	1,416 (19.87)	2,920 (38.05)	2,542 (9.47)
	3rd	—	—	160 (6.04)	—	—	—	—	—
	4th	260 (86.67)	4,345 (54.83)	1,855 (30.53)	210 (4.16)	455 (21.67)	35 (1.68)	—	—
	Total	15,540 (78.88)	21,445 (75.11)	21,624 (35.67)	15,295 (19.60)	7,173 (32.53)	1,766 (12.82)	3,690 (29.10)	7,057 (14.50)
Prawns	1st	953 (8.68)	10 (0.06)	156 (0.90)	639 (1.55)	36 (0.92)	..	..	145 (0.66)
	2nd	1,155 (13.71)	75 (0.84)	545 (1.57)	98 (0.31)	95 (0.60)	..	27 (0.35)	75 (0.28)
	3rd	—	—	20 (0.75)	—	—	—	—	—
	4th	..	290 (3.66)	275 (4.53)	20 (0.40)	20 (0.95)	..	—	—
	Total	2,108 (10.70)	375 (1.31)	996 (1.64)	757 (0.97)	151 (0.68)	..	27 (0.21)	220 (0.45)

Elasmo- branches	1st	8,490 (77.36)	4,300 (24.98)	11,188 (64.86)	22,229 (53.83)	1,205 (30.70)	4,155 (90.82)	7,495 (149.66)	6,210 (28.40)
	2nd	5,165 (61.30)	8,790 (99.04)	35,649 (102.91)	16,672 (52.63)	5,245 (32.73)	2,895 (40.64)	1,896 (24.70)	4,507 (16.80)
	3rd	—	—	480 (18.12)	—	—	—	—	—
	4th	..	1,040 (13.12)	3,038 (50.00)	1,765 (34.95)	1,005 (47.86)	1,350 (65.06)	—	—
	Total	13,655 (69.31)	14,130 (49.50)	50,355 (83.07)	40,666 (52.12)	7,455 (33.81)	8,400 (60.98)	9,391 (74.04)	10,717 (22.00)
Miscella- neous fish	1st	8,418 (76.70)	5,770 (33.55)	6,333 (36.71)	12,340 (29.88)	1,579 (40.23)	2,620 (57.27)	6,340 (126.60)	11,027 (50.42)
	2nd	5,810 (68.96)	954 (10.75)	7,786 (22.47)	5,208 (16.34)	1,855 (11.57)	1,609 (22.58)	3,901 (50.83)	16,862 (62.85)
	3rd	—	—	515 (19.43)	—	—	—	—	—
	4th	230 (76.66)	2,128 (26.85)	1,149 (18.92)	966 (19.13)	390 (18.56)	1,931 (93.06)	—	—
	Total	14,458 (73.40)	8,852 (31.00)	15,783 (26.04)	18,514 (23.73)	3,824 (17.34)	6,160 (44.72)	10,241 (80.74)	27,889 (57.26)
Total for all fish		112,462 (570.87)	62,244 (218.02)	153,280 (252.87)	168,026 (215.37)	38,475 (174.50)	33,451 (242.84)	47,360 (373.33)	159,831 (328.20)

TABLE 4. *Depthwise distribution of effort and catch, and other particulars in respect of areas 18-72, 19-71 and 22-68 during 1968-70.*

Area	Depth range (m)	No. of hauls	Fishing effort (hrs)	Catch (kg)	Catch per haul (kg)	Catch per hour (kg)	Percentage effort	Percentage Catch
18—72	11-20	9	19.00	3,118	346.44	164.10	3.15	2.03
	21-30	61	129.75	35,883	588.24	276.55	21.40	23.41
	31-40	62	148.24	42,420	684.19	286.15	24.46	27.67
	41-50	45	120.66	27,382	608.48	226.93	19.90	17.86
	51-60	62	118.25	26,548	428.19	224.51	19.50	17.32
	61-70	26	52.25	11,543	443.96	220.92	8.62	7.53
	71-80	9	18.00	6,386	709.55	354.77	2.97	4.18
19—71	31-40	31	110.25	24,724	797.55	224.24	14.14	14.71
	41-50	30	103.42	27,214	907.13	263.14	13.25	16.20
	51-60	78	267.83	48,383	620.30	180.64	34.33	28.80
	61-70	80	256.58	57,987	724.84	226.00	32.88	34.51
	71-80	16	40.08	8,773	548.31	218.88	5.14	5.22
	81-90	1	2.00	945	945.00	472.50	0.26	0.56
22—68	21-30	6	19.00	6,392	1,065.33	336.42	3.90	4.00
	31-40	98	316.86	108,179	1,103.86	341.41	65.06	67.68
	41-50	39	139.48	41,578	1,066.10	198.10	28.64	26.02
	51-60	3	11.66	3,682	1,227.33	315.78	2.40	2.30

it was the work of TAIYO MARU No. 17, ASHOK and PRATAP (Jayaraman *et al* 1959) that first threw sufficient light on the abundance and distribution pattern of major groups of demersal fishes. These and the subsequent operations of the New India Fisheries trawlers and the Government of India vessels reported by Rao *et al* (1966, 1972) have shown that the northern areas off Dwarka and Kutch were the most productive, which "compare favourably with some of the richest grounds of the world". Besides, the preponderance of quality fishes in the northern areas is well known. Jayaraman *et al* (1959) reported that the Dwaraka region (which includes two-thirds of the major area 22-68) was the best ground for 'Dara' and 'Koth' fisheries, and this region together with Porbunder (including 21-68 and 21-69) for 'Karkara'. Rao *et al* (1966) found that 'Ghol' and 'Karkara' were most abundant in Kutch and Dwarka regions, and 'Koth' and 'Dara' in Dwarka region. In both the above mentioned investigations it was reported that the maximum quantity of 'Wam' came from Cambay region (including part of 19-71). Rao (1970) states that the highest catch of 'Ghol'

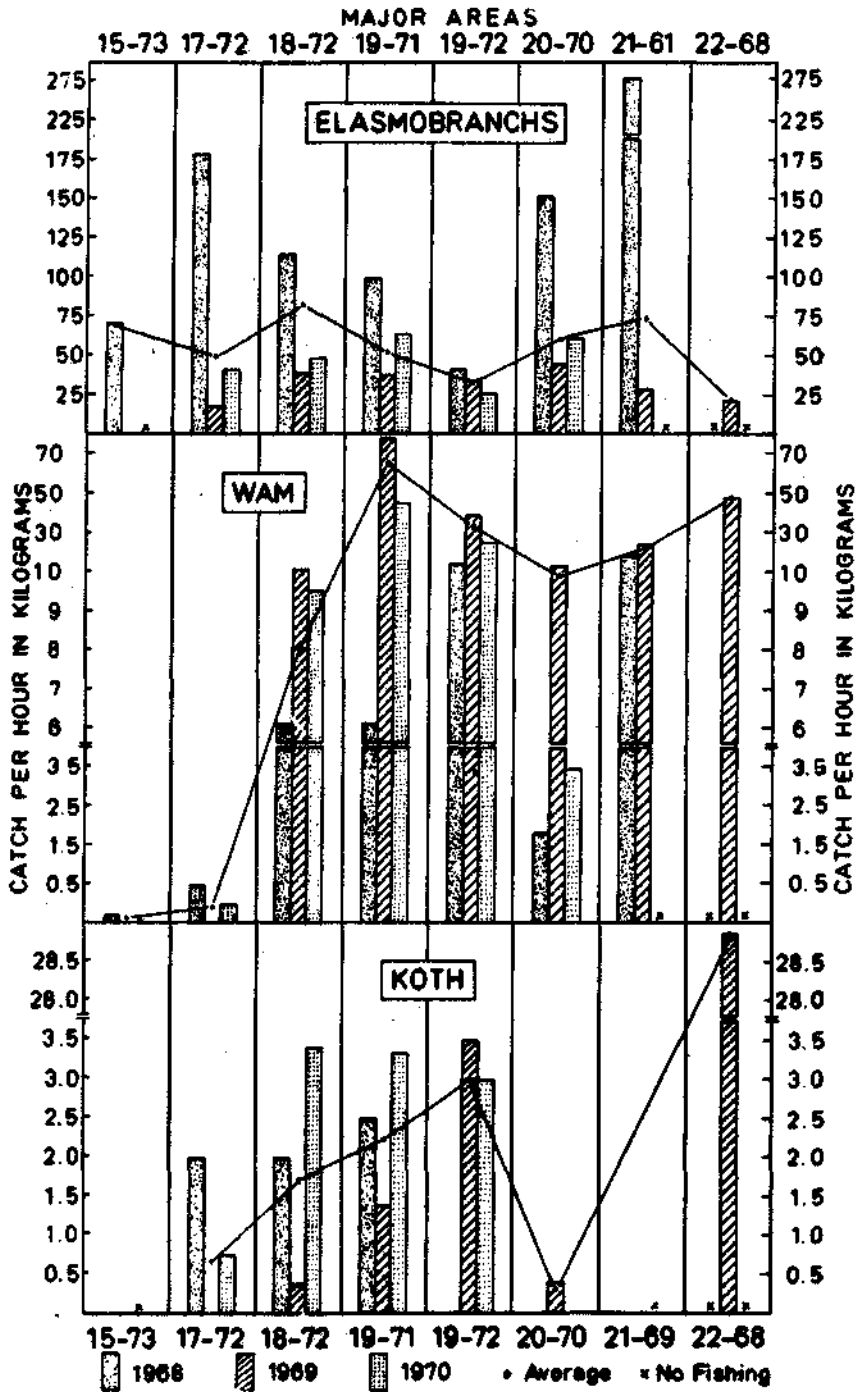


FIG. 3. Yearwise average catch per hour of Koth, Wam and elasmobranchs from 8 major areas.

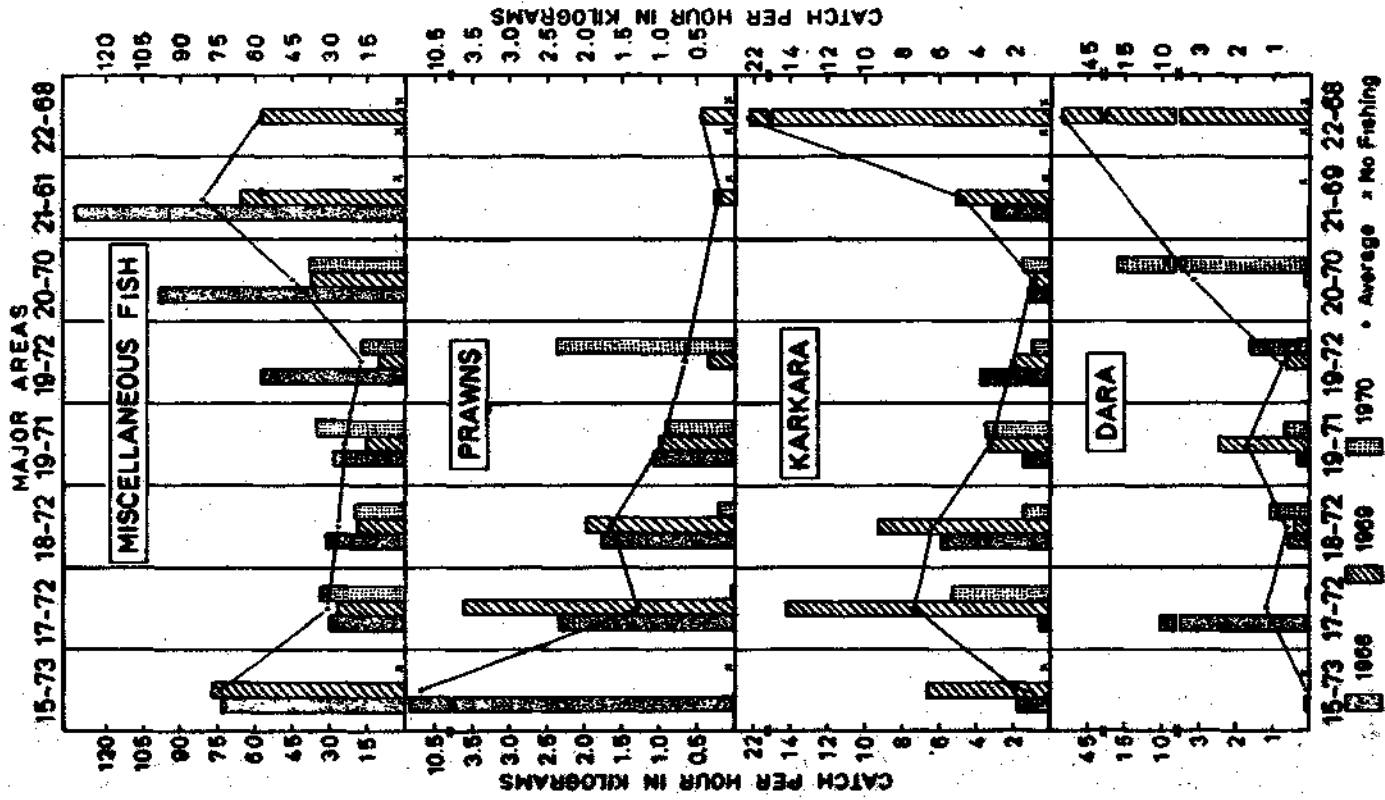


FIG. 4. Yearwise average catch per hour of Dara, Karkara, prawns and miscellaneous fish from 8 major areas.

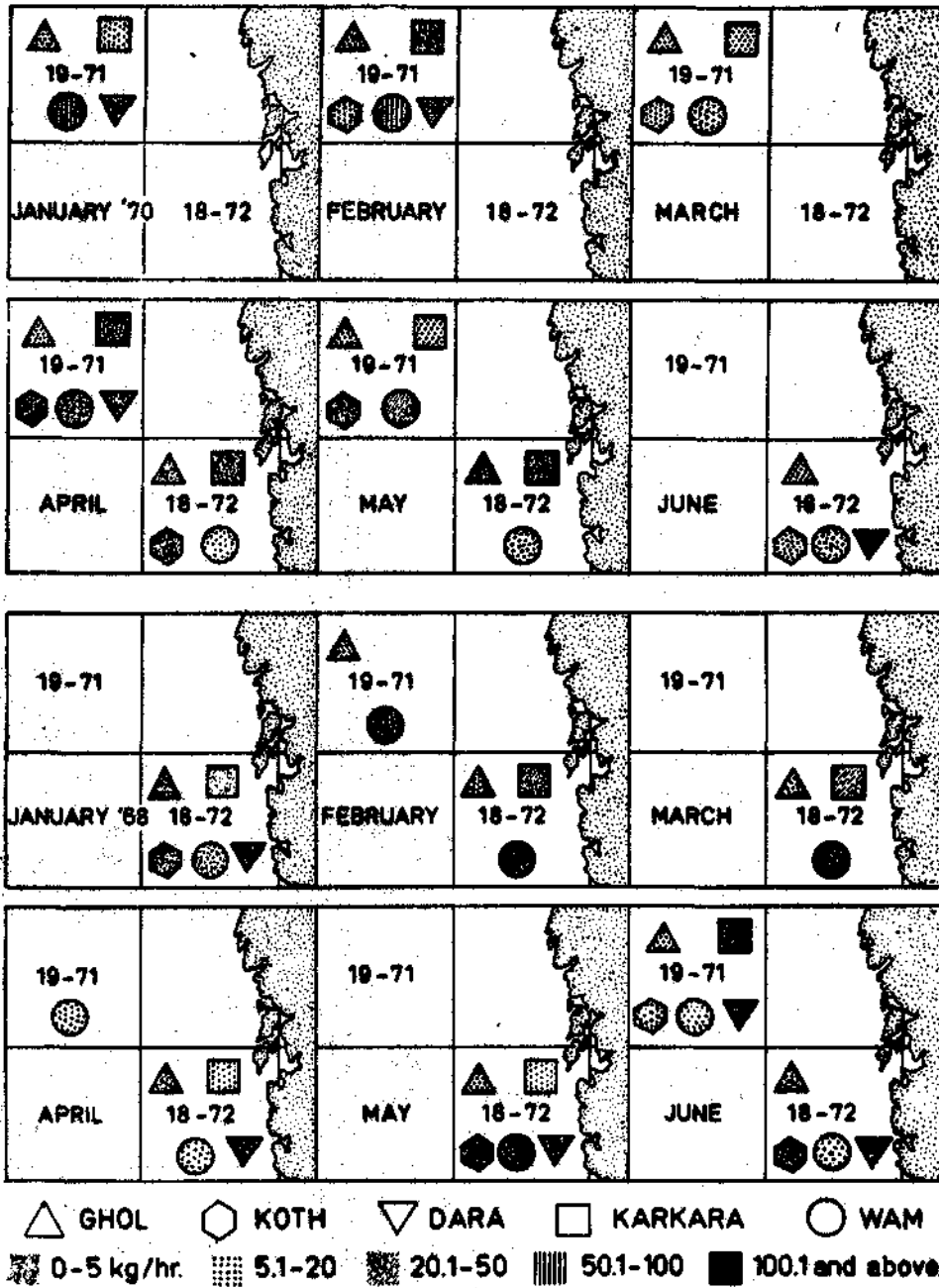


FIG. 5. Monthly distribution of the different species in different areas during 1968 and 1970.

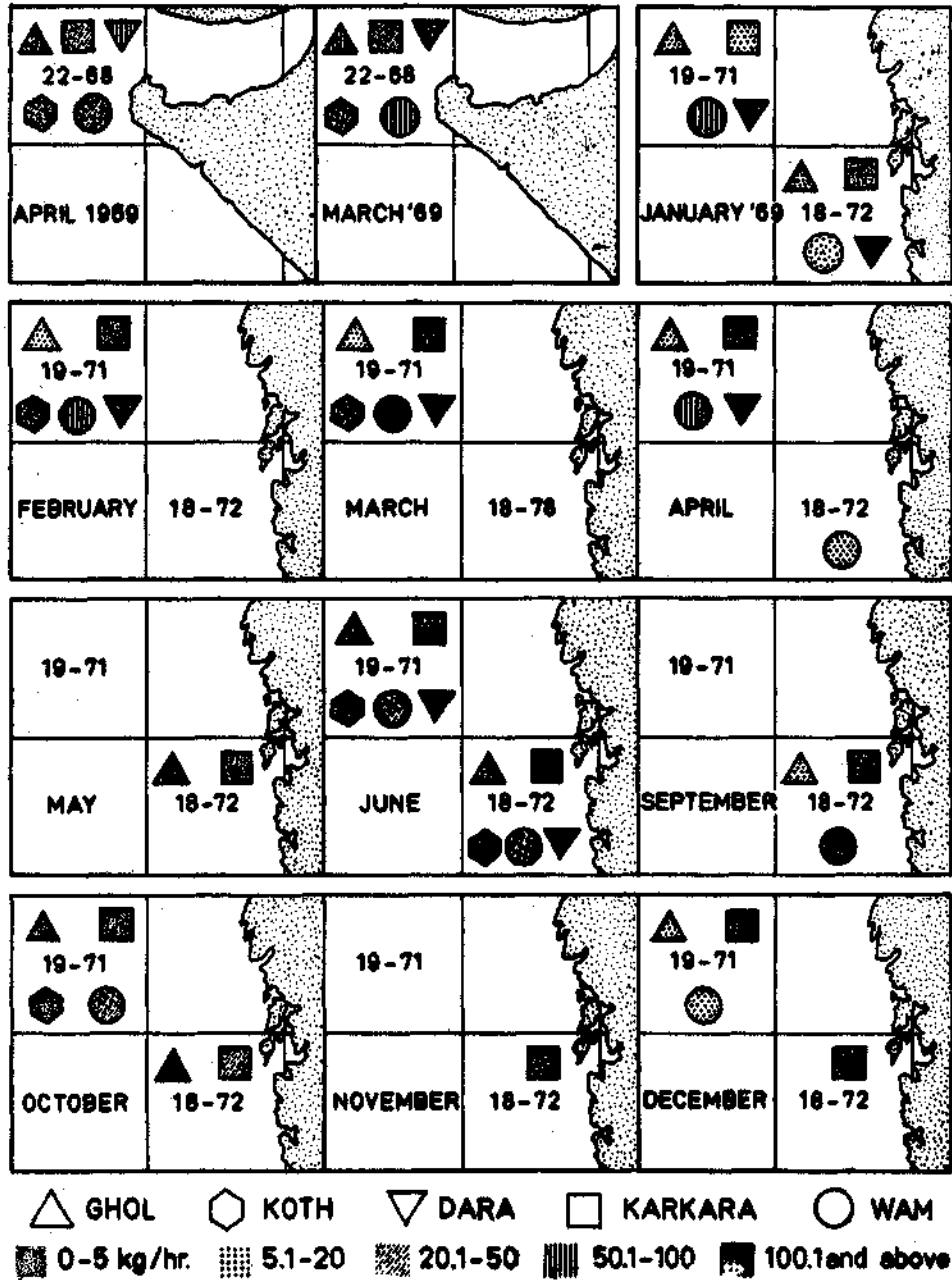


FIG. 6. Monthly distribution of the different species in different areas during 1969.

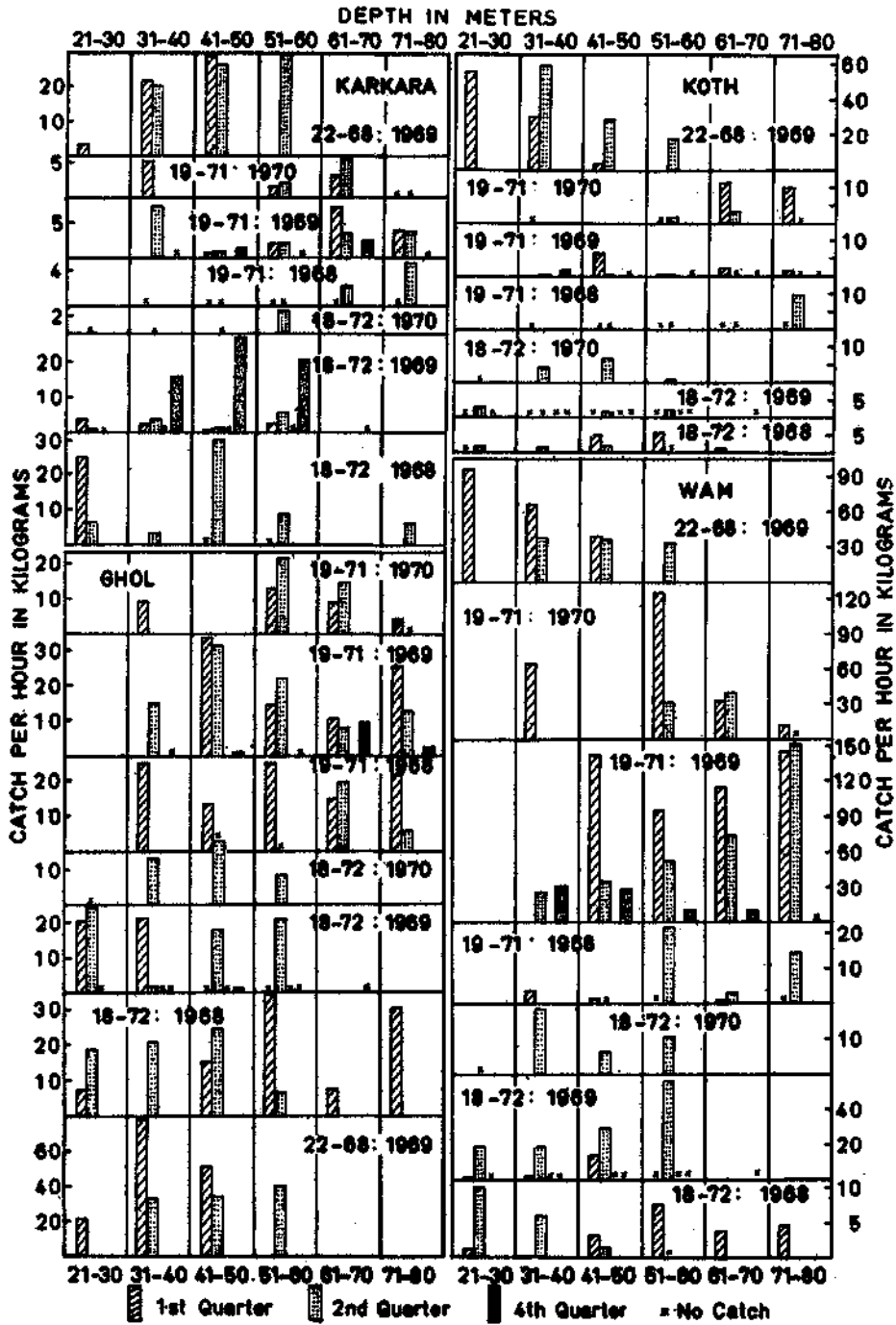


FIG. 7. Depthwise quarterly distribution of Ghol, Koth, Karkara and Wam in three major areas during 1968-70.

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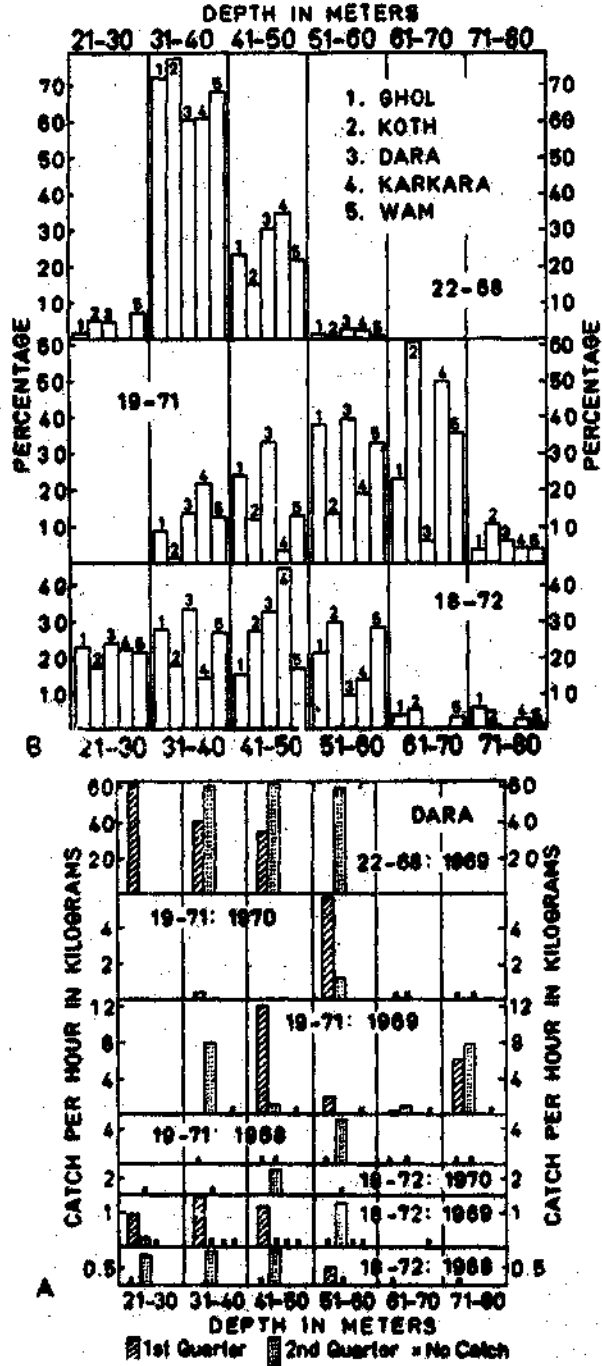


FIG. 8. Depthwise percentage distribution of different species (B) and depthwise quarterly distribution of Dara (A) in three major areas.

was realised from Kutch region in some years and from Dwarka and Porbandar regions in the remaining years. Kagwade (1971) says that the Kutch and Dwarka regions were the best fishing grounds for 'Dara'.

During the exploratory survey under review, the Kutch region was not fished, and of the remaining areas, 22-68 was found to be the most productive. This is amply illustrated by the fact that though fished only for two months in a period of 3 years, this area accounted for about 20% of the total fish catch. Moreover, the share of quality fishes in the total yield from here was as high as 63%, while in 18-72, it was 13% and in the far south area of 15-73 it was not even 1%. In fact, 22-68 alone accounted for 38% of the total catch of 'Ghol' obtained from all the areas, 83% of 'Koth,' 90% of 'Dara', 46% of 'Karkara' and 25% of 'Wam'. For 'Wam' the best area was 19-71 which yielded 50% of this fish, and this is well in conformity with the earlier findings.

Kagwade (1965) states that the Cambay region was the best ground for prawns. Rao *et al* (1966) also found that there was greater abundance of prawns in Bombay and Cambay regions. In contrast to these observations, the present investigation shows that in the areas falling in these regions (18-72, 19-71, 19-72 and part of 20-70) the catch rates of prawns were negligible or this group was even absent (area 20-70). The only area where prawns were available in some noticeable quantity was 15-73.

Among the categories of qualitatively less important fishes, 'Dhoma' was the most dominant, forming more than one-fourth of the total fish catch. About 30% of this group came from the area 15-73. Elasmobranchs, constituting about 20% of the catch, were abundant throughout the period, and areas 18-72 and 19-71 accounted for the bulk of this group. Catfishes and miscellaneous fishes were the other two categories which also were taken all through the period. While the former group was more abundant in the areas south of 19-71 than in the others, the latter was obtained in good quantities from almost all areas.

The exploratory survey done in the major area 15-73 (off Goa) during 1967-68 has been studied in detail by Rao and Dorairaj (1968) and, therefore, this area is not included in the present investigation for detailed study. Though the area was found to be very productive with high overall catch rate (570.87 kg/h), bulk of the catch was composed of low-quality fishes like 'Dhoma', catfishes, elasmobranchs and miscellaneous fishes.

The trend in the seasonal distribution of fish showed that in most of the areas the catch rates were the highest in the 1st quarter. In the case of individual groups like 'Koth', 'Dara' and prawns, the catch itself was too small to show any seasonal variation. Nevertheless, a broad outline could be drawn: while 'Koth' and 'Dara' had their peak in the 1st quarter, 'Ghol' in the 2nd and 'Karkara' in the 4th, 'Dhoma' had no such trend; 'Wam' was abundant all the year round except in the 3rd quarter but the seasonal peaks changed from area to area;

catfishes and elasmobranchs were generally abundant in the 2nd quarter. As regards the monthly variation in abundance of quality fishes, 'Ghol', 'Koth', 'Dara' and to a certain extent 'Wam', had their highest catch rates in the month of June in all the 3 years in the area 18-72, and for 'Karkara' the peak month changed every year. In the area 19-71 also 'Ghol' was most abundant in June; for 'Wam' the highest catch rates were in April 1968, March '69 and January '70; other quality fishes were of little significance in this area.

Jayaraman *et al* (1959), while studying the depthwise distribution of fishes in Dwarka region, have found that the bulk of the catch was from near the 20-fathom line (36.60 meters). Rao *et al* (1972) state that the highest yield was from 21-30 m depth zone followed by 31-40 m when all the areas taken together, and that the overall catch rates obtained from individual 1°-latitude zones differed from these values only slightly. In the bull-trawling operations also the 31-40 m depth range was found to be very rich, accounting for 51% of the total catch (Rao 1969). In the present investigation it was observed that all the 3 major areas taken together, the maximum explored and the most productive depth range was 31-40 m where 31% of the total fishing effort were put in for the return of 36% of the total catch with a catch rate of 304.72 kg/h. Areawise, the maximum catch, catch per hour and catch per haul were from 31-40 m depth range in the area 18-72, 41-50 m in 19-71 (the highest catch was from 61-70 m), and in 22-68 all the highest values came from 31-40 m.

The seasonal distribution of quality fishes in the different depth ranges showed no regular trend, but it varied considerably from area to area and year to year. In the areas 18-72 and 19-71 none of the quality fishes, except 'Wam' in the latter area, was of much significance quantitatively to show any marked depthwise distribution pattern. In the area 22-68 these fishes made substantial contribution to the catch but the duration of fishing was too short to study the seasonal fluctuation. The only conclusion that could be drawn, however, was that in 18-72 the depth range 31-40 m was the best for 'Ghol' and 'Dara', 41-50 m for 'Karkara' and 51-60 m for 'Koth', 'Karkara' and 'Wam'; in 22-68 the depth range richest for all the quality fishes was 31-40 m.

In the present exploratory trawling operations an appreciable degree of diversification of fishing has been evident. In the earlier operations (Rao *et al* 1972), as can be seen in Table 5, most of the fishing was concentrated in a single area, 18-72, which alone accounted for about 75% of the total fishing effort put in by all the larger vessels together (84%, if the smaller vessels also are taken into account). As against this, during the present investigations the same area received only 19% of the total fishing effort (25%, including that of the smaller vessels). This has resulted in the distribution of more fishing effort in other areas, some of which were found to be very productive.

While discussing the merits of taking 1°-latitude zones as units for studying the relative abundance of demersal fishes, Rao *et al.* (1972) state that from

TABLE 5. *Intensity of fishing in the major area 18-72 during the periods 1963-67 and 1968-70. (1963-67 data computed from Rao et al 1972).*

		1963-67		1968-70	
		Area 18-72	All areas	Area 18-72	All areas
Larger Vessels	Effort (hrs)	3,946.23	5,271.13	606.19	3,155.18
	Catch (kg)	1,044,077	1,416,973	153,280	857,378
All Vessels	Effort (hrs)	7,780.46	9,279.06	864.24	3,488.50
	Catch (kg)	1,510,755.5	1,931,817.5	169,461	880,365

the 18° N latitude zone there was a northward increase in the catch rates up to the 22° N latitude zone and also a similar southward increase up to the 15° N latitude zone. However, though the catch-per-hour values given by all the vessels, big and small, showed a progressive increase to both sides, the increase in catch rates in respect of the larger vessels was not regular, the exceptions being the values from 17° N and 19° N latitude zones (Table 6). In the present investigation also an increase towards north and south was evident in a general way but with more exceptions than in the previous case. In the case of larger vessels the catch per hour obtained from 18° N latitude zone was higher than those obtained from two latitude zones lying immediately north of it and one latitude zone south of it. As for the smaller vessels, they did operate only in 18° N and 19° N latitude zones and therefore the pattern of catch-per-hour returns obtained by all the vessels does not vary much from that shown by the larger vessels. Eventhough some of the subareas falling in the northern and southern latitude zones yielded very high catch rates up to or more than 1,000 kg/h, the average catch-per-hour value obtained from each of the latitude zones was much less. Still the catch rates from the northern and southern latitude zones were higher than from the 18° N latitude zone, but no progressive order in the increase could be noticed.

TABLE 6. *Catch-per-hour values (kg) from 1° latitude zones. (1963-67 data from Rao et al 1972)*

Zones	1963-67		1968-70	
	Larger vessels	All vessels	Larger vessels	All vessels
15° N	387.84	387.84	570.87	570.87
16° N	267.40	252.42	264.54	264.54
17° N	210.34	213.01	220.80	220.80
18° N	263.89	193.94	255.00	198.88
19° N	288.37	270.09	206.36	198.25
20° N	276.49	292.10	245.11	245.11
21° N	279.80	326.32	347.47	347.47
22° N	364.62	364.62	326.60	326.60

An interesting aspect in the pattern of catch-per-hour returns is that the comparatively higher catch rates in the northern zones was to a large extent due to the high yield of quality fishes like 'Ghol', 'Koth', 'Dara', 'Karkara' and 'Wam', while in the zones south of 18° N the predominance of economically less important fish groups like 'Dhoma', catfishes and elasmobranchs contributed to the southward increase in the catch rates. This is in agreement with the earlier observations by other workers.

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REFERENCES

- JAYARAMAN, R., G. SESHAPPA, K. H. MOHAMED AND S. V. BAPAT. 1959. Observations on the Trawl Fisheries of the Bombay and Saurashtra waters, 1949-'50 to 1954-'55. *Indian J. Fish.*, 6 (1) : 58-144.
- KAGWADE, P. V. 1964. Prawn catches by mechanised vessels in the trawling grounds of Bombay and Saurashtra. *Proceedings of the Symposium on Crustacea, Marine Biological Association of India, Part IV* : 1348-1381.
- KAGWADE, P. V. 1965. *Polydactylus Indicus* (Shaw) in the landings by bull trawlers operating in Bombay-Saurashtra waters during 1956-'63. *Indian J. Fish.*, 12 (2) : 459-472.
- RAO, K. VIRABHADRA, P. T. MEENAKSHISUNDARAM AND K. DORAIRAJ. 1966. Relative abundance of trawl fishes in Bombay-Saurashtra waters. *J. mar. biol. Ass. India*, 8 (1) : 205-212.
- RAO, K. VIRABHADRA. 1967. Exploratory fishing. *Souvenir, 20th Anniversary, Central Marine Fisheries Research Institute* : 25-36.
- RAO, K. VIRABHADRA. 1969. Distribution pattern of the major exploited marine fishery resources of India. *Bull. cent. mar. Fish. Res. Inst.*, No. 6 : 1-69.
- RAO, K. VIRABHADRA AND K. DORAIRAJ. 1968. Exploratory trawling off Goa by the Government of India fishing vessels. *Indian J. Fish.*, 15 : 1-14.
- RAO, K. VIRABHADRA, K. DORAIRAJ, P. V. KAGWADE AND D. M. PUNWANI. 1972. Results of the exploratory fishing operation of the Government of India vessels at Bombay base for the period 1961-'67. *Proc. Indo-Pacific Fish. Coun.*, 13 (III) : 402-430.
- RAO, K. VENKATASUBBA. 1965. Trend of 'Ghol' landings by the New India Fisheries bull-trawlers for 1959-'62 operating in Bombay and Saurashtra waters. *Indian J. Fish.*, 12 (2) : 556-587.