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SURVEY OF THE SOFT BOTTOM CARNIVOROUS FISH POPULATION USING BOTTOM LONGLINE IN THE SOUTH-WEST LAGOON OF NEW CALEDONIA

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SURVEY OF THE SOFT BOTTOM CARNIVOROUS FISH POPULATION USING BOTTOM LONGLINE IN THE SOUTH-WEST LAGOON OF NEW CALEDONIA.

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INTRODUCTION

Most large South Pacific islands are surrounded by a lagoon which may be divided into several components : coralline areas, soft bottoms, bays and estuaries, mangroves. The fish communities found in these areas interact with one another and if we are to understand the lagoonal system as a whole, we ought to study the fish communities of each of these components. So far, most attention has been oriented towards coralline and mangrove areas. To our knowledge, little has been undertaken on the fish communities inhabiting soft bottoms or bays and estuaries. Soft bottoms do often cover a very large part of the lagoons in south-west Pacific islands (over 80 % of the south-west lagoon of New Caledonia). The contribution of the fish community from these areas to the lagoon ichthyofauna is certainly very important (reservoir for the other fish communities and source of predators and preys). In addition, these soft bottoms shelter an important part of the total fish biomass of the lagoonal system.

The soft bottoms fish communities have so far been little studied mainly because of technical problems. Indeed, most soft bottoms support some coralline formations which prohibit the use of trawl nets. In addition, an average depth often exceeding 15-20 m and poor visibility preclude in most cases visual census

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surveys. Fish traps have been successfully used to study these fish communities in the Caribbeans (MUNRO, 1983), but so far this gear has yielded poor results in the South Pacific (KULBICKI and MOU-THAM, 1987). This brought us to use bottom longlines as sampling gear. In addition to the previous arguments, several other reasons lead to this choice : longlines are easy to use and may fish in most areas, fishing effort can be standerdized, density estimates may be inferred from the results (EGGERS et al., 1982) and at last, hook and line is the main fishing method in use on these soft bottoms in New Caledonia (LOUBENS, 1978). The main drawback is the selectivity of this gear towards large carnivorous fishes. Therefore, the present article deals only with one component of the soft bottom fish communities : large carnivors. One of our future objectives is to assess the role of these carnivors for these communities.

METHODS

The type of longline used is illustrated on Figure 1. Each line has 100 hooks set 2.8 m apart. Medium size circle hooks are used (Mustad 3997L n°7 to 9 and Mustad 3996O n°8 or 9). At first, hooks were baited with cut pieces of trash fish, but most fishing was later done with squid (Notodarius sloanii) a bait of good quality and staying well on the hook.

In 1984, the lines were set by the R.V. VAUBAN, a 25 m boat which was not fitted for this type of fishing. Later, all fishing was done from the R.V. DAR MAD[1], a 10 m catamaran very well adapted to this gear.

The area sampled extends over most of the south-west lagoon of New Caledonia covering a surface of nearly 3000 km^2 (Fig. 2). Because of the extreme heterogeneity of the lagoon a stratified

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[1] R.V. DAR MAD belongs to the "Service Territorial de la Marine Marchande et des Affaires Maritimes" of New Caledonia.

sampling would have been unfeasible: therefore stations were distributed homogeneously over the sampling area (Fig. 2). On each site, two longline sets were performed.

RESULTS

Fishing operations

A total of 289 sets were performed totalizing 34 000 hooks. Fishing took place during daytime between 5 am and 8 pm. Setting a 100 hook line took between 4 and 17 mn with an average of 7 mn. This time depends very much on the training of the crew. Retrieving the line in calm weather took 12-15 mn : however in case of a snag, up to 45 mn may be necessary. On a normal fishing day 1000 hooks were set, with a maximum of 1400. In a commercial operation it may be possible to set 1500 to 2000 hooks/day. Hook loss was 4 % on average ; however, with the R.V. DAR MAD this rate was only 0.7 % which compares well to NELSON's and CARPENTER's 2 % hook loss. The amount of bait was of 1.1 kg of squid/100 hooks (average for 20000 hooks) which is less than the 1.7 kg/100 hooks used in Sri Lanka during FAO experimental fishing trials (ANONYME, 1982).

Yields

The average yield was 8.2 kg/100 hooks with a maximum of 38 kg/100 hooks. This represents an average of 5 fish/100 hooks with a maximum of 23 fish/100 hooks. These results compare well to other trials in shallow water but are lower than those from deep water (Table 1). This is mainly due to the small average size of the fish caught (1.6 kg).

On the R.V. DAR MAD fishing was done by three men. As seen previously the maximum number of hooks set per day was 1400. This allows to estimate that the daily catch/fisherman was : 1400 x 8.2 / 100 x 3 ≈ 38 kg/fisherman/day. One may compare this result to the average catch/day of fishermen using hand lines (Table 2). In coralline areas longlining yields better or similar results than handlining. whereas in other areas handlining is a more efficient method. KULBICKI et al. (1987) indicate that in the south-west lagoon of New Caledonia . longlining gives twice better catch/fisherman/day than handlining.

Species composition

A total of 72 species distributed among 15 families were caught. Four families represent 62 % of all species caught and 65 % of the total catch by weight. They are Serranidae (20 species). Lethrinidae (10 species), Lutjanidae (9 species) and Carangidae (7 species) (Table 3). Table 4 indicates that Lethrinidae are more abundant in the catch than anywhere else. Norfolk Island excepted. One notices also that except in Sri Lanka. these four families always make up more than 60 % of the catch.

Five species. *Lethrinus nebulosus*. *Bodianus perditio*. *Diagramma pictum*. *Epinephelus maculatus* and *Gymnocranius japonicus* amount to 50.8 % of the catch. Altogether. 27 species may be considered as common (90.8 % of the catch by weight) and 47 species as occasional (9.2 % of the catch).

The amount of non commercial species represents 16 % of the catch. This is lower than LOUBENS (1978) or FUSIMALOHI and PRESTON (1983) who had 21 % of trash fish in their catch. MUNRO (1983) reports only 7 % of such species in handline catches but sharks were not included.

Factors influencing catch composition

1. Depth

Figure 3a indicates that there is little correlation between numbers of fish/100 hooks and fishing depth. On the opposite, average weight and yield do increase nearly twice between 5 and 35 m. but drop sharply beyond 40 m (Fig. 3b and 3c). An increase of size with depth is common a phenomenon in tropical handline fisheries (MUNRO. 1983 : WRIGHT <u>et al.</u>. 1986 ; BROUARD and GRANDPERRIN, 1984 ; RICHARDS and SUNBERG. 1984). The sudden drop beyond 35 m is mainly due to the fact that in the south-west lagoon of New Caledonia the bottom at such depth has often high silt contents. On such bottoms habitat is much reduced and food availability is low which may explain smaller sizes and may be lesser densities. There are also changes in the composition of the catch with depth. The contribution of Serranidae. Lutjanidae. Tetrodontidae and sharks to the catch increases with depth (Fig. 4a and 4b). whereas it is the opposite for Carangidae. Haemulidae and Balistidae. Lethrinidae and Labridae maintain a similar contribution to the catch at all three depth classes (Fig. 4a and 4b).

2. <u>Position on the coast-barrier reef axis.</u>

The south-west lagoon of New Caledonia presents a general geomorphological structure which varies mainly on the coast-barrier reef axis (Fig. 5). Since the width of the lagoon varies considerably on a NW-SE axis. it was necessary to homogenize the distance between the station and the coast by considering the ratio : d = distance to coast/distance coast-barrier reef. Any station has therefore a value of d between 0 and 1. One may group d values between 0 and 0.4 as coastal zone. 0.4 and 0.8 as middle lagoon zone and between 0.8 and 1 as barrier reef zone. The contours of these zones are illustrated on Figure 5.

Figure 6a indicates that there is an increase of the catch from the coast towards the barrier reef. Combined with a similar increase in the average weight of most species (Table 5), this result in a nearly twofold increase of yield between the coast and the barrier reef (Fig. 6b). These results may be explained by a combination of hypothesis :

a) There is an increase in fish density from the coast to the barrier reef. This would be supported by the fact that the percentage of hard bottoms increases towards the barrier reef. which increases habitat diversity and abundance.

b) Most small species are caught near the coast (small Serranidae. Lutjanidae and Lethrinidae species). In addition, Synodontidae and Nemipteridae species prefer silted bottoms which lay mainly near the coast.

c) The average size for a given species increases towards the barrier reef : this is supported by the data presented in Table 5. This could be due to a migration with age from the coast to the barrier reef. or to better growth near the barrier reef. To some extent the water gets deeper away from the coast. but not enough to explain such size differences.

d) There is less fishing pressure near the barrier reef. As will be illustrated in the next paragraph, this may explain some differences in size and abundance between the coast and the barrier reef.

Figure 7 indicates that species diversity tends to increase towards the barrier reef. This is certainly related to the increase in hard bottom structures. Figure 7 shows also that there are major differences in the importance of the various families in the catch between the coast and the barrier reef. Thus, some families are better represented near the coast e.g. sharks. Carangidae, Echeneidae and Lutjanidae which are mainly fished in the coastal zone (Figure 7). The sharks caught are juveniles ; the coastal area is likely to be a nursery ground for many of the species, adults being known to spawn in bays and estuaries. Carangidae feed mainly on small pelagic bait fish which are also found in bays and estuaries (CONAND, 1987).

The middle lagoon zone is dominated by the Lethrinidae. Haemulidae are also most abundant in that area. The barrier reef zone is characterized by the Serranidae and Labridae. Their increase in the catch reflects a change in habitat. hard bottoms and corals increasing towards the barrier reef.

3. Distance to Noumea. the main fishing center.

The only large fishing center in the south-west lagoon is the city of Noumea. A widely accepted concept is that coralline fish communities are highly sensitive to fishing pressure. Thus

CRAIG (1979 and 1981) and GOEDEN (1982) indicate that there has been a decrease of the average sizes and yields over time and with distance to the main fishing centers on the Great Barrier Reef. Figures 8a and 8b indicate a gradual increase of the catch in numbers and by weight up to 25 miles off Noumea. Past that distance yields stay fairly stable. This 25 miles limit is approximatively the range of the amateur fishermen who's catch account for nearly 60 % of the total catch in the south-west lagoon of New Caledonia (LOUBENS, 1978). Table 6 indicates that the major families are sensitive in different ways to this fishing pressure. Haemulidae, Lethrinidae and Labridae double their CPUE past 25 miles but their average weight does not change significantly. Serranidae are nearly twice larger away from Noumea but their CPUE in numbers does not increase as much as for the previous families. Trash fish (sharks, Muraenidae, Synodontidae, Echeneidae) are more abundant in the catch or show larger size (Balistidae, Tetrodontidae) near Noumea. Species diversity in the catch is also higher near Noumea. These data suggest that fishing pressure over extended periods may have drastic effects on fish communities.

CONCLUSION

Despite their importance in lagoonal fish populations, soft bottom fishes have so far been little studies. The use of bottom longlines allows to get some important information on the carnivorous component of the populations. In particular variations in size and species composition with depth and geographical position may be better understood and may open new prospectives for research. Thus, in the present study the results indicate an increase in size with depth and distance to the coast. Complementary data (unpublished) indicates that these trends perpetuate beyond the barrier reef for some species such as Lutjanus amabilis or Lethrinus chrysostomus. This brings at least two important questions : is this increase due to migration, differential growth or both and can the outer reef be considered as a fish reservoir for the lagoon ?

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TABLE 1 : Main results of tropical bottom longlining fisheries

ZONE	REFERENCES	MEAN YIELD kg/100 hooks	MEAN YIELD n/100h.	MAXIMUM YIELD kg/100h.	MAXIMUM YIELD n/100h.	MEAN FISH WEIGHT (kg)	BOTTOM TYPE & DEPTH
New-Caledonia	Present report	8.2	5.0	38.1	23.0	1.6	5-60m lagoon
New-Caledonia	Grandperrin-unpubl.	24.0	10.0				100-500m outer reef shelf
Sri Lanka	ANON., 1982	5.9	2.4	14.4	4.4	2.6	10-180m continental shelf
Vanuatu	Brouard and Grandperrin, 1984	39.5	10.0	54.4	10.2	3.9	120-440m outer reef shelf
Hawaii	ANON., 1984	30.3	6.8				200-500m sea mounts
Kenya	FAO, 1981	23.0					200m continental shelf
Caribbean	Kawaguchi, 1974	8.3	3.8	17.8	5.7	2.2	32-450m fringing reefs and sea mounts
Caribbean commercial trial	Kawaguchi, 1974	3.0		4.3			
Guyana and Surinam	Wolf and Rathjen 1974	22.7	3.8	70.0	8.0	6.0	160-400m continental shelf
Gulf of Mexico	Nelson and Carpenter	15.0		45.0			50-500m continental shelf

TABLE 2 : Yield estimates for vertical handlines. Yield/fisherman/day is estimated as 6 times the hourly yield exept for data marked by * in which case the authors have indicated the daily yield (weights in kg).

Fishin zone	hourly yield	daily yield	Reference
New-Caledonia	10.0	38.0*	LOUBENS, 1978a
	2.6	15.0	KULBICKI et al, 1987
I. des Pins : 280-360m	7.8	81.4*	FUSIMALOHI and
Lifou : 80-250m	7.5	52.3*	GRANDPERRIN, 1979
South Pacific Outer reef slope	2.8-9.2	17-55	BROUARD and GRANDPERRIN, 1984
Guam : - lagoon	0.9 +	5.4	HOSMER, 1980
	1.5 +	9.0	MOLINA, 1982a
- sea-mounts	4.7	28.2	HOSMER and KAMI, 1980
Samoa lagoon	0.9	5.4	WASS, 1980
PNG lagoon	1.2 ++	8.6*	WRIGHT and RICHARDS, 1983
	3.9 +++	23.4	
Norfolk	14.0	56.0*	GRANT, 1981
Caribbeans :			MUNRO, 1983b
reefs : 10 - 20 m	1.7	10.0	
20 - 30 m	1.6	9.8	
30 - 40 m	2.6	15.3	
40 - 60 m	1.1	6.4	
outer reef slope			
60 - 100 m	3.3	20.1	
100 - 250 m	1.1	6.4	
Honduras - Nicaragua	16.0	160.0*	WOLF and RATJEN, 1974
Caribbeans northern	7.0	70.0*	WOLF and RATJEN, 1974
Caribbeans : leeward islands	4.5	45.0*	WOLF and RATJEN, 1974
Small West Indien	0.7	7.0*	WOLF and RATJEN, 1974
Guyanes	5.4	54.0*	WOLF and RATJEN, 1974
Australia N.W.	15.6	112.7*	STEHOUWER, 1981
Kenya	4.7-7.5	28.2-45.0	FAO, 1981

\+ recreational fishing

++ exploited zone

+++ virgin zone

TABLE 3 : Catch composition by families

Family	Number of species	% of total weight	% of total numbers	Average weight (kg)
SHARKS	7	3.3	1.0	4.79
RAYS	1	0.1	0.1	2.05
MURAENIDAE	4	0.1	0.9	0.28
SYNODONTIDAE	1	0.1	0.6	0.09
ECHENEIDAE	1	3.3	5.8	0.93
CARANGIDAE	7	2.0	2.0	1.57
SERRANIDAE	20	18.6	26.8	1.23
LUTJANIDAE	9	10.3	5.8	2.87
NEMIPTERIDAE	1	0.2	1.4	0.21
HAEMULIDAE	1	7.1	3.7	3.09
LETHRINIDAE	10	34.5	35.0	1.60
MULLIDAE	1	0.1	0.1	0.23
LABRIDAE	4	15.0	12.3	1.98
BALISTIDAE	3	3.0	2.8	1.75
TETRODONTIDAE	2	2.2	1.7	2.00

TABLE 4 : Importance of Serranidae, Lutjanidae, Lethrinidae and Carangidae in tropical line fisheries

FISHING ZONE	FISHING GEAR	TOTAL NUMBER OF SPECIES	SERRANIDAE		LUTJANIDAE		LETHRINIDAE		CARANGIDAE		TOTAL % OF WEIGHT
			nbre of species	%weight of total catch	nbre of species	%weight of total catch	nbre of species	% weight of total catch	nbre of species	%weight of total catch	
NEW-CALEDONIA	BOTTOM LONGLINE	72	20	19	9	10	10	34	7	2	65
	HANDLINE	62	15	21	12	10	8	50	2	.8	82
VANUATU	HANDLINE	108	20	14	31	62	8	2.5	6	3	82
GULF OF MEXICO	BOTTOM LONGLINE	70	16	21	14	15	-	-	10	43	79
NW AUSTRALIA	HAND LINE			7		80	9			3	99
PNG LAGOON	HAND LINE			10		26	14			14	64
KENYA	HAND LINE		12	25	9	39	8	22	1	3	88
PNG OUTER REEF	HAND LINE	65	15	10	24	76	5	5	12	4	95
CARABEAN 10-45m	HAND LINE	45	5	16	7	19			8	32	67
45-60m		21	2	13	6	42			3	16	71
60m		23	3	12	6	55			5	27	94
NORFOLK	HANDLINE	7	2	11			1	86	2	3	99
SRI LANKA 1st zone	BOTTOM LONGLINE			6		4		26		22	58
2nd zone				3		1		35		7	46
GUAM SEA MOUNTS	HAND LINE	53	13	13	14	50	4	3	7	32	98

TABLE 5 : CPUE and average weight (kg) for each zone on the coast-barrier reef axis(1st column : average weight, 2nd column: CPUE as kg/100 hooks.)

SPECIES	Coastal zone		Middle reef		Barrier reef	
SERRANIDS						
Cephalopholis sonnerati	.88	*	1.02	.12	.92	.22
Epinephelus aerolatus	.50	.12	.72	.10	.35	*
cyanopodus	2.02	.12	2.67	.28	3.41	.45
maculatus	.61	*	1.20	.23	1.11	1.03
rivulatus			.50	.11	.41	.18
Plectropomus leopardus	1.49	*	2.05	.22	1.98	.22
Variola louti			2.30	*	2.96	.39
LUTJANIDS						
Lutjanus adetii	.69	.14	1.10	*	1.30	*
bohar					3.25	.40
Symphorus nematophorus	6.70	*	7.68	.49	11.05	.24
Aprion virescens	6.56	.38	7.20	.23	5.10	.28
LETHRINUS						
Lethrinus chrysostomus	.53	*	.59	*	2.05	
mahsena	.86	.15	.75	.20	.92	.22
nebulosus	2.36	1.23	2.47	2.81	2.28	.65
rubrioperculatus	.66	.14	.64	.19	.57	.14
Gymnocranius rivulatus			1.77	.26	2.60	.29
japonicus	.75	*	1.01	*	1.33	.62
MISCELLANEOUS						
Diagramma pictus	3.09	.46	3.23	.45	2.62	.26
Bodianus perditio	1.86	.28	1.96	.50	1.93	1.79
Echeneis naucrates	1.02	.41	.84	.19	1.08	.24

TABLE 6 : Composition of the catch in relation to the distance to Noumea

FAMILY	CATCH NBRE/100 HOOKS		YIELD KG/100 HOOKS		AVERAGE WEIGHT (KG)		NUMBER OF SPECIES	
	<25 Miles	>25 Miles	<25Miles	>25Miles	<25Miles	>25Miles	<25Miles	>25Miles
SHARKS	0.09	0.03	0.33	0.18	4.27	6.75	5	2
RAYS	0.01	--	0.02	--	2.05	--	1	--
MURAENIDAE	0.09	--	0.02	--	0.23	--	4	--
SYNODONTIDAE	0.06	--	0.01	--	0.08	--	1	--
ECHENEIDAE	0.37	0.26	0.36	0.22	0.95	0.88	1	1
CARANGIDAE	0.09	0.12	0.21	0.10	2.41	0.80	6	3
SERRANIDAE	1.11	1.66	0.87	2.35	0.79	1.41	17	15
LUTJANIDAE	0.17	0.45	0.43	1.37	2.51	3.04	7	7
LETHRINIDAE	1.20	2.51	1.58	4.09	1.32	1.63	10	8
NEMIPTERIDAE	0.12	0.01	0.02	0.01	0.21	0.25	1	1
HAEMULIDAE	0.14	0.24	0.42	0.77	2.94	3.21	1	1
LABRIDAE	0.35	0.97	0.68	1.94	1.94	2.00	4	3
BALISTIDAE	0.12	0.16	0.28	0.23	2.27	1.43	3	3
TETRODONTIDAE	0.05	0.13	0.13	0.24	2.55	1.76	1	2
TOTAL	3.64	6.29	4.89	10.72	1.34	1.70	62	45

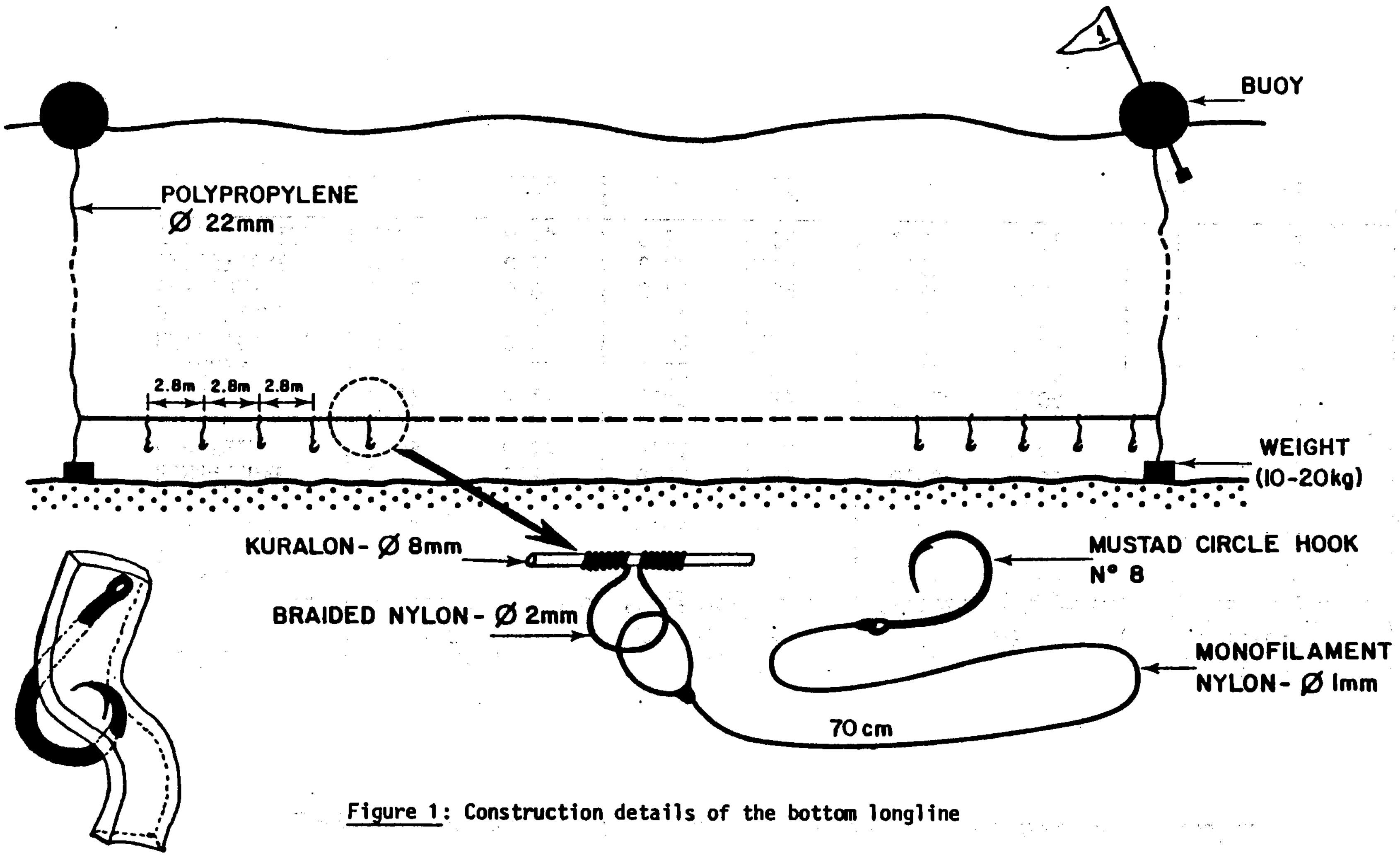


Figure 1: Construction details of the bottom longline

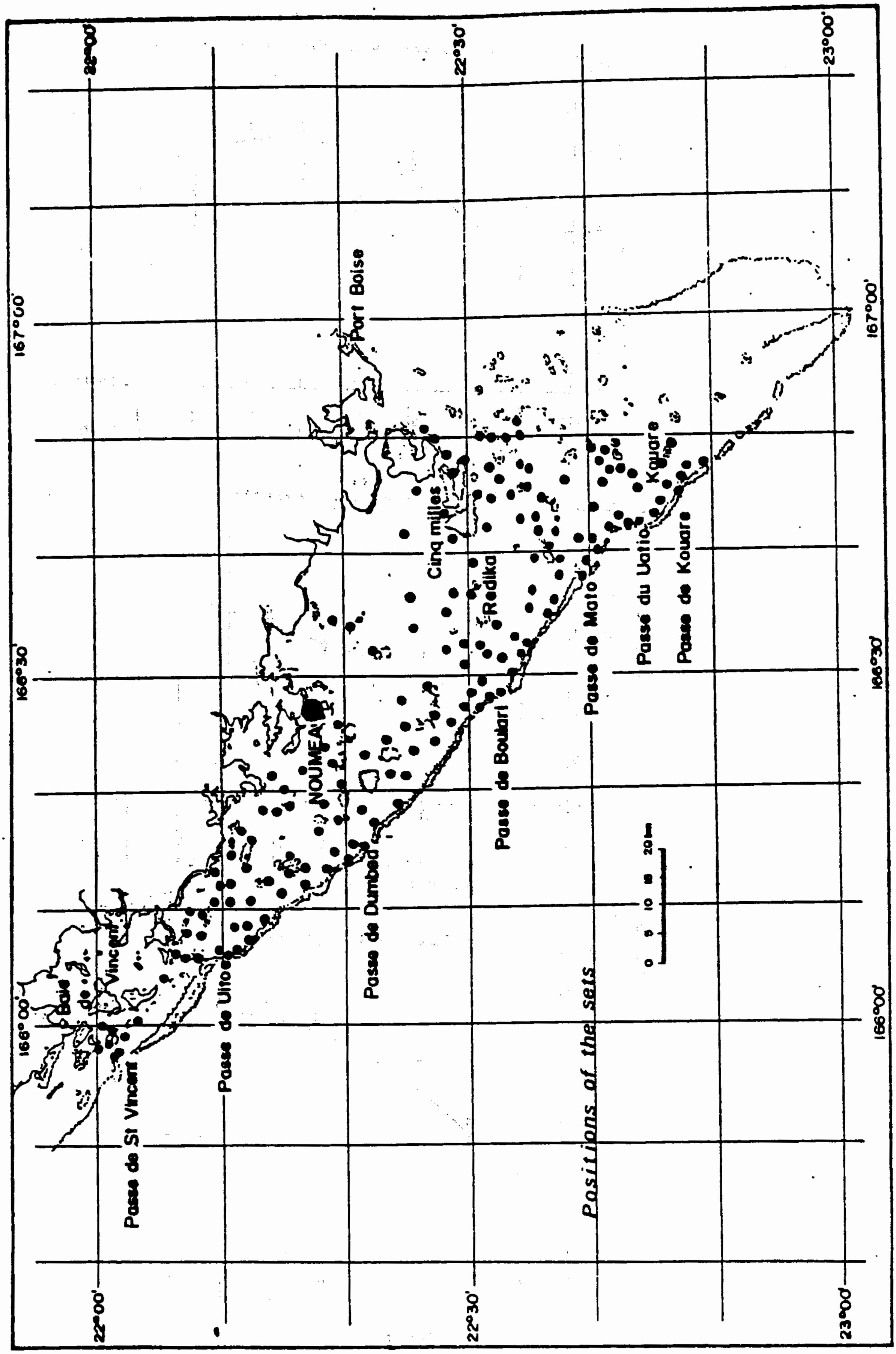
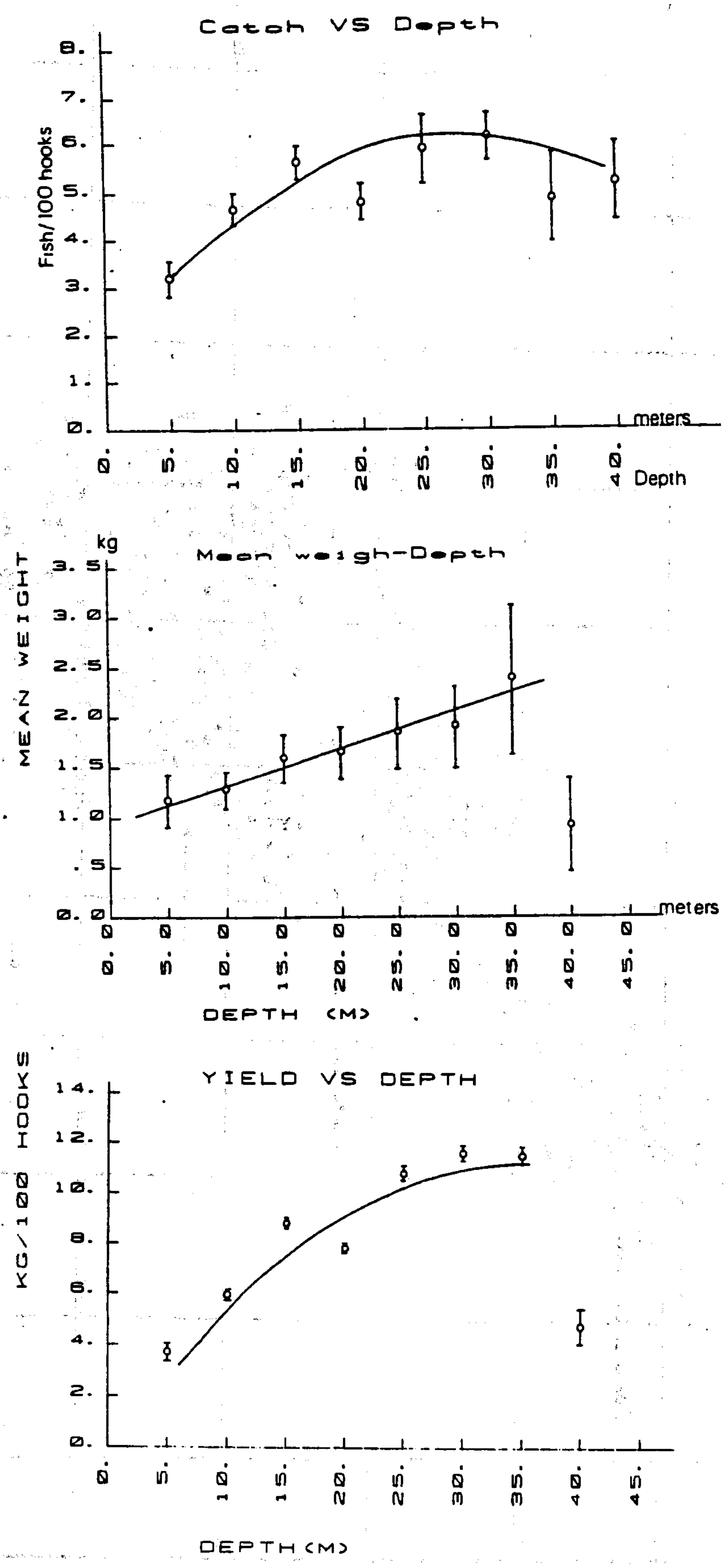
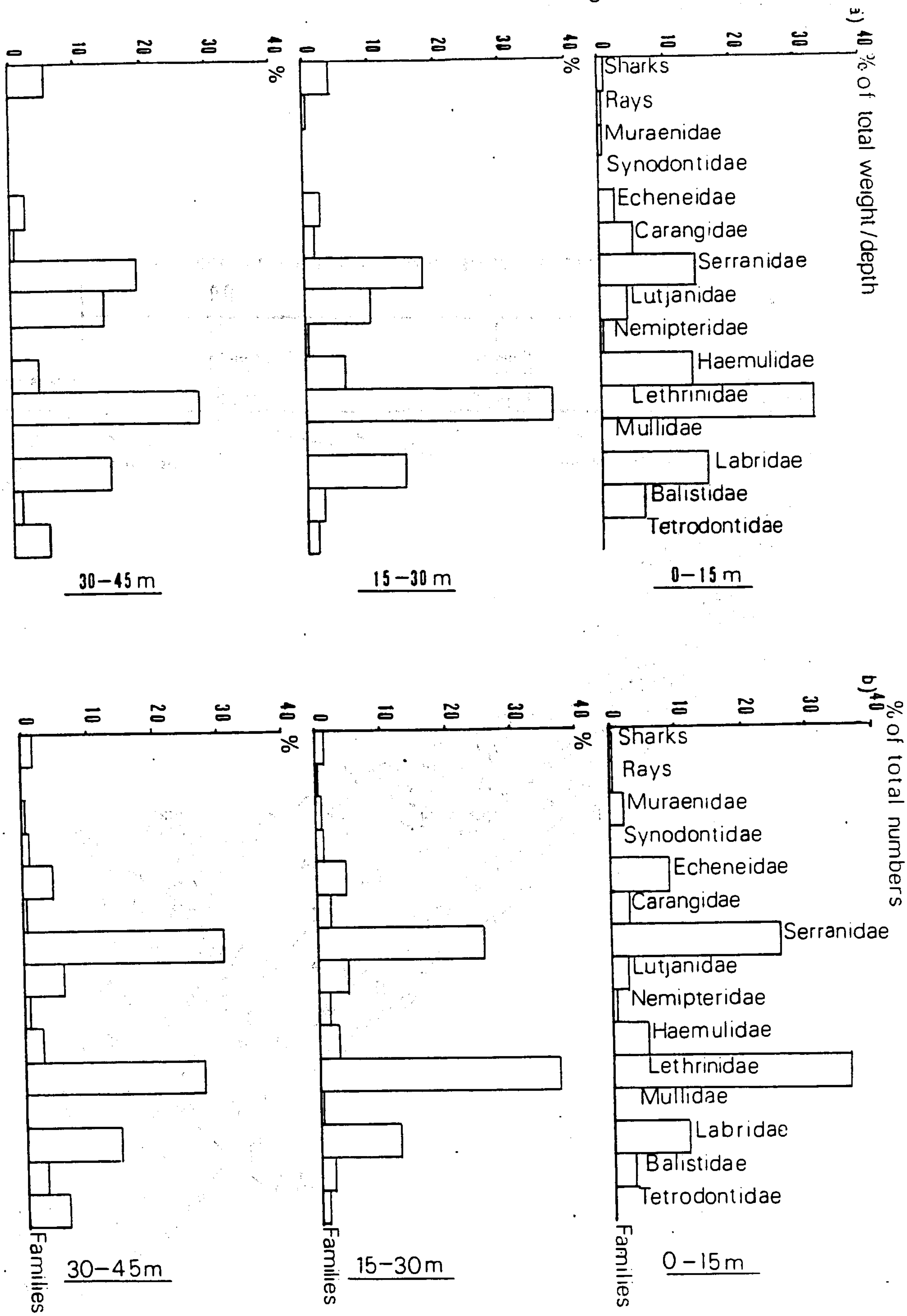


Figure 2 : Location of the 289 sets. One point may represent several sets.

a)
b)
c)



Figures 3a, 3b and 3c : Variations with depth of catch in numbers (5a), mean weight (5b) and yield (5c).



Figures 4a and 4b : Catch composition in relation to depth.

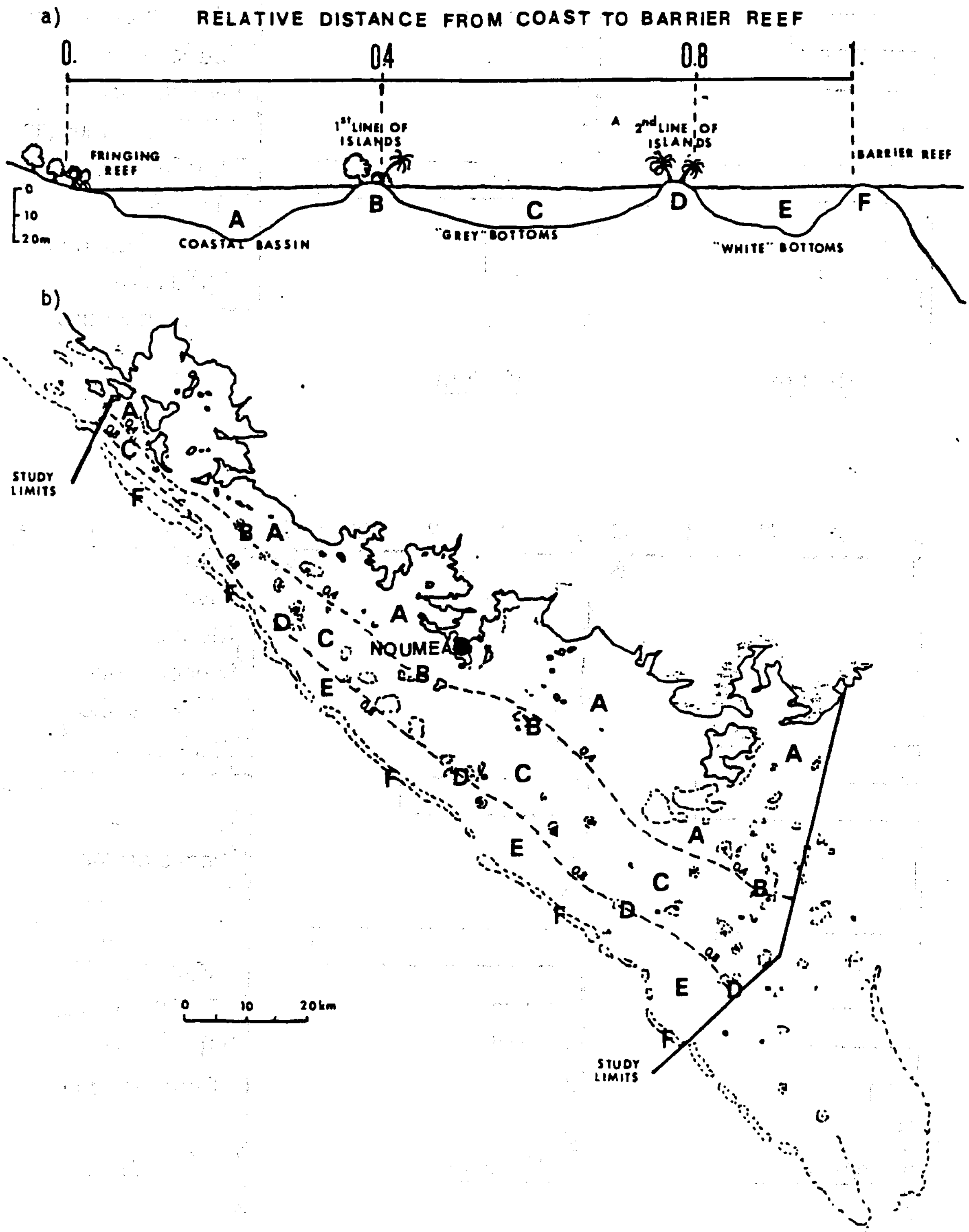
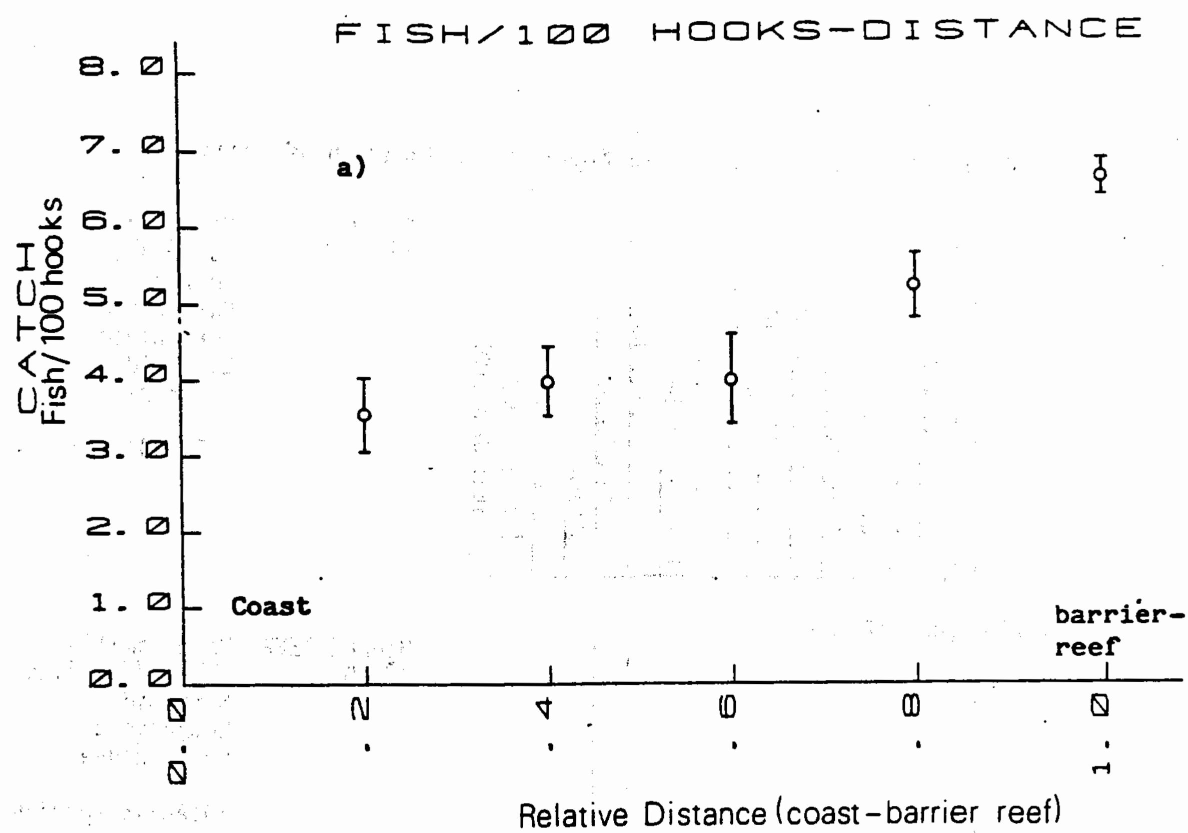
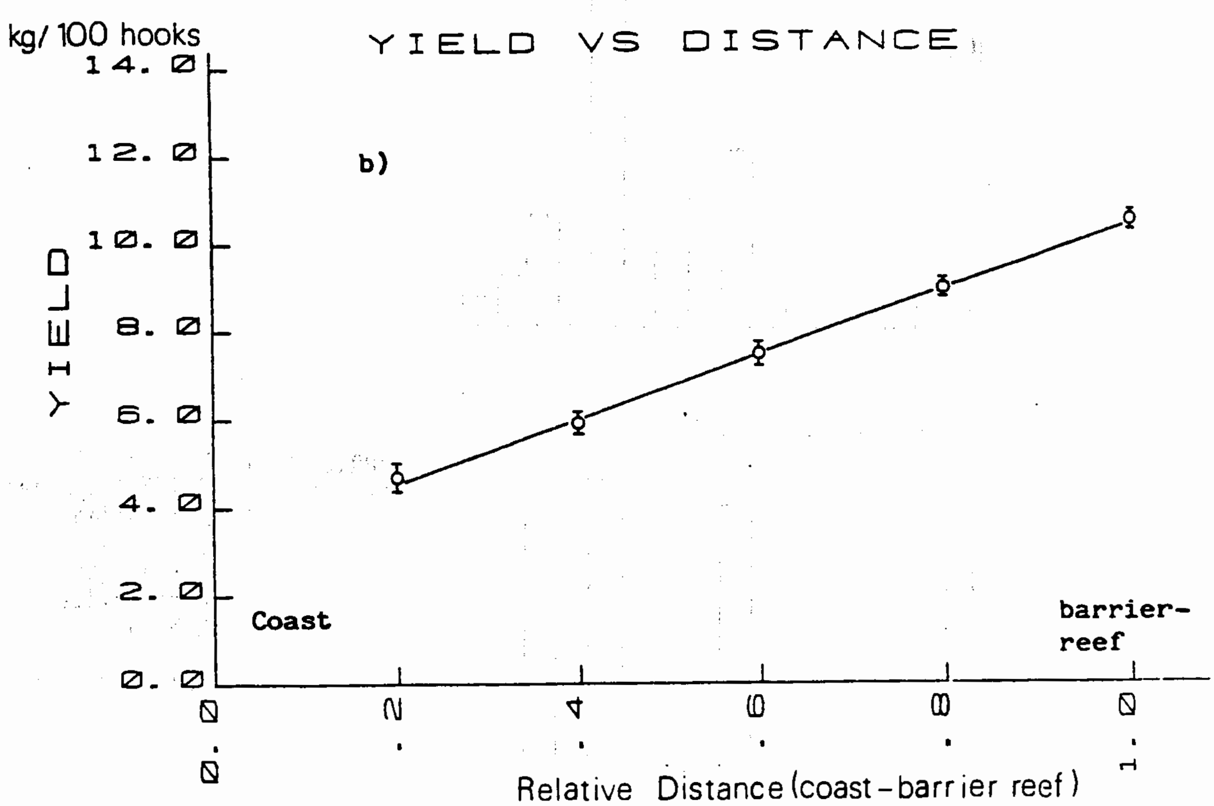
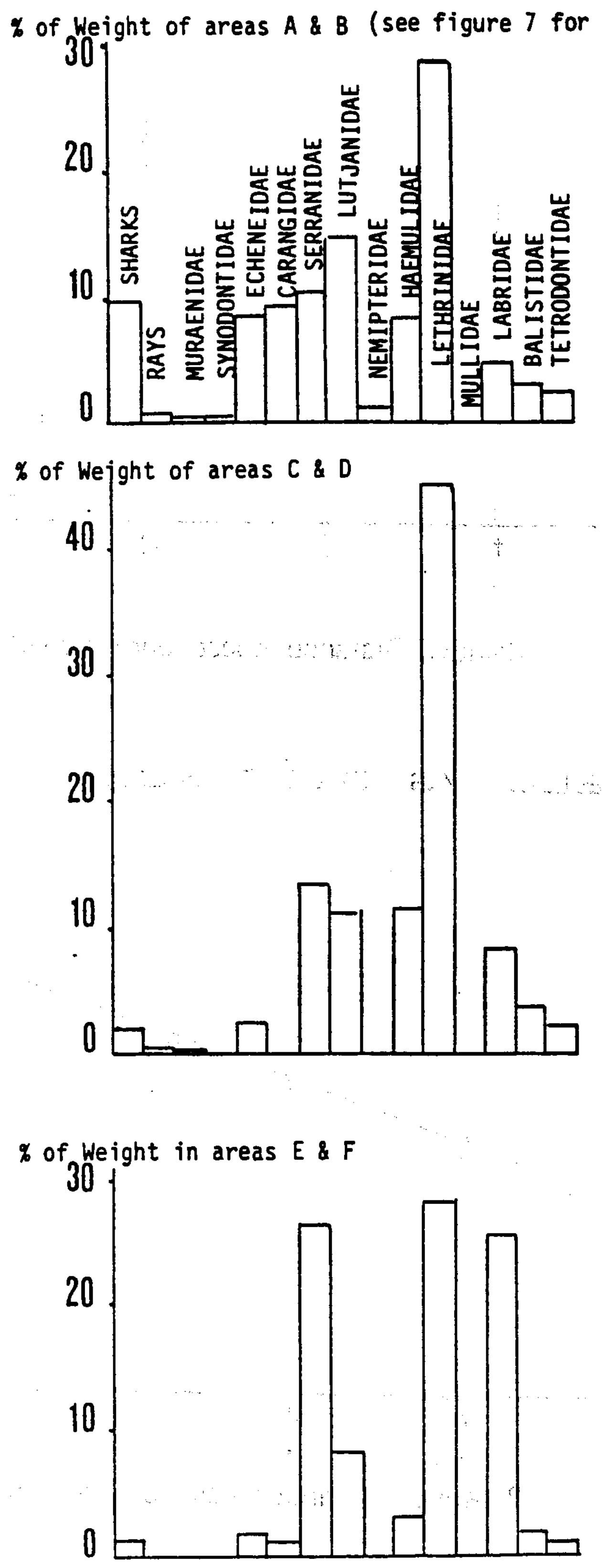


Figure 5 : General morphological structure of the lagoon : a) cross section from coast to barrier reef b) mapping of the 0.4 and 0.8 relative distance contour in the SW lagoon.





<u>Figures 6a and b</u> : **Variations of catch in numbers and weight on the coast to barrier reef axis.**



COAST
A*- B*

Main families:
(over 3 species)

Sharks	: 4	species
Carangidae	: 7	"
Serranidae	: 9	"
Lutjanidae	: 5	"
Lethrinidae	: 7	"

TOTAL:41 species

MIDDLE REEF
C*- D*

Main families:
(over 3 species)

Serranidae	: 15	species
Lutjanidae	: 7	species
Lethrinidae	: 8	species

TOTAL:45 species

BARRIER REEF
E*- F*

Main families:
(over 3 species)

Muraenidae	: 4	species
Serranidae	:15	"
Lutjanidae	: 5	"
Lethrinidae	: 8	"
Labridae	: 4	"

TOTAL:48 species

Figure 7: Catch composition on the coast-barrier reef axis

Maximum near coast-decreases towards outer reef
Maximum on middle reef
Maximum on barrier reef-increases from coast to barrier reef

* see fig. 5 for explanation