

Workshop on Southern Albacore Research  
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Outlines of research on albacore conducted by ORSTOM  
in the Western and Central South Pacific Ocean  
from 1965 to 1985

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A research programme on albacore has been carried out by ORSTOM in the Western and Central South Pacific Ocean from 1965 to 1985. The main results are summarized in this paper at the end of which references of produced documents are given.

SURFACE ALBACORE

The fact that albacore are available to a surface fishery in the Northern Pacific Ocean strongly suggested that a similar resource is present in the Southern hemisphere, not only around New Zealand where a summer fishery has been developed but also further east (ref. 39 and 40). An exploratory fishing survey was therefore conducted in the Central South Pacific Ocean on board the R.V. CORIOLIS (12 February - 4 March 1982) using trolling fishing technique (ref. 28, 32 and 33). "The area surveyed extended from 38°S to 42°S and 157°W to 180° (Fig. 1). During this exploratory cruise measurements of the hydrobiological conditions were obtained in areas immature albacore occurred. This included temperature, salinity and oxygen measurements from 0 to 500 m and chlorophyll "a" contents from 0 to 200 m. Juvenile albacore caught (n = 39) were distributed in four different groups from two to five years and they were present in waters with surface isotherms, well defined structure (16 to 19°C) and frontal zone. These conditions were found in the so called "subtropical convergence" (ref. 51 and 52) which represents a very favourable hydrology structure for concentration of albacore and location of potential albacore surface fishing grounds. Environment of this juvenile and sub-adult albacore population is similar to conditions described in other albacore surface fisheries and they present a comparable age structure to the North Pacific and North-East Atlantic populations".

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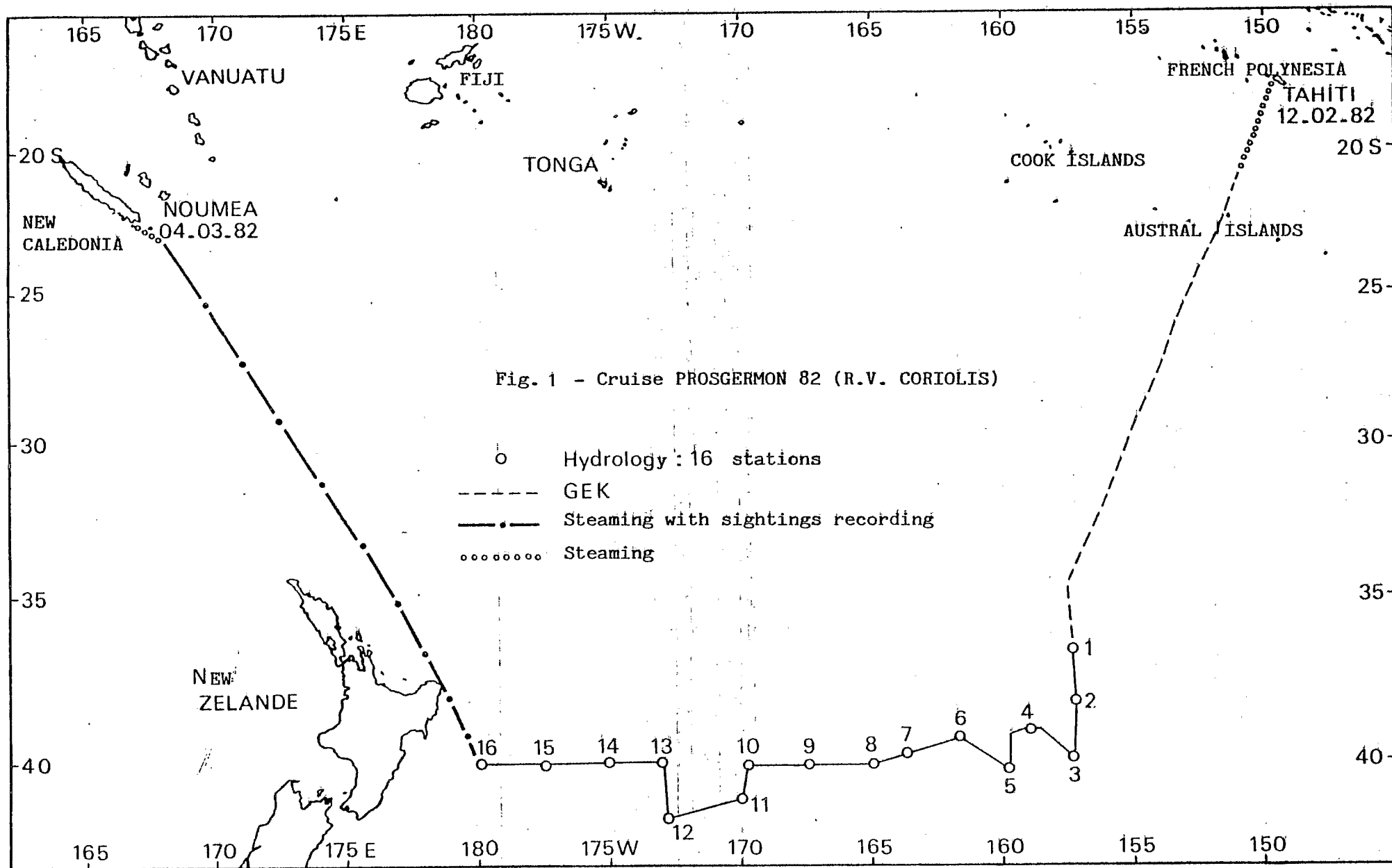
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In order to extend the area surveyed further east a similar cruise is scheduled early 1987 from 155°E to 110°E (longitude of Easter Island).

#### DEEP-SWIMMING ALBACORE

Statistical data from commercial fisheries and biological and hydrological data from research surveys were collected.

##### 1 - Commercial fisheries

They concern the Japanese, Korean and Taiwanese longliners operating in the South West Pacific and within the E.E.Z. of French Polynesia and New Caledonia. Reports on fishing positions, efforts, catches and C.P.U.E. by species, etc... have been produced (ref. 5,6,7,8,9,10,11,12,13,14,15,24,25,26,27,29,30 and 41).

In Vanuatu, a detailed study of the activities of the Taiwanese fleet based in Pallicolo (Santo Island) including fish measurements led to the following conclusions (ref. 3) :

- best catch rates are obtained between 25°S and 40°S (subtropical to temperate waters) where surface temperature gradients (range of fluctuations within a month) are maximum,

- although strong salinity gradients do not seem to influence the fishing, the best catch rates are obtained where surface salinities are above average,

- length - frequencies analysis shows that large-sized albacore are caught in "equatorial" waters (zone extending from the equator to 15°S) from April to June whilst smaller fish are captured in temperate zone from July to December.

##### 2 - Research surveys

From 1965 to 1974 research conducted by ORSTOM was devoted to the study of the pelagic food webs in the tropical Pacific Ocean with emphasis put towards the study of the trophic relationships leading to longline tuna (albacore and yellowfin tuna). About 40 cruises were carried out in order to describe the physical and biological characteristics of the environment. The methods used for sampling and measuring are detailed hereafter.

- Tuna : about 200 horizontal and vertical longline sets (ref. 1,4,20,21,23 and 37); for some of them, the depth of a total of 20 000 hooks and corresponding catches were recorded within the depth range 50 to 650 m.
- Nekton : about 100 midwater trawl hauls from the surface down to depths ranging from 50 to 800 m (net size : 22 m from wing to wing, 50 m from wings to cod-end, about 50 m<sup>2</sup> surface of month opening).
- Micronekton : about 1500 10-foot Isaacs-Kidd midwater trawl hauls (300 of which with an opening-closing type BE cod-end) from the surface down to 1400 m.
- Zooplankton : about 1500 zooplankton net (50 cm and 1 m diameter O-ring nets, OMORI opening-closing larval net) vertical and oblique hauls from the surface down to 1400 m.
- Neuston : about 100 neuston net hauls (15 mn)
- Phytoplankton and primary production : phytoplankton net hauls, sampling of water for filtration using opening closing bottles, in situ incubation using the C<sup>14</sup> method, etc,...
- Hydrology : thousands of stations (temperature, salinity, nutrients, currents, etc...); data from voluntary observing ships.

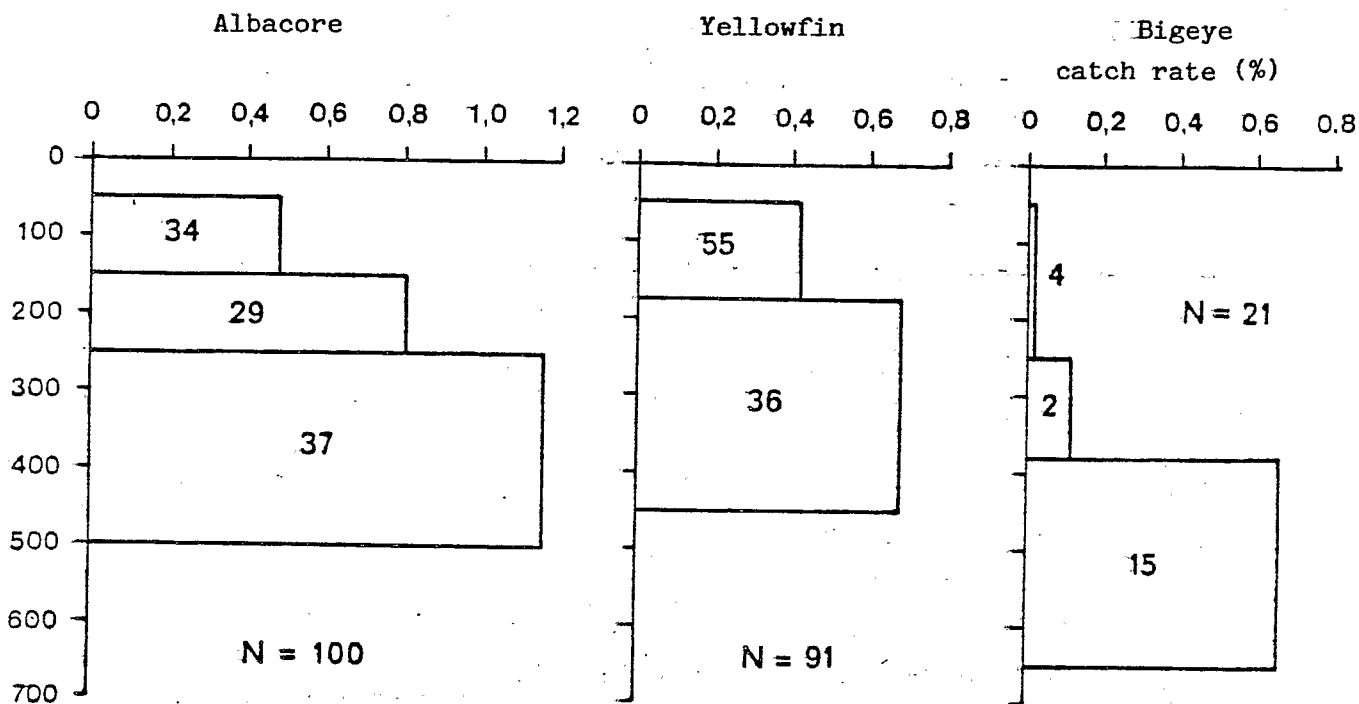
The results concerning mainly albacore and the trophic relationships leading to them are summarized hereafter.

#### Vertical distribution of albacore (ref. 18,19,22,35 and 36).

The distributions of catch-rates and fishing efforts according to depth are shown on fig.2. The maximum concentration of albacore extends from 250 to 500 m. No correlation could be established (statistical tests) between depth and forklength, between depth and sex-ratio nor between depth and gonad maturation. This therefore seems to indicate that there is only one single population of albacore tuna throughout the water column. (ref. 18).

#### Temperature (ref. 18)

Vertical profiles of temperature were recorded from bathythermograph or CTD casts made at longline setting locations. By relating the



Depth (m)

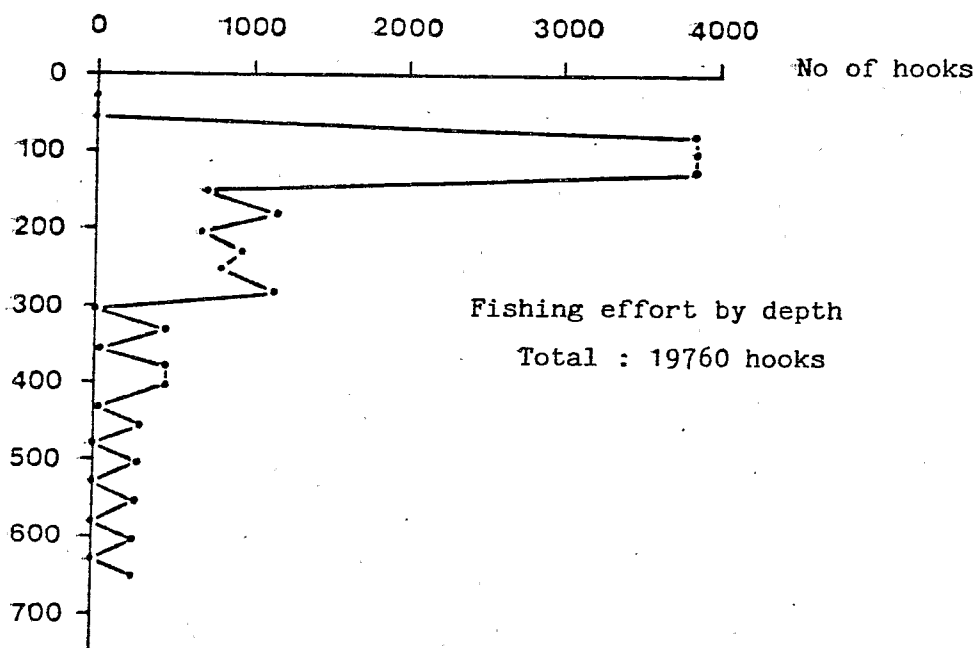


Fig. 2 — Vertical distributions of tuna  
(from GRANDPERRIN, 1975)

depth of every hook and fish caught to the temperature, it then was possible to define several temperature ranges corresponding to different catch rates.

27°C - 28°C : not catch of albacore

25°C - 22°C : catch rates fairly constant; average 0.3 per 100 hooks

21°C - 11°C : catch rates showing strong variability; average 1.1%

10°C - 7°C : no catch.

The above figures show that longline albacore tuna are able to live within a total temperature range of 14°C (25°C to 11°C).

Time of feeding activity (ref. 18, 19, 35 and 36)

Several pairs of longline sets were made, each pair consisting in one set during the day and one set during the following night at the same position. Dawn and dusk periods were avoided. The results are summarized in table 1; they show that longline albacore tuna do not feed at night. An attempt to determine the time of death of catches during longline fishing was made (ref. 42).

Table 1 - Results of pairs of day-time and night-time longline sets (same location)

	day-time	night-time
Number of sets	9	9
Number of hooks	3170	2091
Catch (number)		
Albacore	26	0
Yellowfin	11	0
Bigeye	2	1
Catch rate (%)		
Albacore	0.8	0
Yellowfin	0.3	0
Bigeye		

Diet (ref. 17, 18, 19, 34, 35, 36, 38, 43, 44, 45, 46, 47, 48, 49 and 50)

235 stomach contents of albacore were examined. Their average weight was 17g with values ranging from 0 to 220g (ref. 18). Table 2 gives the stomach contents composition by large taxonomic groups.

Table 2 - Composition of 235 albacore stomach contents :  
percentages of each taxinomic groups (+ means  
present in very small percentage)

Fish and fish larvae		43
Cephalopods		35
Crustaceans		
Euphausiids	+	
Sergestids	+	
Carids	+	
Phronimids (Amphipods)	+	
Other Amphipods		2.6
Stomatopods larvae		1.0
Phyllosoma		0.9
Various larvae		3.5
Various Crustaceans	+	
Total Crustaceans		9
Various plankton		
Heteropods	+	
Phronimids barrels		1.0
Miscellaneous	+	
Total various plankton		1
Unidentified (digested)		12
		<hr/>
		100 %

Appendix 2 and 3 respectively detail the family and species composition of fish ingested (ref. 18).

The otoliths found in the stomach contents were identified including the ones of Cololabis saira used as bait. This allowed to estimate that full digestion lasts a maximum of about 12 hours (ref. 18).

#### Availability of food

Comparison between stomach contents and net catches from the 0-1500 m water column shows that there is a strong discrepancy between the food of tuna and the standing crop (table 3). This might induce to

Table 3 - Percentages of fishes (by number) in tuna stomach contents and in net catches

	Tuna	Nets
. Fishes found only in net catches	-	84 %
. Fishes found in both tuna stomach contents and net catches	63 %	16 %
. Fishes found only in tuna stomach contents	37 %	-
	<hr/>	<hr/>
	100 %	100 %
	(N= 2922)	(N=15248)

think that tuna are selective feeders. In fact, this discrepancy is explained by the fluctuations occurring in the vertical distributions of the nektonic and micronektonic organisms within the 24 hours cycle. Vertical distributions of the main components of the fauna (total biomass, fishes, fish larvae, Cephalopods, Euphausiids, Carids, Sergestids, Peneids, Mysids, Amphipods, Pteropods, Heteropods, jelly fish) have been described (ref. 18 and 36). Space-time distributions have been detailed by species for Euphausiids (ref. 36 and 48), Amphipods (ref. 36 and 45) and fishes (ref. 18 and 36). As far as fishes are concerned, figure 3 shows that they can be classified into six different clusters according to their vertical migratory pattern. As the feeding activity of albacore tuna occurs from the one hand above a depth of 500 m and from the other hand at day-time, albacore can prey only upon organisms present at the same time in the same water layer. As a consequence, figure 3 shows that:

- . type (a) organisms never occur in stomach contents,
- . types (b) and (c) occur occasionally,
- . types (d) and (e) often occur,
- . type (f) always occur.

This leads to the conclusion that albacore tuna are opportunist feeders on the whole fauna available in their habitat at day-time.

#### Reproduction and larvae

Albacore seem to spawn during the warmer months in low latitudes (ref. 26 ). Larvae were caught by the mean of plankton nets in the 0-100 m water layer around New Caledonia between 20°S to 26°S in February-March (ref. 16) and in French Polynesia between 16°S and 27°S from February to April (ref. 31). During the extensive programme carried out



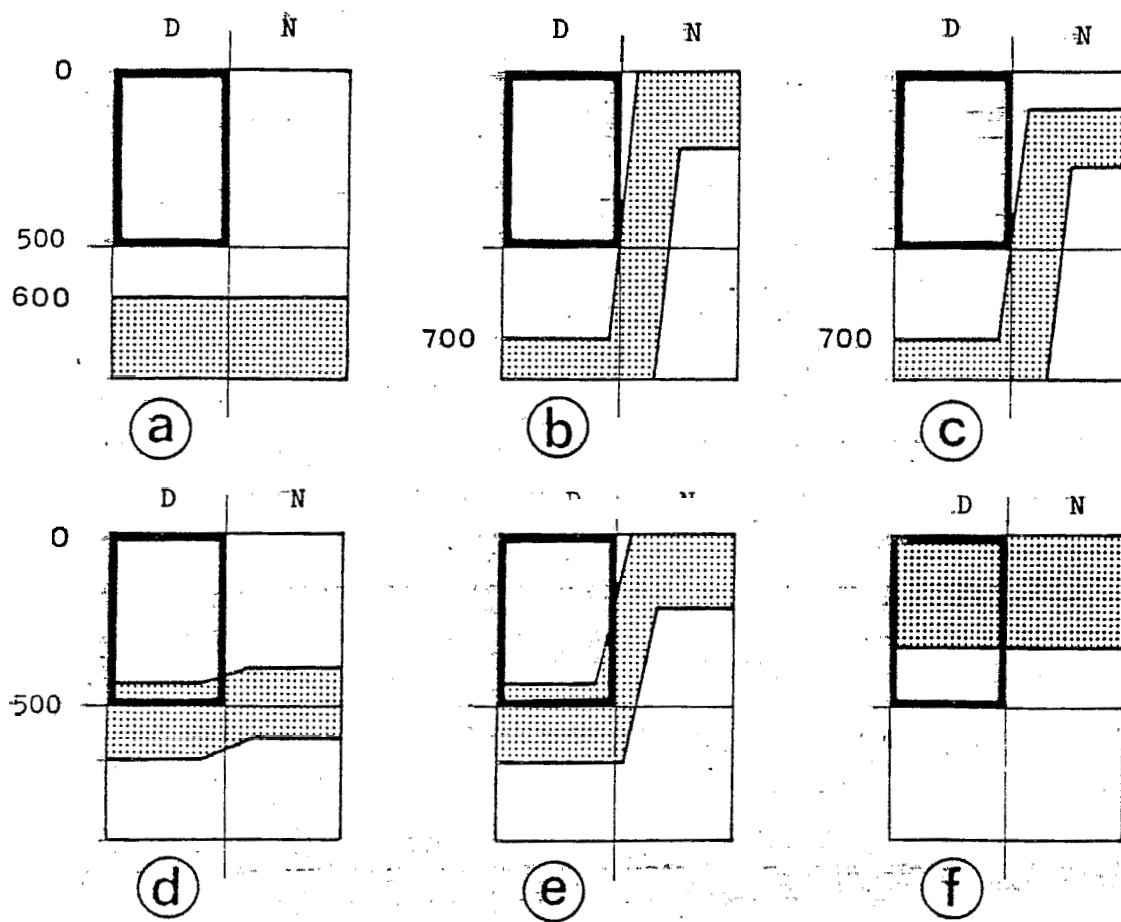


Fig. 3 - Time-space albacore feeding activity and various types of vertical migratory patterns of nektonic and micro- nektonic fish. (from GRANDPERRIN, 1975).



Time-space albacore feeding activity.

- a. deep non migrating fish
- b. large amplitude migrating fish
- c. deep migrating fish
- d. intermediate small amplitude migrating fish
- e. superficial migrating fish
- f. superficial non migrating fish

D : day-time, N : night-time

by the South Pacific Commission Skipjack Tagging and Assessment Programme, 3896 skipjack stomach contents were analysed out of which 38 had a total of 52 albacore tuna juveniles ranging from 10 mm to 120 mm in standard length (ref. 2).

#### CONCLUSION

Since 1965, ORSTOM has devoted a substantial effort into the description of the physical and biological characteristics of the tropical Central and Western-Pacific Ocean environment. These studies have been based on traditional hydrological and biological surveys and more recently on additional sampling by voluntary observing ships (XBT, sea-surface temperature and salinity, chlorophyll and zooplankton). Although the knowledge of the trophic relationships leading to tunas has been substantially improved, we know virtually nothing on the links between the physical characteristics of the environment and the presence of tunas. Emphasis should therefore be put on this matter in discussing research priorities.

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Appendix 1 - Decreasing importance of various albacore fish-preys : families ranked according to number (R1), to occurrence (R2) and to  $R = R1 + R2$  (from GRANDPERRIN, 1975).

Families	Number		Occurrence		R=R1 + R2
	% (1)	R1	%	R2	
Sternoptychidae	8.6	36	16.8	35.5	71.5
Gempylidae	6.0	33	17.5	37	70
Bramidae	6.4	34	16.8	35.5	69.5
Chaetodontidae	8.1	35	8.4	32	67
Myctophidae	2.9	28	9.8	34	62
Latilidae	4.6	31	7.0	30	61
Etalidae	3.5	29	8.4	32	61
Paralepididae	2.7	27	8.4	32	59
Acanthuridae	4.3	30	6.3	28.5	58.5
Alepisauridae	2.1	25	4.9	26.5	51.5
Anoplogastridae	1.7	23	6.3	28.5	51.5
Ostreacionidae	2.3	26	4.2	25	51
Chiasmodontidae	2.0	24	4.9	26.5	50.5
Lutjanidae	23.3	37	1.4	12	49
Nomeidae	5.8	32	1.4	12	44
Molidae	1.4	20	2.8	23	43
Anthiidae	1.4	20	2.8	23	43
Zeidae	1.4	20	2.1	18.5	38.5
Caproidae	1.2	17	2.1	18.5	35.5
Scorpaenidae	1.2	17	2.1	18.5	35.5
Dirietmidae	0.8	11.5	2.8	23	34.5
Scombrolabracidae	1.0	14.5	2.1	18.5	33
Percichthyidae	1.2	17	1.4	12	29
Serranidae	0.6	10	2.1	18.5	28.5
Polymixiidae	0.6	10	2.1	18.5	28.5
Bregmacerotidae	1.5	22	0.7	4.5	26.5
Balistidae	1.0	14.5	1.4	12	26.5
Scopelarchidae	0.8	11.5	1.4	12	23.5
Trichiuridae	0.6	10	1.4	12	22
Tetraodontidae	0.4	8	1.4	12	20
Uranoscopidae	0.2	4	0.7	4.5	8.5
Triacanthidae	0.2	4	0.7	4.5	8.5
Trachichthyidae	0.2	4	0.7	4.5	8.5
Priacanthidae	0.2	4	0.7	4.5	8.5
Omosudidae	0.2	4	0.7	4.5	8.5
Blenniidae	0.2	4	0.7	4.5	8.5
Apogonidae	0.2	4	0.7	4.5	8.5
	100	-	100	-	-

(1) in % of identified fish (N = 518)

Appendix 2 - Decreasing importance of various albacore fish-preys : families, genera and species ranked according to number (R1), to occurrence (R2) and to  $R = R1 + R2$  (from GRANDPERRIN, 1975).

Families, genera, species	Number		Occurrence		R=R1 + R2
	% (1)	R1	%	R2	
. Sternoptyx sp.	5.2	69	10.5	71	140
. Centropyge sp.	6.9	70	5.6	66.5	136.5
. Hoplolatilus sp.	4.6	67.5	7.0	69	136.5
. Brama orcini	4.2	66	9.8	70	136
. Naso sp.	3.5	65	5.6	66.5	131.5
. Anoplogaster cornutus	1.7	60.5	6.3	68	128.5
. Pristipomoides sp.	1.9	62	4.9	64.5	126.5
. Myctophidae ind.	2.9	64	3.8	62	126
. Paralepididae ind.	1.7	60.5	4.9	64.5	124.5
. Argyropelecus sp.	2.0	63	3.5	60.5	123.5
. Nealotus tripes	1.4	55	4.2	63	118
. Alepisaurus brevirostris	1.5	58	2.8	55	113
. Mola mola	1.4	55	2.8	55	110
. Argyropelecus olfersi	1.4	55	2.8	55	110
. Lepidocybium flavobrunneum	1.0	46.5	3.5	60.5	107
. Lutjanus sp.	23.3	71	1.4	36	107
. Chaetodon sp.	1.2	51	2.8	55	106
. Pterycombus petersii	1.0	46.5	2.8	55	101.5
. Setarches guntheri	1.2	51	2.1	47.5	98.5
. Lactoria diaphana	1.5	58	1.4	36	94
. Scombrolabrax heterolepis	1.0	46.5	2.1	47.5	94
. Taractes asper	0.8	39	2.8	55	94
. Pseudoscopelus sagamianus	0.8	39	2.8	55	94
. Diretmus argenteus	0.8	39	2.8	55	94
. Rexea solandri	0.8	39	2.8	55	94
. Scombrosphyraena oceanica	1.2	51	1.4	36	87
. Zanion sp.	1.2	51	1.4	36	87
. Gempylidae ind.	0.8	39	2.1	47.5	86.5
. Anthias squamipinnis	1.0	46.5	1.4	36	82.5
. Cubiceps sp.	4.6	67.5	0.7	14	81.5
. Alepisaurus ferox	0.6	30.5	2.1	47.5	78
. Etelis ocellatus	0.6	30.5	2.1	47.5	78
. Gempylus serpens	0.6	30.5	2.1	47.5	78
. Antigonia rubescens	0.8	39	1.4	36	75
. Diplospinus multistriatus	0.8	39	1.4	36	75
. Scopelarchus guntheri	0.8	39	1.4	36	75

(1) in % of identified fish (N = 518)  
 . true pelagic fish

Appendix 2 (continued) - Decreasing importance of various albacore fish-preys : families, genera and species ranked according to number (R1) to occurrence (R2) and to  $R = R1 + R2$  (from GRANDPERRIN, 1975).

Families, genera, species	Number		Occurrence		R=R1 + R2
	% (1)	R1	%	R2	
. Bregmaceros rarisquamosus	1.5	58	0.7	14	72
. Chiasmodon sp.	0.6	30.5	1.4	36	66.5
. Nesiarchus nasutus	0.6	30.5	1.4	36	66.5
. Cubiceps panciradiatus	1.2	51	0.7	14	65
Anthias sp.	0.4	23	1.4	36	59
Ostracion tuberculatus	0.4	23	1.4	36	59
. Paralepis atlantica	0.4	23	1.4	36	59
. Lestidiops jayakari	0.4	23	1.4	36	59
Polymixia berndti	0.4	23	1.4	36	59
Ostreoberyx sp.	0.4	23	1.4	36	59
Lagocephalus sp.	0.4	23	1.4	36	59
Acanthurus sp.	0.8	39	0.7	14	53
Balistidae ind.	0.8	39	0.7	14	53
Symphysanodon sp.	0.8	39	0.7	14	53
. Chiasmodontidae ind.	0.6	30.5	0.7	14	44.5
Antigonia capros	0.4	23	0.7	14	37
. Benthodesmus sp.	0.4	23	0.7	14	37
Synagrops sp.	0.2	9.5	0.7	14	23.5
Balistes vidua	0.2	9.5	0.7	14	23.5
Cirripectes sebae	0.2	9.5	0.7	14	23.5
. Pteraclis velifera	0.2	9.5	0.7	14	23.5
. Pteraclis sp.	0.2	9.5	0.7	14	23.5
Etelis carbunculus	0.2	9.5	0.7	14	23.5
. Omosudis lowei	0.2	9.5	0.7	14	23.5
Lactoria fornesini	0.2	9.5	0.7	14	23.5
Rhinesomus reipublicae	0.2	9.5	0.7	14	23.5
. Lestidiops pacificum	0.2	9.5	0.7	14	23.5
Polymixia sp.	0.2	9.5	0.7	14	23.5
Pristigenys nipponia	0.2	9.5	0.7	14	23.5
Sacura mergeritacea	0.2	9.5	0.7	14	23.5
Gephyroberyx darwini	0.2	9.5	0.7	14	23.5
Halimochirus sp.	0.2	9.5	0.7	14	23.5
Aphanopus sp.	0.2	9.5	0.7	14	23.5
Uranoscopus sp.	0.2	9.5	0.7	14	23.5
Zenion longipinnis	0.2	9.5	0.7	14	23.5
	—	—	—	—	—
	100	-	100	-	-

(1) in % of identified fish (N = 518)  
 . true pelagic fish.