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SPATIAL DISTRIBUTION OF SMALL PELAGIC FISH IN THE LAGOON OF NEW CALEDONIA.

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ABSTRACT

Two acoustic surveys have been done in the lagoon all around New Caledonia, with a digital integrator. The cruises lasting two weeks were done at six month interval. Much information has been obtained on stock biomass and spatial distribution of fish and schools. Fish are dispersed at night and stay near the surface. During the day they form schools, usually of very small size. Some species are found mostly along the coasts, on the reef flats and far inside in the bays. Some others stay in the middle of the bays or in the central part of the lagoon and occur usually in deeper water at some distance of the bottom. Aerial and diving observations have shown that the fish of coastal schools were feeding on the reef. Species schooling during the day in the middle of the bays usualy occur deep in the water, not far from the bottom where suspended organic matter is abundant. In a shallow water environment like a coral reef lagoon, the concept of pelagic fish is questionable and most species seem to have strong relations with the bottom. The small pelagic fish, preyed by larger pelagic species (jacks, scads, spanish mackerels...), play a role of energy transfer from the benthic to the pelagic compartment.

INTRODUCTION

A research program on small-sized pelagic fish was carried out in the lagoon of New-Caledonia between 1980 and 1983, and some results have already been published (Conand, 1985, 1988).

The island of New Caledonia, 400 km long and about 50 km wide is surrounded by a large lagoon. Its width varies between 1 and 20 km. Depth is usually less than 20 m off the West Coast and from 30 to 50 m off the East Coast. A large variety of sites were tested during more than 300 nights of fishing. Lift net sets were made inside the lagoon, mostly in sheltered bays and also near coral islets and the barrier reef.

Some twenty species are regularly present in the catch. They belong to seven families : Engraulidae (Stolephorus heterolobus, S. devisi, S. punctifer, S. indicus, S. insularis, Thrissina baelama), Clupeidae (Herklotsichthys quadrimaculatus, Amblygaster sirm, A. clupeoides), Dussumieriidae (Dussumieria spp, Spratelloides delicatulus, S. gracilis), Atherinidae (Atherinomorus lacunosus, Hypoatherina ovalaua), Leiognathidae (Leiognathus bindus, Gazza minuta), Carangidae (Decapterus russelli, Selar crumenophthalmus, Scomberoides lysan) and Scombridae (Rastrelliger kanagurta). A correspondance analysis made from 273 nights of fishing and 20 species leads to the five following ecological groups : species of coral reef areas, species of silted coastal zones, species of deep areas of the lagoon, ubiquitous species, and ocean anchovy (figure 1).

A particularly interesting aspect to focus on, is the distribution of the fish. They are probably mostly pelagic but some of them seem to have strong links with the bottom and could play an important part in the relations between the pelagic and the benthic compartments of the lagoon.

MATERIAL AND METHODS

In order to study the distribution of the fish, two acoustic surveys lasting two weeks were carried out in the lagoon around New Caledonia in October 1982 and April 1983. A twelve meter, low draught, motor boat was used during day and night legs. Simutaneously another boat was fishing each night.

Acoustic prospection was carried out with a SIMRAD EY-M (70 kHz) echosounder. Its transducer was trolled at a depth of 80 cm. An AGENOR digital integrator was used to analyse the signal. More details about the acoustic techniques used, are given in PETIT and LE PHILIPPE (1983).

To study the vertical distribution, the reflected signal was analysed by the echointegrator which divided the water column into a large number of layers. Each layer was 5 m deep, except the upper one which was between 3 and 5 m.

This acoustic technique is limited by the difficulty in sailing in very shallow waters strewn with coral-heads. These waters are as a matter of fact, particular habitats where some species live continuously or at certain periods. In these zones, interesting information has been gathered by visual observations made from the coast, from the air or by divers.

RESULTS

Spatial dispersion

Schooling during the day and scattering at night is an usual behaviour of pelagic fish. The observations made during these two surveys confirm this rule. Schools are characterized by their form, size, mass, density, by the species composition and also by the size of the fish.

Two types of distribution are observed on the sounder. The more frequent is given by compact school with a spherical or a column-like shape. They sometimes come into contact with the botttom. Another type corresponds to fish more or less scattered in narrow layers.

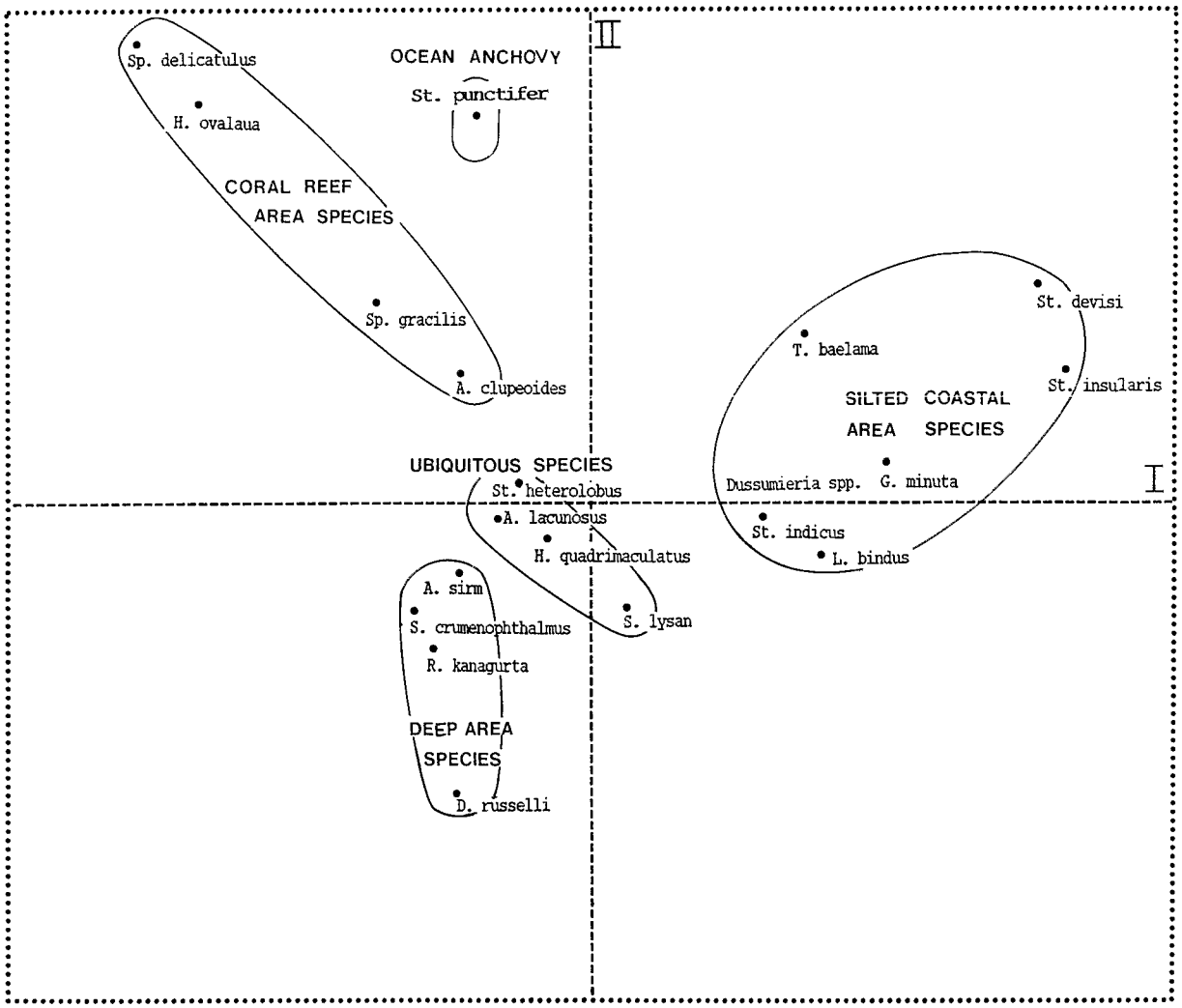

Figure 1. Correspondance analysis with projection of the species in the plane of Axis I and II (from CONAND, 1988).

The size of the schools varies and small concentrations, less than 10 kg are very frequent. Weight class frequency decreases rapidly when the size of the schools increases, and large schools are uncommon (figure 2). The most important did not exceed 6 tons which is rather low for small pelagic fish.

Vertical distribution

Diel vertical movements are clearly evident when the depth of the bays exceeds 20 m (figure 3). In that case, the maximum of biomass is observed during the day, mostly in layers situated at 10 or 15 m above the bottom. At night the pelagic fish are located in the first 10 meters.

Horizontal distribution

From the two legs done in each bay, one during the day and the other at night, a clear tendency to horizontal movement of fish is observed, without beeing a strict rule. Fish occur in costal zones and along the shores of the bays during the day and move to their center at night (figure 4).

At daytime some species, for example sardines (H. quadrimaculatus) and silversides (A. lacunosus), concentrate on the reef flats of fringing reef, on reef of islets or along the barrier reef when the tide allows it. Low-altitude air flights and excursions along cliffs overhanging fringing reefs gave the opportunity to observe schools in very shallow waters (figure 5). They were very quiet, just moving slowly around. One of us had the chance when snorkelling, to come across and stay some ten minutes in a mixed school of H. quadrimaculatus and A. lacunosus. This was in about 50 cm of water over a reef. The fishes were pecking at the bottom, apparently to feed.

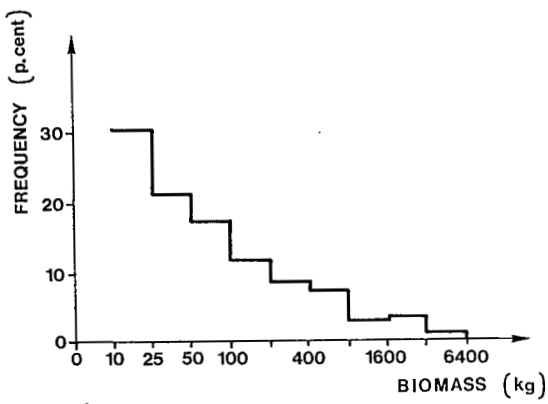

Figure 2. Frequency distribution of the biomass of the schools exceeding 10 kg. Observations made during the acoustic survey of April 1983 (adapted from PETIT and LE PHILIPPE, 1983).

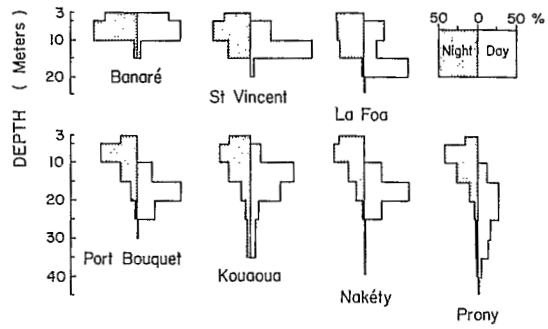

Figure 3. Day and night vertical distribution of pelagic fish in different bays of the lagoon of New Caledonia (adapted from PETIT and LE PHILIPPE, 1983).

DISCUSSION

Spatial dispersion

The study has shown that small pelagic fish scatter at night and school during the day, which is commonly known. The small size of the school, with a mass usually less than one ton, is a more peculiar feature.

In open oceans on continental shelves, particularly in upwelling regions, the schools have an important mass often between 10 and 100 tonnes (HEWITT et al., 1976 ; FREON, 1986) and can sometimes exceed 1 000 tonnes. The diversity of the biotopes and the morphology of the lagoon of New Caledonia, elongated and narrow, can explain that the populations of pelagic fish are themselves diversified and split in small sub-populations.

Vertical distribution

Because of circadian vertical movements, the fish which stay duri... the day at some distance from the coast are found mostly at 10 m above the bottom. This zone is rich in suspended particles on which they can feed. Suspended organic matter in the water column and vertical sedimentation flux, have been studied by Chardy et al. (in prep.), at 5 stations on soft bottoms in the S.W. lagoon of New Caledonia, for a 12 months period. They observed, with sediments traps at 2 m over

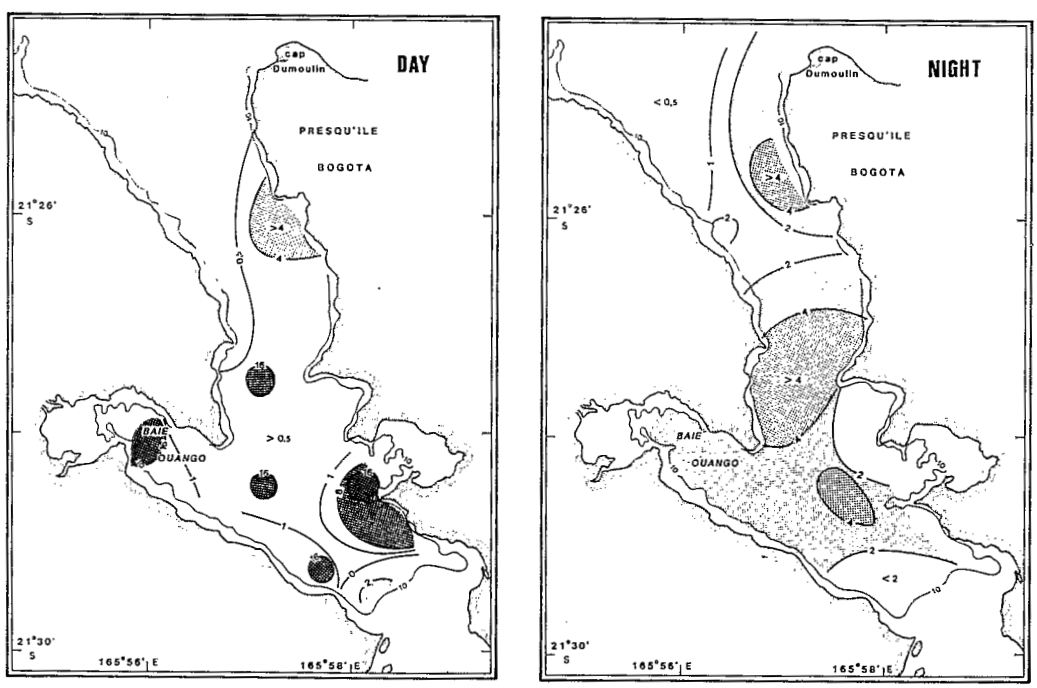

Figure 4. Day and night distribution of pelagic fish in Canala Bay in April 1983 (adapted from PETIT and LE PHILIPPE, 1983).

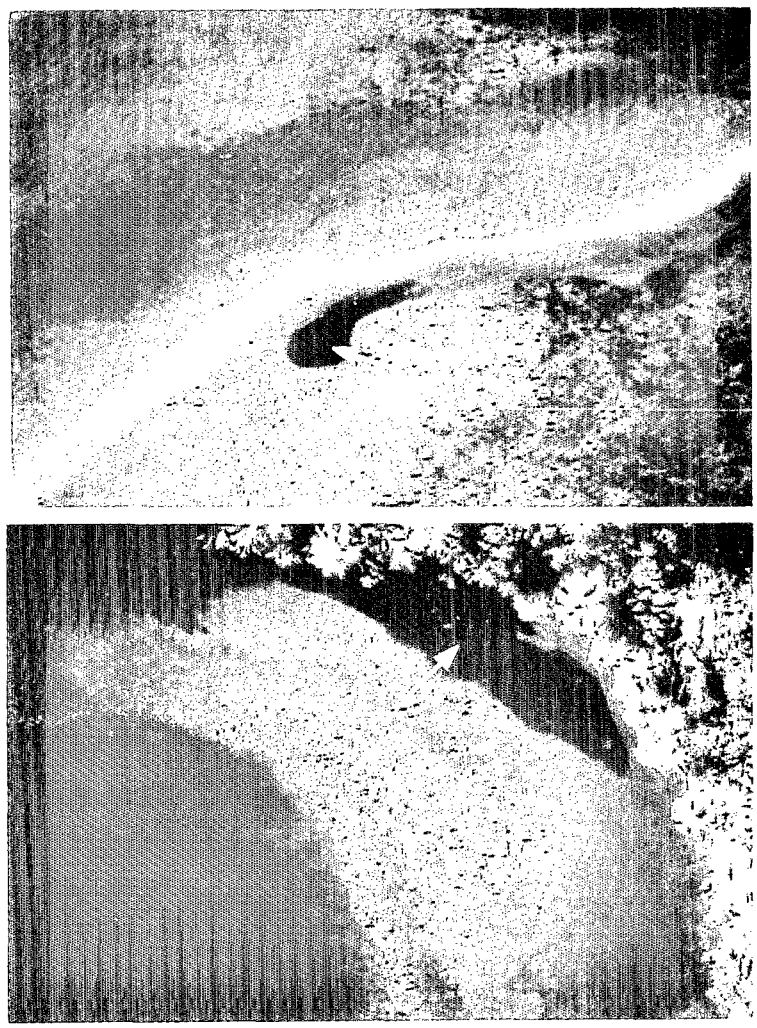

Figure 5. Aerial views of schools. Upper view on a reef flat ; lower view on a fringing reef. (photo Boely).

the bottom a resuspension rate varying between 50 and 70 % depending on the location of the traps.

Analysis of experimental night fishing (Conand, 1988) have shown that the species living in silted coastal areas and unclear waters, are mostly anchovies, Dussumieria spp and Belonathids. Unfortunately, it is almost impossible to catch small fish in such locations during the day, and no stomach content studies were made to confirm the hypothesis of feeding on the suspended particles.

Horizontal distribution

Sardines and silversides move during the day to shallow waters and seem to feed on reef flats when the tide allows it. This point ought to be studied more precisely. Hobson and Chess (1973) and Hida and Uchiyama (1977) point out that silversides' stomachs they analysed in Majuro are full at night and empty during the day. They conclude that these fish feed at night and rest during the day. In New Caledonia, stomach contents of several species caught at night with a lift net after light attraction, were analysed. They were full of plankton. An obvious bias due to the fishing method prevents from concluding that the fish always feed at night. As a matter of fact the light maintains the plankton around the source and the feeding behaviour is generally considered to be one of the main explanation for the attraction of fish to artificial light. For the fish caught during the day with a cast net, unfortunately no stomachs were analysed in detail although observations indicate they were often not empty.

In Tarawa, Ianelli (1988) observed the following proportions in catches made with two different gears, a lift net at some distance from the coast, after light attraction at night and a beach seine during daytime.

Species	lift net	beach seine
H. quadrimaculatus	18	94
S. delicatulus	41	2
A. sirm	28	0
Atherinidae	5	4
Others	8	0

These results show that H. quadrimaculatus gather along the coast during the day and disperse at night. This confirms their ubiquitous character (figure 1). A. lacunosus has a similar behaviour. On the opposite, A. sirm is a species living in deeper areas.

Sprats (S. delicatulus and S. gracilis) seem to have a more typical pelagic behaviour. They can easily be found during the day in clear water near the surface at a short distance from coral heads or coral flats. Because of their small size (adults not exceeding 8 cm F.L.) are very close to macroplankton organism and they are an important forage for larger fish, particularly coastal pelagics (Wilson, 1972).

Conclusion

Most of the small pelagic fish from the lagoon of New Caledonia are characteristic species of the coral reef environment. They occur either in the lagoons of volcanic islands or atolls or on the shelves of large islands with scattered coral shallows (Boely et al., 1986). They have a large biomass. In New Caledonia, Petit and Le Philippe (1983) estimate that it varies roughly between 100 and 10 000 kg/km2 according to the location and the season. In Indonesia around Ceram and Irian-Jaya, Boely et al. (1986) give figures between 1.000 and 10 000 kg/km2. Fishing effort on these fish is generally low due to the small size of individuals and of the schools.

The high biomass of this group of species and the part they play in the relations beetween the pelagic and benthic compartment show their importance in the coral-reef system.

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