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WORKSHOP ON PACIFIC INSHORE FISHERY RESOURCES
(Noumea, New Caledonia, 14 - 25 March 1988)

BECHE-DE-MER IN NEW CALEDONIA: BIOLOGY AND FISHING

Paper presented by

Chantal CONAND
Université de Bretagne Occidentale, France
in co-operation with ORSTOM, Centre de Nouméa, New Calédonie

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1. INTRODUCTION

About 1200 species of holothurians (also called sea cucumbers and beche-de-mer) populate the sea floor at all latitudes and all depths. The dozen species that are fished for human consumption are fairly large sized inshore species. They are eaten either raw, as in Japan and Korea, or processed into the product marketed as beche-de-mer a by fairly complex procedure. In the tropical Pacific in general and in New Caledonia in particular, beche-de-mer processing on a small scale is a long standing activity going back to the 18th century characterised by a high degree of spatial and temporal variability.

Fairly recently in trying to plan management of beche-de-mer fisheries, it was realised that very little indeed was known about the biology and ecology of the commercial species (Bakus, 1973). Several studies were therefore conducted in the region, in particular by FAO (Sachithananthan, 1972; Conand, 1986) and SPC (SPC 1979; Gentle, 1979). The French Institute for Scientific Research for Development in Cooperation (ORSTOM), under its programme: "Knowledge and utilisation of the New Caledonian lagoon", has been conducting research on beche-de-mer since 1979. The main findings are presented here, following on those that have already been published or are in preparation (Conand, 1979, 1981, 1983, 1985, in preparation).

2. BIOLOGY AND ECOLOGY OF THE MAIN COMMERCIAL SPECIES

2.1. Species of commercial value

They are characterised by their large size, their abundance in shallow water and the good quality of their body wall (which is the edible part). They have been classified into three categories on the basis of how they sell on the world market.

First category: species of high commercial value

The teat fish, both the black teatfish *Holothuria nobilis* (mean length mL = 37 cm, mean weight mW = 1800g) and the white teatfish *H. fuscogilva* (mL = 40 cm, mW = 2200g) fetch the highest prices but are usually not very abundant and require a considerable fishing effort. World prices for the sandfish, *H. scabra* (mL = 22cm, mW = 350 g), and *H. scabra* variety *versicolor* (mL = 30cm, mW = 1000g) described only recently (Conand, 1986), are more variable, but their abundance in inshore areas places them in this first category. *H.scabra* at present accounts for the major part of world catches.

Second category: species of medium commercial value.

These include Actinopyga echinites, A. miliaris and Thelenota ananas. A. echinites (mL = 20 cm, mW = 280g) and A. miliaris (mL = 22cm, mW = 400g) are fished despite their small size because of their abundance and accessibility. The popularity of T. ananas (mL = 45cm, mW = 2500g) depends on market fluctuations in Communist China where demand has sharply increased recently, but the prices paid remain fairly low.

Third category: species of low commercial value.

This include Holothuria atra, Actynopyga mauritiana and Holothuria fuscopunctata. There is little demand for these species. Although a few specimens of each species can be found on the markets, commercial fishing for them is not profitable. Only the larger specimens of H.atra (mL = 20cm, mW = 140 g), generally confined to the deeper bottoms, can be considered of value. A. mauritiana (mL = 20 cm, mW = 300g), which lives on the outside of the reef where the surf breaks, is difficult to harvest. Holothuria fuscopuntata (mL = 36cm, mW = 1500g), which has been seen on markets in the Philippines, does not have a pleasing taste. The 38 other species of Aspidochirotae holothurians existing in New Caledonia (Guille et al., 1986) have no commercial value whatsoever.

2.2. Distribution and Abundance

Quantitative assessments have been carried out in New Caledonia by the quadrat method. Counts were made by swimming under water or walking over the reef at low tide, and the density of the various species calculated. Samples taken at the same time were used to calculate mean biomass. Mathematical processing of the data collected at 216 stations distributed in the various biotopes of the lagoon, enabled the main affinities of the species with regard to various environmental parameters to be determined and various holothurian communities to be identified.

Species abundance

To give an overall view, the density and mean biomass of each species was calculated for the stations were it was present and compared with the total catch (all species together). Figure 1 shows the relative abundance, by numbers and weight, of the species.

It can be seen that first category species are not very abundant. Categories 1 and 2 account for only 25% of the total number, but make up 33% of the total biomass, since the species included in them are fairly large-sized. H. atra is the dominant species in the New Caledonian lagoon.

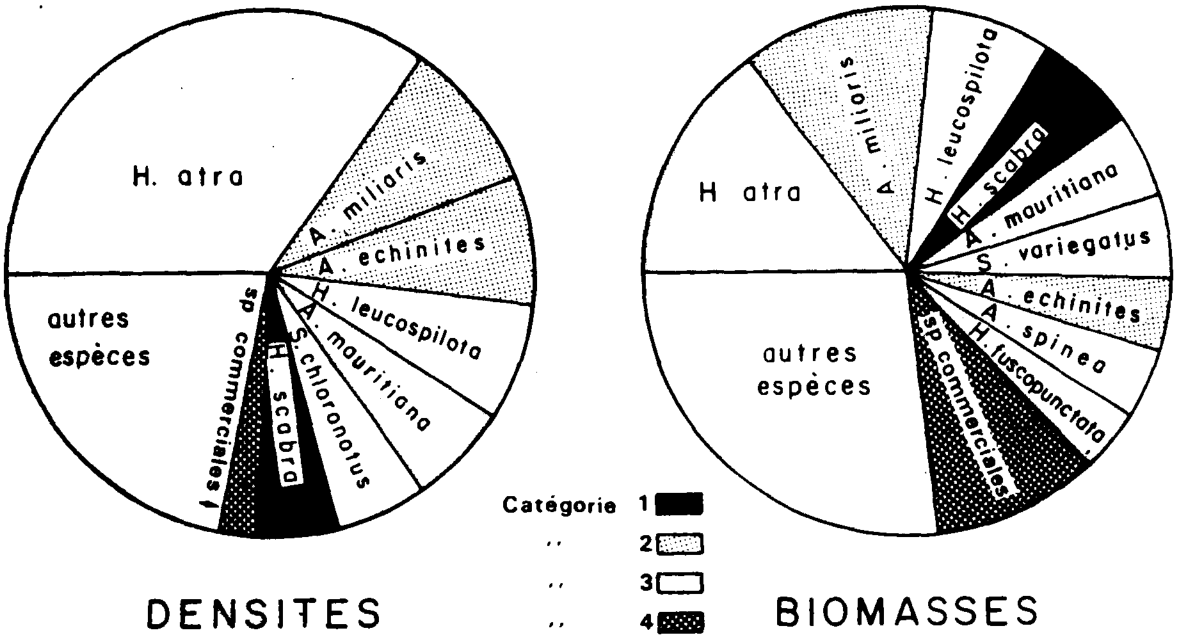

Figure 1: Relative abundance of main species.

Species distribution

Analyses of data showed the effect of environmental factors, some of which present clear gradients in the reef and lagoon complex of New Caledonia.

The first gradient is perpendicular to the shore (figure 2) and corresponds to terrigenous and reef influences, which are generally antagonistic. They enable a distinction to be made between species of the slopes, passes, outer flats of the barrier reef and outer lagoon living in clear and aerated waters on an organogenic substrate, like A. mauritiana, H. fuscogilva, H. nobilis and T. ananas, and species that have an affinity for terrigenous environments like A. miliarias, H. scabra and H. scabra versicolor, the latter been confined to the inner reef flats, the inner lagoon, and the bays, sheltered areas where the waters and bottoms are affected by inputs from the land.

The second gradient is depth. It enables a distinction to be made between the species of the intertidal zones (all three species of Actynopyga) and those of areas that are always under water (T. ananas and H. fuscogilva).

Lastly, groups have also been defined on the basis of their liking for a certain substrate. These range from the epifauna of the coral slabs, (A. mauritiana) to the muddy bottom species (H. scabra).

Communities

The mathematical analyses carried out gave consistent results showing the general characteristics of these reef and lagoon complexes. Thus the grouping of the 16 main biotopes accounts for several gradients:

- a lagoon gradient from the inner lagoon towards the passes,

- a reef gradient from the inner reef flats towards the passes, which also shows the functional gradient existing for each reef, from the inner reef flat towards the slopes.

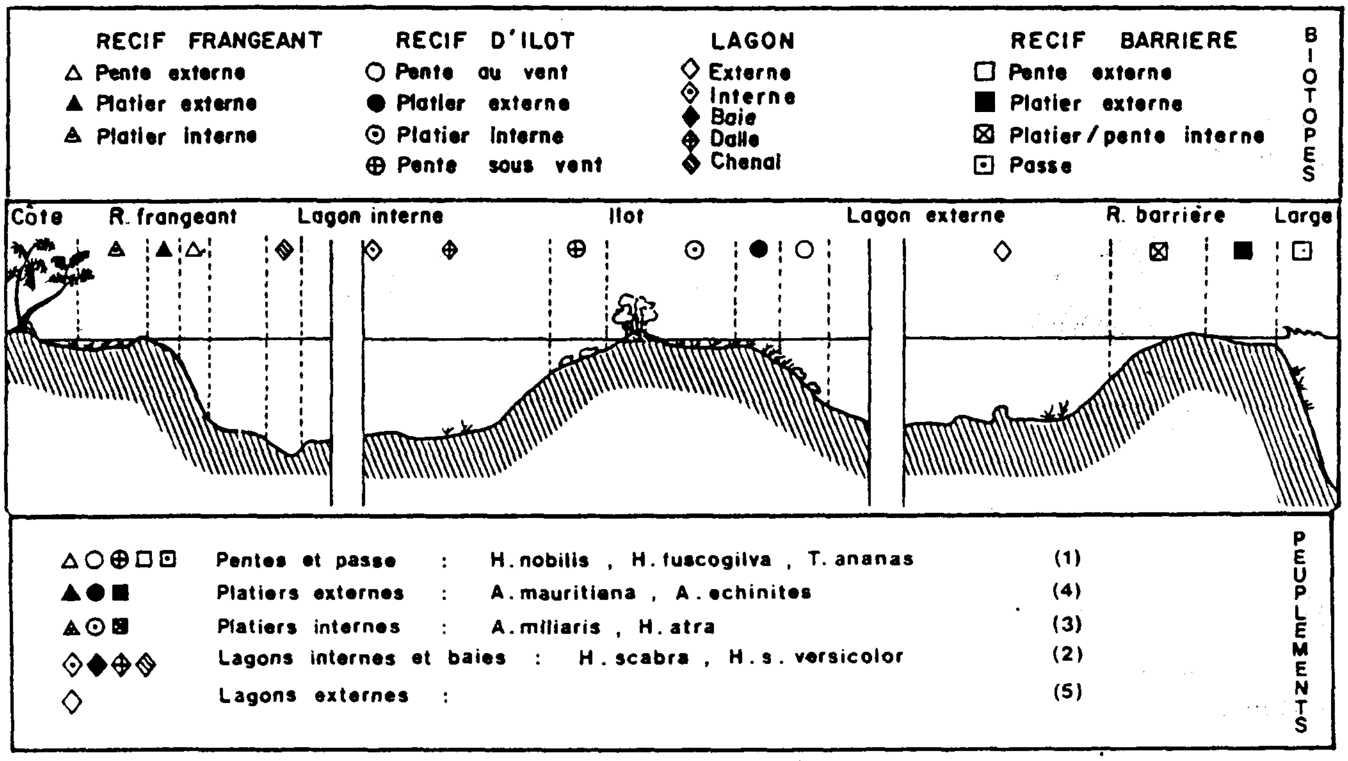

Figure 2: Main biotopes and holothurian communities in the New Caledonian lagoon.

On the basis of species presence or abundance, three main communities with their characteristic species and two less clearly defined communities featuring species with twofold affinity, can be distinguished. Only the commercial species have been considered here (figure 2).

- The reef slopes and passes (1) are a sublittoral reef zone. The commercial species associated with it are H. fuscogilva, H. nobilis, T. ananas.

- The inner lagoon (2) and bays are a sublittoral terrigenous zone. The characteristic species are H. scabra and H. scabra versicolor.

- The inner flats of island and fringing reefs (3) are a enlittoral terrigenous zone. They are characterised by A. miliaris and H. atra. Their separation from the outer flats on the one hand and the bays on the other is subject to slight variations depending on the method of analysis.

- The outer flats (4) are a enlittoral reef zone in an intermediate position, as regards affinity, between the inner flats and the upper part of the slopes. They are characterised by A. mauritiana and A. echinites.

- The outer lagoon (5) is an sublittoral soft-bottom reef zone which does not harbour any commercial species.

On the whole, the abundance (by number and by weight) of these communities increases from the barrier to the fringing reef and from the outer slope to the inner flat. The outer lagoon, slopes and passes are the poorest environments while the inner flats are the richest.

2.3 Reproduction, growth and mortality

Reproduction

Reproduction was studied for all commercial species, except A. miliaris which is hard to identify. Sexes are separate in all species and spawn is released into the environment. The breeding cycle is annual (figure 3) with spawning occurring in the warm season in most cases. H. nobilis spawns in the cool season but the reasons for this unusual behaviour (thermal threshold, selective pressures, adaptation of larvae or juveniles) are not yet understood. H. scabra displays a secondary spawning peak, which seems to be of variable length, in the cool season, a fact which has also been noted in other localities (Australia, Harriot 1980; Papua New Guinea, Shelley 1981). In situ spawning observations, infrequent up to now, have shown very variable environmental conditions that do not enable "triggering" factors to be identified. However, when spawning starts in one or more individuals, this seems to induce spawning in other individuals and other species.

First sexual maturity is defined as the weight at which 50% of the individuals of the sampled population have gonads that macroscopic examination shows to be active, that is to say the maturing, spawning and post spawning stages. The weight at which maturity is reached varies widely with the different species, ranging from 75g in A. echnites to over 1kg in T. ananas (figure 4).

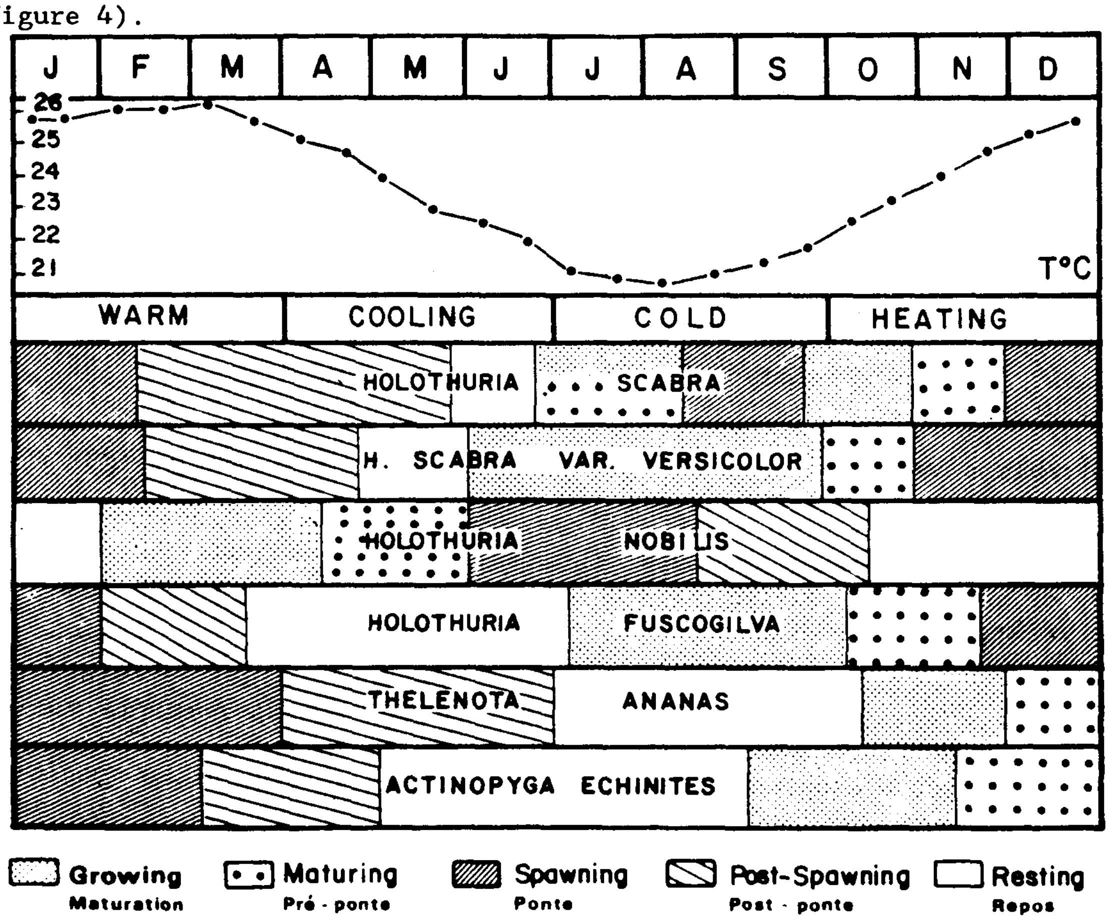

Figure 3: Breeding cycle of main commercial species, in relation to hydrological seasons

Fertility, both at individual and population level, is an important index although its links with recruitment have never been demonstrated in these species where juveniles and young individuals are always scarce. The small size of the eggs (150 to 210 mm) suggests that development probably occurs with planktivorous larvae. Fertility of the small sized species, for example A. echinites, is relatively higher than that of the large-sized species.

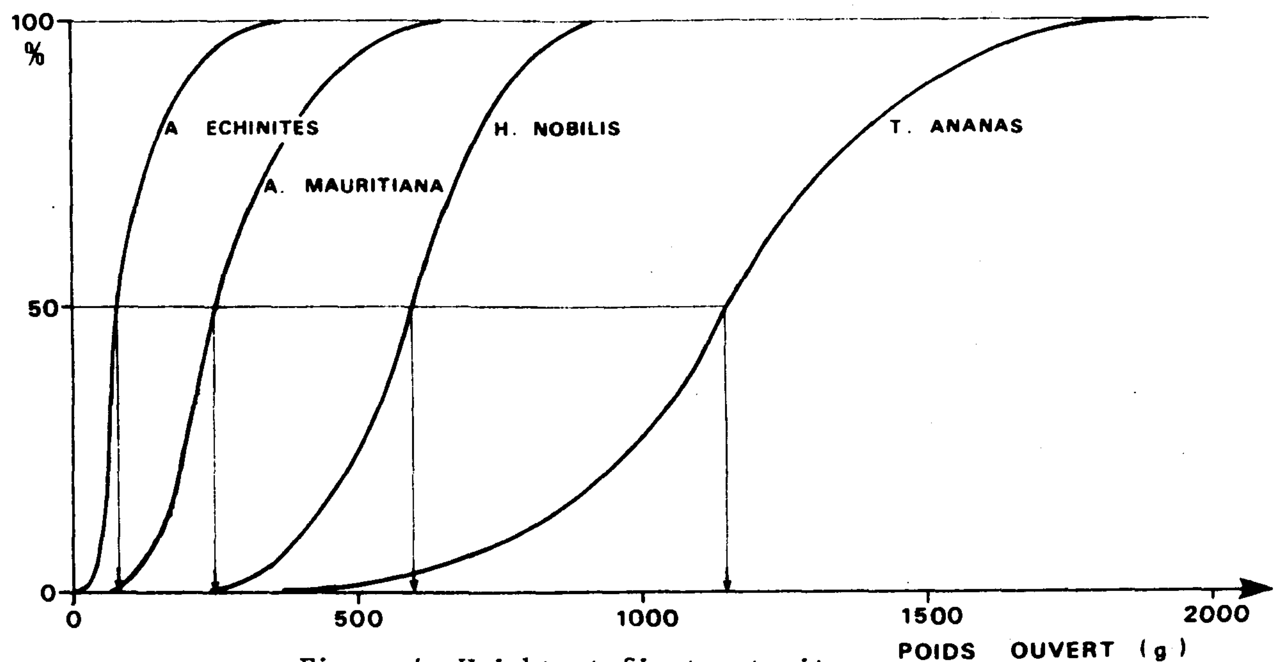

Figure 4: Weight at first maturity.

Growth and Mortality

Growth is particularly difficult to study in these soft bodied animals. Several methods have been tried. External tagging, carried out on seven species with several types of tags, gave very variable results according to species. The effects of tagging range from autoevisceration and shedding of the tags, followed by more or less rapid healing, to considerable weight loss. It would be interesting to find out whether the cause of the latter is nutritional, traumatic or pathological. These effects of tagging made it impossible to determine growth and mortality parameters in five species. However, growth curves were obtained for the two congeneric species A. mauritiana and A. echinites, but underestimation of the growth coeffecient may have occurred.

Problems were also encountered in connection with length frequency and weight frequency distributions. The variability of the length and weight measurements obscures the modes and the calls for collection of very large samples. Determination of the type of distribution is not easy because of the absence or scarcity of juveniles and young specimens: recruitment, about which little is known, is perhaps gradual. Lastly, for several species, no shift in the modes was visible during the study. However for two species (T. ananas and Stichopus chloronotus, the latter of no commercial value), provided that a number of hypotheses on recruitment prove correct, it was possible to follow the cohorts and to determine growth and mortality parameters. These species display different biological strategies: T. ananas, a large sized species, has a longer life span and a lower mortality coefficient than S. chloronotus, a smaller species whose productivy is higher (figure 5).

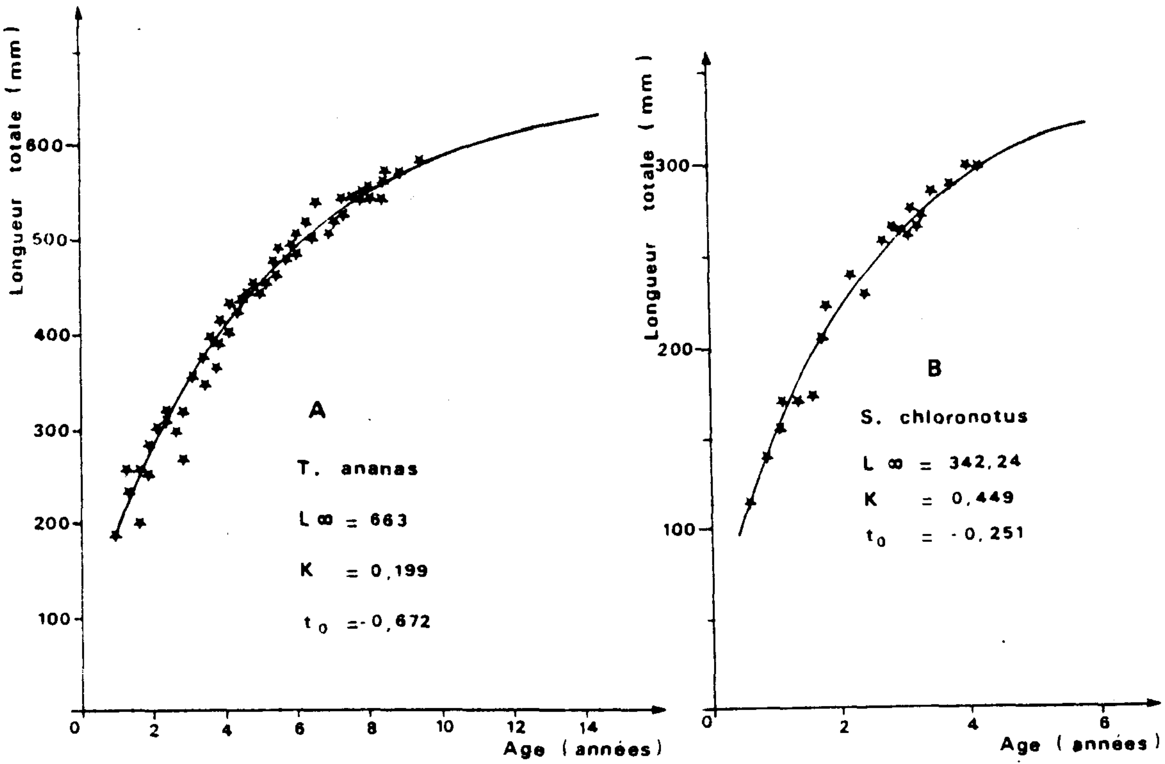

Figure 5 : Growth curves for two holothurian species

3. BECHE DE MER PRODUCTION

3.1 Fisheries and world markets

Beche-de-mer fishing, processing and grading have already been described (Conand, 1986).

World fisheries

They can be divided into several groups by geographic area and species fished (table 1).

- The western central Pacific can be subdivided into "Central Pacific" and "Tropical South Pacific". In the latter the main producers at present are Fiji, the Solomon Islands and New Caledonia, with several other islands producing small quantities of beche-de-mer or interested in reviving production. The large producers of beche-de-mer, namely the Philippines, Indonesia and Malaysia, are located in the central Pacific. Statistics are not always easy to obtain. Several species are commonly fished.

- The Indian Ocean is also a traditional beche-de-mer fishing area, particularly for the species H. scabra. It can be subdivided into East Africa (Madagascar, Mozambique, Tanzania and Kenya) and South West Asia (India and Sri Lanka).

- The North East Pacific (British Columbia, Washington, California) has recently developed small fisheries for two species (Sloan, 1985) but which accounts for only 1% of world production.

Annual catches, from the statistics available, range from 10 to 15.000 tonnes, and seem to have risen slightly in the last few years. The Philippines and Indonesia fisheries are far ahead of the others: the tropical South Pacific accounted for less than 10% of world catches before production developed in New Caledonia.

Table 1: Estimated world catches of Holothurians for preparation of beche-de-mer and distribution by area

Area	1978	1979	1980	1981	1982	1983	1984
South Pacific (%)	8	4	4	2	4	4	22
Central Pacific (%)	54						
North Indian (%)	11	9	10	9	9	10	7
West Indian (%)	26	21	17	11	12	8	5
Total (T. fresh weight	10 860	10 540	15 370	13 300	13 600	14 450	14 140

World Market

It is dominated by the Chinese and very complex. Some producer countries are exclusively exporters while others have a Chinese population component that consumes part of the production locally, and others again are chiefly importers, with or without local production. Furthermore, the processed beche-de-mer can transit through several markets, which makes the statistics hard to interpret.

The two main markets at present are Hong Kong and Singapore. Figure 6 shows fluctuations in tonnages imported and re-exported for these two markets. Hong Kong is now the most important market, with an import figure of nearly 3000 T./year, mostly from the Philippines and Indonesia. Demand has risen sharply in the last few years. Re-exports mainly go to China and Korea. The Singapore market has grown more slowly. Its imports, from various Indian Ocean countries and also from the Philippines, reached 600 tonnes in 1984. Re-exports go mainly to Malaysia, which is one of the main importers, Taiwan's share having decreased.

South Pacific countries and territories were exporting only small tonnages to Hong Kong and Singapore until production was recently reactivated in New Caledonia, but because of the relatively high prices paid for their products their contributions to the total value of imports was 14% for Hong Kong and 17% for Singapore in 1984.

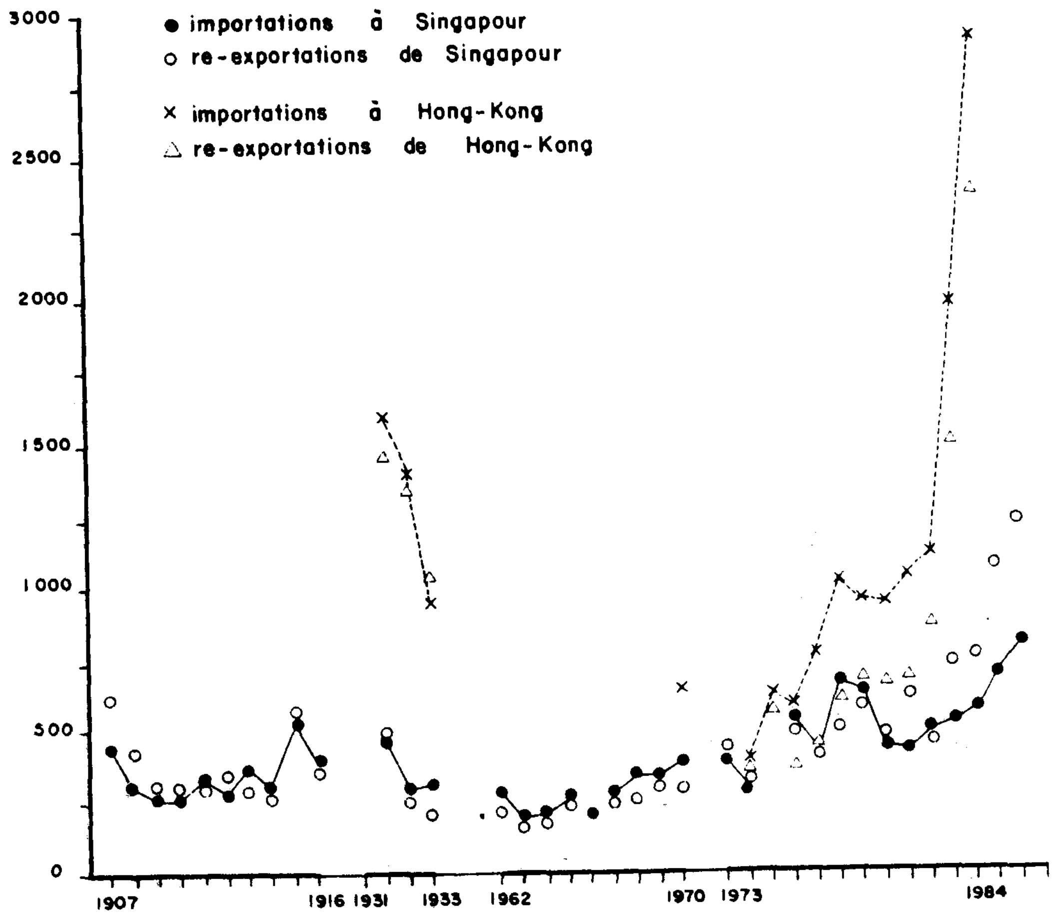

Figure 6: Beche-de-mer market fluctuations

3.2 Beche-de-mer production in New Caledonia

The history of beche-de-mer fishing and trade has been reconstructed from various old documents, and also from the official statistics of the Territory (figure 7). Exports can be seen to have fluctuated widely in the one hundred and twenty five years since production began. Some of the fluctuations are connected with political events such as the two world wars, others with economic changes such as falls in world beche-de-mer prices or new Caledonia's alternating mining booms and slumps.

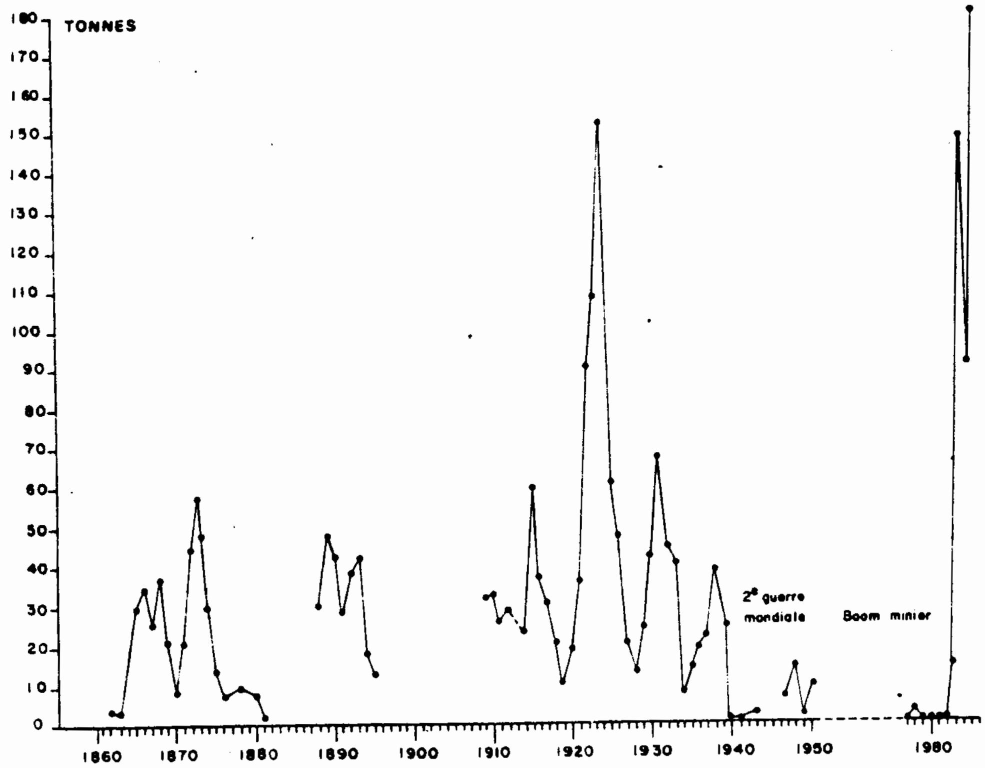

Figure 7: Fluctuations in beche-de-mer export from New Caledonia, 1862-1986.

The current period of high production started in 1983 when a few New Caledonians of Chinese origin undertook to organise beche-de-mer fishing, processing and trade. Figure 8 shows the quantities exported by the companies involved to the different markets over the past five years. It can be seen that exports by the first two companies decreased in 1987 while that of the third company increased markedly. Fluctuations are also apparent in the destination of the exports.

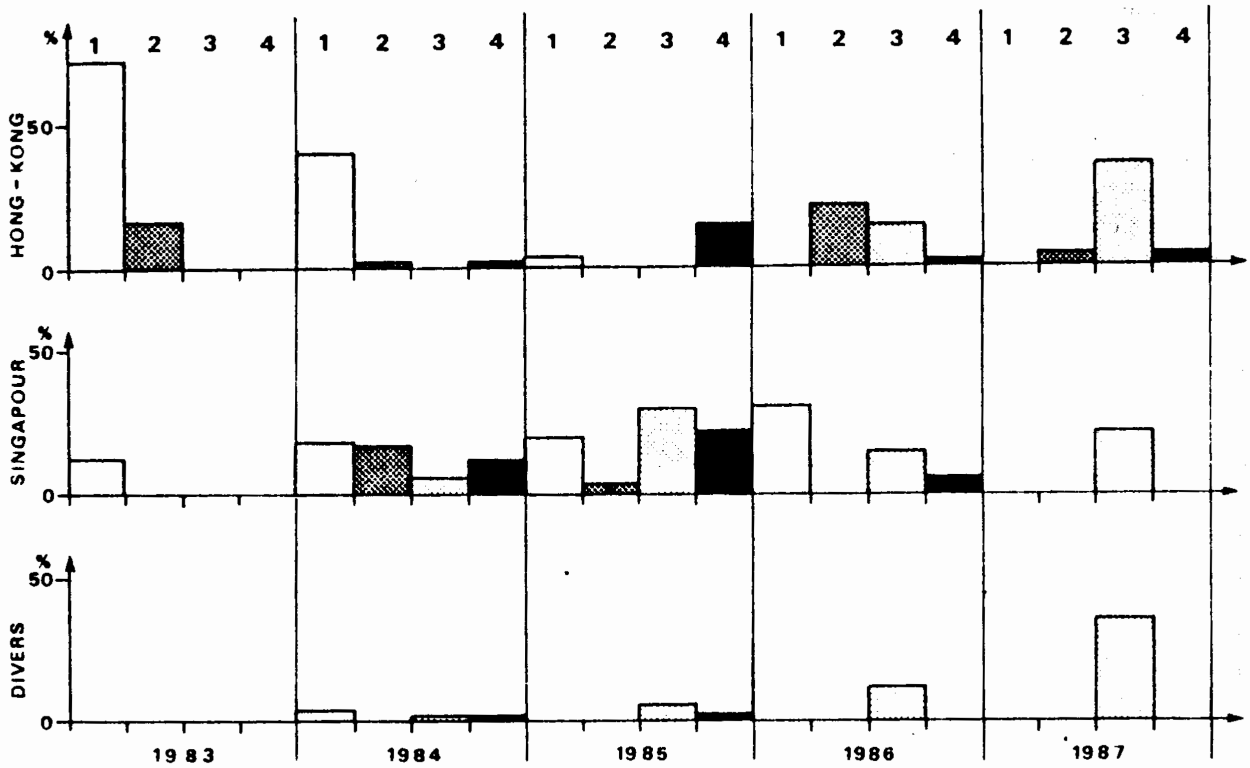

Figure 8: Fluctuations in beche-de-mer exports from New Caledonia in recent years, by company and by destination.

Will production be maintained at the level reached in the past five years and can beche-de-mer stocks withstand such fishing pressure?

4. REQUIREMENTS FOR RESOURCE MANAGEMENT

No production models, hence no fisheries regulations, can be established as yet because too little is known about the biology (growth and mortality) of these species and the scarcity of statistics relating to the fisheries. It has become apparent that the species exploited can change: these fisheries will therefore be regarded as monospecific or focusing on several species of one and the same community.

Scientific studies will need to be pursued to gather more data on growth (which seems slow) and on total mortality of the main species. To do so, quarterly sampling over a number of years, based on total weight at sampling stations where populations are dense and composed of individuals of different size classes, seems to be the most appropriate method.

Resource assessment calls for mapping of the different reef and lagoon communities. Assessment can be carried out by combining a number of different methods: remote sensing in shallow waters, dredging, underwater photography or counting in quadrats.

Collection of statistics should normally first of all focus on the actual fishing operations and provide data on catches, fishing effort (number of divers, or boats), hence the CPUE. But because beche-de-mer fishing ventures are small and scattered, collection of such data is difficult. Statistics can also be collected on the processed beche-de-mer or the exports, in which case they must show tonnages by species and by commercial category. This would require prior standardisation at regional level.

Lastly, socio-economic aspects seem to play an important part in the fluctuations that occur in production. They should be taken into account by integrating data for the world beche-de-mer market and the economic situations of the producer States. Regional fishing regulations could then be established on scientific bases.

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5 - REFERENCES

BAKUS, G.J. 1973 - The biology and ecology of tropical holothurians. In : *Biology and geology of coral reefs* : 325-367.

CONAND, C. 1979 - Bêche-de-mer in New-Caledonia : weight loss and shrinkage during processing in three species ot holothurians. *SPC Fish. Newslet*., (19) : 14-17.

CONAND, C. 1981 - Sexual cycle of three commercially important holothurian species (Echinodermata) from the lagoon of New Caledonia. *Bull. Mar. Sci.*, 31(3) : 523-544.

CONAND, C. 1986 - Les ressources halieutiques des pays insulaires du Pacifique. Les holothuries. *FAO Doc. Tech. Pêches*, 272(2) : 108 p.

CONAND, C. - Les holothuries aspidochirotes du lagon de Nouvelle-Calédonie. Répartition, biologie et exploitation (Thèse de Doctorat d'Etat, en préparation).

CONAND, C. et P. CHARDY 1985 - Les holothuries aspidochirotes du lagon de Nouvelle-Calédonie sont-elles de bons indicateurs des structures récifales ? In : *Proc. 5éme congr. int. Recifs coral., Tahiti, vol. 5* : 291-296.

CPS (Commission du Pacifique sud), 1979 - La bêche-de-mer dans le Pacifique tropical. Manuel à l'usage des pêcheurs. *CPS Man.*, (18) : 31 p.

GENTLE, M.T. 1979 - Population ecology of commercial bêche-de-mer (Echinodermata : Holothuroidea) in Fiji. *SPC Fish. Newsl.* (18) : 13-15.

GUILLE, A., LABOUTE P. et J.L. MENOU - Guide des étoiles de mer, oursins et autres échinodermes du lagon de Nouvelle-Calédonie. Ed. ORSTOM, Coll. Faune tropicale, 25 : 238 p.

HARRIOT, V.J. 1980 - The ecology of Holothurian fauna of Heron Reef and Moreton Bay. M.S. Thesis, University of Queensland Brisbane, 153 p.

SACHITHANANTHAN,K. 1972 - South Pacific Islands Bêche-de-mer fishery. A report prepared for the South Pacific Islands Development Agency. Rome, FAO, FI:DP/RAS/69/102/11.

SHELLEY, C.C. 1981 - Aspects of the distribution, reproduction, growth and fishery potential of holothurians (Bèche-de-mer) in the Papuan coastal lagoon. M.S. Thesis, University of Papua New-Guinea, 165 p.

SLOAN, N.A., 1985 - Echinoderm fisheries of the world : a review. In : *Echinodermata*. Keegan and O'Connor (ed.). Balkema, Rotterdam : 109-124.