THE SOUTH PACIFIC COMMISSION FISHERIES NEWSLETTER

Editors: J. Crossland (Fisheries Assistant) and
R. Grandperrin (Fisheries Adviser)
South Pacific Commission
P.O. Box D5, Noumea Cedex
New Caledonia

No. 16 July 1978

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1050/78

EDITORIAL

Since the last issue of the Newsletter the main fisheries event for the SPC has been the Tenth Regional Technical Meeting on Fisheries held in Noumea from 13-17 March 1978. A brief description of the meeting and its recommendations is given on page 2 . For anyone wishing to gain an understanding of the current state of fisheries in the South Pacific, and of the range of activities of the SPC and other organisations, the full report (obtainable from the SPC) provides a useful starting point.

Another important meeting was that of the Planning and Evaluation Committee, in May. At this meeting the proposed work programme and budget of all SPC activities were considered. Under the heading of artisanal fisheries, funds were allocated for deep-sea fisheries development, fish poisoning research, training in bêche-de-mer processing, for short-term consultants, and for the annual fisheries meeting. Some funds were also provided for oceanic fisheries (skipjack); the main part of this project is, however, funded from outside the SPC budget.

The fisheries staff of the SPC was increased in May by the appointment of a Fisheries Assistant (Mr James Crossland), among whose duties is the co-editing of this newsletter. Also new to the SPC staff is Master Fisherman, Mr Tevita Fusimalohi, from Tonga. He will take charge of the Deep Sea Fisheries Development Project. The skipjack team has also been strengthened with the arrival of Dr Pierre Kleiber, who will work on the computer processing of the great amount of data generated by the success of the tagging cruises.

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Contributions to this issue include an up-to-date report on the skipjack tagging programme by Dr Bob Kearney. The programme recently set a <u>world record</u> for the number of skipjack tagged in one day. The tagging programme is designed, among other things, to investigate the possibility of the existence of different skipjack stocks in the Pacific. A different approach to the same problem is described in the paper by Dr Barry Richardson on page 8 which outlines the genetic method of stock identification.

Also of relevance to skipjack and other migratory oceanic fishes is the report by Mr Donguy and Mr Henin on their long-term hydroclimatic studies in the Pacific. Information on the correlation of temperature and salinity data and fish distribution could make a significant contribution to directing fishing effort to the appropriate area, or predicting years of poor recruitment. Another related paper in this issue concerns the importance of reefs to oceanic fishes, and is of interest because it indicates how different parts of the environment are inter-related.

The bêche-de-mer fishery in Fiji, which was long dormant after the Second World War, continues its revival, as the article by Mr Suliasi Vatoga shows. This is the second article by Mr Vatoga on the work of the Fish Processing Unit (see Fisheries Newsletter 13), and is particularly appropriate at this time because of the recently announced appointment of Mr P. Gentle on a one-year consultancy to study the biology of bêche-de-mer. Mr Gentle will be attached to Fiji's Ministry of Agriculture, Fisheries and Forests on funding from the SPC.

Over the years this Newsletter has reported on both new and continuing fisheries projects. Among these have been several (see Fisheries Newsletters 3 and 4, 5, 10) on the setting up and progress of the aquaculture station at the Baie de St Vincent in New Caledonia. It is very pleasing therefore to publish in this issue the considerable results and achievements in penaeid shrimp culture over the last six years, as described by Mr D. Coatanea of AQUACAL in his contribution.

The last section of the newsletter contains two related articles. Firstly there is a report of the important meeting held in Suva from 5-10 June at which the various countries of the Pacific discussed the setting up of a regional fisheries organisation. Secondly, there is a short article listing all the countries of the SPC area, their population, land areas and sizes of their proposed 200-mile zones. The vast size of the total sea area involved, approximately 31.7 million km^2, and the small population of 4.7 million are very strong arguments in favour of the setting up of the proposed regional fisheries organisation.

* * *

TENTH REGIONAL TECHNICAL MEETING ON FISHERIES

The Tenth Regional Technical Meeting on Fisheries to be organised by the SPC was held in Noumea from 13-17 March 1978. Representatives of twelve countries and territories from the area attended, as well as twenty observers from thirteen countries outside the region and various organisations. During the meeting 25 working papers were presented. Each of the country representatives gave a statement on the fisheries year in his country. Considered together these give a very good picture of fisheries in the South Pacific, and demonstrate the great amount of activity going on throughout the area.

SPC fisheries activities for the past year were also reviewed. Dr Bob Kearney reported on progress with the skipjack programme (a more recent report appears on page 3 of this newsletter). SPC activities in fields other than skipjack research were described by Dr René Grandperrin; these included projects on outer reef artisanal fisheries, lobsters, turtles and bêche-de-mer.

A third group of working papers and reports, presented by the various observers at the meeting, covered a wide range of topics: the activities of the FAO and UNDP in the region, the CNEXO aquaculture programmes, turtles, fish productivity, and various aspects of the tuna fishery. A particularly interesting paper on the identification of different stocks of skipjack, by Dr Barry Richardson, is reproduced in full on page 8 of this newsletter.

The working papers and reports provided the basis for much discussion. The meeting made eight recommendations:

1. Where possible, the SPC should provide advice and assistance on skipjack research to countries outside its own area.
2. Funding should be sought for blood and tissue analysis of skipjack.
3. The Expert Committee on Tropical Skipjack should meet concurrently with the annual Technical Meeting on a regular basis.
4. Commercial observers should be invited to future meetings.
5. Funds should be sought for research on deep-bottom fishes.
6. The proposed workshop on the implications of the 200-mile exclusive economic zones should be deferred.
7. A consultant should be obtained to study the economics of foreign fishing operations in the SPC area.

8. A portion of the funds previously budgeted for the 200-mile workshop should be used to implement recommendation seven.

The full text of these recommendations is given in the report on the meeting, copies of which can be obtained from SPC.

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SPC SKIPJACK SURVEY AND ASSESSMENT PROGRAMME SUMMARY REPORT - 23 SEPTEMBER 1977 TO 30 JUNE 1978

R.E. Kearney

PROGRAMME FUNDING

The details of the funding of the Skipjack Programme were given in the first summary report to 23 September 1977 which appeared in Fisheries Newsletter Number 15 of October 1977. However, since this time, the French contribution to the programme has been increased to FF 679,000 (approx. US$ 139,000), and Australia has made available an additional A$ 33,000 to cover the costs of analysing the blood samples collected as part of the programme. At present exchange rates, pledged contributions to the programme now approximate US$ 1,006,000 per annum.

SURVEY AND ASSESSMENT RESULTS

The operational phase of the programme actually commenced on October 4 1978 when the chartered vessel, the Hatsutori Maru, departed from Kavieng, Papua New Guinea, with a full complement of scientists and crew and commenced fishing in the waters to the north of Papua New Guinea. After completion of the survey cruise in this country, the vessel moved progressively to the Solomon Islands, New Hebrides, New Caledonia, Fiji, Tonga, Wallis and Futuna, American and Western Samoa and Tuvalu. The survey in each area extended over approximately one month.

To the end of June 1978, baitfish survey and research work had been successfully carried out in each of the countries and territories visited and while there has been great variation in the size and species composition of the bait catches made, in general, skipjack and tuna fishing has not been severely restricted by the lack of bait. In several countries and territories the baitfish surveys by the Hatsutori Maru were the most comprehensive conducted to date and provided new and extremely valuable data on the nature of the resources available.

More than 43,000 skipjack and other tunas were tagged and released to the end of June. This exceeded the target for the whole of the first year of the programme by more than 13,000 and included the release of a world record - 2,985 tagged skipjack on a single day (Fig. 1). To date almost 1,000 recaptures have been reported and although little time has elapsed to enable the dispersement of tagged fish, five international recoveries have already been reported.

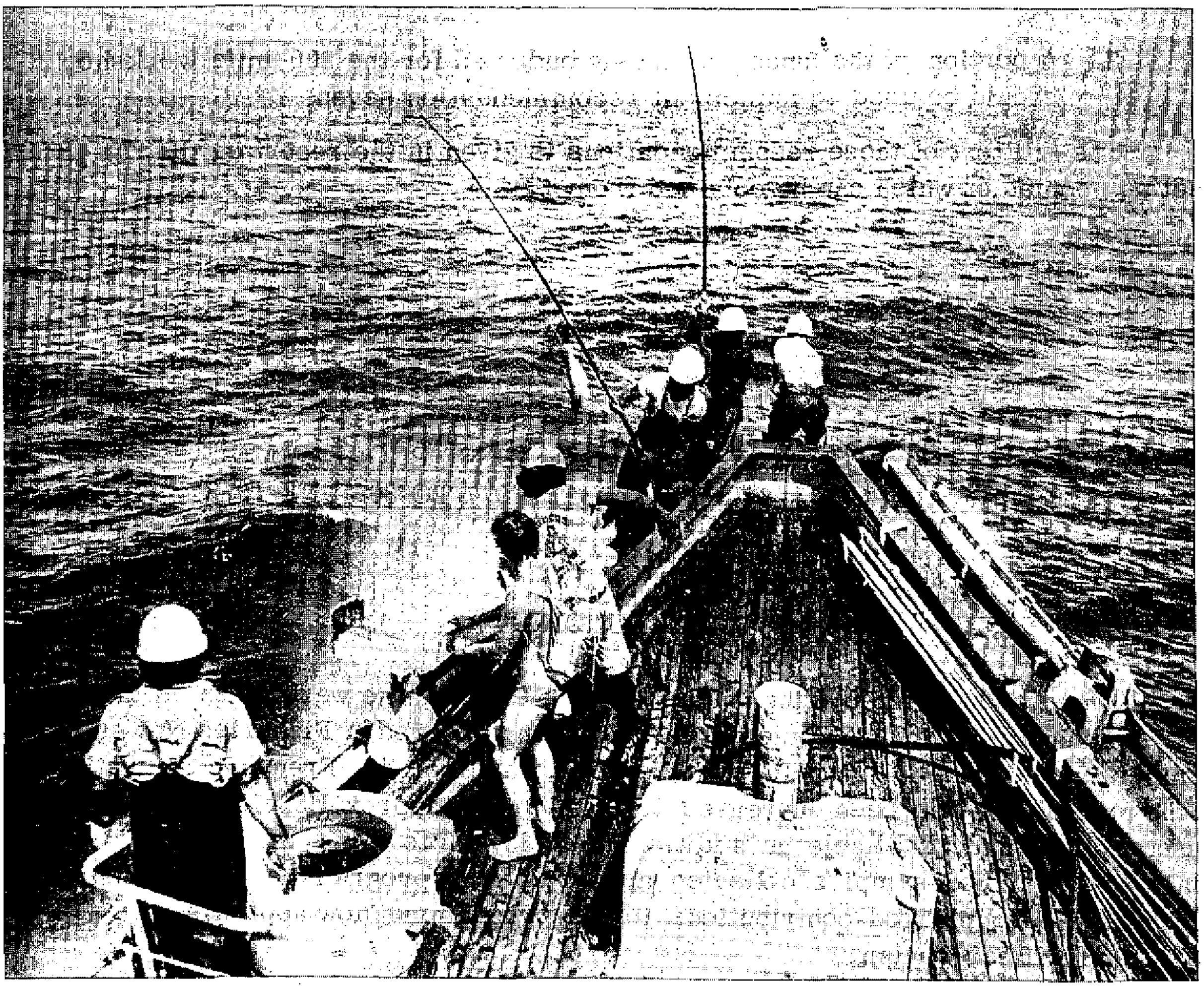

Fig. 1: The record-breakers in action

In addition to the baitfish and tagging experiments, a great deal of additional data has been collected on general tuna occurrence and tuna biology. This data will be processed together with tag release and recapture information and relevant catch and effort data to assist in regional stock assessment studies. To facilitate these studies, comprehensive computer data processing systems have been established and their updating will be an ongoing aspect of the programme. The creation of a computerised tag release and recapture masterfile is considered to be a priority requirement and the programmes and computer accessibility necessary for this task should be finalised in early July.

FUTURE SCHEDULE

In July 1978 the Hatsutori Maru should conclude its first survey in Tuvalu and proceed to the Gilbert Islands and Trust Territory of the Pacific Islands before concluding the first charter of ten months in Japan on August 23. Negotiations relating to the charter of the Hatsutori Maru for a second ten month period commencing on October 1 1978, when the vessel will depart from the port of Shimizu, Japan, have already been finalised. Survey work will recommence with the continuation of the work in the Trust Territory of the Pacific Islands, before the vessel proceeds in turn to Guam, Tokelau, Cook Islands (northern), French Polynesia, Cook Islands (southern), Niue and New Zealand. The schedule from March 1979 has not yet been finalised.

HYDROCLIMATIC STUDIES IN THE PACIFIC OCEAN

J.R. Donguy and C. Henin
Centre Orstom
Post Box A5
Noumea Cedex
New Caledonia

INTRODUCTION

The surface data needed for the determination of the hydroclimatic features of the ocean are the temperature and the salinity. The meteorological data may be gathered directly by the observer ships or later by official ways. The surface measurements in the south-west Pacific from the ORSTOM Centre in Noumea started in 1958 with merchant ships between Sydney and Noumea and also from Noumea to Panama via Tahiti. The measurements stopped in 1964. They started again in 1969 between Noumea and Japan, and since 1974 they have been extended to the whole Pacific. The following sailing routes have been operated with variable frequency; generally one measurement was taken each 60 nautical miles:

Noumea - Hong Kong - Singapore - Noumea
Noumea - South Japan
Noumea - North Japan
Noumea - Honolulu - California
Tahiti - California
Noumea - Tahiti - Panama
Tahiti - New Zealand
Noumea - New Zealand
Noumea - Australia

Since 1975, the density of the observations has been sufficient to describe the measured parameters monthly. All the early observations have been compiled to produce half-yearly surface salinity maps from 1956 to 1973, and quarterly maps from 1973 to 1975.

RESULTS

Seasonal variations between New Caledonia and Japan

Since September 1969, four Japanese ships have made regular surface observations every 60 nautical miles, measuring temperature and salinity. They cross the equator at 150°E and 160°E. By 1977, eight years of measurements between 20°S and 10°N and five years between 10°N and Japan, had been collected.

In the south the surface salinity is lowest from February to June ($S < 34.5$ ‰) each year. About 7°N, the salinity is lowest from June to December (Donguy & Henin, 1974, 1975). These low-salinity waters are due to the rainfall connected with the west wind and with the presence of the convergence zone of the wind. The diluted water occurs almost two months after the start of the west wind. The salinity maximum at 3°S is due to the equatorial updwelling induced by the east wind.

North of 10°N, the salinity is maximum from January to July with values more than 35.5 ‰ between 20°N and 27°N at the place of the north anticyclone. North of 35°N, the salinity and the temperatures are low and variable because of the boundary occurring between Kuro Shio and Oya Shio (Donguy & Henin, 1977).

Local formation of water masses

Study of the seasonal variations shows they are connected closely with meteorological features. For the years 1956-1974 surface salinity data along the 180° meridian were compared with rainfall figures for the October-March and April-September periods. On the equator the high-salinity periods (several years) are connected with low rainfall periods. South of the equator, the low-salinity periods are associated with strong rainfall periods. On the equator again, short periods of low salinity are connected with short periods of strong rainfall and with the occurrence of abnormal features in the whole Pacific.

Occurrence of abnormal conditions

The surface variations are not only seasonal, but in some years completely anomalous hydrographic conditions may occur, as in 1958, 1965 and 1973 (Donguy & Henin, 1976). Instead of the equatorial salinity maximum, a minimum spread as far as 10°S and 150°W. Between 10°S and 20°S, from 160°W to 180°, a maximum takes the place of the salinity minimum.

This exceptional situation coincided with exceptional meteorological conditions. West of 160°W, the convergence zone of the wind was set between the equator and 10°S. Consequently, the winds coming from north-east, north of the equator, were deflected to the north-west about 5°S; they brought rainfall and explained the presence of low-salinity water. South of 10°S, the south-east winds induced a drought in the south-western Pacific. During these same years, other drastic changes occurred in several areas of the Pacific, such as the appearance of the "El Nino" countercurrent along the South American coast.

Monitoring and observation of "El Nino" in the eastern Pacific

The equatorial upwelling due to the trade-winds forms a hydrographic boundary separating the waters of the northern hemisphere from those of the southern hemisphere. When the convergence zone of the winds moves southward, the upwelling stops, the boundary collapses and the low-salinity water coming from the north penetrates into the southern hemisphere and constitutes the so-called "El Nino". The surface data gathered since 1974 between Tahiti and Panama show that each year in February-March, a weakening or vanishing of the trade winds produces the stopping of the equatorial upwelling and warm, low-salinity water crosses the equator to the south. Generally, this interruption of the upwelling is short-lived and the low-salinity waters do not reach the South American coast. During the years of abnormal conditions (1957, 1965, 1972), the trade-winds vanished for several months and "El Nino" became catastrophic.

A hydroclimatic anomaly in the eastern Pacific is followed six months later by a hydroclimatic anomaly in the western Pacific.

CONCLUSIONS

The economy of the fishing industry is bound up with favourable hydrographic and meteorological conditions. The continuous observation of these conditions provides interesting information on fishing possibilities. Between New Zealand and New Caledonia, we have found a thermal front possibly associated with tuna schools.

Recent research points out that the survival of fish larvae is directly connected with the surface conditions. Tuna larvae, for example, live in water of well-defined temperature and salinity. An anomalous change of these parameters would cause high mortality, noticeable two years later by decreased catches. With sufficient surface data, it would be possible to organize tuna fishing more rationally, and avoid the destruction through ignorance of stocks existing in precarious conditions.

It is also possible to associate with hydroclimatic data biological information leading to interesting interpretations for fisheries. The chlorophyll content of the sea surface is certainly the best indicator. It is the easiest to gather; sampling and filtration aboard ships takes only a few minutes, and its variations in space and time certainly influence the growth and movements of fish stocks.

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SKIPJACK TUNA STOCK IDENTIFICATION*

B.J. Richardson

Department of Population Biology
Research School of Biological Sciences
Australian National University, Canberra, Australia

Because of the highly migratory behaviour of skipjack tuna (Katsuwonus pelamis), the same group of fish can expect to be chased by different people at different times. Thus skipjack tuna are caught by fishermen of distinct nationalities in the waters around many different Pacific countries. Obviously all those countries that find a particular group of tuna passing through their area will have to work together to make the most efficient harvest of that group.

To reach this kind of agreement it is necessary to know which countries are involved in harvesting a particular group of tuna. The nature of this 'group' is the first problem. Obviously it is larger than a single school and clearly it is smaller than the entire tuna population of the Pacific Ocean. The group can be defined as the smallest self-sustaining genetic unit found in nature. That is, it is a group of tuna schools found in a particular area of the Pacific Ocean that are replaced by their own offspring, not by the offspring of other tuna groups. If all the tuna in this group are caught then either they would not be replaced at all, or they would be replaced only slowly by migrants from other groups.

There are two main ways to identify natural groups of fish. Firstly one can tag fish and then recapture them after elsewhere. The range of movement of many recaptures shows the range of that group of fish. This technique also gives valuable information on growth rates and survival and is widely used for such purposes.

Secondly one can use genetic methods. As the members of a group give rise to the next generation of that group, the animals in an area are genetically related to one another but relatively unrelated to tuna belonging to other groups. A similar situation can be seen in human populations where hair colour and eye colour are genetically inherited characters. Blonde, blue-eyed Swedes are more closely related to each other than they are to dark-haired, dark-eyed Italians (i.e. the frequency of genes for blue eyes and blonde hair are much higher in Sweden than they are in Italy) and the two groups constitute two different 'stocks'.

The process of identifying stocks of tuna is similar, One looks for genetic variation in the fish and then looks to see if schools in different parts of the species range have different frequencies of the gene. If the gene frequencies are markedly different then they come from different breeding stocks. However, if the gene frequencies are the same it does not follow that they come from the same stocks, as two stocks may have the same gene frequency by accident. Looking at a series of different genes would clarify the issue.

Unfortunately it is not possible to find such easily-identifiable genetic characters as hair or eye colour in fish, so more complicated tests have to be used. Differences in particular proteins are usually inherited as simple genetic characters and because many different kinds of protein can be detected specifically, the result is a very useful set of genetic characters which can be studied.

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* Originally given as Working Paper 6 at the 1978 Regional Technical Meeting on Fisheries.

The laboratory technique used in this kind of study is called electrophoresis, and involves the separation of proteins by their electrical charge and size. The charge and size of a particular protein molecule depends on its stucture, which is genetically determined. The 'blueprint' used for the construction of a particular protein is carried as a gene in each cell of the body, and is inherited from generation to generation in a similar fashion to blood groups.

Electrophoresis allows the detection of genetic differences between animals when more than one 'blueprint' for a particular protein is present in a population. The relative proportion of one of the alternate forms of the protein in a population is described as the gene frequency. Many different proteins can be studied. Some of them are found in blood cells, some in liver cells or other tissues of the body. For the tuna work carried out to date blood proteins have been examined in an effort to find new characters useful for genetic studies.

Skipjack tuna have now been studied from many parts of the Pacific Ocean and two different proteins have been typed (Fujino, 1970). The first, transferrin, has not proved useful, because the same gene frequency is found at many places in the Pacific. The second protein, esterase, is found in three different genetic forms. The frequency of the common form in different parts of the Pacific is shown in Fig. 1. Clearly the gene frequency is different for populations from different parts of the Pacific Ocean. In the eastern Pacific the gene frequency is less than 0.55, while in the western Pacific (Papua New Guinea, Palau and Japan) it is greater than 0.55. It might be concluded from this that at least two different genetic stocks of tuna exist in the Pacific; in Hawaii schools of either genetic stock may be found.

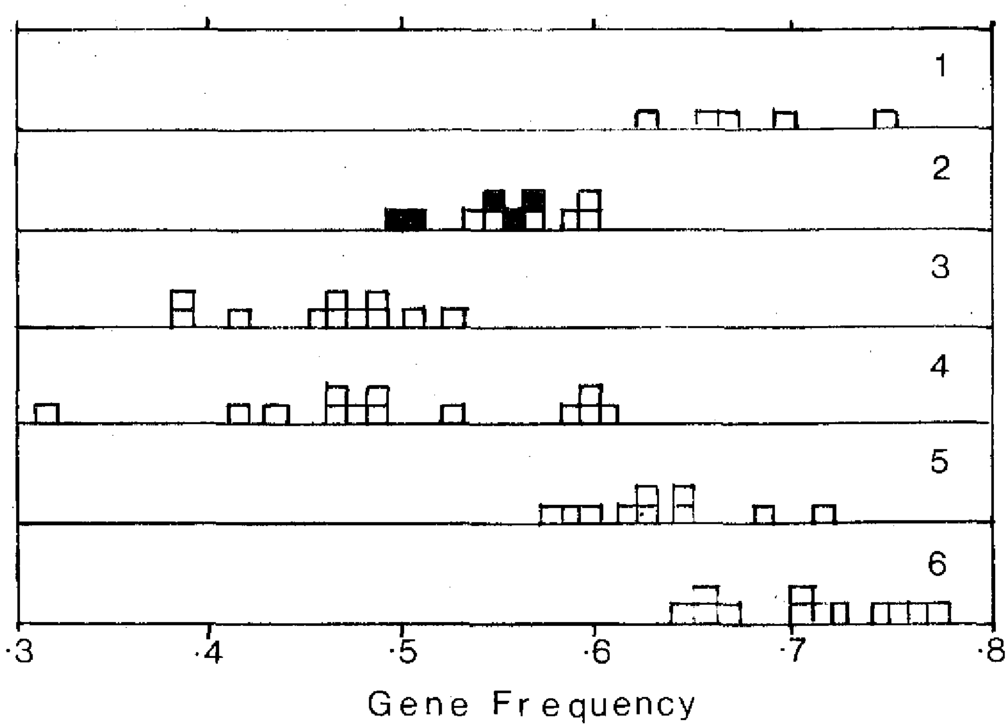

Fig. 1.: Distribution of esterase gene frequencies for different parts of the Pacific Ocean. Data from South Pacific Commission (1976) and Richardson (unpublished). 1. Papua New Guinea, 2. New Zealand, 3. *Eastern Pacific*, 4. *Hawaii*, 5. Japan, 6. Palau. Black squares show 1976/7 season.

The problem with the 'two-stock' hypothesis is the heterogeneity within each stock. That is, the different schools sampled in New Guinea waters do not all have the same gene frequency, and the difference is greater than that to be expected by sampling errors. This implies that there may be more than one stock spending time in New Guinea waters and that the western Pacific stock in reality consists of two or more stocks.

The New Zealand data also present a problem, as they do not match either the eastern or western genetic stock in gene frequency. Perhaps the New Zealand tuna come from a third stock found in the south central Pacific. Alternatively it may be a mixed stock, like that of New Guinea, but consisting of fish from the eastern and western stocks. The distribution of the genes within and between schools however makes this possibility unlikely. The difference in gene frequency of New Zealand fish between 1976/7 and earlier years is also difficult to understand. Perhaps last season's fish had a different origin as they were a different size from those of the previous year. More work is needed to resolve the problem.

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IMPORTANCE OF REEFS TO OCEAN PRODUCTION*

R. Grandperrin
Fisheries Adviser
South Pacific Commission

INTRODUCTION

All emerged land, whether continents, islands, islets or reefs, has a decisive impact on the richness of ocean waters throughout the world. This influence is proportional to the proximity to land; both production and productivity are greater in coastal waters than in the open sea. There are many reasons for this:

(a) The mineral salts in deposits carried down by the erosive action of rivers, streams and rain water stimulate the development of phytoplankton. By the interaction of trophic processes, this primary production constitutes the basis of the entire food chain.

(b) Water masses adjoining the coast and in island-influenced areas are subjected to turbulence causing deep waters, also with a high mineral content, to well up to the surface.

(c) The pelagic sphere is enriched by a continuous discharge of coastal fauna from the coastal ecosystem (reef ecosystem in many Pacific islands). This permanent infusion represents a substantial biomass; it takes the form, almost exclusively, of larvae of benthic species (organisms dwelling or occurring on the sea bed) drifting unattached in open water, and larvae of meroplanktonic organisms (benthic organisms at adult stage, but with larvae having a pelagic phase). Generally observed drifting under floating objects, these larvae are a prime source of food for large predators.

The purpose of this brief note, which deals only with (c) above, is to quantify the consumption of coastal species in the total food intake of ocean fish of economic significance such as tuna. It is based essentially on the works of Grandperrin (1975) and Legand et al. (1972).

EQUIPMENT AND METHODS

The survey covered tuna vulnerable to long-lining: albacore, yellowfin and bigeye. The fish were taken from 1959 to 1974 during expeditions by the French Office for Scientific and Technical Research Overseas (ORSTOM) in the area shown in Fig. 1. The stomach contents of 143 albacore, 449 yellowfin and 16 bigeye were analysed. Food species were identified whenever the state of digestion was not too advanced; in other cases it was only possible to list the genus, or sometimes just the family.

The results which follow concern only fish consumed by tuna, as particular attention was paid to identifying them. A similar study could equally well have been conducted for cephalopods and crustaceans, as these also make up a substantial part of total tuna intake. In all, nearly 3,000 food fish were identified. The work involved was very great, as identification was in some cases only made possible by examination of otoliths.

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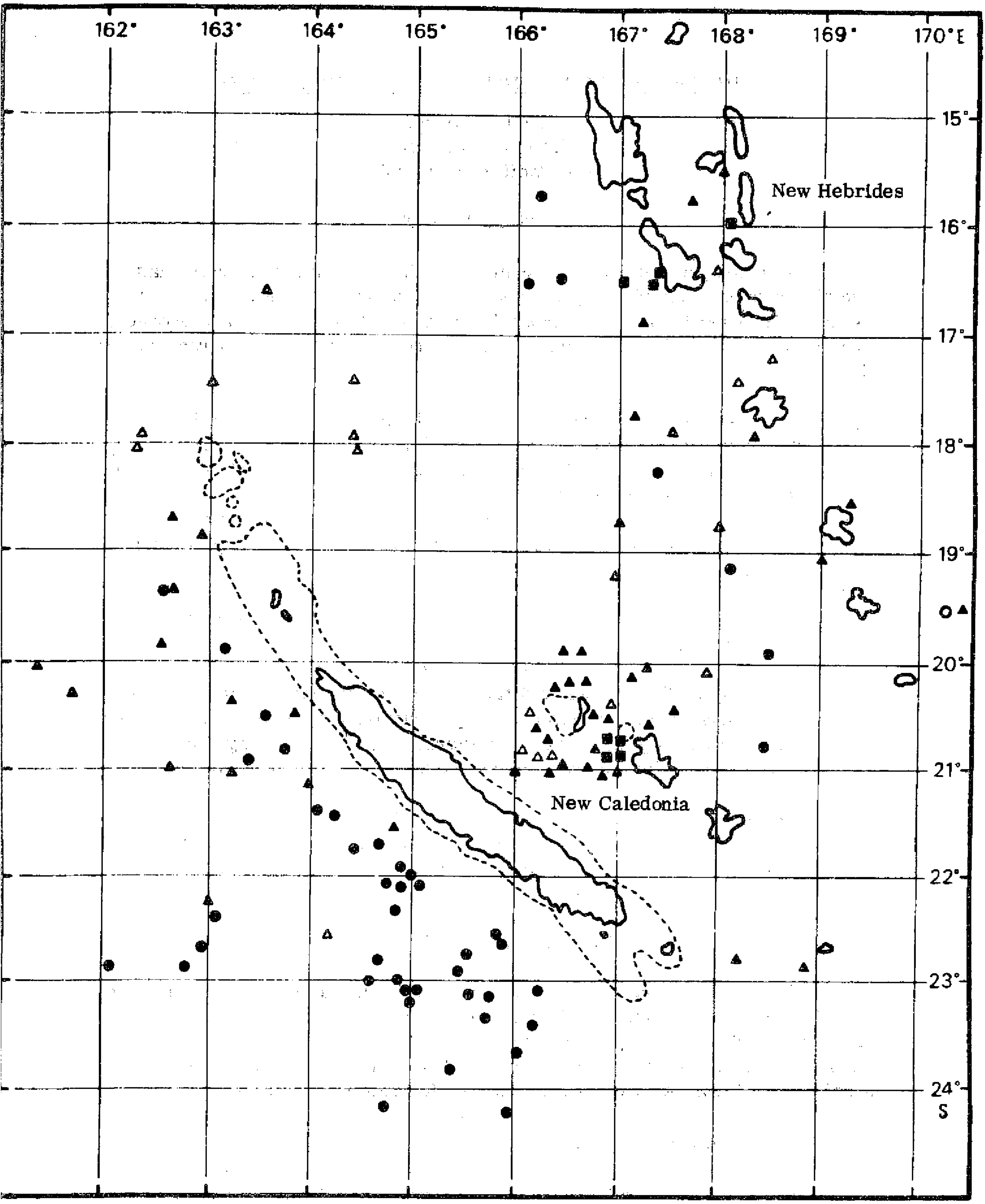
* Originally given as Working Paper 9 at the 1977 Technical Meeting on Fisheries.



● Horizontal long-lines : 1959-1962

■ Horizontal long-lines : 1968

△ Horizontal long-lines :1971-1974

▲ Horizontal and vertical long-lines :1971-1974

Fig. 1: Sample stations (111) for long-line tunas, 1959-1974.

RESULTS

In Table 1, food fish have been divided into two categories. Firstly, true pelagic species, having no connection at any period of their life with the sea bed or the coast; and secondly, coastal species, associated with the sea bed or the coast either all their life, or during a limited period (meroplanktonic organisms). These two categories have been expressed as percentages of the total number of food fish identified. Biomasses were not taken into consideration, as the fish were sometimes in an advanced state of digestion.

Table 1 clearly shows that coastal forms make up a large proportion of the fish intake of albacore (58%) and yellowfin (73%) vulnerable to long-lining. They are entirely absent in the case of bigeye. Of the three species the yellowfin lives nearest the surface; consequently, it has easiest access to coastal organisms drifting on the surface or sub-surface. The albacore, found at greater depths than the yellowfin, consumes a greater proportion of pelagic forms. As for the bigeye, which has the deepest habitat of all, it consumes only true pelagic forms.

Table 1: Percentage frequencies of pelagic and coastal fish species in the diet of albacore, yellowfin and bigeye tuna caught by long-lines (n = number of food fish identified).

	Pelagic species	Coastal species	n
Albacore	42	58	2,518
Yellowfin	27	73	2,364
Bigeye	100	0	40

CONCLUSIONS

These results concern only tuna vulnerable to long-lining, in other words deep-swimming species captured relatively far from the coast. As may readily be imagined, examination of the stomach contents of tuna living nearer still to both coast and surface - juvenile yellowfin and skipjack for example - would bring forth even more conclusive results.

Coastal ecosystems, whether mangroves, reef formations or shoals, provide the pelagic ecosystem with a permanent infusion of a number of organisms that make up a substantial part of the food available to species like tuna which undergo intensive industrial fishing.

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BECHE-DE-MER BRINGS CASH TO REWA VILLAGERS

Suliasi Vatoga,
Information Section,
Ministry of Agriculture,
Fisheries and Forests,
Suva, Fiji.

Fiji's sea gold during the early trading days, bêche-de-mer (sometimes called sea cucumber) has generated a lot of interest among local fishermen since the Food Processing Unit of the Fisheries Department began reviving the old art of processing bêche-de-mer and salted mullet last year.

The news of the lucrative cash earnings on bêche-de-mer from different fishing groups especially in the outer islands has stimulated the interest of three villages in Vutia, Rewa. Having no knowledge at all on bêche-de-mer processing, or whether their fishing grounds (mainly around Nukulau Island and the Laucala Bay area) were inhabited by the sea cucumber, the villagers decided to comb the area for this prized commodity.

The fact that a part of the land area near the three villages is named Vale ni Dri, which means "the bêche-de-mer house", indicated that the slug was processed in this particular spot during the old days, and the creature would be present in the nearby sea area. This theory was confirmed when the first dive by some villagers not far from Vutia resulted in the harvesting of a number of teat fish ("sucuwalu"), the most prized bêche-de-mer species.

Five men from the villages then went to the Lami Fisheries headquarters and learned all about bêche-de-mer processing. For three weeks 30 men from the three villages,led by Elima Rokodravu,were engaged in diving. Their average catch was 200 bêche-de-mer a day which they processed with the help of a Fisheries Department staff member, Inoke Seru. So far the villagers have already harvested and processed 17 60 lb bags of bêche-de-mer. The sale of this is hoped to realise $ 5,000. Diving and processing is continuing.

Mr Seru said that the department is helping with the provision of fuel for their outboard motor. He said that compared with other fishermen, the group was well equipped with boats and processing facilities, and the department was only advising them in the processing and marketing of bêche-de-mer.

The head of the Food Processing Unit of the Fisheries Department, Mr Saimoni Tuilaucala, said that fishing groups serviced by the unit have already earned more than $ 26,000 from 8,000 kilos of bêche-de-mer harvested since the project began in the middle of last year. Nearly all bêche-de-mer were auctioned, and the bidding price has skyrocketed to a fantastic price of $ 4.50 per lb for good quality teat fish or 'sucuwalu'. The normal buying price of bêche-de-mer has been 90 c per lb.

Bêche-de-mer was a major export industry in Fiji in the first half of this century and attracted many traders after the sandalwood boom. The industry died out, however, in the 1940's due mainly to the start of the Second World War, and low prices. However, according to Mr Tuilaucala "Today the picture has changed completely - we have high prices, good markets, and a good supply of bêche-de-mer in our waters. Good quality bêche-de-mer is required for export and we have been carrying out processing trials to determine the best methods to get this quality. Those we have sold overseas have been given good reports and we're now in a position to advise fishermen on the correct processing methods."

He emphasized that processing bêche-de-mer is still something of an art - the all-important stage being the boiling which usually lasts for about 15 minutes. After boiling, the bêche-de-mer are gutted, cleaned and dried. After boiling and drying, about 10 to 15 lbs of dried bêche-de-mer is obtained from 100 lbs of the actual slug. "A fisherman can collect 400 to 600 lbs in one day's fishing from a good area", Mr Tuilaucala said.

Four teams from the unit are at present engaged in advisory work on bêche-de-mer in Viwa and Nacula in the Yasawas and Vulaga and Ogea in the Lau Group. The unit supplies the villagers with goggles, sacks, outboard motor fuel and spare parts, charged to the accounts. Each team takes with it portable smoke houses and supervises the processing, with villagers doing the work. According to Mr Tuilaucala, bêche-de-mer processing is a viable business proposition for which operating costs could be kept to a minimum.

Bêche-de-mer is a prized commodity and is in demand by Chinese all over the world. It is regarded by the Chinese and other eastern people as a luxury. They use it in the preparation of gelatinous soups, and as an adjunct to other dishes made famous world over by Chinese cooks. It is considered a "must" by epicureans who like the authentic touch in their exotic foods.

The Chinese are not alone in their liking for bêche-de-mer. With increased travel nowadays there is a growing tendency for people, particularly Europeans, to alter their eating habits and to experiment with the foods of other people. The growing popularity of bêche-de-mer is just another example of this "food consciousness".

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GROWTH OF PENAEID SHRIMPS IN NEW CALEDONIA AT AQUACAL (CENTRE EXPERIMENTAL DE CULTURES MARINES DE LA BAIE DE ST VINCENT

D. Coatanea (AQUACAL)*

ABSTRACT

These experiments in the culture of penaeid shrimps took place since 1972 at the Centre Expérimental de Cultures Marines de la Baie de St Vincent. About 20 cultures of a semi-intensive type have been carried out with seven species of shrimps. The species which responded best to the different experimental conditions were Penaeus monodon, P. stylirostris and P. vannamei. Production achieved is of the order of 3-5 tonnes/hectare/year, in the kind of ponds used.

INTRODUCTION

The Centre Expérimental de Cultures Marines de la Baie de St Vincent was establishment in 1972 under the auspices of the South Pacific Islands Fisheries Development Agency (SPIFDA) funded by FAO, UNDP and SPC. The SPIFDA programme ended in November 1973 and the activities of the Centre Expérimental were taken over by the Association pour le Développement de l'Aquaculture en Nouvelle-Calédonie (AQUACAL). Its funding is assured by backing from the Territory of New Caledonia, from the Fonds d'Investissement et de Développement Economique et Social (FIDES) and from the Centre National pour

* Scientific "AQUACAL" team: M. Autrand (Director of Station), D. Coatanea (Biologist), J. Mazurie (Biologist), J. M. Peignon (Experimental Officer).

l'Exploitation des Océans (CNEXO). The research centre of CNEXO at Tahiti, the Centre Océanologique du Pacifique (COP), supervises the work undertaken at AQUACAL. This work is mainly concerned with the reproduction and culture of penaeid shrimps.

FACILITIES

When it was first established in August 1972 AQUACAL had at its disposal only one pond of 1.2 hectares, situated on the site of an old salt pond. The centre's facilities now comprise an earth pond of 1 hectare, one of 4300 m^2, six ponds of earth and compacted schist of 1200m2 each, and 14 ponds of concrete and fibre glass of 3-12 m^2. There is also a hatchery consisting of seven 1 m^3 cylindrical-conical vats, a production room for single-celled algae, a production system for prepared foods with a daily capacity of 100 kg, two electric generators (16 KVA and 25 KVA), and residential premises on the site.

SITUATION

AQUACAL is situated in Deama Bay to the north of the Baie de St Vincent, and within the mangrove zone. The waters are rich in plankton and contain a natural population of penaeid shrimps, mostly Penaeus merguiensis. The water in the culture ponds is supplied by direct pumping and its temperature and salinity are similar to those of the surrounding natural water. Salinity variations are directly dependent on precipitation. In the dry season the salinity range is 35-38‰. At the period of highest rainfall the salinity of the water in Deama Bay occasionally drops as low as 25‰. Seasonal changes in temperature (Fig. 1.) are more important than salinity variation, because temperature directly affects the growth of cultured shrimps. Maximum temperatures of 29-30^{o} were experienced in the culture ponds in January and February, and minima of 19-20^{o}C in July to September.

CULTURE METHODS

Natural sources. Early culture trials used the young of Penaeus merguiensis and Metapenaeus ensis obtained from the mangrove zone. These post-larvae and juveniles (0.1 - 3 g), very abundant from October-December, were caught with fyke nets (Doumenge, 1973), or in nets of mosquito gauze. A few individuals of the species Penaeus semisulcatus and Penaeus monodon were also captured and placed in the cultures. This procedure, however, proved unsuitable for mass or separate stocking.

Hatchery production. In 1973 COP (Tahiti) managed to get P. merguiensis to breed in captivity (AQUACOP, 1975) starting with a stock of offspring partly originating from New Caledonia. The hatchery technique they used was perfected at the Galveston laboratory and adapted for tropical conditions by the staff of COP (AQUACOP, 1977a). This technique, used by AQUACAL since February 1975, enables the raising of up to 100,000 post-larvae per 1m^3 vat through a larval cycle of around 15 days, by strict control of conditions in the culture medium. These are: temperature 26-29^{o}C; sea water filtered at 50 and 5 microns, chlorinated, then dechlorinated before use; prevention of fungal and bacterial infection by treatment with tinfuraline and antibiotics (erythromycin and chloramphenicol).

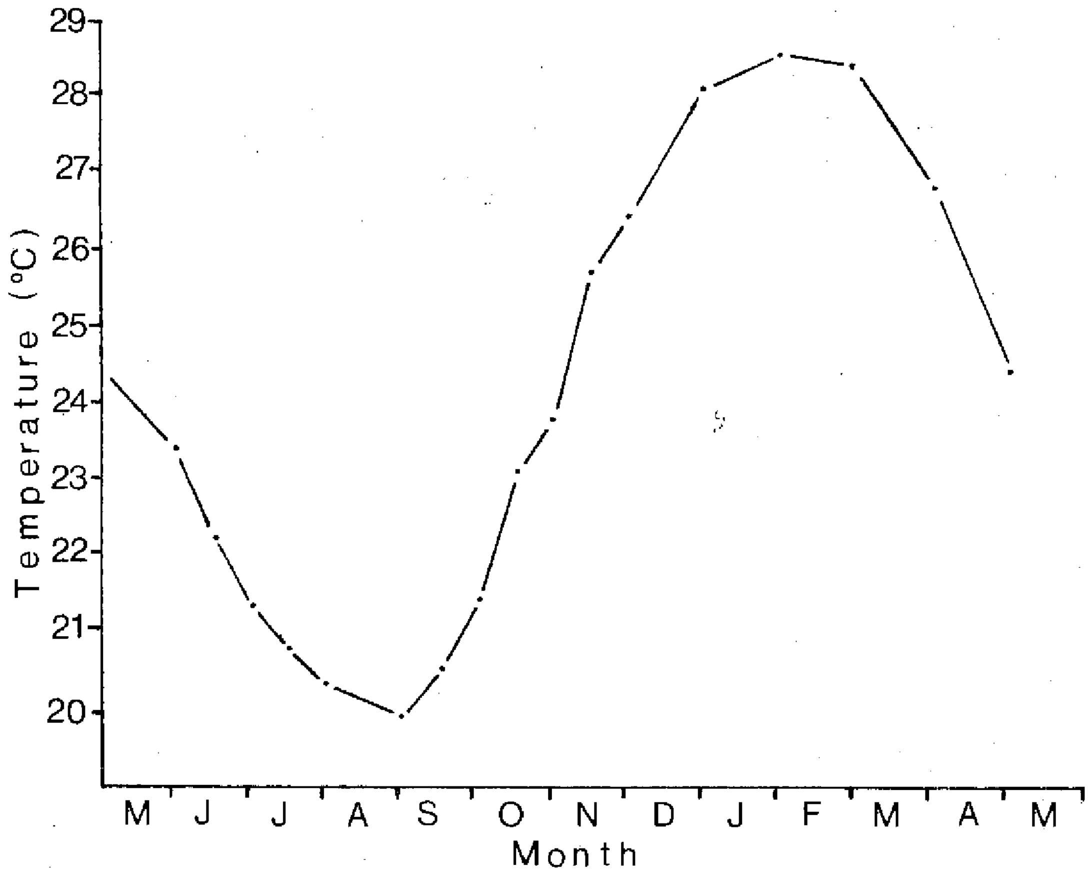

Fig. 1: Seasonal variation in the water temperature of the growth ponds (means of 1973-76). Recordings made at 0800.

During the zoea stage the larvae are fed on single-celled algae. The types used are Isochrysis sp., Cylindrotheca sp. (cultured at 5 million cells/ml), and Tetraselmis sp. (1 million cells/ml). Rotifers and brine shrimp cultured in neighbouring vats are used to feed the mysid and post larval stage.

Between October 1975 and February 1978 the types and numbers of post-larvae produced were: P. merguiensis 332,000; P. stylirostris 88,000; P. semisulcatus 45,000; P. monodon 25,000. The production of P. monodon was insufficient for stocking the ponds and some had to be imported from COP (Tahiti).

GROWTH

Management of the ponds. The growth of animals takes place in earth ponds supplied with sea water by pumping (about 10 per cent is renewed daily). Before being redistributed the water is decanted, and then filtered (1mm and 500 microns) to prevent the introduction of predators. The ponds are supplied with a sluice gate allowing the removal of either bottom or surface water. Each pond is ploughed over before filling to remove all traces of decomposition in the sediment.

After the ponds are filled phytoplankton growth is encouraged by the addition of agricultural fertiliser (NPK) at 20-50 kg/hectare. The maintenance of phytoplankton stocks is essential - for the growth of zooplankton, protection of the shrimps against an excess of light, inhibition of benthic algae - but proves difficult outside the warm season. Growth in the ponds is followed regularly by collecting and weighing samples of shrimps.

Two stages of culture are practised. Firstly, the young animals are grown on in 1200m^2 ponds in dense cultures of 50-150 animals/m^2. This is for a short period (2-3 months) until they reach a size of 1-2 g, when they are used to stock the large ponds (1 hectare and 4,300 m^2). In these ponds they go through the main growth stage which takes them up to a commercial size of 15-25g.

The shrimps are harvested with nets (trap, casting and seine) allowing the produce to be put on sale and supplying good quality, graded shrimps.

Nutrition. During the early cultures only supplementary food was supplied - fresh minced fish and a wet mash with a protein content of 29 per cent made from waste meat products and cereals. In subsequent cultures a diet formulated by AQUACAL was used. The main ingredients were fish meal, and meat imported from Australia and New Zealand. Although the composition of these diets (Table 1) is simple, they produce acceptable growth rates. The net production cost was 60 CFP/kg for materials and manufacture.

Table 1: Percentage composition of the two principal diets formulated at AQUACAL

	Diet AQ1	Diet AQ2
Fish meal	40	30
Meat meal	40	30
Coprah oilcake	0	20
Wheat flour	18	18
Vitamin mixture	2	2
Protein content	44.5	38.2

RESULTS

Twenty-three culture trials using seven species of shrimps have been carried out since 1972. The first trials were with P. merguiensis and M. ensis, collected as juveniles in the mangroves. These early attempts were at a low stocking density and resulted in the production of some P. merguiensis of about 40 g. Later cultures at greater densities (6-55/m^2) showed that in such conditions the rapid growth of the first three months (even in the cool season), slowed up greatly when the average weight reached 3 g. In these conditions, productivity could, however, exceed 2 tonnes/hectare/year. A similar growth rate was obtained with M. ensis.

In October 1974 600 post-larvae of P. japonicus from the COP hatchery were placed in a culture at AQUACAL, growing to an average weight of 19 g six months later, with a survival rate of 17 per cent. In May 1975 this experiment was carried out on a larger scale - 100,000 post-larvae from Japan were put in the 1 hectare pond, in a culture mixed with 20,000 P. merguiensis and M. ensis; from this culture only 31 individuals of P. japonicus survived (mean weight 6.6g). Massive mortality took place at the end of October when the water warmed up again. The shrimps were hit by an infection described by Shigueno (1975) under the heading of bacterial diseases. Different explanations can be advanced for this mortality - the nature of the sediment, unsuitable to P. japonicus, stagnation in the sediment, diet too low in protein (29%) and not satisfying the high requirements of this species (60%).

P. aztecus gives a good growth rate in the warm season and also in the cool season. On the other hand, it does not seem adapted to culture at high densities. Futhermore this species is subject to a tetanus infection (Johnson et al, 1975) during the warm season when the temperature goes above 26°C. It is also often attacked by "white pleura" disease caused by a species of Vibrio (AQUACOP, 1976).

With its fast growth rate P. monodon appears a promising species for culture in the tropics (AQUACOP, 1977c). It is extensively cultured in the Philippines, India and Taiwan (see Blanco (1972), and Primavera and Apud (1976)). According to Racek (1972) P. monodon can grow to 95 g in a year in large cultures. Culture at the higher density (10-50/m^2) achieved at AQUACAL confirmed the good performance and growth of P. monodon in semi-intensive conditions, but only in the warm season. When the temperature goes below 25°C growth is greatly reduced and stops altogether at 20°C. In addition, at the time of stocking the ponds with post-larvae from the hatchery, particular attention must be given to making sure that there is a supply of phytoplankton and zooplankton, to avoid serious mortality in the first days of the culture.

The two species P. stylirostris and P. vannamei were introduced in April 1976 from a supply of post-larvae imported from the U.S.A. P. stylirostris is interesting for its good growth in all seasons. A mean weight of 60 g was reached in 16 months. It was cultured at a density of 10/m^2 for the first 7 months, and at 1/m^2 for the last 9 months. The size reached by P. vannamei is less (mean, 35 g in 16 months, for the same conditions), but this species can be the subject of intensive raising in the warm season. Representative growth curves for the six Penaeus spp. are shown in Fig. 2.

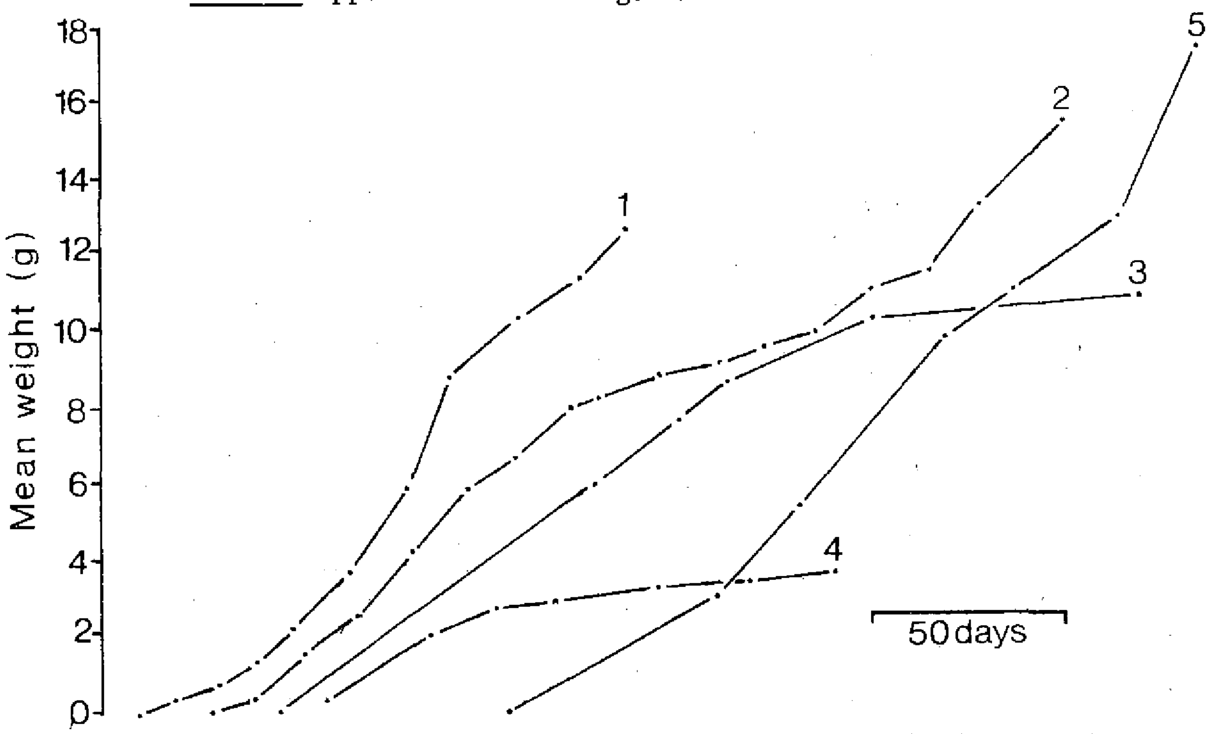

Fig. 2: Representative growth curves: 1, Penaeus monodon 31/12/75-11/5/76, density 11/m^2; 2, P. vannamei 12/4/76-26/11/76, 15/m^2; 3, P. aztecus 12/5/76-31/12/76, 10/m^2; 4, P. merguiensis 6/4/76-23/8/76, 11/m^2; 5, P. stylirostris (plus P. vannamei) 12/5/76-31/12/76, 10/m^2.

DISCUSSION AND PROSPECTS

As a result of these trials it is possible to evaluate the importance for aquaculture in New Caledonia of the species of penaeids which have been studied.

Growth of P. merguiensis is poor whatever the temperature as soon as the density of animals exceeds 5-6/m^2. The shrimps produced only have a mean weight of 3g. However, they are suitable for an existing market in New Caledonia, and the culture of this species is foreseeable for short-term production (3-4 crops for per pond per year).

P. monodon, which grows well at a density of 10-20/m^2, proves to be a good species only for the warm season. P. vannamei, also a warm season species, can be kept at a higher stocking density (AQUACOP, Internal report).

It is desirable to raise a complementary species for the cold season so that two crops can be harvested per pond each year. P. stylirostris and to a lesser degree P. aztecus would be able to fill this role. If this condition is met a yield of 3-5 tonnes/hectare/year can be obtained in the type of ponds used at AQUACAL.

Depending on the preliminary establishment of a large-scale hatchery for stocking growth ponds, and a production unit for manufactured food, these results permit the development of penaeid shrimp farming in New Caledonia to be envisaged in the near future.

Editors' note: Since this article was written in October 1977 the results of additional growth experiments have become available. It is planned to present these, and the results of experiments currently taking place, in a supplementary report early in 1979.

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SOUTH PACIFIC REGIONAL FISHERIES ORGANISATION MEETING

The resumed session of this meeting took place at the South Pacific Bureau for Economic Co-operation (SPEC) headquarters in Suva, from 5-10 June 1978. The object of this session was to complete a draft convention for the establishment of a South Pacific regional fisheries agency, a task begun at the earlier session in November 1977.

The meeting was opened by the Director of SPEC, the Hon. Mahe Tupouniua, and chaired by Mr Paul Cotton of New Zealand. Countries attending were: Australia, Chile, Cook Islands, Fiji, France, Gilbert Islands, Nauru, New Zealand, Papua New Guinea, Solomon Islands, Tonga, Tuvalu, United Kingdom, United States of America and Western Samoa. Observers present were from Japan, Republic of Korea, the South Pacific Commission, the Food and Agriculture Organization of the United Nations, and the University of Hawaii. During the meeting the Congress of Micronesia Law of the Sea Delegation and the Marshall Islands Maritime Authority were also accorded observer status.

The meeting considered the draft articles provisionally agreed to in November and also proposals for the uncompleted articles. After full discussion and negotiation a final text for the Draft Convention was completed, and the delegates agreed to recommend its text to their Governments for favourable consideration.

The Draft Convention is now to be considered by all the goverments which participated in the meeting, and the South Pacific Forum in Niue in September 1978. The meeting recommended that if the Draft Convention be acceptable to both governments and the Forum, then it be adopted, and opened for signature at a Plenipotentiary Conference on a date and at a place to be decided by the Forum.

THE COUNTRIES AND TERRITORIES OF THE SOUTH PACIFIC COMMISSION AREA AND THEIR PROPOSED 200-MILE EXCLUSIVE ECONOMIC ZONES

An article in the July 1977 Fisheries Newsletter (No. 14) described the structure and functions of SPC, and listed the member countries and their territories. The purpose of this article is to provide a more detailed listing of the main islands and island groups, and to indicate their political status. In addition there is a separate tabular presentation giving the approximate areas of the proposed 200-mile exclusive economic zones, and relating these to the estimated populations. The boundaries of these proposed zones can be found on the map of the SPC area in Fisheries Newsletter 14.

American Samoa is an unincorporated territory of the United States. It comprises seven islands and two small islets. The administrative centre, Pago Pago, is situated on Tutuila, the largest island.

The Cook Islands are a self-governing state in free association with New Zealand. They consist of two main groups, the Northern Cooks and the Southern Cooks. Most of the population lives in the Southern Cooks. The administrative centre is Avarua, on Rarotonga.

Fiji is an independent Dominion within the British Commonwealth. It comprises two large islands, Viti Levu and Vanua Levu, and many smaller ones totalling about 300. The capital, Suva, is on Viti Levu.

French Polynesia is an overseas territory of France. It consists of some 130 islands in five main groups: the Society Islands, the Tuamotu Archipelago, the Marquesas, the Gambier Islands and the Austral Islands. The administrative centre, Papeete, is on Tahiti in the Society Islands.

The Gilbert Islands are a self-governing colony of the United Kingdom, expected to become independent in 1979. The colony consists of four groups: the Gilberts, the Phoenix Islands, the Northern and Southern Line Islands; and one single island, Ocean Island. A few small, uninhabited islands amongst these are United States possessions: Howland and Baker in the Phoenix Islands, and Kingman, Palmyra and Jarvis in the Line Islands. The islands of Canton and Enderby in the Phoenix group are jointly administered by the United Kingdom and United States. The administrative centre of the Gilberts is Bairiki, on Tarawa.

Guam is an unincorporated territory of the United States, and is the southernmost of the Mariana chain of islands. The administrative centre is Agana.

Nauru is an independent republic and an associate member of the British Commonwealth. The administrative centre is in the Yaren district.

New Caledonia is an overseas territory of France. It comprises the main island of New Caledonia, where the capital Noumea is situated, the Loyalty Islands, and a number of smaller islands, including the Chesterfield Archipelago.

The New Hebrides are a condominium, jointly administered by France and the United Kingdom. The condominium comprises about 80 islands, the largest of which is Espiritu Santo. The administrative centre, Vila, is on Efate.

Niue is a self-governing state in free association with New Zealand. It comprises a single island; its administrative centre is Alofi.

Norfolk Island is a territory of Australia. The administrative centre is Kingston.

Papua New Guinea is an independent state, and member of the British Commonwealth. It consists of the eastern part of the island of New Guinea and many offshore islands, the largest of which are New Britain, Bougainville, New Ireland and Manus. The capital, Port Moresby, is on the mainland.

Pitcairn Island is a dependency of the United Kingdom. Adamstown is the main settlement.

The Solomon Islands became independent on 7 July 1978, and are a member of the British Commonwealth. The group comprises six large islands and many smaller ones, including the Santa Cruz Islands. The capital is Honiara on Guadalcanal.

Tokelau is a New Zealand dependency, included in the boundaries of New Zealand. It consists of three atolls, each with its administrative centre.

Tonga is an independent kingdom, and a member country of the British Commonwealth. There are three main island groups and many small islands. The capital is Nuku'alofa on Tongatapu.

The Trust Territory of the Pacific Islands is a United Nations trust territory administered by the United States. It comprises about 2,000 islands in three main archipelagoes: the Marianas, Carolines and Marshalls. The administrative centre is on Saipan in the Marianas.

Tuvalu is a self-governing colony of the United Kingdom due to become independent on 1 October 1978. It comprises nine small islands with the administrative centre on the largest of these, Funafuti.

Wallis and Futuna is a territory of France, and consists of two groups of islands. The administrative centre is Mata'Utu on Wallis Island.

Western Samoa is an independent state and member country of the British Commonwealth. It comprises two large islands, Savai'i and Upolu, and several small ones. The capital Apia is on Upolu.

The sizes of the exclusive economic zones (Table 1) depend on various factors, and do not correspond to the land areas of the various countries. The largest zones correspond to island groups which are widely scattered, the most extreme example of this being the Trust Territory of the Pacific Islands which has by far the largest zone, followed by the Gilbert Islands, another greatly dispersed group. Another factor determining the size of a zone is the nearness of a territory to its neighbours. Thus Western Samoa has a very small zone because it is close to four other countries, American Samoa, Wallis and Futuna, Tonga, and Tokelau.

Table 1: Populations, land areas, approximate sizes of the proposed 200-mile exclusive economic zones (EEZ), and their area per head for the countries and territories of the South Pacific Commission area.

	Population (1977)	Land Area (km^2)	EEZ Area (000 km^2)	Area per head (km^2)
American Samoa	30 500	197	410	13
Cook Islands	18 500	240	2 200	119
Fiji	592 000	18 200	1 370	2
French Polynesia	137 000	4 000	5 380	39
Gilbert Islands	53 500	684	4 430	83
Nauru	7 300	30	290	40
New Caledonia	134 000	19 100	1 540	11
New Hebrides	99 500	11 880	670	7
Niue	3 800	260	350	92
Norfolk Island	1 900	35	570	300
Papua New Guinea	2 908 000	461 693	2 300	1
Pitcairn Island	65	4	970	1 493
Solomon Islands	206 000	28 500	1 520	8
Tokelau	1 600	10	330	206
Tonga	90 000	697	720	8
Trust Territory of the Pacific Islands (incl. Guam)	216 000	1 800	7 460	35
Tuvalu	7 500	25	760	101
Wallis and Futuna	9 700	16	280	29
Western Samoa	152 000	2 934	160	1