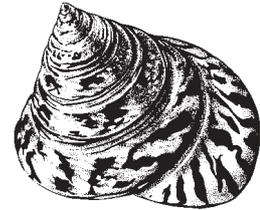




FISHERIES INFORMATION PROJECT
SOUTH PACIFIC COMMISSION
PO BOX D5 - NOUMEA CEDEX
NEW CALEDONIA



TROCHUS

INFORMATION BULLETIN

Number 1 — July 1992

About the Trochus Special Interest Group

Welcome to the inaugural edition of the *Trochus Information Bulletin*. This bulletin is the medium and catalyst for the Trochus Special Interest Group.

This SIG was established as a result of Recommendation No 4 of the Twenty-third Regional Technical Meeting on Fisheries, held in Noumea, from 5 to 9 August 1991. This recommendation was in turn based on a recommendation of the Workshop on Trochus Resource Assessment, Development and Management, held in Vanuatu in May/June 1991. A résumé of the workshop is presented in this bulletin.

The SIGs are being established in response to the needs of Pacific Island fishery scientists and development workers, as expressed at the SPC Workshop on Pacific Inshore Fishery Resources held in Noumea in March 1988. The participants stressed that communication difficulties have always been one of the principal constraints on fisheries research in the Pacific.

The concept behind SIGs is to establish networks of individuals working in similar subject areas, so as to encourage the sharing of information and ideas in the region.

As a first step, the South Pacific Commission circulated questionnaires on the establishment of SIGs to the fisheries divisions of the region and beyond. (contd. p.2)

Inside this issue

Report on the SPC/SPRADP Workshop on Trochus Resource Assessment, Development and Management
by G.L. Preston Page 2

Trochus reseeding experiment in Vanuatu
by M. Amos Page 8

Studies on juvenile *Trochus niloticus* (L.) with a view to using reared juveniles to repopulate reef areas
by L.L. Castell-Perez Page 10

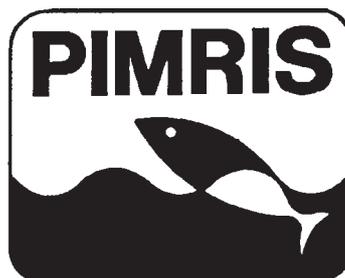
Study of the Aitutaki trochus fishery
by G.L. Preston Page 10

Information on trochus fisheries in the South Pacific
by B. Fao Page 12

Trochus marketing trends: Solomon Islands
by H. Bibi and T. Adams Page 16

Bibliographic references on trochus
by J.P. Gaudechoux Page 17

PIMRIS is a joint project of 4 international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the South Pacific Commission (SPC), the South Pacific Forum Fisheries Agency (FFA), the University of the South Pacific's Pacific Information Centre (USP-PIC), and the South Pacific Applied Geoscience Commission (SOPAC). Funding is provided by the International Centre for Ocean Development (ICOD) and the Government of France. This bulletin is produced by SPC as part of its



Pacific Islands Marine Resources Information System

commitment to PIMRIS. The aim of PIMRIS is to improve the availability of information on marine resources to users in the region, so as to support their rational development and management. PIMRIS activities include: the active collection, cataloguing and archiving of technical documents, especially ephemera ("grey literature"); evaluation, repackaging and dissemination of information; provision of literature searches, question-and-answer services and bibliographic support; and assistance with the development of in-country reference collections and databases on marine resources.

The questionnaire responses were used to gauge the relative interest of different subject areas to Pacific Island fishery workers and to identify individuals who might provide technical information. The responses (about 350) have been entered into a computerised database and the most common areas have been identified.

As part of the support offered to each SIG, the South Pacific Commission undertakes to circulate literature, technical materials, and correspondence relevant to the interests of group members on an occasional basis, mainly in this bulletin.

This first *Trochus Information Bulletin* will give group members an idea of the type of information we hope to include and provide a stock-take of currently available bibliographic information relevant to the interests of the group. An introductory list of SIG members is also given.

In return, we ask group members to keep us informed of their own work activities in the subject field, and send us single copies of any material or information that may be relevant to the interests of other members of the group, on topics such as:

- Research activities in biology and ecology;
- Fishing and marketing activities;
- Conferences, books and other publications; and
- Questions by members or information requests.

Thanks in advance.

Jean-Paul Gaudechoux
Fisheries Information Officer
South Pacific Commission

Report on the SPC/SPRADP Workshop on Trochus Resource Assessment, Development and Management, 13 May – 2 June 1991

*by G.L. Preston,
 South Pacific Commission,
 Noumea, New Caledonia*

Introduction

The topshell, *Trochus niloticus*, is native to countries of the Western Pacific, and has been introduced to many additional locations throughout the Pacific Islands. This shell is collected and exported for button-making and other uses, and provides an important source of income for rural and outer island dwellers in the region.

The Pacific Islands region is the most important trochus-producing area in the world. In 1986, the latest year for which complete figures are available, regional production was at least 2,166 tonnes. At present-day prices this would have a value to fishermen of around US\$ 26 million. Most of these earnings accrue to coastal communities whose alternative earning opportunities are frequently limited.

In recent years, the market value of trochus shell has increased markedly. As a result, the level of exploitation has also increased in many Pacific Island countries. There are fears in some locations that present levels of harvesting will not be sustainable and that serious resource depletion will occur if management regimes are not developed and instituted. This will result in undesirable consequences for those communities to which trochus harvesting is presently economically important.

The Twenty-Second SPC Regional Technical Meeting on Fisheries, held in Noumea in August 1990, discussed this issue in some depth. The meeting also discussed several related topics, including:

- factors determining regional and global variation in trochus quality, and therefore value;
- the merits of regional co-operation in the marketing of marine products, including trochus, as a means of increasing economic returns to Pacific Island countries from the resource;
- appropriate management approaches for trochus and other marine resources, including the use of hatchery-produced juveniles to replenish depleted natural populations.

As a result of these discussions, the meeting recommended that the South Pacific Commission take action to assist Pacific Island countries in maximising the returns they obtain from their trochus resources by promoting regional collaboration and information exchange in the development of effective exploitation, marketing and management systems. Given the interdisciplinary nature of the topic, the meeting also recommended that the Commission seek the active co-operation of other regional agencies, in particular the South Pacific Regional Aquaculture Develop-

ment Project and the Forum Fisheries Agency, in this work.

As part of its response to these recommendations, the Commission, through its Inshore Fisheries Research Project, organised a three-week Workshop on Trochus Resource Assessment, Development and Management.

The overall aims of the workshop were: to update participants on recent developments in trochus processing and marketing; to expose participants to current biological and aquacultural information relevant to trochus fishery resource assessment and management; to train selected participants in the conduct of field work aimed at providing assessment of the status of local trochus resources; in so doing, to develop a standard trochus survey methodology for use within the region, so as to allow direct comparison of survey data in the future; and to promote an exchange of trochus fishery management experiences in the region, in order to promote effective management of this important resource.

Venue and funding

The workshop lasted slightly more than three weeks, from Monday 13 May to Sunday 2 June 1991 inclusive. It was hosted by the Fisheries Department of the Government of Vanuatu and executed in collaboration with the FAO South Pacific Regional Aquaculture Development Project. Funding support was provided by the International Centre for Ocean Development (Canada), the UK Overseas Development Administration, the Commonwealth Secretariat, the Food and Agriculture Organisation of the United Nations, and the South Pacific Commission.

Workshop structure

The workshop was structured as three approximately one-week segments. All participants attended for the first week (13 - 18 May inclusive); selected participants stayed on for the second and third weeks (13-26 May inclusive, and 26 May - 2 June inclusive). Participants were not permitted to join the workshop part-way through.

Week 1 was aimed at a broad range of individuals involved in work on trochus, from those dealing with aspects of resource assessment and the provision of management advice, to those involved in decision-making at a senior level, or in product quality assessment, control or marketing. Parts of Week 1 were also relevant to individuals from the private sector.

Sessions during Week 1 consisted of lectures and discussion groups covering of aspects of trochus biology and life history, population dynamics, basic resource assessment methods, hatchery technology and juvenile propagation, resource management, shell processing and quality assessment, and marketing. Some attention was also given to the species *Tectus pyramis* and *Turbo marmoratus*, which occupy similar habitats and are traded in ways similar to *Trochus niloticus*. Site visits to commercial shell processing factories and to the government trochus hatchery were organised, and participants were able to observe trochus spawning and subsequent larval development.

Week 2 was aimed at individuals involved in survey and assessment work on trochus and other sessile marine invertebrate resources. Participants in Week 2 were required to have completed Week 1.

Week 2 consisted of two main elements:

- comparison of field survey methods for trochus, one of the aims being to develop a standardised survey methodology for use in future Pacific Island trochus surveys;
- an experiment to monitor intensively the short-term effects of a mass release of trochus juveniles in a selected location. Such experiments will be essential if we are to assess correctly the usefulness of the juvenile release programmes for fishery enhancement that are being considered in some parts of the region.

Week 3 provided an opportunity for participants to assist with an intensive field survey in Aneityum island, using the standardised methodology developed during Week 2. The survey formed part of Vanuatu Fisheries Department's national trochus assessment project and thus provided important support for trochus resource development in Vanuatu. Participants in Week three were required to have first completed Weeks 1 and 2.

Resource people and participants

Five people acted as resource persons for one week or more of the workshop. They were Garry Preston, South Pacific Commission, weeks 1-3; Warwick Nash, Tasmanian Sea Fisheries Department, weeks 1-3; Hideyuki Tanaka, Regional Aquaculture Development Programme, weeks 1-2; Kay Legras, South Pacific Commission, weeks 1-2; Seamus McElroy, Private, week 1. A further seven individuals acted as resource persons for short periods (one or two hours) in support of specific items on the workshop programme. They were

Serge Bordet, Private, Vanuatu; Robert Gillett, FAO/UNDP Regional Fishery Support Programme, Fiji; William Bour, ORSTOM (French Overseas Research Agency), New Caledonia; George Joe, Melanesian Shell Products Ltd, Vanuatu; Hirofumi Kubo, Okinawa Prefectural Fisheries Experimental Station, Japan; Masayoshi Murakoshi, Okinawa Prefectural Sea Farming Centre, Japan; Nory Ozaki, Kiyohara Co. Ltd., Japan.

The 37 participants from 16 countries who took part in various stages of the workshop were Kelvin Passfield, Patricia Ngamata Tuara (Cook Islands); Esaroma Ledua, Abdul Rahim, Apisai "Terminator" Sesewa, (Fiji); Ronald Cheneson (French Polynesia); Simpson Abraham, Flynn Curren, Donald David, Jerry Fagolimul, Joe Fanafal (Federated States of Micronesia); Temawa Taniera (Kiribati); Nena Kilma, Hilary Kobaia (Marshall Islands); Bernard "Ambassadeur" Fao (New Caledonia); Ken-ichi Kikutani, Steven Patris (Palau); Molean Chapau, Joshua Ako Kari, Kingsford Naniura (Papua New Guinea); Jon Leqata, John Mao, Eddie Oreihaka, Peter Ramohia (Solomon Islands); Suia Gaulofoa (Tokelau); Tevita Finau Latu (Tonga); Nikolasi Apelinu (Tuvalu); Moses Amos, Albert Carlot, Felix Nguyen (Vanuatu); Henrietta "Bag of Beans" Winterstein (Western Samoa); Jim Gillespie, Erik Hunter, Karina Magro, Alex McCarthy, Jeremy Prince (Australia).

Week 1

Week 1 consisted of a large number of presentations and discussion sessions that fell within the following areas: status of Pacific Island trochus resources; Trochus trading and marketing; trochus biology and aquaculture; population and distribution characteristics of Trochus resource; potential Trochus management systems and enhancement methods; and a session on green snail (*Turbo marmoratus*). Each of these themes was treated more or less as a separate one-day "mini-workshop", moderated by a different resource person. The presentations and discussion sessions were extremely productive, and highly interactive, with all but a very few participants taking an active role in the interchange. The presence of numerous technical specialists, especially those from the shell industry and trade, led to a large body of otherwise inaccessible information being made available.

During the sessions, the following original papers were copied and distributed:

- Country statement - Queensland;
- Resource statement - Western Australia;
- Country Statement - Cook Islands;
- Status of trochus in Fiji;
- Situation de la ressource en Trocas en Polynésie Française;
- Country statement - Palau;
- Country statement - Papua New Guinea;
- Trochus assessment, development and management in Solomon Islands;
- Trochus resource in Tuvalu;
- History and present status of the trochus resource in Vanuatu;
- Trochus resource of Western Samoa;
- Country statement - Okinawa;
- Kiyohara Company outline/ Where trochus shell and shell button stand in Japan;
- Processing and trade of Melanesian Shell Products Ltd;
- Mass seed production and restocking of trochus in Okinawa;
- Methodology of trochus seed production in Vanuatu;
- Juvenile release in Palau;
- Updated table of Pacific trochus introductions;
- Studies on trochus ecology and its propagation in Micronesia (abridged translation);
- Remote sensing of trochus habitat on Tetembia reef, New Caledonia.

All the presentations and discussion sessions were recorded on audio tape for subsequent transcription. Unfortunately faulty sound recording equipment meant that recordings of some sessions are of poor quality and may be impossible to transcribe. Session transcriptions will be combined with the presented

papers in a workshop proceedings. It was originally planned to issue the proceedings early in 1992 but this has not been achieved. We hope nevertheless that they will be available before the end of the year.

Week 2

The 24 participants who stayed on for Week 2 relocated to Erakor Island, where accommodation and classroom facilities are conveniently located close to foot access to a fringing reef with a viable trochus population. This Week and Week 3 were more in the nature of a training course. Participants were given instruction in statistical procedures and survey design by the resource people, and were required to put this instruction into practice by carrying out survey work on the reef flat and analysing the results.

Because of heavy surf which made diving over the reef-edge dangerous, and general ease of access, survey work during the early part of the week focussed on benthic invertebrates other than trochus. This did not detract from the purpose of providing instruction in the basic principles of survey design and conduct. During the later part of the week, weather and tides allowed access over the reef and it was possible to target trochus specifically.

A juvenile release experiment was also carried out during this week. 2,000 juvenile trochus were tagged and released in 4 treatments at different places on the reef. Instantaneous monitoring was carried out on the following and subsequent days. (A further

check on the animals was carried out by one or two participants who had transit days in Port Vila after the end of Week 3. The Vanuatu Fisheries Department has been monitoring the site since the time of the release, and in August 1991 produced a progress report which is summarised as a separate article in this bulletin. Early survival rates were extremely encouraging, far better than anticipated or achieved in any other trochus release experiment, including the large programmes carried out in Japan. Vanuatu Fisheries Department now plans to carry out additional releases in order to obtain further improvements in survival rates.

Week 3

Week 3 involved 16 of the 24 Week 2 participants, who travelled to the island of Aneityum, in the south of the Vanuatu archipelago, to carry out survey work on the island's trochus population. This was a change in the original schedule, in which it was planned to carry out this field work on the island of Emae. The change was requested by the Vanuatu Fisheries Department, who needed management-related information in order to advise the island council on re-opening the fishery. Trochus and green snail harvesting had been banned for three years before the study team's visit and the situation thus presented an ideal opportunity both to assess the effects of the closure, and to provide useful advice to the island council.

The week was spent on board the chartered vessel *Coriolis*. Steaming to Aneityum took about 28 hours in each direction, in very rough weather. Most



Erakor Island



A tagged juvenile trochus, about 20 mm diameter (estimated), newly released on the reef. The dark spot on the tip of the shell is a blob of pink-coloured cyanoacrylate glue, used to help find the tiny shell after release.

participants were seasick and unable to function on the trip down, but by the end of the week some were sufficiently adapted to carry out data analysis and write-up of results on the return leg. After arrival at Aneityum, the *Coriolis* anchored in a sheltered location, and survey work was carried out using the vessel's two outboard-powered dive tenders.

Most survey work was carried out in the south of the island close to the centre of population and the main site of the fishery in previous years. At the end of the week, an afternoon stop was made on the northern side of the island to obtain comparative information from an unfished site, but continuing rough weather made survey work ineffective and these results were ultimately discounted in the final analysis.

Survey work consisted of the following activities: strip transects to estimate relative abundance; depletion experiments to estimate absolute abundance; mark-recapture experiments to refine the abundance estimates; and gathering of length-frequency information for use in the study of population demography and in virtual population analysis. All data gathering, recording, and interpretation were done by the participants, working in groups of four, under the supervision of the two resource people.

At the end of the week each group was required to use the data it had gathered, plus the information and experience presented during the first week, to draft a management plan for the Aneityum fishery. The plan was to be written in such a way that it could be presented and explained in a convincing way to the island council. Each group had access to the data gathered by the other three groups, but was asked to work independently.

The four management plans were compared and discussed in depth during a final session in Port Vila after the vessel returned. Although each has individual features, there is a consistency in approach which strongly suggests that workshop participants had effectively absorbed the information and techniques covered in the workshop. The merits and demerits of each plan were discussed, and based on this information the Vanuatu Fisheries Department has provided management advice to the island council, which has been accepted.

National workshop

After the main workshop, a smaller gathering of ten representatives from the various islands of Vanuatu was convened for two days by the participants from the Vanuatu Fisheries Department. This element was administered entirely by the Vanuatu Fisheries Department, and funded by ICOD.

The purpose of the national workshop was to advise island representatives on management of their own local trochus resources, based on information from the main workshop. The presentations were made in the local Bislama language by two of the ni-Vanuatu participants in the main workshop, and stimulated considerable interest and discussion. Island representatives were made aware of the likely biological and economic consequences of different approaches to managing this fishery. At

the same time, the Fisheries Department staff used the opportunity to gather up-to-date information on patterns of exploitation in different areas, and to discuss means of gathering additional research information through cooperation with local fishermen. The workshop was a valuable extension exercise which the Vanuatu Fisheries Department intends to repeat and capitalise on in the future.

Workshop documentation

Two documents will be produced as a result of the workshop:

—a report of proceedings, containing all papers tabled and edited transcriptions of the verbal presentations and discussion sessions. This report will essentially condense and disseminate the information presented during Week 1.

—a manual of survey techniques and statistical procedures for use in future survey work on benthic marine invertebrates. This manual is intended as follow-up support to participants, as well as providing a means of extending the training beyond the original participant group and a step towards standardising survey methodology.

Although preparation of both documents has been held up because of the pressure of other work commitments, both are now in an advanced state and are expected to appear before the end of 1992.

It is also expected that a formal scientific paper will be written on the results of the trochus juvenile release experiment, and submitted to the journal *Aquaculture* or another suitable publication vehicle. This work will be undertaken by Vanuatu Fisheries Department staff, with support from the FAO/UNDP Regional Aquaculture Development Programme.

Recommendations

The following recommendations were made during Week 1 of the workshop:

1. that the Commission assist Pacific Island countries to make use of remote sensing and image processing in survey work on trochus and other marine resources, especially benthic invertebrates;
2. that the Commission establish a new Special Interest Group (SIG) on shells and the shell trade, focussing especially on trochus;
3. that the Commission encourage the detailed study of the Aitutaki trochus fishery as a case study, in order to provide management-related

information that will be applicable to the developing fisheries in other atolls of the region;

4. that the Commission encourage the adoption of standardised survey techniques for trochus and other benthic marine invertebrates in Pacific Island countries, so as to enable comparison of results by different workers and from different areas.

The recommendations were subsequently endorsed by the Twenty third SPC Regional Technical Meeting on Fisheries in August 1991, and approved by the South Pacific Conference in October 1991, so the Commission is committed to their implementation. The first recommendation will be dealt with within the framework of a broader project aimed at developing the use of RS/ GIS technology for marine resource assessment, which has just been approved by the SPC Committee of Representatives of Governments and Administrations.

The second is now being addressed, which is why you are able to read this bulletin. The third recommendation, for a detailed study of the Aitutaki trochus fishery, is just about to go ahead, and is the subject of a separate article in this bulletin. The fourth recommendation will be addressed principally through the publication of the manual of standardised survey techniques for trochus (and, by inference, for other marine invertebrates) that has already been mentioned above.

The enthusiasm of the participants was far beyond what was anticipated. During Week 1, there were numerous sessions in the evenings and on Saturday morning, and all were fully attended (more or less). Most individuals had a genuine strong desire to participate fully and to take home information that would be of direct application in their own situations, and this attitude greatly encouraged the free flow of information and the sharing of experience.

During Week 2, resource persons were surprised to discover that participants had been out on the reef in the middle of the night or before dawn, checking the released trochus juveniles and preparing early surveys so as to take full advantage of the tide. Many participants carried out additional transects on Sunday so as to ensure their data achieved the desired level of precision.

During Week 3, participants were expected to dive regularly at night, to work in surf or rough weather, and to carry out data analysis at other times. All these activities were carried out without complaint and with considerable enthusiasm (even by those individuals who managed to get themselves

dumped on the reef by the surf, losing diving gear and a fair bit of self-respect in the process), right until the last day. After an extremely rough 28-hour boat trip home, everyone was still keen to participate in the final discussion of the management plans, which began mid-Sunday afternoon and continued until 8 at night.

The workshop proved to be both an invaluable source of information on all aspects of the trochus resource, and an effective means of heightening

awareness of the factors influencing fishery management decisions on the part of the Pacific Island participants. In particular, the socio-economic aspects of management, and the requirements of the shell trade, were emphasised, so that any management decisions made are not by biological considerations alone. This approach ultimately resulted in participants developing considered management plans that were likely to make sense to rural people dependent on the fishery for their income.

Trochus reseedling experiment in Vanuatu

by Moses Amos,
Fisheries Department,
Vanuatu

In recent years the harvesting activity of trochus shells in Vanuatu has increased due to the steadily growing demand for the shell, whose market value has increased markedly. This has resulted in the establishment of three shell processing factories in Port Vila, thus increasing the level of exploitation of the resource throughout the island regions.

To determine whether re-seeding of depleted reefs with hatchery reared juveniles is a practical tool for management, an experiment on re-seeding of trochus was carried out in May 1991. This article is a summary of a progress report written in August 1991, about 3 months after the release was made. For further details, refer to Working Paper 26 from the Twenty-third SPC Regional Technical Meeting on Fisheries (August 1991).

Trochus were spawned at the Vanuatu Fisheries Department hatchery in Port-Vila during the first 3 months of 1990. A total of 1400 juvenile *T. niloticus* were tagged and released. Of these 1,000 had maximum basal shell diameter greater than 20 mm and 400 had basal shell diameter less than 20mm

The juvenile *T. niloticus* were segregated into 4 groups, with each group containing 350 juveniles with a separate tag colour (Group 1 – pink; Group 2 – white; Group 3 – green and Group 4 – blue tags). The juveniles in each group were individually marked in three different ways:

- a) small numbered polyethylene Hallprint tags attached to the shell with cyanocrylate glue;
- b) a drop of red-coloured cyanocrylate glue applied to the apex of the shell; and
- c) the number on the polyethylene tag was inscribed with pencil on the nacre inside the lip of the shell.

The juvenile Trochus were then measured (with Vernier callipers to the nearest 0.1 mm) and returned to a flowing seawater tank, where they were all left overnight before being transferred to the reef.

For convenience, a reef flat on the seaward side of Erakor Island, close to Port-Vila, was chosen as the release area. Before the experiment commenced, the village that owned the reef agreed to ban trochus fishing on it for a period of one year. All the release sites chosen were within the suitable habitat zone, so that comparison of survival rates could be done at different levels of protection from predators. The most suitable place for releasing the juveniles was a narrow band of coral rubble immediately shoreward of the elevated reef crest. The rubble was encrusted with coral and algae and the spaces between the rubble were considered the most appropriate size for small trochus to shelter.

The tagged juveniles were collected from the tanks at the Fisheries Department, taken in tanks of seawater to Erakor Island and placed in the shade at the top of the beach. Lumps of coral were placed in the tanks, and the juveniles were placed on the coral. These blocks with juveniles attached were later transferred to the sites selected for releases. They were placed at each of the four chosen sites and were provided with the following types of protection from the predators:

- Group 1: the coral blocks with the juveniles attached were covered with coral rocks (mainly plate *Acropora*) to shelter them from wave action and predation;
- Group 2: plastic mesh with 1 cm holes was placed over the blocks. The mesh was anchored in place with coral blocks placed around the edge while steel rods were hammered through the substrate to hold corners of the mesh firmly in place;

— Group 3: as for group 1 but looser (more open) coral covering the blocks to which the released juveniles were originally attached;

—Group 4: as for group 2.

Juveniles were released during the early hours of the evening (2 hours before low tide) to help them adjust to their new surroundings before the reef was fully recovered and to minimize exposure to predation immediately after release.

Recapture surveys, with minimal disturbance of the substrate, were carried out to assess rates of recovery, mortality and movement of the juveniles. Each of the four sites was searched thoroughly for juveniles, both live and dead. The area around each of the four sites was also searched carefully, to find juveniles that might have moved out from the shelter of the site, and the distance that these juveniles had moved was noted. The site was then dismantled (mesh removed, all shelter boulders removed and placed to one side after carefully searching for attached juveniles). All juveniles were removed, and their tag numbers recorded. They were then placed on coral lumps to which they could attach. They were later replaced in each site. Crushed shell fragments were collected and tag number (if still attached to the shell fragment) recorded.

Recapture of juvenile trochus for each group for the period 21 May – 10 July, with intervals of 4, 7, 16 and 22 days between the five surveys carried out, provided the following results:

- Group 1: of the total juveniles released, 352, 268, 142, 107 and 79 respectively were recaptured during the five surveys;
- Group 2: of the total juveniles released, 350, 303, 184, 156 and 164 were recaptured;
- Group 3: of the total juveniles released, 350, 316, 138, 190 and 194 were recaptured; and
- Group 4: of the total juveniles released 350, 346, 253, 166 and 187 were recaptured.

After each survey the juveniles were replaced and the shelter reconstructed.

Two measurements of about 50 juvenile *T. niloticus* from each group were made roughly every fortnight, using Vernier callipers.

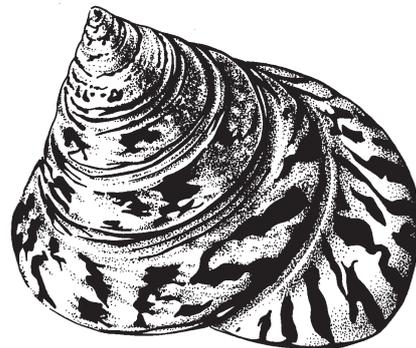
Growth rate appeared to be fast, since the number inscribed with pencil on the shell lip had moved inside the shell aperture.

The movement pattern showed juveniles going out from under the shelters (more found outside the shelters than in them). The shelters seemed too dark, and the darkness is likely to inhibit algal growth. The juveniles moved different distances at the four sites, with movement being most at Site 1, somewhat less at Site 2, and not very much at the sites with group 3 and 4.

A strong net direction movement toward the sea (movement into the reef crest) was recorded at site 1. The juveniles were found up to 25 m from the shelter. Some juveniles had moved into spaces between the coral rubble, while others sought shelter under pieces of dead coral.

Forty-nine days after release, the total survival, mortality and missing rates of juveniles for the 4 groups were 42.2, 7.1 and 48.7 per cent respectively.

Further recaptures and size-frequency sampling will take place at periodic intervals during the next few months, in order to gather data on survival and growth over a one-year period. The data will be analysed using multiple-recapture techniques after this time. An update on the experiment, and hopefully final results, will be presented in the next issue of this bulletin.



Studies on juvenile *Trochus niloticus* (L.) with a view to using reared juveniles to repopulate reef areas

by **Laura L. Castell-Perez**,
Zoology Department, James Cook University,
Townsville, Australia

Natural stocks of *Trochus niloticus* have been seriously depleted in most countries where Trochus has been commercially harvested (Heslinga, 1981; Heslinga and Hillmann, 1981; Nash, 1985; Isa, 1991). Strict fishing regulations have been implemented to allow natural stocks to recover. As well as imposition of a size limit, restricted fishing seasons and the creation of sanctuary areas, management strategies have included translocation of adults.

More recently, effort has been directed to the use of reared juveniles. Because of the relative simplicity of rearing techniques, thousands of individuals can be produced. Survival rates in reseeded experiments have been generally low and have shown great variability among localities (Nash, 1985; Hoffschir, 1990; Amos, 1991; Isa, 1991). This implies a need for further research to understand the process that occur when hatchery-reared juveniles are liberated on a reef.

The overall objectives of my study are to investigate further the possibility of reseeded areas with reared juveniles and to develop a better understanding of the ecological processes involved with juveniles in natural habitats. I will examine the following:

—Comparison of rearing techniques. Rearing in tanks, in hanging baskets and in baskets fixed in the intertidal zone will be compared on the basis of juvenile growth, mortality, survival rates and behaviour;

—Aspects of larval development:

1. Effects of temperature;
2. Importance of parental energy reserves and potential to use external source of nutrients to complete development;

—Laboratory studies of predation on reared juveniles;

—Experimental reseeded with reared juveniles of various sizes under a variety of conditions;

—Ecology of juveniles in natural populations.

Literature cited

Amos, M. (1991). Trochus reseeded experiment in Vanuatu. South Pacific Commission, Twenty-third Regional Technical Meeting on Fisheries, WP 26.

Heslinga, G. and A. Hillmann (1981). Hatchery culture of the commercial top snail *Trochus niloticus* in Palau, Caroline Islands. *Aquaculture*, 22: 35.

Hoffschir, C. (1990). Introduction of aquaculture-reared juvenile trochus (*Trochus niloticus*) to Lifou, Loyalty Islands, New Caledonia. *SPC Fisheries Newsletter*, 53: 32–37.

Isa, J. (Eds.) (1991). Mass seed production and restocking of Trochus in Okinawa. Report for the South Pacific Aquaculture Development Project; Food and Agriculture Organisation of the United Nations, Suva, Fiji. FAO.

Nash, W. (1985). Aspects of the biology of *Trochus niloticus* and its fishery in the Great Barrier Reef Region. A report submitted to Fisheries Research Branch, Queensland Department of Primary Industries and the Great Barrier Reef Marine Park Authority. 210 pp.

Study of the Aitutaki trochus fishery

by **G.L. Preston**,
South Pacific Commission,
Noumea, New Caledonia

Background

Exports of trochus shell from Pacific Island countries were worth an estimated US\$ 26 million in 1989. Most of this revenue is returned directly to rural communities where the harvesting takes place. Trochus fisheries make an important contribution to rural economies in many countries, thereby

helping to mitigate against urban drift and other undesirable effects of centralised economic development. Pacific Island governments recognise the importance of trochus and other marine invertebrate fisheries in maintaining economic and social stability in rural areas, and are keen to ensure that these resources are managed wisely and sustainably.

Aitutaki trochus fishery

Trochus is one of the most valuable marine resources presently exploited in the Cook Islands, mainly on the island of Aitutaki. The most recent harvest of trochus at Aitutaki, in late 1990, was 35 tonnes, which sold for a total of about NZ\$245,000. This income makes an extremely valuable contribution to the islands economy.

Trochus is not native to Aitutaki: 300 mature adults were introduced in 1957 and the present-day fishery has developed from this initial breeding stock. Following the establishment of the Aitutaki population, the Cook Islands Ministry of Marine Resources (MMR) has attempted to introduce trochus to other islands in the Cooks, and these efforts are continuing.

The growth of the Aitutaki population following introduction has been subject to research by MMR and there exists a body of historical data on the population. Since the commencement of exploitation, good records have been kept of harvests and exports. In addition, there exist several SPOT satellite images of the Aitutaki reef, taken before and after periods of extreme environmental damage (cyclone), and at times that coincided with field trochus research.

The Aitutaki trochus fishery is now tightly managed by the island council, following advice from MMR based on the research carried out so far. Harvests presently take place over a period of only one or two days, with each animal being landed live for size verification before shucking. Large numbers of people participate in the harvest, which means that exploitation occurs very intensively and the instantaneous effects of fishing can be assessed. A system of individual transferable quotas permits every individual on the island to participate in the harvest, or to trade his quota.

The unique situation of the Aitutaki fishery presents opportunities for research that could provide answers to several key questions relating to trochus abundance estimation, a critical element in the development of any management plan. Through a well-designed study, timed to take place around the period of the harvest, field survey methods could be calibrated against actual takes, depletion experiments to estimate absolute abundance could be carried out in conjunction with actual fishing, and the subsequent population response to intensive harvesting, in terms of growth and recruitment, could be monitored. In addition, the correlation of intensive field survey data with the existing body of historical information would allow an exceptional

understanding of the evolution of the population and its response to disturbance.

Workshop on Trochus Resource Assessment, Development and Management

The Twenty-second South Pacific Commission (SPC) Regional Technical Meeting on Fisheries, held in August 1991, discussed biological, economic and social issues relating to the development and management of trochus resources in the region. The topic was originally raised by the Cook Islands delegation. The session concluded with a recommendation that SPC organise a Workshop on Trochus Resource Assessment, Development and Management. The workshop was conducted in Port Vila, Vanuatu in May 1991 (see separate article this issue) and made four recommendations to SPC for further action in helping Pacific Island countries develop appropriate management plans tailored to local conditions. One recommendation was that the Commission encourage the detailed study of the Aitutaki fishery as a case study, in order to provide management-related information that will be applicable to the developing fisheries in other atolls of the region.

This recommendation was made because of the unique nature of the Aitutaki fishery. The workshop recognised the value of this research opportunity in providing trochus fishery management information to countries of the region. The data from a study carried out at Aitutaki would be of direct relevance to all areas where trochus populations exist, especially atolls and other environmentally similar areas. In all cases, data gathered could be used as a basis for predicting trochus population response to harvesting, and mitigating against overfishing.

All four recommendations were endorsed by the Twenty-third SPC Regional Technical Meeting on Fisheries (August 1991), and subsequently by the thirtieth South Pacific Conference (October 1991), thus mandating the Commission to commence their implementation. Action is being taken in regard to each recommendation.

Implementation

Following the formalisation of the workshop recommendation, MMR and SPC have jointly developed an approach to enable the study to be carried out on behalf of countries of the region. The project is considered a regional activity by both the two major implementing organisations. Funding support is being provided by the Australian Centre for International Agricultural research, by the British Government through the UK-sponsored SPC

Inshore Fisheries Research Project, and by the South Pacific Regional Aquaculture Development Programme.

The survey will be carried out by an eight-member field survey team, comprising six scientists from Pacific Island countries (preferably selected from trochus workshop participants), including at least two from the Cook Islands, one scientist from SPC, and one Australian scientist. The team will spend three weeks undertaking field work on the island at the time of the next harvest, with a further week being allocated to data analysis and reporting before the team disperses. The timing of the harvest is at the discretion of the Island Council and has been set for 17 August 1992.

The team will undertake: transect surveys to estimate relative trochus abundance; depletion experiments in conjunction with local fishermen, to estimate absolute abundance; and gathering of length-frequency data to provide demographic information on the population. All activities will be carried out intensively before during and after harvest, so as to assess the response of the population to exploitation.

Monitoring of population recovery at three-month intervals will be assured by MMR. An Australian AVA volunteer will be posted to the MMR giant clam hatchery in Aitutaki in January 1992. The possibility of this person also being involved in monitoring the trochus resource is presently under consideration by the Ministry.

SPC will undertake to arrange appropriate broad classification of SPOT images of Aitutaki to assist in field survey planning. Preliminary image classifications are kindly being provided by the French Polynesian Remote Sensing Station (Station Polynésienne de Télédétection). After the survey, more detailed processing will be carried out to relate field observations to detectable features on the satellite images that indicate habitat variation. Through this work, it is intended to verify and

improve the reliability of estimates of the extent of the trochus resource through the use of remotely sensed data.

Outputs

Data analysis and interpretation will include estimates of relative and absolute abundance, catchability and population size structure, and changes in these in response to harvesting. Virtual population analysis based on length-frequency data will permit estimation of recruitment patterns, and these can be verified by subsequent monitoring. Verification of a promising new stock assessment technique being developed for abalone in Tasmania, based on changing ratios of pre- and post-recruits in samples taken immediately before and immediately after intensive harvests, will also be attempted.

The SPC and Australian scientists will be responsible for co-ordinating the production of a detailed preliminary report on the field study within a month of its completion, with inputs from all members of the field team. A final report of the study will be produced by SPC following an estimated 18 months of monitoring. This will include results of the follow-up monitoring and of the satellite data interpretation as well as a recapitulation of the original field survey results.

A key output of the project will be in human resource development. The Pacific Island scientists participating in the survey will be selected from the best participants at the trochus workshop. The field survey will comprise an important extension of the training they received during the workshop, and will greatly reinforce their ability to carry out similar work on their own behalf effectively after returning home. Promoting the ability of Pacific Island countries to develop fishery management approaches using their own human resources is a mandate of the SPC fisheries programme. Experience has shown that participation of national fishery scientists in field activities such as this is an effective means of contributing to this end.

Information on trochus fisheries in the South Pacific

by Bernard Fao,
Service de la Mer,
Province Sud, Nouvelle-Calédonie

Introduction

This paper, which is based on information presented at the SPC/SPRADP Workshop on Trochus Assessment, Development and Management, was presented at a meeting ("Comité consultatif des pêches") held in Kone, Northern Province, New Caledonia in May 1992.

Trochus niloticus, commonly known as trochus or top shell, a gastropod found on coral reefs, is extensively harvested for its shell, used in the manufacturing of mother-of-pearl buttons and other items, such as jewellery. It is a significant source of income for rural and island populations of the region.

In practice, the demand for mother of pearl buttons fluctuates with changes in the clothing industry, the greatest of which occurred just after World War II, in 1950, when the major clothing manufacturers started using the much cheaper, mass-produced plastic buttons. The plastic 'invasion' decreased the demand for trochus but did not wipe it out, as mother-of-pearl is more resistant to detergents and frequent washing.

Statistics, though somewhat difficult to obtain or inaccurate, put world production of trochus shell at about 4,000 t/year. In 1990, the Pacific islands covered 70 per cent of Japan's requirements by supplying 1,159 t, the remainder coming largely from Indonesia. The demand of the European market, for which very few data are available, is estimated at around 6,000 t, only 33 per cent of which can be covered by supplies available from Africa, the Indian Ocean and South-East Asia.

Main South Pacific trochus fisheries

Papua New Guinea

Trochus harvesting started after World War II. Recent export statistics show 568 t for 1989 and 305 t for 1990, as compared with the record volume of 1,030 t exported in 1951. Trochus is bought from the fishermen by 6 exporters through their respective networks of buyers in the provinces.

Purchase price from the fishermen*: 1.1 to 1.35 Kina/kg (1.20 to 1.50 US\$/kg)
Selling price (FOB) to Japan: 5.50 Kina/kg (≈6.10US\$/kg)

The main export markets are Japan, Korea, and very recently Singapore and Hong Kong.

*Solomon Islands***

Trochus shell exports have been decreasing steadily since 1986, dropping from 662t to 445.2t in 1987, to 460t in 1988, to 371.6t in 1989 and to 306.5t in 1990. According to Solomon Islands fisheries officers, monitoring of production in the provinces suggests that over-exploitation is occurring in many areas. This is all the more alarming as the first button blank factory opened in 1989 (in partnership with Korean investors), with a requirement for bulk (unprocessed) trochus shell estimated at 150t per year. A second factory (in partnership with French investors) is in the process of being set up. The staff for this second factory is being trained by technicians

from the Vanuatu company Melanesian Shell Products.

Unworked trochus shells are bought from the fishermen for about SI\$15.00/kg (≈ 6.75US\$/kg) and sold for export, mainly to Japan and Korea, at approximately 7,000 US\$/t.

Regulations prohibit collection of trochus under 8 cm in base diameter.

Vanuatu

The only harvest statistics available for the 1970s were drawn up from trochus landings by inter-island ships. These put the catch at 10.2t in 1976, 28.2t in 1978 and 11t in 1982. Production has been estimated more accurately since 1983, thanks to closer co-operation with the local trochus processing plants, which now absorb the entire harvest.

Three button-blank cutting plants operate in Vanuatu:

- Melanesian Shell Products;
- Hong Shell Products;
- Vanuatu Coral Shell Products.

Trochus shell exports were 213t in 1978, 77t in 1982 and 37t in 1984. Export of unwrought shell was discontinued in 1984, and the entire harvest channelled to the local blank-making plants. 37t, 40t and 18.7t of button blanks were exported in 1985, 1988 and 1990 respectively, to Japan, Italy, Hong Kong and France.

—Average purchase price from the fishermen: 190 to 210 vt/kg (≈ 1.80 to 2.00US\$/kg) for unprocessed shell;

—Selling price (FOB) of same: 500 vt/kg (≈ 4.80 US\$/kg);

—Export price of button blanks: 550 vt/kg (≈ 5.20 US\$/kg)

Current regulations prohibit collection of shells under 9 cm in base diameter as well as export of unworked trochus shells.

In 1985, Vanuatu opened a hatchery to produce trochus juveniles which, despite limited financial resources and damage caused by Cyclone Uma in 1987, yielded 3,500 juveniles in 1990.

(*) The price information in this article was current in mid-1991 and has changed since that time.

(**) See also other article in this issue

Australia

Trochus fishing started in the Torres Strait area in 1912 (Nash, 1977). Export curves show a peak in 1927 with 1,027t, followed by a drop to only 6t in 1944, and another peak at the beginning of the 1950s through to 1952 with exports amounting to 1,400 t. Recent statistics indicate 92t in 1987 and 611t in 1990.

Regulations: minimum and maximum catch sizes are 8 cm and 12.5 cm respectively. Export quota are 500t divided between the Torres Strait and East Coast areas.

French Polynesia

Introduced in 1957 from Vanuatu, trochus was first harvested commercially in 1971, i.e. 14 years later.

1971 to 1983	1,580 t
1985	38 t
1990	380 t

The purchase price paid to the fishermen for trochus shells (still containing the animal) rose from 160CFP francs in 1985 to 450 and even 500 CFP francs in 1990.

In 1990, 227t were exported to Japan and 40t to Australia.

Regulations: –Restricted fishing season
–Size limits: minimum 8 cm, maximum 11 cm
–Catch quotas determined per lagoon
–Reserve areas

Cook Islands

Trochus was introduced in 1957 from Fiji (300 adults with a 6 cm base diameter). The first harvest took place in 1981 (23 years later), and yielded 200t during a 15-month-long open fishing season. Stock assessment began in 1974 and regulations have been adjusted to comply with the scientists' recommendations.

1983	35 t (3 fishing months)
1985	27 t (2 consecutive days + 2 more separate days)

Regulations: –Catch quotas
–Fishing season
–Catch size: between 8 and 11 cm
–Reserve areas

Recent trochus introductions

The two last-mentioned fisheries result from earlier introductions. The first transplantations occurred in the 1920s, mainly in Micronesia, and became more frequent in the 1950s and 60s. The most recent introductions (1990) were from Fiji to Samoa.

Nearly 50 introductions have been conducted to date, without any adverse effect being observed, except perhaps in the Cook Islands where Sims (1984) suggests that competition may be occurring with another gastropod.

Further introductions may thus be safely envisaged.

Aquaculture

Research on the use of hatchery-produced juveniles to regenerate depleted natural stocks began only very recently. The work being conducted in Vanuatu and Okinawa (Japan) was outlined at the Trochus Workshop held in Vanuatu in June 1991.

Okinawa

Although results obtained at latitudes 24 to 26 degrees North are not directly applicable in our region, it was interesting to hear about the methods and procedures used in this research programme.

Research on hatchery production of juveniles started in 1988 and the results obtained over the past few years are shown in the following table.

Year	1987	1988	1989	1990
Number (1,000's)	30	358	1,050	632
Diameter (mm)	5.0	5.0	2.4	4.0

Every year, 110,000 to 180,000 juveniles are released into the natural environment. Their size at release ranges from 8 to 16 mm.

The best survival rate obtained was 43% after 80 days.

The thrust of the investigations at Okinawa was then turned to understanding and defining the release conditions that would optimise juvenile survival.

—Habitat: In the adult habitat, the dominant algae by weight are the brown algae, with 2 varieties (*Pocockiella variegata* 42% and *Spathoglossum pacificum* 18%) accounting for 60 per cent of total weight of algae.

- Predators: 18 carnivorous animal species were selected for assessment of the major predators of trochus juveniles. The balloon fish (*Diodon holocanthus*) was found to be the largest consumer of juveniles during the trial, although it is uncommon on sites suitable for trochus.

On the basis of the laboratory results, the minimum release size was set at 17 mm and a list of the major predators drawn up as follows:

Gonodactylus chiragura
Thalamia danae
Pilumnus vespertilio
Planocera reticula

Acclimatisation of juveniles in the natural environment, their movements after release, the relationship between survival rate and type of bottom were also investigated.

Vanuatu

The trochus aquaculture programme started in 1985 with the construction of a hatchery, and has two objectives:

- Determining the feasibility of rearing trochus spat in the hatchery;
- reseeding the natural reef environment with juveniles.

The first batch of 3,500 juveniles was produced in 1990. In May 1991, a major release of juveniles was effected on the reef of Erakor Island with the assistance of participants at the Trochus Workshop.

1,400 juveniles, 1,000 of which were larger than 20 mm and 400 smaller than 20 mm in base diameter, were released after tagging, on 4 different sites.

The trochus aquaculture and reseeding work is not yet far enough advanced to enable useful conclusions to be drawn; however, it is important to note that the spat production procedure, though efficiently conducted, is highly labour-consuming.

Information on the button industry

The two major markets (Europe and Japan) differ in the size of button most in demand. Japanese people prefer small buttons, while Europeans prefer larger ones.

Germany: 50 mm in diameter
 Japan: 16–17 mm in diameter

There are just on 40 button manufacturers in Japan, all near Osaka. The current trend is to use button blanks produced outside Japan, where labour is cheaper. Japan is now importing button blanks from Indonesia, Thailand, the Philippines, Fiji, and – very recently – the Solomon Islands.

In the whole Europe, there are only six button manufacturers, located in Spain (1), Germany (2) and France (1).

The combination of thickness and strength determines blank quality. The best shells, in this regard, are those from South-East Asia, East Africa and the Central Pacific, where the first cutting operation gives a proportion of waste as low as seven per cent of the shell weight.

The New Caledonia trochus, locally called 'chamber pot' because of its rather broad base, is considered of medium quality because its thickness requires additional polishing down, which increases both waste and production cost.

Current prices: batch of 1,728 buttons (12 gross); size: 11,5 mm

- Polyester: from 500 to 1,400 CFP francs (\approx US\$ 5.50 to US\$ 15.20) which corresponds to 0.54 CFP francs per button (\approx 1/2 cent)
- Nylon: 2,200 CFP francs (US\$ 23.90) which corresponds to 1.27 CFP francs per button (\approx 1.4cent)
- Trochus: 14,400 CFP francs (US\$ 156.50) which corresponds to 8.33 CFP francs per button (\approx 9cent)

Literature cited:

- Nash, W. (1977). Commercial culture of the marine gastropod *Trochus niloticus* in Torres Strait, its feasibility and prospects. ICLARM, Manila. 7 p.
- Sims, N.A. (1984). The status of *Trochus niloticus* in the Cook Islands. 18th Regional Technical Meeting on Fisheries, WP 18. 25 p.



Trochus marketing trends: Solomon Islands

by *H. Bibi* and T. Adams***,

** Fisheries Division, Fiji*

*** South Pacific Commission, New Caledonia*

The trochus situation in the Solomons has been reported as interesting. On his first duty visit to the Solomons, the newly appointed SPC Senior Inshore Fisheries Scientist Dr Tim Adams compiled the following information.

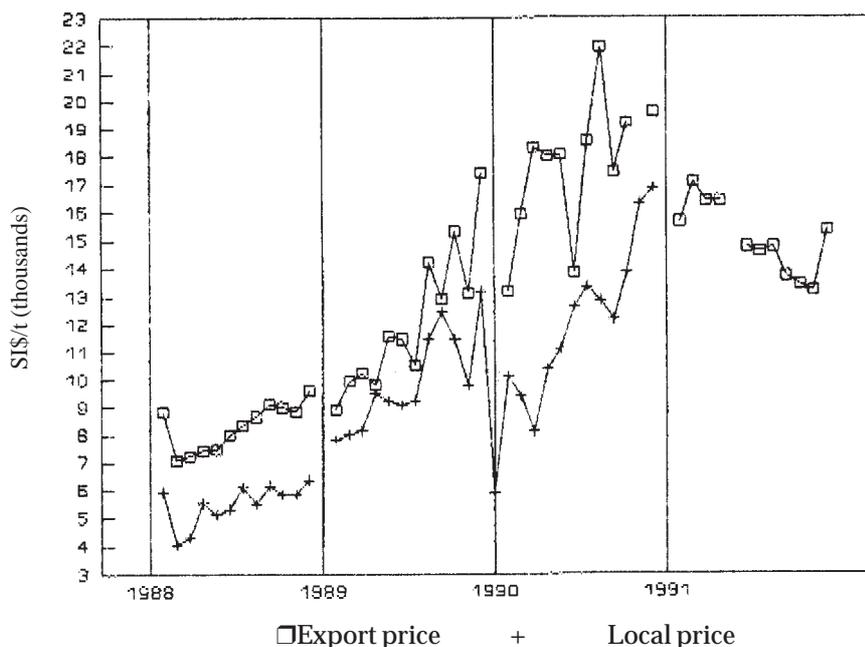
Exports of raw trochus shell dropped right down over the past two years with a total of 306,569 kg valued at SI\$5,466,707 being exported during 1990 compared to 87,475kg valued at SI\$1,444,601 during 1991.

The reduction is almost certainly due to the influence of the two new button factories — Daido which opened early in 1990 and only processed 25 t in that year and Solko which opened in 1991. However, this does not appear to have dampened the enthusiasm for button factories — another new factory is planned to open soon, so the market prospects appear to moderately buoyant (unlike Fiji, where all was doom and gloom in the button factories)

A notable feature, however, is that the Solomons is going through a beche-de-mer 'boom' at the moment and 'beche-de-mer fever' is gripping the islands, with people abandoning crops and copra and fishing on behalf of Chinese and Australian beche-de-mer traders. These fishermen are probably also contributing to the trochus catch and it is possible (only possible, the two events may be unlinked) that when the beche-de-mer boom crashes Solomons will see a drop in trochus supplies, as happened in Fiji. As in Fiji, these button factories may be built on shaky ground.

The Fisheries Division gets price, quantity and source information direct from the exporters when they apply for export licences, but the data are probably incomplete, or incorrect. However the Division also gets a complete record of export figures from the Ministry of Finance Statistics Section (from Customs records). Following are the latest export figures from the Statistics Section:

Trochus Exports	1987	1988	1989	1990	1991
Weight (kg)	445,216	460,065	371,693	306,569	87,475
Value (SI\$)	2,045,169	3,814,538	4,541,445	5,466,707	1,444,601



Customs-quoted export prices and Fisheries-quoted local price for the last 4 years (monthly)

Drop in price observed for the trochus shell between mid-1991 and mid-1992

by W. Nash,
Department of Primary Industries,
Hobart, Tasmania, Australia

Correspondence from Warwick Nash (Department of Primary Industry Tasmania, Taroona Research Laboratories, GPO Box 619F, Hobart, Tasmania 7001, Australia) to Garry Preston, concerning the drop in price observed for the trochus shell between mid-1991 and mid-1992.

'... There are several factors contributing to the price drop. When prices were increasing steadily (and quite rapidly) a couple of years ago, some of the button processors, particularly the smaller ones, were concerned that the increasing price of shell might price them out of the market. So they bought more shell than they could use immediately. This stockpiling later slowed down demand and the price dropped.

The price drop was helped along by re-entry of the Indonesian shell into world markets. The Indonesians, who had placed a ban on the collecting of trochus in 1987 are again selling trochus shell. Since it seems that shell buyers want Indonesian

shell in preference to shell from anywhere else, the demand for shell from the Pacific dropped — particularly since the buyers had stockpiled shell from other countries.

Other shell appears to be competing with *Trochus niloticus* for a share of the button market. El toro, the big button factory in Spain, has reportedly placed an order for 4,000 tonnes of 'Port Sudan shell' (presumably a trochid) at US\$ 2,000 per tonne, which is substantially less than the price of *Trochus niloticus* shell at the moment (about AS 4,000 in December 1991) Tom Cyran was also told by Italian buyers that cheaper shell is coming onto the market from 'somewhere'.

So it seems that there are several factors all helping to push the price of trochus shell down. None of these seem to be transient in their effects, so I anticipate that there will not be much of an increase in shell price in the near future...'

Prices on local and overseas market in Vanuatu for trochus

by J.P. Gaudechoux,
South Pacific Commission,
Noumea, New Caledonia

According to the Fisheries Department, Port-Vila, Vanuatu, there are now five shell processing factories in Port-Vila. The two main products processed are trochus and green snail.

The buyer pay to fishermen 200–300 vt/kg for raw trochus. The export prices (for processed trochus) are:

Blank buttons	20.00 US\$/kg;
Cut pieces	4.00 US\$/kg;
Waste	0.50 to 1.00 US\$/kg

Bibliographic references on trochus

by J.P. Gaudechoux,
South Pacific Commission,
Noumea, New Caledonia

All the documents in the list below are catalogued in the Fisheries Information Project's trochus bibliographic database and are held either in the SPC library or in other collections known to us (we have additional documents awaiting cataloguing and these will be noted in future issues). Some are publications, but many are internal documents, mimeo reports and other forms of ephemera. In some cases we can provide single photocopies of references free of charge to SIG members or fisheries

officers in Pacific Island countries. In other cases, where confidentiality requirements or copyright restrictions apply, we may be limited to advising enquirers of contact addresses through which they may be able to obtain the document in question.

If there are documents that you feel should be added to the database, please send us a copy, or, if this not possible, a photocopy of the cover page. Documents do not need to be formal publications

- many of those in the list are not — and we are keen to archive as much 'grey literature' — meaning internal reports, correspondence, unpublished data, etc. — as possible.
- Angot, M. (1959). Evolution de la pêche du troca *Trochus niloticus* en Nouvelle-Calédonie: un exemple d'overfishing avec ses causes et les remèdes apportés. *La terre et la vie*, 106(4): 307—314.
- Anon. (1961). SPC officer re-surveys shell beds. *South Pacific Bulletin*, SPC, Noumea.
- Anon. (1972) Commercial exploitation of stocks of trochus, French Polynesia. *SPC Fisheries Newsletter* Nos. 3 and 4. p. 32
- Anon. (1982) Development of trochus shell industry in New Caledonia. 14th Regional Technical Fisheries Meeting, *WP 2*, Noumea. 2 p.
- Anon. (1983). Trochus hatchery feasibility study for Vanuatu. *SPC Fisheries Newsletter*, No26: 7.
- Anon. (1984). After "Trochus Vanuatu" - The lesson learned from an unsuccessful venture. English translation of newspaper article, *Les Nouvelles Calédoniennes*, 3 March . 4 p.
- Asano, N. (1991). Studies on trochus ecology and its propagation in Micronesia. FAO South Pacific Regional Aquaculture Development Project. 56p.
- Bouchet, P. and R. Grandperrin (1978). Rapport de mission aux Nouvelles-Hébrides. Trochus and green snail survey, ORSTOM, Noumea. 5p.
- Bouchet, P. (1979). Pêche nacrrière en Nouvelle-Calédonie. ORSTOM Nouméa. 5p.
- Bour, W. (1982). Croissance et mortalité naturelle des trocas de Nouvelle Calédonie. ORSTOM: Nouméa. 54 p.
- Bour, W. (1983). Trochus shells: a resource for New Caledonia. ORSTOM: Noumea. 18 p.
- Bour, W. and R. Grandperrin (1983). Croissance des trocas à Vanuatu. Notes et Documents d'Océanographie no. 14, ORSTOM, Port Vila. 31p.
- Bour, W. (1984). Remote sensing and thematic mapping of reefs: its use for identifying the biotope suitable for trochus. 16th Regional Technical Meeting on Fisheries, *WP 11*. 3p.
- Bour, W. (1985). Assessment and management of the trochus resource in New Caledonia, 17th Regional Fisheries Technical Meeting on Fisheries, *WP11*. 14 p.
- Bour, W. (1987). The trochus resource in New Caledonia. *ICLARM Quarterly*, 10(1). p. 3-4.
- Bour, W. (1988). Synoptic study of trochus in the Pacific. Workshop on Pacific Inshore Fishery Resources, *WP 3*, Noumea. 43 p.
- Bour, W. (1990). Les ressources halieutiques des pays insulaires du Pacific: troisième partie, les trocas — The fishery resources of Pacific island countries: part 3, Trochus. *FAO Fisheries Technical Paper*, 272.3. 89 p.
- British District Agent. (1976). Green snail and trochus — Futuna, Southern District. 1 p.
- Crossland, J. (1983). Fisheries management plans . 8 p.
- Devambeze, L. C. (1956). Trochus study by French Institute. *South Pacific Bulletin* 6 (1): 9-10.
- Devambeze L. C. (1957). Survey of trochus reefs in the central and southern group of the New Hebrides. 7 p.
- Devambeze, L. (1959). Survey of the trochus reefs in the central and southern groups of the New Hebrides. 7 p. plus appendix.
- Devambeze, L. C. (1960). Trochus transfer to Cooks apparently successful. *South Pacific Bulletin* 10 (4). p. 31-46.
- Devambeze, L. (1961). Report on the supplementary survey of trochus and green snail in the central and southern groups of the New Hebrides. 11 p. plus appendix
- Doumenge, F. (1973). Developing the exploitation of *Trochus niloticus* stock on the Tahiti reefs. *SPC Fisheries Newsletter*, 10. p. 35-36
- Fagolimul, J. (1988). Yap Proper trochus stock assessment: 1987. SPC Workshop on Pacific Inshore Fisheries Resources, *BP63*. 8 p.
- Gail, R. (1957). Trochus fishing. *South Pacific Bulletin*. p. 48
- Gail, R. (1958). Contribution a l'étude du troca en Nouvelle-Calédonie. Nouméa ORSTOM, 1958. 37 p.

- Gillett, R. (1986). A summary of the Tokelau trochus transplant project. *SPC Fisheries Newsletter* no. 38. 7 p.
- Gillett, R. (1988). Transplantation of trochus to Tuvalu. FAO/UNDP Regional Fishery Support Programme . 42 p.
- Heslinga, G. (1981). Hatchery culture of the commercial top snail *Trochus niloticus* in Palau, Caroline Islands. *Aquaculture* 22. p. 35–43.
- Heslinga, G. (1981b). Larval development, settlement and metamorphosis of the tropical gastropod *Trochus niloticus*, *Malacologia*, vol. 20, no. 2. p. 349–357.
- Heslinga, G., Orak, O. and M. Ngiramengior (1985). Coral reef sanctuaries for trochus shells. *SPC Fisheries Newsletter*, no. 35. p. 17–20
- Hoffschir, C. (1989). Introduction des trocas (*Trochus niloticus*, L.) à Lifou par transplantation de juvéniles produits en aquaculture. Conventions Sciences de la Mer: Biologie marine. no. 1. 24 leaves
- Holness, A. P. J. (1976). The mother-of-pearl fishing. *South Pacific Bulletin* 26 (4). p. 28–29
- Martin, J. (1984). Report on a visit to Vanuatu to evaluate the feasibility of establishing a trochus hatchery in Vanuatu, 10-13 March, 1984. 4 p.
- McGowan, J. (1957b). Trochus studies in U. S. Trust Territory. *South Pacific Commission Quarterly Bulletin*, April. 3 p.
- McGowan, J. R. (1957). Trochus studies in the US territory. *South Pacific Bulletin* 26 (4). p. 22–23
- Nash, W. (1977). Commercial culture of the marine Gastropod *Trochus niloticus* in Torres Strait, its feasibility and prospects. ICLARM, Manila. 7p.
- Nash, W. (1987). Bibliography of trochus *Trochus niloticus* (L.) (Gastropoda: Trochidae). *ICLARM bibliographies*; 7, Manila. 14 p.
- Nash, W. (1988). The Queensland trochus fishery and management-related aspects of trochus biology. Workshop on Pacific Inshore Fishery Resources. Noumea. 11 p.
- Parkinson, B. (1984). Field survey of the trochus resources of the Republic of Seychelles. *Technical Report*, Vienna, UNIDO. 25 p.
- Parkinson, B. (1984). Report on the potential for the introduction of trochus (*Trochus niloticus*) to Tuvalu. Report prepared for the South Pacific Commission and the Government of Tuvalu. 7p.
- Powell, R. (1960). Notes on the pearl shell in the South Pacific. 12 p.
- Sims, N. (1984). The status of *Trochus niloticus* in the Cook Islands. 16th Regional Technical Fisheries Meeting on Fisheries. *WP 18*. 25 p.
- Sims, N. (1984). Notes on the ecology of *Trochus niloticus* on Aitutaki, Cook Islands. Ministry of Marine Resources, Rarotonga. 12 p.
- Sims, N. (1984). Notes on the ecology of *Trochus niloticus* on Aitutaki, Cook Islands . 17 p.
- Sims, N. (1988). Trochus research in the Cook Islands and its implications for the management. Workshop on Inshore Fishery Resources, SPC, Noumea. *BP 37*. 13 p.
- South Pacific Commission (1957). Trochus studies in the U. S. Trust Territory. *SPC Quarterly Bulletin* – April. 3 p.
- Van Pel, H. (1957). Transplanting trochus in the Eastern Pacific. *South Pacific Bulletin*, July 1957, SPC Noumea.

Members of the SPC Trochus Special Interest Group

by J.P. Gaudechoux,
South Pacific Commission,
Noumea, New Caledonia

We had received completed questionnaires from the individuals listed below at 26/7/92. If you are on the list and your name and address is wrong, please send us a correction. If you are not on the list and want to be, fill in the form enclosed with this bulletin or write us for a new form.

- Benzie J.A.H.
Australian Institute of Marine Science
PMB 3 - Townsville - QLD 4810
Australia
- Beumer J.
Dept. of Primary Industries
GPO Box 46 - Brisbane - QLD 4001
Australia
- Braley R.D.
Aquasearch
6-10 Elena St. - Nelly Bay - Magnetic Isl. QLD 4819
Australia
- Byrne M.
University of Sydney
Zoology AO8 - Sydney - NSW 2006
Australia
- Castell-Perez L.L.
James Cook University
Townsville - QLD 4811
Australia
- Colman P.H.
Australian Museum
PO Box A285 - Sydney South - NSW 2000
Australia
- Craik W.
Great Barrier Reef Marine Park Aut.
PO Box 1379 - Townsville - Qld
Australia
- Cropp D.A.
Aquatech Australia Pty Ltd
15 Wignall St. - North Hobart - 7000 Tasmania
Australia
- Dybdahl R.E.
Western Aust. Marine Research Lab.
PO Box 20 - North Beach - WA 6020
Australia
- George C.D.
C. Dennis George & Sons
PO Box 5811 C.M.C. - Cairns - QLD 4870
Australia
- Gleeson F.J.
Queensland Dept. of Environment & Heritage
Po Box 2066 - Cairns - QLD 4870
Australia
- Joll L.M.
Fisheries Dept of Western Australia
PO Box 20 - North Beach - WA 6020
Australia
- Lucas J.S.
James Cook University
Dept of Zoology - Townsville - QLD 4811
Australia
- Nash W.J.
Tasmanian Department of Sea Fisheries
Crayfish Point - Taroona - Tasmania 7053
Australia
- Norton J.H.
Dept of Primary Indust. Qld Government
PO Box 1085 - Townsville - QLD 4810
Australia
- Poiner I.R.
CSIRO - Division of Fisheries
PO Box 102 - Cleveland - QLD 4163
Australia
- Preker M.
University of Queensland
Heron Isl. Res. Station Via Gladstone - QLD 4680
Australia
- Rose R.A.
Pearl Oyster Propagators
7 Tabard Street - Greenwood - WA 6024
Australia
- Sanders S.
Darwin Pearl Oyster Hatchery Project
2/132 East Point Rd - Fannie Bay - NT 0820
Australia
- Savva N.M.
Darella Holdings Pty Ltd
PO Box 509 - Broome - WA 6725
Australia
- Smith B.
ACIAR
PO Box 21 - Cronulla - NSW 2230
Australia
- Trendall J.T.
CSIRO - Div. of Fish. Research
Bungalow PO - Cairns - QLD 4870
Australia
- Williams G.
Bureau of Rural Resources
PO Box E11 - Parkes - ACT 2600
Australia
- Wood K.
Ocean Pearls International
PO Box 1491 - Cairns - QLD 4870
Australia
- Caughley T
New Zealand Representative
PO Box 21 - Rarotonga
Cook Islands
- Howard N.T.
Ministry of Marine Resources
PO Box 85 - Rarotonga
Cook Islands

- Chief Magistrate
Nukuoro Municipal Government
PO Box 883 - Kolonia - Pohnpei 96941
Federated States of Micronesia
- Curren E.F.
Pohnpei Marine Resources Division
PO Box B - Kolonia - Pohnpei 96941
Federated States of Micronesia
- Dahl C.R.
Community College of Micronesia
PO Box 159 - Kolonia - Pohnpei 96941
Federated States of Micronesia
- Edwards A.
Community College of Micronesia
Po Box 159 - Kolonia - Pohnpei 96941
Federated States of Micronesia
- Fagolimul J.O.
Dept. of Resources & Development
PO Box 251 - Colonia - Yap 96943
Federated States of Micronesia
- Falanruw M.C.
Institute of Natural Science
PO Box 215 - Yap 96943
Federated States of Micronesia
- Friberg C.S.
Yap Fishing Authority
PO Box 338 - Colonia - Yap 96943
Federated States of Micronesia
- Mailo M.M.
Truk Maritime Authority
PO Box 789 - Truk 96942
Federated States of Micronesia
- Paatmag P.N.
Marine Resources Management Division
PO Box 251 - Colonia - Yap 96941
Federated States of Micronesia
- Pekalibe P.
Yap Fishing Authority
PO Box 338 - Colonia - Yap 96943
Federated States of Micronesia
- Syne D.S.
Community College of Micronesia
LRC/library - PO Box 159 - Pohnpei 96941
Federated States of Micronesia
- James S.
Community College of Micronesia
PO Box 159 - Kolonia - Pohnpei
Federated States of Micronesia 96941
- Iou J.B.
Marine Resources Management Division
PO Box 251 - Yap State - Western Caroline Island
Federated States of Micronesia 96943
- Alatoa H.G.
Commonwealth Youth Programme
USP - PO Box 1168 - Suva
Fiji
- Bibi H.
Fisheries Division
PO Box 358 - Suva
Fiji
- Esaroma L.
Fisheries Div. - Min. of Primary Ind.
PO Box 358 - Suva
Fiji
- Gillett R.
FAO/UNDP Reg. Fish. Support Pgm
UNDP - Private Bag - Suva
Fiji
- Lagibalavu M.
Fisheries Div. - Min. of Primary Industries
PO Box 358 - Suva
Fiji
- McDowell R.
Library - University of The South Pacific
PO Box 1168 - Suva
Fiji
- Rawlinson N.J.F.
C/O Fisheries Division
PO Box 358 - Suva
Fiji
- Sharma S.P.
Fisheries Division Lami
PO Box 358 - Suva
Fiji
- Tanaka H.
South Pacific Aquaculture Dev. Project
UNDP - Private Mail Bag - Suva
Fiji
- W.N. King Obed
University of The South Pacific
PO Box 1168 - Suva
Fiji
- Cabral P.
EVAAM
BP 11 - Avatoru - Rangoroa
French Polynesia
- Fougerouse A.
EVAAM
BP 20 - Papeete - Tahiti
French Polynesia
- Wrobel L.
EVAAM
BP 20 - Papeete - Tahiti
French Polynesia

- Yen S.
EVAAM
BP 20 - Papeete - Tahiti
French Polynesia
- Kruckenberg W.
Aquatic & Wildlife Resource Division
Dept. of Agriculture - PO Box 2950 - Agana
Guam 96910
- Gawel M.
120 Bengbing St
Y Papas Estates
Guam 96929
- Gates D.E.
National Marine Fisheries Service - SW Region
1320 Aupapaohe St. - Kailua
Hawaii 96734
- Sims N.A.
73-4369 Old Govt.Mauka Rd
Kailua-Kona
Hawaii 96740
- Katase S.A.
Royal Hawaiian Sea Farms Inc.
PO Box 3167 - Kailua Kona
Hawaii 96745
- Main K.L.
Center for Tropical & Subtropical Aquaculture
Oceanic Institute - Makapuu Pt. Waimanalo
Hawaii 96795
- Nitta E.T.
NOAA Fisheries - SW Region - Pacific Area Office
2570 Dole Street - Honolulu
Hawaii 96822
- Mienis H.K.
Zoological Museum
Hebrew University - 91904 Jerusalem
Israel
- Gianuzzi-Savelli R.
Societa Italiana de Malacologia
CP 22 - 90146 Palermo
Italy
- Yamaguchi M.
University of The Ryukyus
Dept. of Marine Sc.- Nishihara - Okinawa 903 01
Japan
- Tekinaiti T.
Fisheries Division
PO Box 276 - Bikenibeu - Tarawa
Kiribati
- Yeeting B.
Biosystems C/O USP Centre
Teaoraereke - Tarawa
Kiribati
- Wong Tat Meng
Centre for Marine & Coastal Studies (CEMACS)
Univ. Sains - 11800 Penang
Malaysia
- Alfred R.V.
Marshall Islands Marine Resources Authority
PO Box 860 - Majuro
Marshall Islands 96960
- Chef du Service des Pêches
Province Nord
BP 41 - Kone
New Caledonia
- Cillaurren E.
ORSTOM
BP A5 - Noumea
New Caledonia
- Etaix-Bonnin R.
Service Ter. de La Mar. Mar et des Pêches Marit.
BP 36 - Noumea
New Caledonia
- Farman R.
Service de la Mer - Province Sud
BP 2386 - Noumea
New Caledonia
- Galinie C.
IFREMER
BP 2059 - Noumea
New Caledonia
- Grandperrin R.
ORSTOM
BP A5 - Noumea
New Caledonia
- Smali T.
10 Rue Raillard
Koumac
New Caledonia
- Creese R.G.
University of Auckland
Marine Laboratory - R.D.1 - Leigh
New Zealand
- Hickman R.W.
MAF Fisheries
PO Box 297 - Wellington
New Zealand
- Sommerville W.S.
Asil Group Ltd
Trade Center - 173 Victoria St. - Wellington
New Zealand
- Leolahi S.H.
Fisheries Division Government of Niue
Dept of Agr. Forest.and Fish. - PO Box 74- Alofi
Niue

- Palacios A.I.
Division of Fish and Wildlife
CNM Government - Saipan
Northern Mariana Islands
- Asigau W.
Department of Environment and Conservation
PO Box 6601 - Boroko
Papua New Guinea
- Kaiowai M.
Div. of Agriculture, Stock & Fisheries
PO Box 1 - Esa'Ala - Milne Bay Province
Papua New Guinea
- Kalinau D.
East Sepia Youth Fishing Project
PO Box 554 - Wewak
Papua New Guinea
- Kuk R.
Dept. Fisheries & Marine Resources
PO Box 1343 - Port Moresby
Papua New Guinea
- Landu H.
Dept. of Fisheries & Marine Resources
PO Box 165 - Konedobu
Papua New Guinea
- Lokani P.
Department of Fisheries & Marine Resources
Fisheries Research Station - PO Box 337 - Kavieng
Papua New Guinea
- Mobiha A.
Dept. of Fisheries & Marine Resources
Fish. Research Lab- PO Box 54 - Daru - West.Prov.
Papua New Guinea
- Mungkate A.J.
University of Papua New Guinea
Biology Dept. - PO Box 320 - Waigani
Papua New Guinea
- Oroki M.D.
Tetebe Business Group
PO Box 725 - Boroko
Papua New Guinea
- Polon P.
Fisheries Research Lab.
PO Box 54 - Daru - West. Prov.
Papua New Guinea
- Rajeswaran N.
Dept of Fisheries & Marine Resources
PO Box 165 - Konedobu
Papua New Guinea
- Rodwell L.J.
Dept of Fisheries and Marine Resources
Library - PO Box 165 - Konedobu
Papua New Guinea
- Tenakanai C.D.
Dept of Fisheries & Marine Resources
Library - PO Box 165 - Konedobu
Papua New Guinea
- Vonole R.
Dept of Fisheries & Marine Resources
Library - PO Box 165 - Konedobu
Papua New Guinea
- Wararu W.
Dept of Fisheries & Marine Resources
PO Box 165 - Konedobu
Papua New Guinea
- Williams I.
Masurina Lyd
PO Box 80 - Alotav - Milne Bay Province
Papua New Guinea
- Ladra D.F.
Bureau of Fisheries And Aquatic Resources
860 Arcadia Bldg. - Quezon Ave. - Quezon .City.
Philippines
- Mingoa S.S.
Marine Science Institute
Univ. of Philippines - Diliman - Quezon City 1101
Philippines
- Bautil B.
Seychelles Fishing Authority
PO Box 449 - Victoria - Mahe
Seychelles
- Ahukela A.
Ministry of Natural Resources
Fisheries Division - PO Box G 24 - Honiara
Solomon Islands
- Carlot A.
Forum Fisheries Agency
PO Box 629 - Honiara
Solomon Islands
- Diake S.
Fisheries Div.- Ministry of Nat. Resources
PO Box G 24 - Honiara
Solomon Islands
- Gervis M.
ICLARM
PO Box 438 - Honiara
Solomon Islands
- Govan H.
ICLARM - Coastal Aquaculture Centre
PO Box 438 - Honiara
Solomon Islands
- Leqata J.
Fisheries Division - Min. of Nat. Resources
PO Box G24 - Honiara
Solomon Islands

- Munro J.L.
ICLARM South Pacific Office
PO Box 438 - Honiara
Solomon Islands
- Omeri N.
Forum Fisheries Agency
PO Box 629 - Honiara
Solomon Islands
- Rubaha B.
Community Education
Community Education Office - Buala - Ysabel
Province
Solomon Islands
- Sade E.
Development Services Exchange
PO Box 556 - Honiara
Solomon Islands
- Saeve H.M.
Fisheries Division
PO Box 77 - Gizo - Western Province
Solomon Islands
- Toata Molea
ICLARM Coastal Aquaculture Centre
PO Box 438 - Honiara
Solomon Islands
- Koloa T.
Ministry of Agriculture, Forestry & Fisheries
Fisheries Division - PO Box 14 - Nuku'Alofa
Tonga
- Langi V.
RDA/Tonga
PO Box 95 - Neiafu - Vava'U
Tonga
- Wells S.M.
IUCN - The World Conservation Unit
56 Oxford Road - Cambridge CB4 3PW
United Kingdom
- Yakolev Y.
Institute of Marine Biology
690032 Vladivostok
URSS
- Boss K.J.
MCZ Harvard University
Cambridge - MA 02138
USA
- Glucksman J.
2401 Wendy Rd
Alva - FL 33920
Usa
- Hahn K.
14431 Holt Ave.
Santa Ana - CA 92705
USA
- Zingmark R.
University of South Carolina
Columbia - SC 29208
USA
- Meava S.M.
Fisheries Department
PO Box 129 - Port Vila
Vanuatu
- Naviti W.
Fisheries Department
Port Vila
Vanuatu
- Takau H.
Fisheries Department
Mail Bag 045 - Port Vila
Vanuatu
- Pelasio M.
Agriculture & Fisheries Dept. Office for Tokelau
PO Box 865 - Apia
Western Samoa
- Toloa F.
Office for Foreign Affairs
PO Box 865 - Apia
Western Samoa