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TROCHUS

incorporating molluscs and other shellfish

Number 11 – September 2004

INFORMATION BULLETIN

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Editorial

The process of broadening the scope and increasing the appeal of the SPC *Trochus Bulletin* continues.

I have added a new section on "Profiles". I believe it is important to acknowledge the numerous contributions of the country-based indigenous workers in the Asia-Pacific region, especially in the field of community-based management of aquatic resources and other related fisheries management issues. I hope this new section will give the profile of at least one or more new and young researchers and workers in future issues of this bulletin.

In addition to highlighting indigenous involvement in trochus and other shellfish activities, this issue contains an article on the community-based trochus and molluscs hatchery at One Arm Point, Australia. I have also included articles from Asia: one on mollusc meat processing in India, and another on the status of the Sudanese trochus fishery.

I would like to inform readers that this will be my last issue as editor of the *Trochus Bulletin.* I believe I have placed the bulletin in a strong position for future expansion. The broadening of the bulletin to include other shellfish, wider coverage to include Asia, inclusion of new sections on community involvement, and profiling workers in the Asia-Pacific region will strengthen the bulletin considerably in years to come.

It is sad to leave something that I have enjoyed doing for the past three years. However, I am pleased to be passing the job to a well-established researcher based in the Pacific. Beginning with the next issue, Dr Warwick Nash from the WorldFish Center at SPC in Noumea will take over from me as the new editor of the SPC *Trochus Bulletin*. I am confident the bulletin will be in safe hands. Please join me in welcoming Warwick to the bulletin and I hope all readers will support him by sending news and articles for incorporation in the coming issues of the Bulletin.

Once again, thank you to all who have supported my work with the bulletin.

Chan L. Lee

Inside this issue

Community-based aquaculture hatchery, One Arm Point, Dampier Peninsula, the Kimberley, Western Australia – a community success story

Chan L. Lee[1], Jacynta Fong[2], Barry Sharpe[3] and Charla Clements[2]

Introduction

Since 1995, the Australian Centre for International Agricultural Research (ACIAR) has been supporting trochus research and development projects in Australia, Indonesia and Vanuatu. In the 2003–2005 phase of the ACIAR project, Samoa replaced Indonesia as one of the collaborating agencies. This short article highlights the successful hatchery work, completed in the previous phase of the ACIAR trochus project, achieved by the Australian node of the project involving the Bardi Aboriginal community in One Arm Point (OAP), the Kimberley Aquaculture Aboriginal Corporation (KAAC) and other supporting agencies in Western Australia (WA).

The Bardi Aborigines Association Inc (BAA) represents about 350 indigenous people living in the OAP community 230 km northeast of Broome, in Western Australia. In 1998, the ACIAR trochus project (FIS/94/10-Extension) was required to produce a large number of trochus juveniles for seeding research on numerous reefs off OAP and Cunningham Point. However, the long timeframe that was required for finalising agreements with funding bodies resulted in delaying the completion of KAAC's AUD 3.5 million multi-species hatchery, which was contracted to produce the trochus juveniles for the research work (see *Trochus Bulletin* #10, which contains an article on KAAC's hatchery). This resulted in the need for the project coordinator, Dr Chan Lee, to find an alternative hatchery to supply the juveniles needed.

Working collaboratively with the Bardi people and Ardyloon Inc (the business entity responsible for the hatchery operations of BAA), and with assistance of KAAC, a community-based trochus hatchery was built at OAP to supply juveniles to the research project. Funding support was provided by the following agencies:

- Aboriginal and Torres Strait Islander Commission (ATSIC)
- Department of Fisheries (DoF), Western Australia (WA)
- Aquaculture Development Council (ADC), WA and
- ACIAR-funded trochus project.

The first step

Like many indigenous communities in isolated parts of countries, infrastructure and resources are often very poor. The project is made more difficult because the hatchery needs to be near the sea and existing utilities (such as power and freshwater supply), but away from the community living areas. Despite the multitude of daunting tasks and impediments, stakeholders were able to quickly resolve these issues and move forward by working collaboratively:

- BAA and KAAC - got the community behind the project, contributed some 32 solar panels for the hatchery, provided site management, native hardwood for building structure, and some manpower for construction
- ATSIC - provided a grant of AUD 20,000 to cover some materials and other community related costs
- ADC and DoF - provided another AUD 20,000 for a hybrid solar management system for power supply
- ACIAR - provided the project coordinator, a part-time technical staff to work in OAP, and additional materials for the hatchery
- All donors agreed that the hatchery would be handed over to OAP at the end of the ACIAR trochus project.

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3 Manager, One Arm Point Hatchery via Broome, Australia
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OAP hatchery at the beginning of construction
Note the use of bush hardwood for construction.

View of hatchery on completion.
Note: the solar panel on the left provides power supply to the hatchery.

One Arm Point community members assisting in construction work.
Note: 3rd from left is Louie bin Mourie, OAP Chairperson at the time of the hatchery project and 1st from left on the vehicle is Barry Sharpe, hatchery manager.

View of solar panel power supply to the hatchery.

Funding provided by the Minister of Fisheries, WA.
Note: L to R: the Minister of Fisheries, WA at the time of the hatchery project, an OAP elder, Louie bin Mourie, Chair of OAP and Dr Chan Lee.

Some community staff working at the hatchery.
Note Barry Sharpe, hatchery manager in the centre and Charla Clements, Chair KAAC at the right.

Inside view of the OAP hatchery showing production tanks.

Trochus juveniles grazing along the side of tank.

Juveniles growing on rubble in the tank.

Polished shells for sale at KAAC's multi-species hatchery.

Tropical abalone: another commercial species for OAP.

Figure 1. **The One Arm Point hatchery, Dampier Peninsula, the Kimberley, Western Australia**

It was a magnificent effort by all parties that resulted in the hatchery project successfully completed within a six-month time frame. The outcome was a state-of-the-art community-based trochus hatchery that uses a hybrid solar power system, which incorporates a solar inverter with a bank of batteries for power storage and an automatic generator backup for power supply when needed. The hatchery was built with local hardwood collected by community workers and covered with shade cloth. It contains twelve 5-t circular and three 3-t production tanks. Pictures of the construction and completion of the hatchery are shown in Figure 1.

The spawning work and juvenile production

Training for Ardyaloon Inc hatchery staff began in mid-1999. The goal was to produce juvenile trochus for the ACIAR seeding research work on the reefs. During its first season of operation, the hatchery produced over 100,000 juveniles for the project.

The Ardyaloon Inc hatchery has since been continually used for spawning and growout of approximately 200,000 trochus juveniles for the aquarium trade supply and reseeding purposes.

Future development of the hatchery

Handover, expansion

In 2000, the hatchery was handed over to the BAA, OAP by the Director of Fisheries, WA. Since that time, the hatchery has been upgraded by Ardyaloon Inc with 24 new 10-t polycarbonate tanks for growout, one 3-t tank, two 32-t supply tanks, additional plumbing and fittings, pump upgrades, additional filtration, a new generator, scientific equipment, two new blowers and concrete flooring with labour provided by Barry Sharpe and OAP workers. These upgrades will increase juvenile trochus production in the hatchery and allow the production of other suitable species of interest to the stakeholders.

It is anticipated that future expansion of the hatchery will include the construction of staff quarters, amenities for spawning work, office facilities, an algae room and further growout facilities for trochus as well as tropical abalone, giant clam and barramundi.

Presently, hatchery workers undertake the usual daily hatchery operating activities, offer tours in peak season, and polish trochus shells for sale to tourists. Staff also undertake occasional broodstock collection and reseeding activities.

Ardyaloon Inc hatchery aims to undertake further spawning between August 2004 and March 2005 to produce a minimum of 12,000 trochus for the aquarium trade and 26,400 trochus for reseeding onto the aquaculture licensed reef of BAA, using existing infrastructure. The hatchery has the capacity to generate income through sales of the following items:

- Polished shells – AUD 25,000
- Juveniles for the aquarium trade: AUD 21,000, selling 20–30 mm and 30–40 mm specimens at AUD 1.50 and AUD 3.50, respectively.

Staff and training

The hatchery, which is managed by Barry Sharpe, provides ongoing training for at least five community trainees completing Certificates 1, 2 and 3 in aquaculture with the Kimberley College of TAFE. Students from the community school are also provided with training and work experience through the hatchery as part of their curricular activities.

Ideally located and with proven production ability, the Ardyaloon hatchery at OAP has excellent capacity for commercial development and the establishment of an economically viable and sustainable enterprise for the OAP community over the next few years. However, additional infrastructure and support is vital to the hatchery's development as a commercial enterprise and is beyond the immediate means of the community. The venture requires long-term commitment from stakeholders and service providers with essential support required from funding bodies in the short to medium term for the development of the hatchery as a commercial community enterprise.

Review of the trochus fishery in Sudan

Dr Mohamed Mustafa Eltayeb[1]

Sudan has a total coastline of about 750 km that lies in the Red Sea between latitudes 18°N and 22°N (Fig. 1). The widest part of the Red Sea is 306 km and the greatest depth for the central trough that lies off Port Sudan is 3040 m. Much of the coast is bordered by fringing reefs that are 1–3 km wide and a few meters deep, with occasional depressions (25 m deep or more) such as those north of the harbour entrance at Port Sudan, at *mersas* (coastal inlets), and at Tokar Delta.

The reefs off the Sudanese coast have been described as having the highest diversity of habitats and species in the region. The coastal people are semi-nomadic. Fishing is their main activity along with herding small numbers of goats and camels. Generally speaking, Sudanese Red Sea fisheries are small-scale fisheries and mainly artisanal. The unemployment rate in coastal areas is very high and fishing pressure on the reefs is intense.

The two main commercial mollusc species in Sudan are trochus (*Trochus dentatus*) and pearl oyster (*Pinctada margaritifera)*. Although this fishery makes a low contribution to the overall Sudanese economy, it is of importance to coastal people as a source of income and an important source of animal protein found in the fresh fish markets in coastal areas.

The average annual Sudanese trochus (*T. dentatus* and *T. virgatus*) export between 1970 and 1998 was

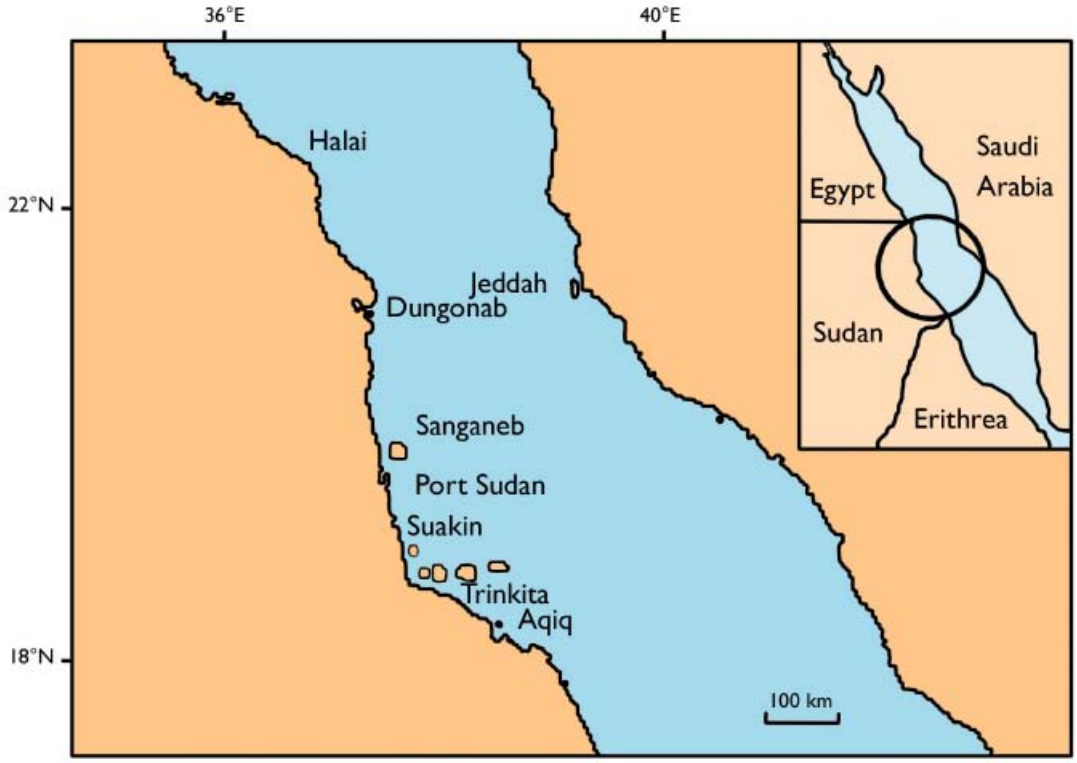

Figure 1. **The Sudanese Red Sea Coast**

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521 tonnes (t) per year (Fig. 2) valued at USD 182,803. *T. dentatus* forms the backbone of the mollusc fishery (Eltayeb 1999). The value of the trochus export is equivalent to about 0.042% of the total value of Sudanese exports (Fig. 3).

According to FAO statistics, between 1980 and 1997, New Caledonia and the Solomon Islands — with an average annual production of 349 and 578 t, respectively — were the two major trochus producing countries in the world. Sudan's average annual trochus export during the same period was 489 t, indicating that Sudan is among the major world trochus producers (Figs. 4 and 5).

The trochus fishery in Sudan has faced dramatic changes over the past 40 years. An analysis of the official Sudanese *T. dentatus* export figures show some interesting trends. In the early 1960s there was a flourishing shell fishery in Sudan and surrounding countries. At that time, native Red Sea fishermen of different nationalities would sail their loaded *sambouks* to the shell markets in Ongoiai and Suakin (Sudan), Mosowa (Eritrea), Jeddah (Saudi Arabia), Djibouti (Djibouti), Barbara (Somalia), Aden (Yemen) and Safaga (Egypt). In these markets, trochus shells collected from all parts of the Red Sea were sold to local businessmen and traders. However, Ongoiai and Suakin shell markets in Sudan were the most important and most favoured by shell fishermen of all nationalities living along the Red Sea (Ali et al. 1990). This was mainly due to:

- A shell ordinance in 1959 in Sudan, ensuring shell fishermen, irrespective of their nationality or the source of their shells, would get the best price and the best protection from buyers and brokers. Such arrangements were not available in any other Red Sea market.
- During the 1950s, 1960s and to some extent 1970s, the majority of shell fishermen who landed shells in Ongoiai and Suakin were Saudi (Gihainia tribes), Eritreans and Ethiopians (Danakla tribes) and Yemenis; some were Egyptians and a few were Sudanese. During this period, foreign fishermen contributed to about 90% of shell landings in Suakin.
- Foreign fishermen were allowed to buy barter commodities in Sudan using the proceeds from shell sales. Often these commodities were difficult to obtain in their native countries.
- By means of special permits, foreign fishermen were allowed to collect shells from Sudanese territorial waters and sell them at Ongoiai or Suakin shell markets.
- The central geographical position of Ongoiai and Suakin along the Red Sea had, no doubt, contributed to their importance.

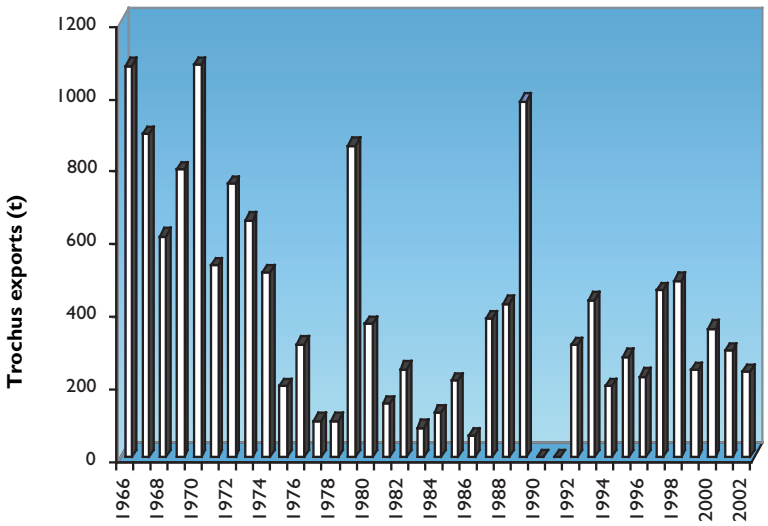

Figure 2. **Official Sudanese trochus exports from 1966 to 2002**

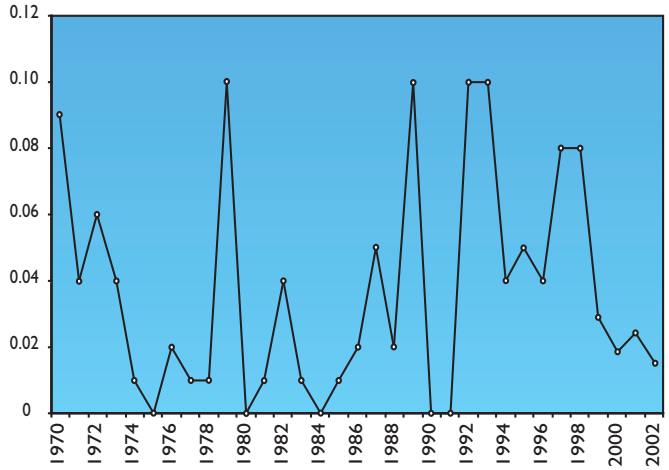

Figure 3. **Trochus contribution to overall Sudanese exports (in %).**

However, during the 1970s, the trochus fishery declined, apparently because of the following reasons:

- The government decision to stop involvement of foreign fishermen in shell trading and fishing in Sudan and to replace them gradually with Sudanese. Withdrawal of these fishermen deprived Sudan from receiving shells from foreign waters.
- Crossing national borders had become increasingly difficult.
- The Saudi fishermen, rich with oil money, had abandoned shell collection.
- Almost all the barter commodities that were previously desired by foreign fishermen had become commodities of high national and international demand and were no more available for bartering.
- The appearance of plastics and other similar synthetics that could substitute shells to make buttons, jewellery and artefacts during the 1960s.
- Sudanese shell fishermen were thought to be smugglers. Consequently, larger boats capable of sailing across international waters were often confiscated and put out of business. This limited shell production to national territorial waters.
- The closure of the Suakin shell market in 1978. This became inevitable after withdrawal of foreign fishermen from the business, tightening security measures to counteract smuggling, and the many difficulties that Sudanese fishermen faced in collecting shells from other countries' shores (mainly Saudi Arabia) (Ali et al. 1990).

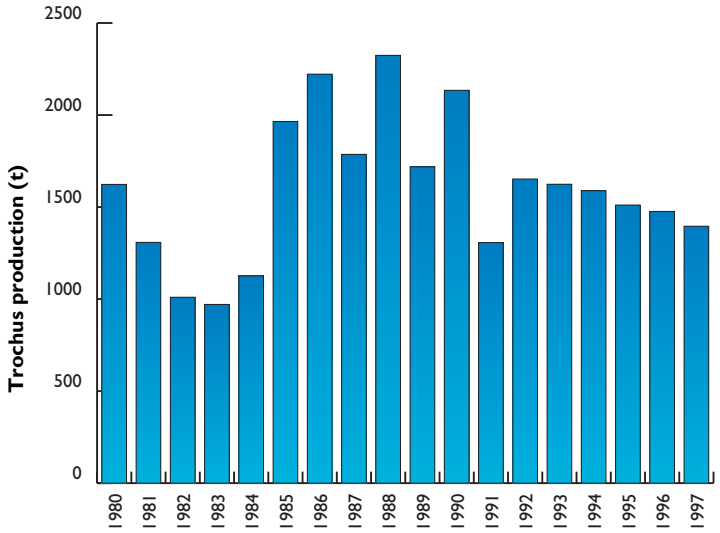

Figure 4. **World trochus production 1980–1997 (source: FAO statistics)**

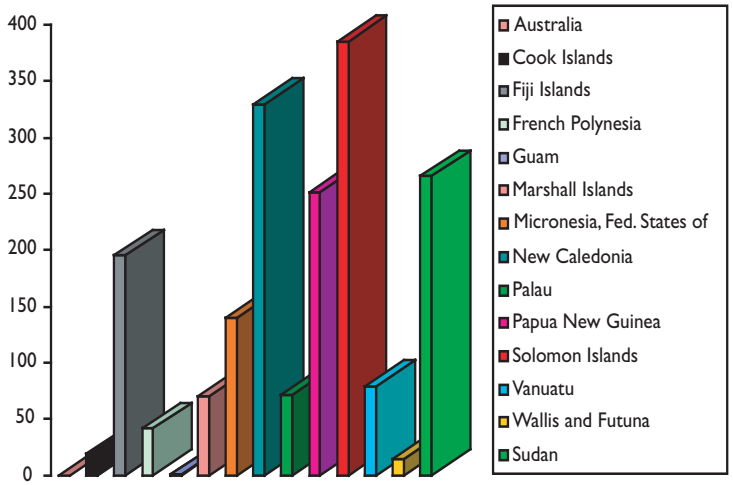

Figure 5. **Comparison of average catches (in tonnes) in major trochus producing countries, 1980–1997 (source: FAO statistics).**
Note: Sudan figure only shows exports

In addition to the government restrictions cited above, traditional fishing grounds have been overexploited and most of the fishing activity has taken place on barrier reefs and near coral islands, the main trochus habitat. Therefore, the majority of *T. dentatus* collected today are small and the catch per unit effort has decreased. A study (1992 to 1999) indicated increases in the overall *T. dentatus* catch in the Red Sea, but careful analysis showed that most of these *T. dentatus* were illegally collected from Saudi Arabian Red Sea waters. All these factors indicate that the Sudanese *T. dentatus* fishery may be overexploited. Unless management practices are established and implemented, the decline in the catch and, hence, exports of trochus shell will continue.

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Smoking – an ideal method to preserve mollusc meat

Jamila Patterson[1]

Foods have been preserved using smoke for millenia and the practice of smoking fish and shellfish has been around ever since people contemplated ways to preserve a portion of their catch. Smoked products in tropical countries have storage properties that enable them to be marketed without the use of sophisticated refrigeration systems.

Fish spoilage can be delayed by many methods, including temperature, pH, and smoke, which eliminate, or at least reduce, microbial growth, enzyme activity, oxidation or insect infestation. Smoking for example helps to preserve fish by reducing moisture content, thereby retarding bacteria growth.

Due to limited facilities and extreme climatic conditions, smoking is carried out as an inexpensive option for preservation in less developed countries to reduce and avoid post-harvest loss. In developed countries, smoking is used to obtain products that are popular for their texture and flavour. In many developing countries, smoked or dried fish is very popular and continues to be a major source of inexpensive dietary protein. The preservative process, which combines smoking with salting, drying and heating, gives the product a characteristic and desirable flavour.

Today, smoked products are often treated as delicacies in many countries. Any species of fish and shellfish can be smoked, and nearly everything that comes out of the smokehouse tastes good. In its simplest form, smoking of meat and fish is similar throughout the world depending on the end product desired.

The long storage life of smoked fish is due more to the drying and cooking process than to the preservative value of the chemical compounds deposited on the fish by the smoke. Smoking methods vary, but all are based on the few common principles below:

- First, the product is treated with salt, either dipped in strong brine (very salty water) or covered with dry salt. The process is called curing.
- During curing, a two-way exchange takes place, with much of the moisture drawn out and some salt absorbed by the product. This process may take up to two days.
- The combination of reduced moisture and increased salt content in the product inhibits the growth of bacteria, a basic principle for all cured meats.
- Secondly, the product is smoked inside a chamber filled with smoke from smouldering hardwood.
- The smoking chamber temperature can be adjusted to obtain a "cold" or "hot" smoking process.
- On completion of smoking, the product is left in the smoking chamber so that the temperature reduces gradually.

The methods of cold and hot smoking and their differences are summarised in Table 1.

Mussels, scallops, and oysters are some of the important mollusc species that are smoked and eaten in different parts of the world.

Whole mussels are usually smoked with oak wood. Smoked mussels are delicious as stews or chowders, or eaten with a splash of lemon. Canned smoked mussel meat is popular on the international market because of its characteristic flavour.

Smoked scallops are an excellent appetizer and often used as an "anytime-snack". Italians have used smoked scallops as their "secret ingredient" in spaghettis for centuries. Similar to mussels and scallops, smoked oysters with their unique flavour, are highly nutritious shellfish and best enjoyed without further cooking. Other smoked molluscs include the Buccinid gastropods, which usually have a very strong flavour; the product is popularly called "scungilli". In Japan smoked squid meat is increasingly popular among consumers.

Research on smoke curing of molluscs such as mussels, oysters and gastropod meat has been

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studied in India for a number of years (Muraleedharan et al. 1979; Jeyachandran et al. 1988; Shanthini and Patterson 2001; Patterson, 2001). These studies indicate that the shelf life of smoked mollusc products may be up to eight months.

A simple process for smoking mollusc meat in India is summarised below.

- gastropod shells are washed and then boiled for 20 to 30 minutes.
- the meat is shucked off the shell using a sharp-tipped knife.
- the edible portion, such as foot and adductor muscle, is cut off and the mucus and pigmentation in the foot muscle are scrapped off with a sharp knife.
- for smoke curing, the meat is cut into thin slices to facilitate uniform smoking. Blanching the meat in a 5% brine solution gives it a salty taste and removes substantial moisture.
- the meat is left to dry in the shade for 30 minutes before smoking; this is an important step as drying allows subsequent uniform absorption of the smoke.
- smoking can be done in home-made smoking kilns (Figs. 1–4) or electrical kilns using sawdust. The flavour of the smoked meat will depend on the type of wood used.
- the preservative effect of the smoking process results from drying and the deposition in the flesh of natural wood smoke chemicals. During smoking, the smoke from the burning wood contains a number of compounds that inhibit

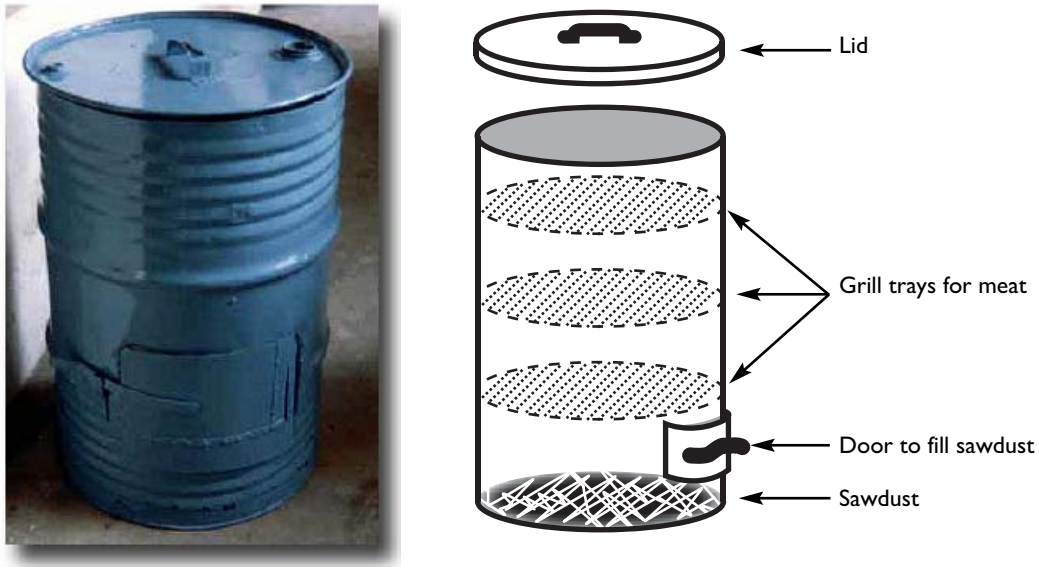

Figure 1. **An oil drum modified to be used as a smoking kiln**

Figure 2.
Inside view of smoking kiln

Figure 3.
Freshly salted and dried meat ready for smoking

Figure 4.
Smoked meat, ready for consumption or storage

bacterial growth, while the heat dries and cooks the flesh, thereby preventing both bacterial growth and enzyme activity.

- hot smoking is best for gastropod meat. The meat can be smoked until it becomes golden brown. After that, it is once again sun dried and can be preserved for a long time in proper airtight packing.

The above process is summarised in Figure 5.

The shelf life of hot smoked products is generally longer than that of cold smoked products. The method given above is an inexpensive and effective method of preserving mollusc meat.

Table 1. **Differences between the cold and hot smoking methods**

Smoking method	Characteristics and product
Cold smoking	• Temperature never rises to a level that would modify the protein content or cook the flesh (30°C maximum). • Smoking lasts 4–6 weeks. • This method is mainly used for temperate species, because high temperatures easily denature their proteins. This is not the case for tropical water species.
Hot smoking	• "Mild temperature" smoking is conducted at 30–50°C, "high temperature" smoking is conducted at temperatures up to 80°C. • Smoking lasts 3–8 hours. • It is essential that the temperature in the smoking chamber be carefully controlled to avoid product charring. • In developing countries, it is the heat, rather than the smoke, that is mostly used as the curing factor. • Hot smoking produces firmer and flakier meat than cold smoking, yet moister than when grilling or barbecuing. • Usually, hot smoked fish is cut into cubes, chunks or flakes rather than slices, which may crumble if they are cut too thin.

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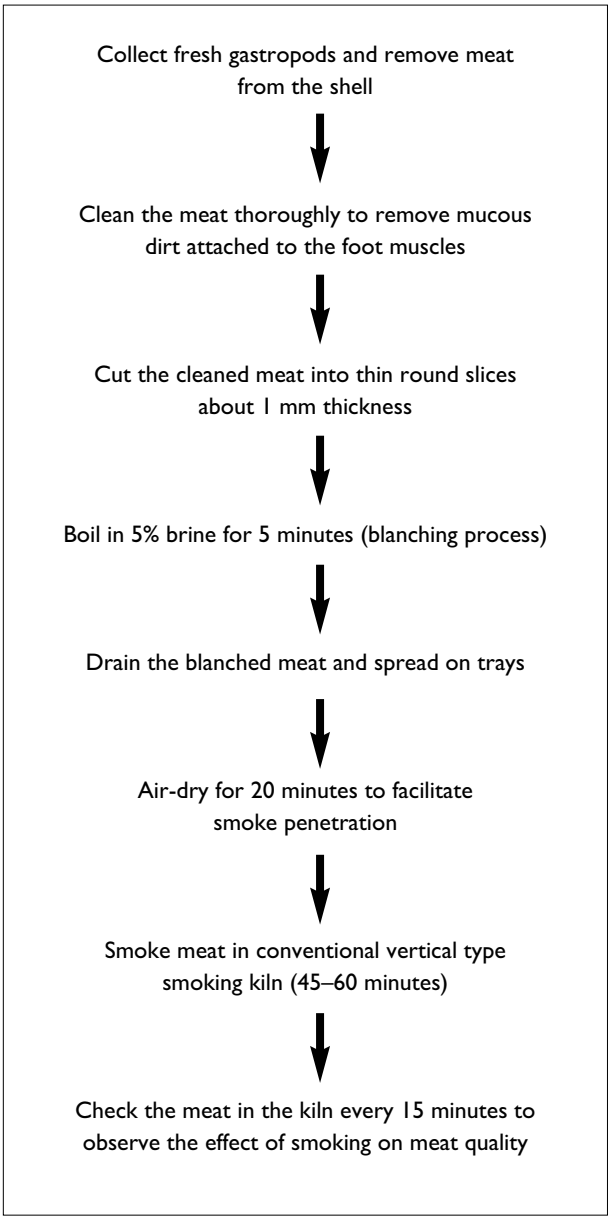


Figure 5. **Smoking process**

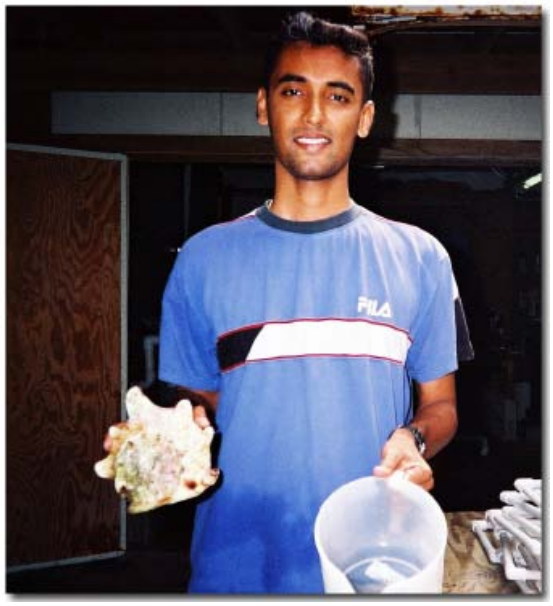
CMI Land Grant Aquaculture Research Program achieves breakthrough in producing baby horned helmet shells (*Cassis cornuta*)

Dr Manoj R. Nair[1]

The Aquaculture Research Program of the College of the Marshall Islands (CMI) recently achieved a breakthrough. The programme closed the life cycle of the edible and ornamental gastropod mollusc *Cassis cornuta*, commonly called horned helmet shell and known locally as *bok bok* in Marshallese. Two female and one male *bok bok* were kept at CMI's Arrak Research facility as exhibit specimens for young school students who visit the campus. The females spawned naturally and produced an egg mass in the form of capsules. Project scientists Dr Manoj Nair and Rand Dybdahl encouraged the Marshallese staff trainees to hatch these eggs and rear the larvae at the Land Grant Arrak experimental blacklip pearl oyster hatchery until they settle and become small helmet shells (about two month's time). Dr Nair and Mr Dybdahl provided technical input and minimal supervision, leaving the project under the leadership of Land Grant Aquaculture Research Aide Tabwi Aine.

Around 30 per cent of the 80,000 eggs (40,000 from two separate spawnings by the two different females) became larvae that settled inside the tanks. The settled larvae were thinned out and a few hundred juveniles are being kept in the outdoor circular tanks to observe their growth.

The significance of the breakthrough is that it is the first time this species has been reared to a juvenile stage in the Pacific region and, possibly, worldwide. This is also the first time that a gastropod species has been reared successfully at the Marshall Islands' research hatchery. This information could be useful in future stock enhancement programmes in the country for this species and other shellfish species such as cowries and triton shells, which are valued and being overfished for their shells. Moreover, there may even be a market in the marine ornamental trade industry for small horned helmet shells.



Dr Manoj Nair (Land Grant research scientist) presenting a helmet shell spawner with freshly produced eggs in pitcher

Group photo of project staff and trainees holding a spawned helmet shell in front of the Arrak hatchery. From left to right: Tanney Smart (trainee), Dr Manoj Nair (Land Grant research scientist), Charles Isiah (trainee), Jude Allen Anjan (RALGOV trainee), Tabwi Aine (Land Grant research aide) and Rand Dybdahl (Land Grant/ CTSA research scientist)

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The project team's next challenge will be to maintain, breed and produce juvenile triton shells, *Charonia* sp. This could be attempted when the hatchery is not busy producing valuable blacklip pearl oyster spat for the commercial pearling industry in the Marshall Islands.

Project staff are thankful for the encouragement of CMI President Dr Wayne Schmidt and Mrs Diane Myazoe Dean, from the CMI Land Grant Cooperative Research & Extension Program, and Coordinator of USDA CTSA program at CMI's Arrak Campus near Laura. Project staff acknowledge the support of the Mayor of Rongelap Atoll Local Government (RALGOV) Mr James Matayoshi for his support of the research programme. The staff are also grateful to Mr Don Hess and Dr Dean Jacobson of CMI's Liberal Arts and Marine Science Program for funding (from the Minority Serving Institution Grant) project staff, and photographing the different larval stages.

Helmet shell spawner with freshly produced eggs in pitcher

Swimming helmet shell larvae

Newly settled helmet shell juvenile

Three-month old juveniles

Vanuatu's progress report on the integration of broodstock replenishment with community-based management to restore trochus fisheries: An ACIAR-funded project

Robert A. Jimmy[1,2] and Moses J. Amos[1]

Introduction

This article reports on the progress made in the Vanuatu node of the ACIAR Trochus Broodstock Enhancement and Community-based Management Project FIS/2001/085. The Vanuatu node has six study sites (three seeding treatments and three controls) spread over three islands: Epi, Malekula and Pentecost. The following is a summary of the activities and achievements made.

Site selection and seeding

Site selection and seeding work were completed in May 2003. Initial contacts with communities were made through the radio, requesting people to apply should they be interested in the project. Following on from community requests, preliminary surveys were carried out to identify suitable project sites. In each area, a local coordinator, nominated by the community concerned, was appointed by the project team to oversee the establishment of the project work in that area. The cage construction and seeding of 400 adult trochus in each of the three seeding sites were successfully carried out between April 2003 and May 2003.

Monitoring research work is carried out on a quarterly basis by project staff and local coordinators at each site. Other volunteers involved in assisting project staff with the fieldwork include high school dropouts and high school students from the communities. Their involvement is useful as it allows them to gain basic training on stock assessment surveys as well as being involved in the project. Such involvement also enables project staff to pass on vital information on work progress to the respective communities.

Marine protected areas

Since May 2004, the project, with the approval of the communities, has established marine protected areas (MPAs) for all seeding and control sites used in the study. This action was in line with one of the three broad development objectives of the project. Declaration of the treatment site in Malekula Island (Crab Bay area) as an MPA has successfully been achieved with the collaboration of Vanuatu's International Waters Program (IWP), which uses the area as a pilot site for the Vanuatu component of their activity.

Results and discussion

Preliminary results based on the change in trochus density per hectare (ha) between treatment and control sites 12 months after the seeding are given in Figures 1 and 2. In the juvenile habitat (Fig. 1) at the treatment site, trochus density increased from 22 trochus ha^{-1} to 508 trochus ha^{-1} 12 months after enhancement. The increase in density may be due to immigration and/or recruitment of trochus into the juvenile habitats. In the control site, trochus density only increased from 105 to 178 trochus ha^{-1}. This indicates that recruitment is occurring, but at a slower rate than at the treatment sites. Some of the improvement in trochus density between t_0 (April 2003) and t_1 (October 2003) could also be attributed to improved searching skills of staff.

In the adult habitat (Fig. 2), there has been an increase in density on both treatment (from 100 to 1044 trochus ha^{-1}) and control sites (from 64 to 233 trochus ha^{-1}). This indicates recruitment on both sites. In the case of the treatment site, seeded broodstock may account for some of the observed increase. There has been a notable decline in density in the treatment sites between t_1 (October 2003) and t_3 (May 2004). Some of this decline may be due to the emigration of adults outside of the survey site.

Breeding and cultivation of trochus in the land-based holding tanks has always sparked great curiosity among rural communities. However,

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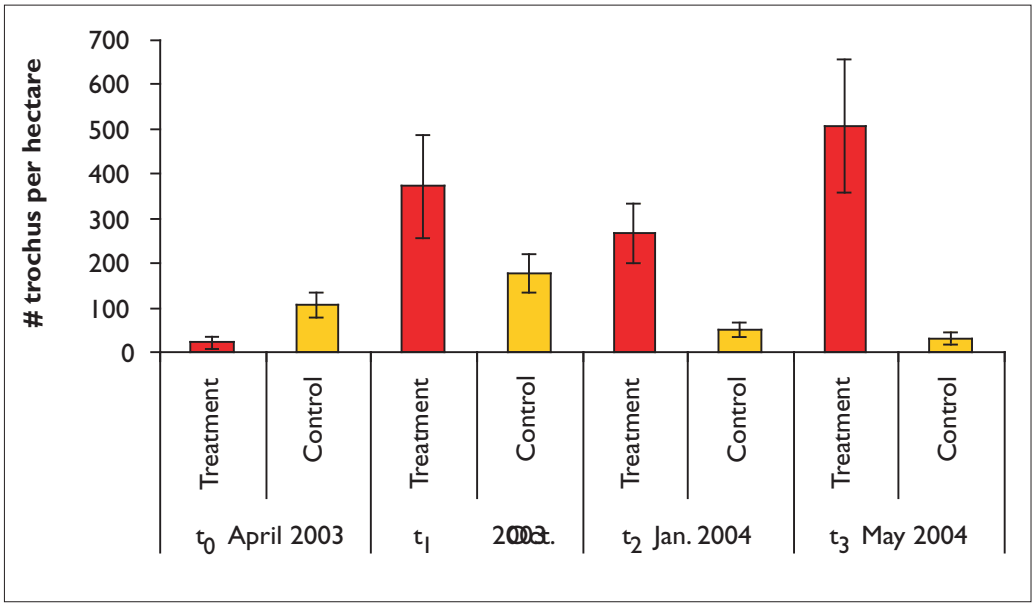

Figure 1. **Mean trochus density (± standard error) in juvenile habitats located on treatment and control sites (n = 220).**

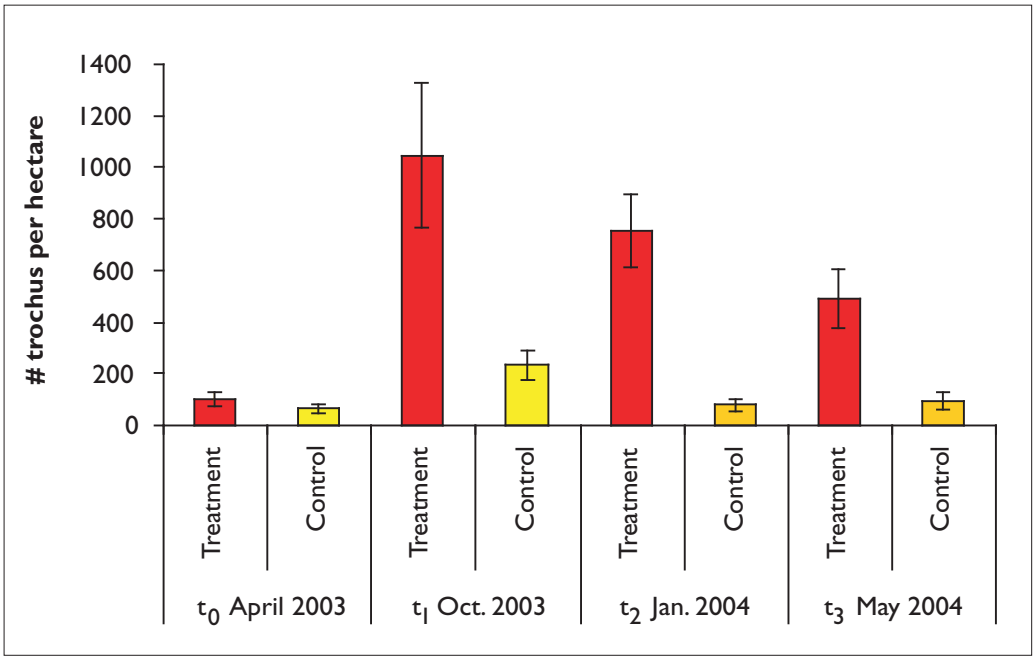

Figure 2. **Mean trochus density (± standard error) in adult habitats located on treatment and control sites (n = 220).**

transferring this technology to rural areas remains a problem because of the high establishment and operational costs as well as the level of technical knowledge required. Therefore, the current seeding technique, and particularly the use of cages, seems better suited for local communities who consider it as affordable and accessible as it only requires simple technical skills and basic knowledge of trochus biology.

Overall, it is obvious from the results that recruitment of juveniles is occurring in the treatment sites. The participation of the communities has so far been very good and more so once positive results have been obtained. In addition, community involvement through the local coordinators and volunteers has greatly assisted the project's field work and strengthened the community-based management of marine resources in Vanuatu.

Integration of broodstock replenishment with community-based management to restore trochus fisheries: Seeding and enhancement work in the Australian node

Justin Bellanger[1]

The Australian node of the ACIAR-funded trochus reseeding project is situated on nearshore reefs surrounding One Arm Point and Cunningham Point, approximately 200 km north of Broome in Western Australia. These sites have a long history with trochus research and development, having attracted various types of activity almost continuously since 1970. The current ACIAR-funded enhancement project in the Kimberley has two main objectives:

1. community consultation and the establishment of community-based marine protect areas; and
2. reef seeding and enhancement research.

The second component of the project activities is contracted to the Department of Fisheries, Western Australia and is the focus of this paper.

In August 2002, the trochus team visited some reefs that, through consultation with the local traditional owners, were identified as suitable for either enhancement activities or as control reefs. From a brief survey of the different habitat types on each reef, areas that were suitable for broodstock enclosures and for surveying adult and juvenile numbers on a regular basis were identified.

While one part of the team was surveying the enhancement and control reefs for their pre-enhancement trochus numbers, the rest of the team travelled long distances to collect broodstock for the project. The animals were kindly stored at the One Arm Point (OAP) Trochus Hatchery (thanks to the Manager, Barry Sharpe) where they were all individually measured and tagged. Afterwards, 400 broodstock were placed into wire mesh enclosures on four enhancement reefs. A number of the shells spawned as they were put into the enclosures, rewarding the team for all their hard work.

Three post-enhancement surveys were completed in January, July and October 2003. In Western Australia, no trochus has ever been found to be less than 22 mm (basal shell width) — the size of a one-year-old trochus. So, although the broodstock trochus have been on the reefs for more than 12 months and have spawned, no recruitment has been observed thus far. It is expected that juvenile trochus will begin to be seen in the survey sites, if indeed recruitment has been enhanced during 2004.

In addition to surveying the ACIAR-project reefs, the Department of Fisheries has been proactive in erecting signage to inform local trochus fishers and the general public about the project. The signs and posters have been erected around the One Arm Point community; at the local shop, in the council office, at the trochus hatchery and at boat ramps. We have been encouraged by the fact that there have been no reports of fishers taking shells from the closed project reefs. No signage was necessary at Cunningham Point because the site is relatively isolated from all other trochus fishing grounds.

Like the international components of the ACIAR project, the surveys will continue until July 2005, at which stage it is envisaged that permanent marine protected areas will be established to preserve trochus broodstock that supply the local reefs with juveniles. Ongoing consultation with local communities and trochus fishers by the Kimberly Aquaculture Aboriginal Corporation and the Department of Fisheries will assist in establishing a sustainable trochus fishery in the Kimberley.

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Profiles

In this issue, the profiles of two young Pacific researchers and an indigenous community worker involved in the trochus enhancement work in Australia are featured. They are Malwine Lober (Samoa), Robert Jimmy (Vanuatu) and Charla Clements (Kimberley, Australia). I hope readers will nominate more country-based indigenous researchers involved in molluscs and shellfish research and management in the Asia-Pacific for inclusion in subsequent issues of the bulletin.

Malwine Lober

Malwine Lober (we all call her Mal) is a Senior Fisheries Officer with the Fisheries Division of the Ministry of Agriculture in Samoa. Upon completing her BSc degree in New Zealand, she returned to Apia and started working with the Fisheries Division. She has been with the division for five years and presently heads the Aquaculture Section.

Mal is busy developing various commodities for stock enhancement and commercialisation trials in Samoa. Commodities promoted include trochus and giant clam. The Division is also trialling the potential of giant clam and sea urchin growout in community marine reserves. Other activities under consideration for future implementation include Nile tilapia farming and a mud-crab fattening exercise.

Mal is a highly motivated, dedicated and hardworking researcher. She believes in the application of aquaculture to enhance food security for resource-poor Pacific countries.

Robert Jimmy

Robert Jimmy (or Rob) is Principal Fisheries Biologist with the Vanuatu Fisheries Department. He has an associate diploma of applied science in aquaculture, an MSc in shell fisheries biology from Wales, United Kingdom obtained in 2000, an MSc in environment management from Scotland obtained in 2001, and a postgraduate certificate in geographic information system from Switzerland obtained in 2002.

Robert joined ICLARM's Coastal Aquaculture Centre (CAC) in Solomon Islands in 1993 as a scientific research assistant before returning to Vanuatu as a senior fisheries biologist in 1995. He took up his current position in 2003. Over the past 10 years, Robert has been involved in giant clam, blacklip pearl oyster, green snail and trochus research work.

He was also responsible for coordinating and carrying out marine resource surveys and assessments of numerous marine species, and was involved in the 1995–1998 ACIAR trochus reseeding research project involving Australia, Indonesia and Vanuatu.
Robert's current responsibility at the Research and Aquaculture Section at the Vanuatu's Fisheries Department includes:

- managing and coordinating all Fisheries Department programme activities relating to research, resource assessment and aquaculture; and
- appraising and providing recommendations to the Director of Fisheries on issues regarding the implementation of new fisheries sector investment proposals.

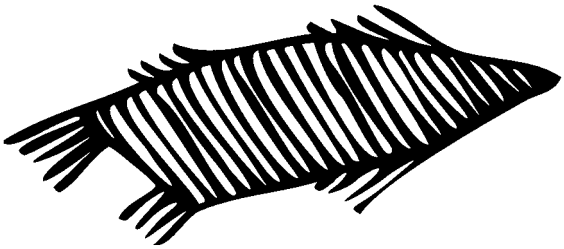
Charles Clements

Charles Clements likes to be called "Charla". A native of the Bardi tribe, his immediate family is based in the west Kimberley (Broome, Derby and OAP), Western Australia.

Charla has been involved in trochus fisheries at One Arm Point since the 1970s. He joined the Kimberley Aquaculture Aboriginal Corporation (KAAC) in the mid-1990s before becoming its chairperson in 1999. He has been re-elected to the position three times.

Under his leadership, the AUD 3.5 million multi-species hatchery (MSH) and the Manbana Tourism and Discovery Centre were funded and constructed (see *Trochus Bulletin* #10 for information on the MSH). KAAC is the commissioned organisation for the ACIAR-funded trochus project FIS/201/085, which is due to be completed in June 2005. In his capacity as the project community coordinator, he worked closely with Dr Chan Lee, the project coordinator.

Charla is a firm believer in utilising aquaculture as a tool for economic development for the indigenous people in the Kimberley. His effort and contribution to indigenous aquaculture development was recognised with the award of the Bicentenary Medal by the Australian government in 2003.



Publications and conferences on trochus and other molluscs

Note from the Editor

In *Trochus Bulletin* #10, I provided some shellfish articles of interest to readers from the "Proceedings of the 11th International Congress & Workshop of the Tropical Marine Mollusc Programme (TMMP), 28 September to 8 October 2000". More articles on molluscs from TMMP 2000 and other publications are included in this issue for perusal.

Latama G., Niartiningsih A., Syam R. and Indriani S. 2001. Survival of giant clam larvae (*Tridacna squamosa*) fed zooxanthellae from three sources. Phuket Marine Biological Center Special Publication 25(1):101–104.

Summary: Zooxanthellae from giant clam *Tridacna squamosa*, coral (*Acropora* sp.) and sea anemone (*Stichodactyla gigantea*) were used as sources of dinoflagellate symbionts for *Tridacna squamosa* larvae. There was a significantly higher rate of survival of larvae offered zooxanthellae from coral and giant clam compared with larvae offered zooxanthellae from sea anemone or larvae offered no zooxanthellae (controls).

Fermin A.C. and Buen S.M.A. 2001. Photoperiod effects on feeding, food conversion, growth and survival of abalone (*Haliotis asinina* Linne) during nursery rearing. Phuket Marine Biological Center Special Publication 25(1):113–118.

Summary: Juveniles of 10 mm shell length were subjected to four photoperiodic regimes namely, 6L:18D (6 hours of light and 18 hours of darkness), 0L:24D, diffused 12L:12D, and ambient light (12L:12D) serving as control. Juveniles were fed fresh seaweed, *Gracilariopsis bailinae*, in excess amounts throughout the experiment. At the end of a 105-day experiment, juveniles held under ambient photoperiod were significantly bigger and had higher average daily growth rates than the rest of the treatments. Feed conversion efficiency was higher at ambient light than at other photoperiodic regimes. Daily feeding rates at 65-day culture period were similar for all treatments; however, towards the end of culture period, feeding rate of abalone at ambient light was lowest compared to the rest of the treatments. Survival rate was significantly higher in animals at ambient lights and at 6L:18D photoperiodic regime, with 99% and 97% survival respectively, than at other photoperiodic regimes.

Hua, N.P., Nguyen T.X.T., Mai D.M., Phan D.H. and Kieu T.Y. 2001. Spawning characteristics of *Babylonia areolata* (Neogastropoda: Buccinidae). Phuket Marine Biological Center Special Publication 25(1):161–166.

Summary: The Babylon snail (*Babylonia areolata*) is a gonochoristic, internally fertilized gastropod. Sex ratio of snails with a length of 35–50 mm was 1:1.3 (M:F) and 1:2.6 in the largest snails. Seven months after hatching, snails had reached 35–42 mm in length and began to spawn. Adult snails kept in cement ponds deposited egg capsules throughout the year with spawning peaks in March and July. Vasiform transparent egg capsules were laid during the night and attached to sandy bottom or coarse substratum in pond. Each breeder deposited from 18–75 (average 38) egg capsules. Egg capsules measured 30.6 x 9.9 mm on average and contained an average of 743 eggs in jelly-like fluid. About 6 days after

spawning, bilobed veliger larvae hatched out. Veliger larvae spent 12–14 days at free-swimming stage and metamorphosed to crawling juveniles after 16–18 days. Average fertilization and hatching rates were 83% and 90%, respectively.

Winanto T., Soekendarsi E. and Paonganan Y. 2001. Hatchery production of spat of pearl oyster *Pinctada maxima* (Jameson) in Indonesia. Phuket Marine Biological Center Special Publication 25(1):189–192.

Summary: Spawning of *Pinctada maxima* was induced by thermal stimulation. Fertilized eggs were harvested by grade screen net and placed in a 5-tonne fiberglass tank. Larvae were reared in 1-tonne fiberglass tanks and fed with phytoplankton; *Isochrysis galbana*, *Pavlova lutheri* and *Chertoceros* sp. Veligers measured 80 x 75 μm (density 5–7 ind. ml^{-1}). The umbo stage was reached from day 12 to 16 (density 3–5 ind. ml^{-1}). Pediveligers developed on the 18th day and measured 220 x 210 μm. Density was 2–3 ind. ml^{-1} until the larvae settled. Survival from fertilized eggs to spat settlement on day 60 was 0.55–4.47%.

Le D.M. 2001. Preliminary results on the artificial breeding of the abalone *Haliotis asinina* Linne, 1758 in Vietnam. Phuket Marine Biological Center Special Publication 25(1):203–206.

Summary: Wild-caught broodstock of the abalone *Haliotis asinina* were placed in a 600-L capacity composite tank and conditioned to photoperiods of 12 h light and 12 h darkness. Spawning occurred after 17–22 days. More than 400,000 newly hatched larvae were cultured. On average 1.29% of them reached the juvenile stage, which occured after 35–40 days of rearing.

Other publications

Purcell S.W., Moses M.J. and Pakoa K. 2004. Releases of cultured sub-adult *Trochus niloticus* generate broodstock for fishery replenishment in Vanuatu. Fisheries Research: 67(2004):329–333.

Conferences and News

The Asian Fisheries Society (AFS):

The 7th Asian Fisheries triennial forum of the AFS will be held 30 November–4 December 2004 in Penang, Malaysia. The theme for this year's forum is "New dimensions and challenges in Asian Fisheries in the 21st century". Some technical sessions that may be of interest to Pacific Island nations are given below:

- Increasing aquaculture productivity
- Promoting environmentally-friendly aquaculture
- Restoring and sustaining capture fisheries
- Value-added products
- Enhancing the ornamental fish industry
- Socioeconomic perspectives
- Understanding aquatic resources

In addition to the technical sessions, numerous symposia will also be organised during the forum. For more information on the forum and about the Asian Fisheries Society:
Forum information: http://www.usm.my/7AFF2004
Asian Fisheries Society: http://www.compass.com.ph/~afs or http://www.worldfishcenter/v

Australasian Aquaculture 2004:

The conference will be held in Sydney from 26–29 September 2004. There is a one-and-a-half day session on indigenous aquaculture. For more information on the conference, email: worldaqua@aol.com or go to http://www.australian-aquacultureportal.com

The European Aquaculture Society (EAS) conferences:

- *AQUACULTURE EUROPE 2004*, Barcelona, Spain, 20–23 October 2004
  Theme: "Biotechnologies for quality"
- *AQUACULTURE EUROPE 2005*, Trondheim, Norway, August 2005
  Theme: "Lessons from the past to optimise the future"
- *AQUA 2006*, Firenze, Italy (Joint EAS-WAS event), 9–13 May 2006
  Theme: "Linking tradition with technology"

Note to future SPC Trochus Bulletin *contributors*

Starting with the next issue, the SPC *Trochus Bulletin* will have a new editor and coordinator: Dr Warwick Nash from the WorldFish Center at SPC in Noumea. All correspondence concerning contributions to future editions of the bulletin should be addressed to him and/or to the SPC Information Section.

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The Information Section of SPC's Marine Resources Division takes this opportunity to warmly thank Dr Chan Lee for keeping the bulletin alive and kicking since January 2000. The editor's role entails good networking abilities and the difficult task of getting authors to write...on time. Dr Lee has clearly demonstrated these abilities and we look forward to reading his contributions to the bulletin as "just" an author.

PIMRIS is a joint project of five international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the Secretariat of the Pacific Community (SPC), the South Pacific Forum Fisheries Agency (FFA), the University of the South Pacific (USP), the South Pacific Applied Geoscience Commission (SOPAC), and the South Pacific Regional Environment Programme (SPREP). This bulletin is produced by SPC as part of its 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.

PIMRIS

Pacific Islands Marine Resources Information System