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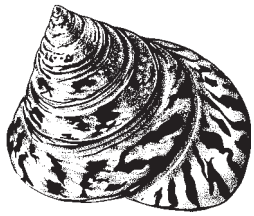

TROCHUS

INFORMATION BULLETIN Number 2 — September 1993

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EDITORIAL

Our readers will remember that the Special Interest Group on trochus was formed in July 1992 following a recommendation by the 23rd Regional Technical Meeting on Fisheries, which was held in Noumea in August 1991.

The first bulletin came out in July 1992 and was designed both to act as a catalyst and to supply members with reliable information. Despite the first issue's popularity, members' contributions have been few and far between. In hindsight, it may have been a mistake to concentrate on trochus alone. From the next issue onwards, we plan to cover not just trochus but also the mother-of-pearl industry in general (except for the pearl oyster which is handled by a separate SIG).

What do readers think of this idea? I hope I can rely on your responses and would stress that this bulletin, like the others, should be interactive and that its members should play a full part. It is your bulletin and only you can make it interesting!

This issue, then, provides information on trochus production in Maluku Province in Indonesia. Also in its pages, the Northern Province Fisheries Service in New Caledonia summarises trochus production from 1987 to 1992, while Laura Castell, of the Department of Zoology of James Cook University in Townsville, Australia, offers us the initial results of her reseeding-oriented study on juvenile trochus.(cont'd page 2)

Inside this issue

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 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

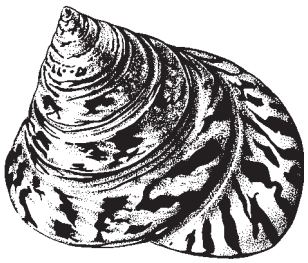
I wish to thank all contributors, but also to appeal to those who have not yet sent in any material. We are anxious for information on prices and resource management measures in producing countries and on the problems encountered in trochus exploitation. Has the trochus market recession started to bottom out? Is the debate on reseeding closed? Many queries remain unresolved and require further information. So, please, pick up your pens!!

This issue also contains a feature which is called Out of the Past, where we reprint articles which first came out some decades ago. It is striking to realise that some of the problems met in the past remain topical today.

I will finish this editorial by saying that articles for most other SIG bulletins are prepared for publication by an editor external to the SPC. Amongst our readers I am sure there is some slumbering editorial talent just waiting for an opportunity to be released. If you think you can be of assistance, please do not hesitate to get in touch with us.

Jean-Paul Gaudechoux

TROCHUS INFOS



Some aspects of the ecology of juvenile *Trochus niloticus* relevant to population enhancement

by Laura Castell,
James Cook University,
Townsville, Australia

Reseeding of reefs using hatchery-reared juveniles is one of the options proposed to increase depleted stocks of fished species such as *Trochus niloticus.* Its feasibility as a management tool is still under investigation and there is a major need to identify the right procedures to follow when 'planting' juveniles, and the post-planting processes occurring in the community.

Most reseeding experiments with *T. niloticus* have used juveniles larger than 15 mm shell diameter (Hoffschir 1990; Amos 1991), although there is at least one example of the use of 8 mm size trochus (Shokita et al. 1991).

Using very young hatchery-reared juveniles (shell diameter < 5 mm) is a desirable alternative because reduced grow-out means many of them can be produced at relatively low cost and effort, and because it would minimise the problems of inappropriate behaviour patterns potentially associated with cultivation (Schield & Welden 1987). So far, this option has not been explored intensively, perhaps because of the difficulty in tagging and tracking such small individuals.

Here I present a brief summary of some results from a study of the mortality of hatchery-reared juvenile *T. niloticus* released into rubble with its associated fauna. The experiment was done in the laboratory but it aimed to replicate as far as possible the arrangement of species (predators, prey and their interactions) found in the natural environment.

Methods

Juvenile *T. niloticus* reared in tanks, ranging between 3 and 14 mm maximum shell diameter, were used in the experiment. Rubble from the intertidal reef flat at Orpheus Island (70 km north of Townsville) was collected in plastic bags. The area was assumed to be a favourable habitat for *T. niloticus* because of the relatively high density of adults.

In the laboratory, the rubble was treated in two different ways: half was treated with anaesthetic solution 1 per cent (v / v) ethanol in seawater (Prince & Ford 1985) and left for approximately 10 minutes. The rubble was then shaken and removed from the solution.

With this process most of the fauna associated with the rubble was removed. The other half of the rubble was left as collected. Both treated and non-treated rubble were then left with continuous water flow for two days to recover from the handling

process. The rubble treated with anaesthetic solution is referred to hereafter as 'Reduced Density of fauna' treatment, and the non-treated rubble as 'Natural Density of fauna' treatment.

Approximately equal amounts of rubble were put in plastic containers 30 x 27.5 x 14 cm with approximately 8.25 l of fresh filtered seawater (25 µ mesh) supplied continuously at a rate of 800 ml per minute. Twelve containers were assigned to each treatment and were distributed randomly on a bench in shaded space. After six hours, 15 *T. niloticus* individuals of <5 mm and 5 individuals of >5 mm shell diameter were introduced into each container and observed to attach themselves to the rocks.

The experiment ran for four days to decrease the chances of 'tank artefacts' building up. I made daily observations (early morning and late afternoon) of the position of juveniles on the rocks and any indication of mortality or predation activity. On Day 4 I scrutinised each container, first picking up all *Trochus* observed and any other animals, and then treating the rubble with the anaesthetic solution as above. All material was collected with a sieve (200 µ mesh), and fixed in 10 per cent formalin. It was subsequently sorted under a dissecting microscope to quantify all fauna present (crustaceans, worms, molluscs and echinoderms).

A contingency table was used to compare the frequencies of live, dead and missing juveniles between the two treatments. The null hypothesis was that the density of fauna had no effect on these frequencies.

Results

A total of 36 juveniles was found dead in the Natural Density of fauna treatment, compared to 5 individuals in the Reduced Density of fauna treatment (see table). The Chi-square analysis revealed a significant difference between the two treatments, indicating that the presence of fauna had an effect on the survival of juveniles ($X^2 = 25.3$ $p<0.0001$). This effect seems to be accentuated by the few cases where mortality of juveniles was particularly high (as for containers 7, 8 and 11 for the Natural Density of fauna treatment – see table), since, for most of the cases, the number of trochus surviving was comparatively high in both treatments.

Stomatopods and / or crabs (likely predators of juvenile *T. niloticus (*Shokita et al. 1991) were present in those containers where mortality was found to be high, but they were also present in seven of the containers where mortality was very low. Identification of these species is presently in process.

Using the number of dead juveniles from the Natural Density treatment (mean 2.75 ind / 4 days; 95% C.I.), the estimate of mortality rate is 0.18% per day (95% C.I.).

Discussion

Mortality rate of juvenile *Trochus* in the Natural Density treatment varied considerably, with some containers showing high mortality and others very low or nil mortality, even in the presence of recognised predators.

Although many variables, such as the effect of large mobile predators and of tides and wave exposure, cannot be included in a laboratory study, the results of this study suggest that in the natural habitat the probability of a juvenile surviving is highly variable in space and time. Based on the estimates of mortality rate obtained in this study, if 20,000 juvenile *Trochus* between 5 and 14 mm shell diameter are released on a reef, assuming a constant mortality rate, after six months we would expect a **mean** survival of 26 individuals.

Number of alive, dead and missing juvenile *Trochus niloticus* after four days exposure to rubble with two different densities of fauna

Fauna	Container	Alive	Dead	Missing
Reduced density	1	17	0	3
	2	19	0	1
	3	18	1	1
	4	17	0	3
	5	18	0	2
	6	15	2	3
	7	20	0	0
	8	18	2	0
	9	17	0	3
	10	17	0	3
	11	18	0	2
	12	19	0	1
Natural density	1	19	1	0
	2	19	0	1
	3	19	1	0
	4	20	0	0
	5	18	0	2
	6	19	1	0
	7	15	5	0
	8	12	11	0
	9	19	0	1
	10	20	0	0
	11	3	17	0
	12	20	0	0

Although this number seems discouraging, the amplitude of the 95% confidence interval (0 to 20,000 individuals surviving) suggests that there is space for obtaining better results. The ecological effect that reseeding has on the community needs investigation. Manipulating the availability of potential prey may have significant effect on the intensity of predation upon them (see Fairweather 1987, 1988 for examples).

The predatory whelk *Morula marginalba* forms aggregations that seem to be a response to stressful environmental conditions. Planting juveniles in areas close to these refuges could have disastrous effects on their survival. I did not examine the effect of juvenile density since only one was arbitrarily chosen, but density of juveniles is likely to be an important factor in survival if it affects the probability of predator-prey encounter. It is possible that reseeding has more potential than has been shown to date, but the study of simple (although not necessarily easily answered) questions about the ecology of juvenile *Trochus* in the wild, such as density, distribution on the shore, desirability as a prey within the natural assemblage, all seem relevant in designing reseeding programmes.

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Notes on trochus (Lola) production in Maluku Province, Eastern Indonesia

by Rick Braley,
Marine Science Education Project,
Malaku, Indonesia

It is well-known that Indonesian trochus shell is considered by international buyers to be of excellent quality. Since Indonesia is not directly involved with the South Pacific Commission, there is a gap in our knowledge of trochus shell production from this part of this gastropod's natural range. The following is a brief description of trochus shell production in Maluku Province, eastern Indonesia.

The Provincial Government Fisheries Department (Dinas Perikanan – Ambon) produces annual statistical records for Maluku Province. Figure 1 is based on these records from 1991. The considerable decrease (62 per cent) in shell production from 1989 to 1990, and the identical level of production in 1991 indicate a drastic reduction of stocks available for harvest, or a lack of information by Dinas Perikanan. There were no limits put on the fishery during these years. Dinas Perikanan suggested that perhaps villages in the islands made their own arrangements with buyers from Java and so complete records could not be obtained. There is no information to determine the cause of the trend for certain.

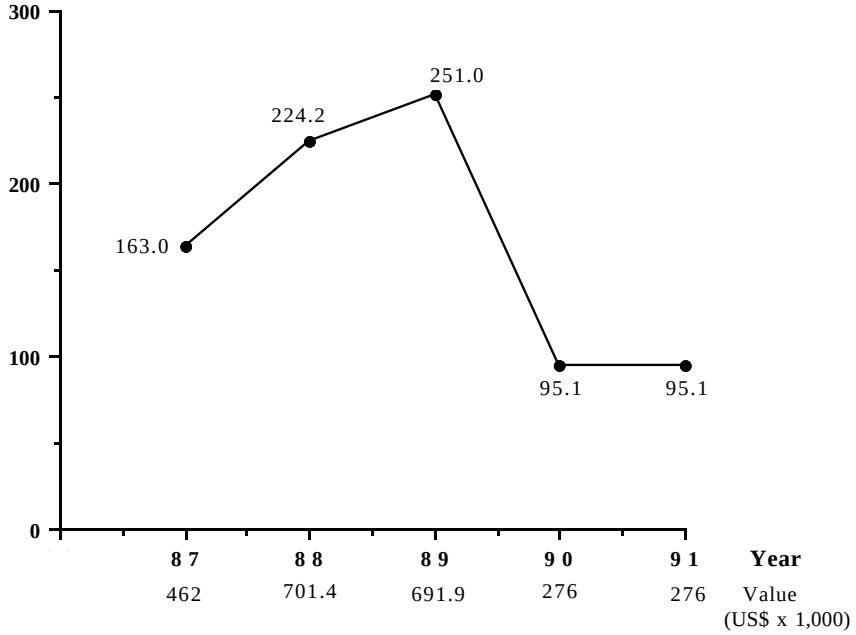
One of us had the opportunity to see the start of the **buka sasi** (open collection period) for trochus in early December 1992 at one island (Hatta) in the Banda Island group. There were perhaps 100 **parahus** (outrigger canoes) over the excellent reef; a wide reef area (to 10 m depth at the steep reef slope drop-off) provided considerable habitat for the trochus. Most parahus were laden with *Trochus niloticus*, 5 cm shell base diameter and larger. The season was to be open for only about 10 days.

At the same island, we had letters of permission from the **Bapa Raja** or **Camat** (king) of the Banda Islands and from the University in Ambon to pur-

chase or collect specimens of trochus for live transport to Ambon.

These would be used as broodstock spawners for our hatchery facility along the campus at Pattimura University. Despite our supporting letters the local head of government for the island village would not sell us any trochus for aquaculture use . He was clearly suspicious about helping anyone else with a resource that was of monetary value to their village.

The **sasi** should protect the trochus resource if the local government of the village or island is observant enough to notice trends in the size or total amount of shell harvested from year to year. However, this depends on those persons responsible for establishing the **sasi** keeping in view the need to conserve and manage their marine resources.



Trochus shell production in Maluku Province, Indonesia (1987–1991)

The trochus fishery in the Northern Province of New Caledonia

Source: Fisheries Division, Northern Province, Kone, New Caledonia

In New Caledonia, trochus for harvest, like crab, is subject to conservation regulations: the diameter of the shell must not be less than 9 cm.

The main production areas in New Caledonia are found in the eastern and northern parts of the lagoon, while the western section, which had been overfished, now appears to be experiencing a resumption of activity.

Trochus yields two products: the **flesh**, a by-product, and the **shell**. After boiling, the flesh is removed from the shell for home consumption or sale (500 francs / kg approx., with the flesh accounting for 5 per cent of the animal's total weight). The shells are stored in 60 to 70 kg sacks for sale, either directly to one of two exporters, or to a consortium which sells them on. Trochus is the main source of income for most of these marketing groups.

Most of the raw shell output goes to make mother-of-pearl buttons in Japan and Europe, while the material left over after this process is used in jewellery and inlay work.

Total production for the Northern Province last year was approximately 100 metric tonnes, or 85 per cent of the Territory's total harvest.

An initial analysis of this activity has been carried out with the assistance of the main trochus buyer.

The total labour force involved has been estimated at 400 people, producing 95 metric tonnes annually. Many suppliers are only occasional and 12 per cent of all the fishermen account for 70 per cent of production. The latter get together to sell in bulk either through formal structures (economic interest groups) or in association with a fisherman.

The price at first sale was between 350 and 400 CFP

francs/kg until July 1991, but the world slump in the market then led to a total suspension of purchasing in the Territory for four months.

The price per kilo in November that year dropped to 210 CFP francs. To avoid this total dependency on the world market, the fishermen involved will need to diversify their activities.

Professionals and scientists have mixed feelings about the current stock. On the basis of annual catch figures, the trend would appear to be a downward one. However, this impression is also due to other factors such as restrictions on catches (at Canala) or mechanical breakdowns. Monitoring catch levels will be an important task in forthcoming years.

Trochus exports (kg) 1987-1991, by exporter (since 1988, two exporters have accounted for 93% of the local market), and by country (exports mainly go to Italy, but also, since 1989, to Japan). Source: Customs Service statistics.

Year / Exporters	1987	1988	1989	1990	1991
A	84,800	92,240	65,300	80,700	91,400
B	85,000	68,030	68,000	87,500	34,175
C	23,624	4,574	7,918	9,816	10,000
D	29,335	11,000			
E	574				
F			2,861		
G				1,150	
Total	223,333	175,844	144,079	179,166	135,575

Year / Countries	1987	1988	1989	1990	1991
Italy	152,800	160,270	88,800	134,200	91,400
Japan	17,000	274	36,861	39,966	34,175
Hong Kong	41,624	15,300	7,918	5,000	
Spain					10,000
French Polynesia			10,500		
U.S.A	574				
Taiwan	11,335				
Total	223,333	175,844	144,079	179,166	135,575

Establishing trochus fisheries biology in King Sound, north-western Australia

by Karina L. Magro,
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University of Western Australia

The marine gastropod *Trochus niloticus* occurs on the northern reef platforms in King Sound, north-western Australia. The Bardi Aborigines Association, based at One Arm Point, has fished trochus commercially since mid-1979 and it is regarded as a traditional resource.

The annual catch of trochus has declined from the 1980 high of 135 tonnes but has remained relatively stable at around 40 to 70 tonnes. The catch in 1991 was 40 tonnes, which supplied a gross revenue of A$360,000 in the form of raw shell sold to overseas buyers. Value-adding facilities at One Arm Point provide additional income through the sale of jewellery and polished trochus shell.

There is little information about the fishery but anecdotal accounts from fishermen suggest reefs are becoming depleted, especially those closest to the mainland. There is also a possibility of impact on the fishery by illegal Indonesian fishing. An additional source of concern is the recent issuing of further licences for the fishery.

The Aboriginal Economic Development Corporation initiated a collaborative research project in

mid-1990 between the Bardi Aborigines Association and the University of Western Australia. Its aim was to provide some basic biological information for management of the trochus fishery, specifically to:

- ☞ develop suitable methods of measuring trochus abundance to efficiently record changes in stock levels;
- ☞ examine trochus life history characteristics: reproduction, recruitment, growth and mortality; and
- ☞ investigate some of the processes controlling the variability in population structure and life history characteristics.

The program was funded by Bardi Aborigines Association and the University of Western Australia. A preliminary report is currently being written to document the results of trochus research conducted so far.

An analysis of factors influencing the development of policy for management of trochus

by Bu Wilson, Murdoch University, Western Australia

Presented below is an abstract of Bu Wilson's Honours Thesis.

It is proposed that policy development occurs within a complex of interacting factors. While some of these factors are directly concerned with the policy's subject matter, other relevant factors may appear extraneous. This is illustrated by an analysis of factors influencing the development of policy for the management of the marine gastropod *Trochus* in the waters off the north-west coast of Australia. Historical influences and legislative and policy arrangements for the Aboriginal trochus fishery at One Arm Point and the Indonesian fishery for trochus in Australian waters are reviewed and compared to determine factors that impact on management of the fishery.

Factors relevant to the development of policy are explored. These include not only biological constraints and questions of nature conservation and ecosystem management, but also the socio-political issues of sovereignty over coastal waters, requirements for quarantine and questions concerned with Indonesian-Australian international relations. In addition, a discussion of the term 'traditional' examines how the variable nature of this term fails to give clear guidelines for policy.

It is concluded that a diversity of influences have bearing upon the environmental management of trochus in a situation of increasing social, cultural and technological change.

Beached in Broome: Indonesians, trochus and the Bardi of One Arm Point

by Bu Wilson

Excerpt from an article by Bu Wilson, entitled Beached in Broome – Indonesian, trochus and the Bardi of One Arm Point (How do the Indonesians in Broome jail and the local Aboriginal community feel about Indonesian fishing in Australian waters?), *published in* Inside Indonesia, *October 1990.*

About 20 km out of Broome on the dirt road to One Arm Point is the turn off to Willie's Creek. It's here that Craig and Coralie Kennedy are charged with caring for the growing numbers of Indonesian trochus fishermen awaiting trial in Broome or repatriation to Indonesia. While out at Willie's Creek the men live either on their boats or in a partly finished house on the property and spend their days fishing and being interviewed by relevant authorities.

Under an agreement between the Australian and Indonesian governments made in 1974 and unilaterally updated in 1988 it was recognised that traditionally Indonesians have fished in what are now regarded as Australian waters. Under this Memorandum of Understanding Indonesian fishermen are allowed to fish in an area adjacent to Ashmore Reef *(Pulau Pasir)*, Cartier Island, Browse Island, Scott Reef and Seringapatam *(Pulau Datu)*. The agreement allows them to fish inside the Australian

Fishing Zone in what is known as the boxed area for trochus, beche-de-mer, abalone, green snail, sponges and other mollusc, provided that 'traditional' methods are used. 'Traditional' in this case refers to the use of sail-powered boats, often called Type I and Type II, depending on the number of sails. The agreement prohibits the use of motorised boats known as Type III, and hookahs or other underwater breathing apparatus. Outside this area no fishing by Indonesians is permitted in any area of the Australian Fishing Zone.

There is an extensive institutional framework that has emerged in Broome in response to the large numbers of fishermen apprehended in Australian waters for breaches of the Memorandum of Understanding. These fishermen are at the centre of a debate often framed in environmental terms but with strong cultural and political undercurrents.

Prison

On the Sunday that I visited there were almost seventy Indonesian fishermen in Broome Regional Prison. Numbers had swelled from the six who had been there only the week before. Some of the prisoners were in for the second, or in the case of one man, Ali Domun, the third time.

Most of the men were from Sulawesi but some, including Ali, were from Roti and had been convicted either under the State Fisheries Act, or under the Justices Act for breaking good behaviour bonds (or being unable to pay fines) imposed under the Commonwealth Fisheries Act or the Continental Shelf (Living Natural Resources) Act.

The men we spoke with all anticipated coming back to Australia as economically they feel they have little choice. The villages they come from are particularly poor and pressure on fishing stocks has increased. There are no longer any reefs worth fishing for trochus closer to home and they now have the added burden of having to pay back money borrowed to finance the trip and for the **parahu** that has been forfeited to the Australian authorities.

Fisheries and Customs officers in Broome are exasperated at the apparently never-ending volume of work generated by having to carry out surveillance and apprehension of the boats and the subsequent interviewing and court procedures. Yet all paid tribute to the bravery and exceptionally good navigational skills of the fishers who arrive here in boats that are often 'held together with spit and string', using home-made compasses and maps torn out of school atlases. Many commented that if they found themselves in the same economic situation they would do exactly the same thing.

Fisheries and Customs seem to vacillate between hoping that the latest round of apprehensions will perhaps stop the illegal visits and the work that it entails, and accepting that the visits are an ongoing part of life. Many of the officers are getting much better at speaking Indonesian.

My interpreter, Ben Raja, is from an Indonesian family, but was born in Singapore. He now teaches music at the Catholic college in Broome. The connections between Broome and Indonesia are long standing. Early traders from Makassar, now Ujung Pandang, visited the Kimberley coast as well as the better known trade visits to the areas further north. Later on, a significant part of the labour force for the Broome pearling industry was 'Koepangers', which referred not only to those people who came from Kupang in Timor, but was also a more generic term applied to all Indonesian, Malay and Filipino workers. Today there is a significant Indonesian and Malay population in the town, with well-established families who arrived in Broome from Alor north of Timor over fifty years ago.

Aboriginal rights

In all the debates surrounding traditional trochus fishing in Australian waters, the long-standing connections between the Indonesian and Aboriginal fishing cultures have not been adequately explored.

Within Western Australia the only people allowed to fish for trochus are Bardi Aborigines living at One Arm Point, or Ardyulloon as it's known in Bardi. The One Arm Point Aboriginal community is some 240 kilometres from Broome, along a treacherously bumpy road.It sits on the tip of the Dampierland peninsula at the northern entrance to King Sound. Many of the islands are visible from the beach.

Around 400 people have lived there since 1967, when many of the residents of the now-abandoned Sunday Island Mission decided to settle at the point closest to the old mission. The tribal and language grouping at One Arm Point is known as Bardi and the community is run by the Bardi Council, elected from seven family groupings in the community.

Traditionally people have fished through all the islands, right over to the other side of King Sound, for trochus, dugong and turtle. At the instigation of the missionaries, marketing of the trochus shell started while people were living on Sunday Island. Nowadays the Bardi community are the only people

allowed to take trochus in the area, under an agreement with the Fisheries Department, which has also set a size limit for trochus of between 65 and 100mm. The smaller shells are allowed to remain on the reef so that they can grow to a reproductive size and the larger ones are left, partly because they are good 'breeders' and partly because once they attain this size the shell tends to be fairly worm-ridden and of little commercial value.

Fishing parties, usually of two or three people, bring the trochus back at the end of the day. A fire will be made either on the beach or outside their house and the trochus boiled up in 44-gallon drums. The meat is then tapped out and the shells left to dry. The shell is then weighed, bagged up and sold through the Bardi Council to one of two dealers in Perth or the Eastern States. From there it is sent overseas for the manufacture of buttons, jewellery, and as an additive in car paint and nail lacquer.

In addition to this a workshop has been established for the manufacture of jewellery and a machine for manufacturing button blanks is due to arrive soon. Trochus remains an important source of income for the community and allows an increasing degree of economic independence.

While visiting One Arm Point I noticed in a number of kitchens that not only were there the standard tea, sugar, flour and powdered milk but also coriander, chillies and lemongrass. Cooking was often done in woks.

'We're rice people', I was told. Children who visited in the evening were very keen to teach us some words in Bardi language but would occasionally get mixed up and one would interrupt and say 'No, no, that's an Indonesian word'. It seems that in the past contact between Indonesian fishermen and Bardi people was harmonious. Nowadays antagonism is sometimes expressed by people at One Arm Point towards the fishermen from Sulawesi and Roti who collect trochus in the King Sound area. Sightings of Indonesian boats are reported to Coastwatch, and apparently some boats found in the mangroves have been burnt to the water line.

Traditional ownership

The reasons for the antagonism are complex. In the early 1980s growing Aboriginal claims for recognition of their traditional ownership of and involvement with the land led, in Western Australia, to the setting up of the Aboriginal Land Inquiry, with Paul Seaman QC as Chairperson.

Several submissions, both oral and written, were lodged by the Bardi Aborigines Association jointly with Lombadina and Beagle Bay, two other communities on the Dampierland peninsula. In summing up, Paul Seaman recognised people's claims to protect the sea for their use and recommended that water be protected for Aboriginal people for uses which were still a part of traditional life. The failure of the ensuing Aboriginal Land Bill 1985 to pass through the Western Australian State Parliament has meant that land and sea tenure have remained unresolved issues for people in these communities.

When asked what were the most important issues in relation to trochus management, One Arm Point people invariably mentioned the need for some security of tenure over the islands of the King Sound and Buccaneer Archipelago, so that they could be guaranteed continued usage of the area for hunting, fishing, camping and collecting wood. In a climate where a lot of time and energy is spent on negotiating with the white Australian legal and administrative system over a resource base that is seen as traditionally owned and managed by Aboriginal people, attitudes tend to become polarised and resentment towards 'outsiders' using the trochus resource occurs.

Many claims are made that Indonesian fishermen are depleting the trochus resource by stripping the reef, but the truth of this I have found almost impossible to ascertain. Trochus has certainly been fished out in other parts of the world, notably the Pacific and the Indonesian archipelago, but the extent and nature of the problem in King Sound has been impossible to determine. Till now no ongoing work assessing the stocks has been carried out, and hearsay and rhetoric have paraded as environmental concern.

Fisheries and Customs officers perceive their role to be not only one of protecting Australian sovereignty but also of protecting a traditional Aboriginal fishery. They take this duty seriously. The call by the Derby Chamber of Commerce for increased defence spending in the area to protect traditional Aboriginal fishing grounds can possibly be viewed with somewhat more scepticism.

Co-operation

Apprehending Indonesian fishermen in large numbers and imprisoning them in Australia is realistically not a long-term solution for the Australian Government and certainly does nothing to improve the situation of fishermen in southern Sulawesi and Roti. The last thing we asked Indonesian prisoners in Broome was what they saw as a solution to the problem. They felt the trochus be-

longed not to the Australian Government, but to all people. Pressed a little further, they expressed an interest in a cooperative venture of some kind between themselves and the Aboriginal people at One Arm Point. Many had heard of proposals for Australia to assist with setting up a hatchery project in Indonesia to restock the reefs closer to home. Whether this idea, which was to be set up through the Department of Foreign Affairs, is going ahead appears uncertain at the moment.

However a long-talked-about hatchery project for One Arm Point is being set up through the Maritime Studies section of Technical and Further Education (WA) and the Aboriginal involvement in business enterprises. An important spin-off of this work is that finally some assessment of the trochus stocks and population dynamics in the King Sound area will be carried out, something long overdue.

The August 1992 transplantation of trochus to Tonga and Niue

by Bob Gillett

This work was completed by Bob Gillett as part of the FAO/UNDP Regional Fishery Support Project which closed its doors at the end of 1992.

Trochus niloticus is commercially the most important gastropod in the Pacific Islands. It occurs naturally from islands in the Indian Ocean east to Wallis and the Lau Group of Fiji. Starting in the 1920s, trochus has been transplanted outside its natural range to almost every island group and has resulted in the establishment of substantial fisheries in many locations. Since 1986 the FAO/UNDP Regional Fishery Support Programme (RFSP) has transplanted trochus in six operations to nine islands in Tokelau, Tuvalu and Western Samoa.

Niue and Tonga have been interested in obtaining trochus for several years but transportation has been a problem. In July 1992 the Defense Attaché at the U.S. Embassy in Suva, Major Timothy Christenson, informed RFSP of the possibility of using U.S. military aircraft to transport trochus to Niue and Tonga from Fiji.

On 21 July he confirmed that a flight would be possible on Saturday 8 August. Still on 21 July, I departed Suva for Lakeba Island for three days to make preliminary arrangements for the collection of trochus.

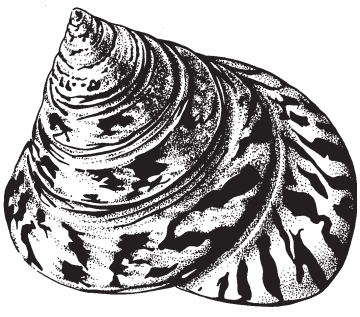
The world market price of trochus has increased significantly in recent years. This has caused trochus to be relatively scarce near populated areas. The island of Lakeba was chosen as a source for the transplant because its isolation results in reduced fishing pressure on trochus, yet it has an airstrip. Lakeba is a fairly round island with eight villages on the perimeter.

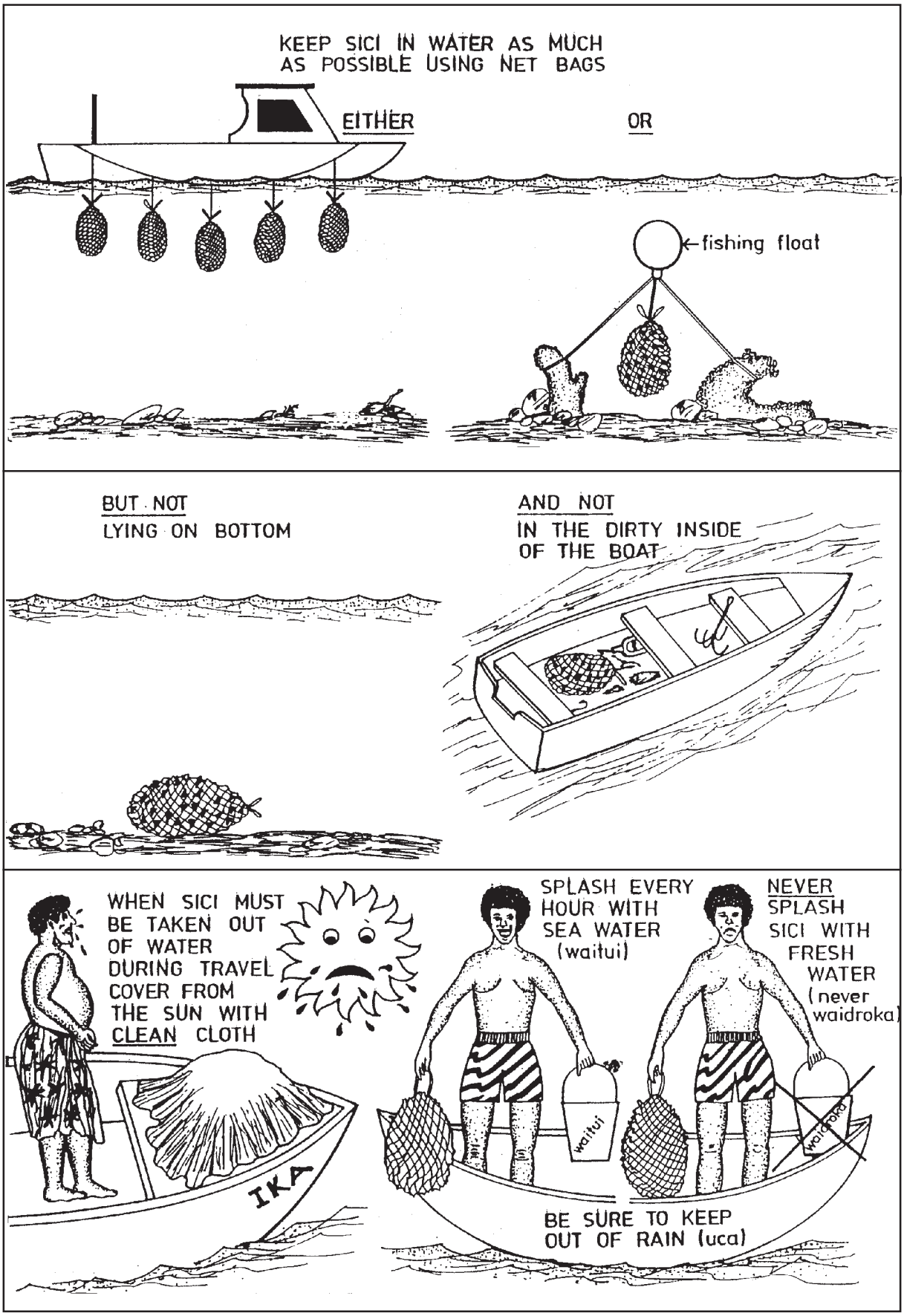
In consultation with Fisheries Division officials in Lakeba, it was decided that it would be best to meet with divers at each of the villages. Accordingly, a trip was made around Lakeba, stopping at each village. Because most of the divers in Lau are harvesting beche-de-mer at present, little trochus is taken in Lakeba. The price ranges between F$3 and F$6 per kilo or about F$.60 to F$1.20 per empty shell.

I therefore proposed to pay F$3 per live trochus, which appeared to offer adequate incentive to the divers to temporarily stop beche-de-mer activities. The need for having live trochus was explained and a pictorial explanation was circulated.

On 31 July I rang the U.S. Marine Corps Operations Center at El Toro, California and spoke to Major Wormeester. He said that 'barring an act of God, the C-130 will be able to land at Lakeba and Vava'u'.

We returned to Lakeba later the same day in preparation for the actual transfer operation. It was decided to commence diving on Wednesday 5 August. A telephone call on 3 August to T. Christenson at the U.S. Embassy revealed that, because of the length of the Lakeba landing strip, it would probably not be possible to land the C-130 Hercules.





Poster explaining how to keep trochus alive

We then switched to the backup plan and reserved 300 kg of cargo (at F$ 1 per kg) on the 7 August Fiji Air flight to Suva where the C-130 would pick up the trochus. That would allow, however, only two days of diving. At that point there was concern about receiving more trochus than we could pay for or transport. On 5 August we learned of another complication. Because of construction activities at the Vava'u airstrip, only small planes were able to land. This resulted in a plan to land in Tongatapu and use the local Twin Otter aircraft to fly to Vava'u.

5 August was a fairly calm day and a total of 295 trochus was collected from the villages; 185 came from Nasagalau Village. It was windy, rainy and cold on 6 August and fewer trochus were obtained. The overall total was 555 shells.

On 7 August I received a call from our office indicating that the Hercules had broken down in Hawaii and the operation had been cancelled. At that point I booked 150 kg of excess baggage (at F$ 4.20 per kg) on the flight from Suva to Tongatapu. At mid-morning the trochus were re-bagged. The total number was at that point 545; some small ones apparently fell out and I kept an unusually large 16.5cm specimen. The total weight was 174 kg or about 3 trochus per kg. Although there was some thought that the Fiji Air flight from Lakeba to Suva would be cancelled due to horrible weather, we arrived in Suva at 1500 hrs.

Because of some misunderstanding, my booking for 150 kg of excess baggage on the flight to Tonga the next day had disappeared. A quick check of the airline schedule showed that another flight would depart shortly, excess baggage was booked, a panic dash was made to the airport. On arrival in Tongatapu at midnight all trochus were taken to the Fisheries Division where they were placed in two newly constructed aquaculture tanks. I then learned that, because several flights that day from Tongatapu to Vava'u had been cancelled, the airline would not carry any excess baggage. At 11h00 the next day I took 30 kg of trochus (approximately 100 shells) on the flight to Vava'u and left my suitcase behind.

The shells were placed about one mile east of Tapana Island, a reef half a mile east of Fenua Tapa. The bottom was flat rock strewn with coral boulders. About 20 trochus were placed on each of five of these rocks.

Soon after placing the trochus I contacted personnel of the New Zealand Navy aboard the ship *Canterbury* then visiting Vava'u. They had received official notification from New Zealand authorities that they would be carrying trochus to Niue. I arranged a meeting for the following day to demonstrate to the ship's officers how best to transport the shells. The meeting did not take place: a diving accident occurred during the night and the ship left at midnight to take a patient to a recompression chamber in Tongatapu.

9 August was a Sunday and it was impossible to travel or make any travel arrangements. On 10 August I learned that it would not be possible to travel to Tongatapu for at least three days to pick up the remaining shells or visit the *Canterbury* (now in Tongatapu) to arrange for transporting shells to Niue.

I spent the next few hours on the phone trying to bargain the remaining trochus onto the flight. In summary 150 trochus arrived at 15h30 and were taken to a location half a mile north of the earlier implant site, probably an extension of the same reef. Although there was less wind, there was more wave activity, suggesting the area was more exposed to the open sea. There were also somewhat more holes, pockets and ridges in this reef: an apparently ideal trochus habitat. Twenty-five trochus were placed in one spot, 50 about 200 metres north, and finally the remaining 75 about 500 metres further north.

On my return to Tongatapu, I was told by Tonga Fisheries Department workers that approximately 260 trochus had been transferred to the *Canterbury* by the Fisheries Department. They were placed in two plastic containers and were constantly flooded with a deck hose. An additional 35 trochus were kept by the Tonga Fisheries Department for spawning, experiments, and algae control in the tridacna tanks.

Communication with the fisheries workers in Niue indicated that the *Canterbury* arrived early on 12 August (Niue date) with 213 trochus in four net bags. All the trochus were alive, however the total number to arrive was approximately 46 trochus less than that reported to have been placed on the vessel in Tonga. This apparently corresponds to one net bag full.

Ninety-nine trochus were placed on the reef at Uani near Hakupu Village, 77 at Matalave and Makatutaha near Namukulu Village, and 47 at Patuoto near Tamakautoga Village. The placement was complete by 1000 hrs on August 12.

In summary, 250 trochus were transplanted to Vava'u, 213 were transplanted to Niue, and 35 retained in Tongatapu.

Pacific Islands trochus introductions

by Bob Gillett

For more than 60 years, experiments on trochus introductions have been conducted by several Pacific Islands countries. In the paper presented below, Bob Gillett has listed these introductions.

Date	Areas	Details	Source
Before 1927	Palau to Truk	Unsucessful attempt Palau to Pohnpei	McGowan 1957
1927-1931	Palau to Truk	Total of 6724 shells transferred in bait wells of skipjack boats; 5 years elapsed before judged successful. First harvest 1939, greatest annual harvest (1952) 230 tons.	McGowan 1957, McGowan 1958
1930	Palau and Yap to various sites in Caroline Islands	Japanese Govt and private companies transferred shells to many islands including Ngulu, Ngatik, Mokil, Pulawat. Transfers to Sorol, Woleai, Ifaluk, Kapingamarangi, and Nukuoro not successful.	McGowan 1957
1937	Palau to Phoenix Island	No details of transfer available; 1985 status unknown to Kiribati officials. Probably mis-taken, Enderbury (Phoenix) could have been confused with Enderby (Pulawat, Truk).	Bour et al. 1982, Onorio, pers. Comm
1938	Palau to Saipan	2974 individuals released.	South Seas Government 1939
1939	Truk to Pohnpei 2 trips	Skipjack vessel transported shells in Inenami 1939	Asano and Inenami 1939
1939	Truk to Jaluit	6143 tonne cargo ship carried shells in 4 water tanks	Asano and Inenami 1939
1939	Palau to Pohnpei	6745 shells transferred; greatest harvest (1951) 180 tons;	McGowan 1957
1939	Palau to Satawal	5000 shells transferred; success not known	McGowan 1958
1939 or 1940	Yap to Ulithi	Very successful	McGowan 1957, 1958. McCoy, pers. comm.
1939	Palau to Jaluit	Shells transferred to other atolls of the Marshalls including Majuro and Ailinglaplap; transfer to Ebon not successful.	McGowan 1957, Bour et al. 1982
1940s or early 1950s	Pohnpei to Kosrae	Unsuccessful operation	McGowan 1958
Early 1950s	Saipan to Guam	Shells transplanted by two fishermen; very successful	Stojkovich and Smith 1978. Smith, pers. comm. 1986
1952	? to Hawaii	39 shells released in Kaneohe Bay.	Katekaru, pers. comm.
1954	? to Kili Atoll	Unsuccessful	McGowan 1958
1957	Fiji (Viti Levu) to Aitutaki	2 transfers; one in sea water, other damp in crates (40 shells); seaplane used; trochus population plentiful in 1965. First harvest 1981 (200 tonnes).	Van Pel 1957, Devambez 1960, Sims 1984, Powell, pers. comm.
1957	Vanuatu to Tahiti	1200 shells shipped in circulating water tanks. 40 survived the 15-day trip.	Yen 1985, Yen, pers. comm.
1958	Fiji to American Samoa	No details available.	Bour et al. 1982
1958	New Caledonia to Tahiti	40 shells transferred by aircraft in damp sacks. First harvest 1971; greatest annual harvest (1973) 261 tonnes.	Van Pel 1957, Anon. 1972
1959	Pohnpei to Kosrae	500 live trochus released at 13 locations.	Gawel 1982
1963	Guam to Hawaii	750 trochus released in Kaneohe Bay; 1967 survey showed trochus surviving, but no indication of reproduction observed; some trochus observed in 1970.	Katekaru, pers. comm., Kanayama, 1967

1963	Tahiti to Moorea	800 shells transferred.	Anon. 1972, Yen 1988
1964	Tahiti to Raietea	400 shells transferred.	Anon. 1972, Yen 1988
1963	Tahiti to Bora Bora	660 shells transferred.	Yen 1988
1968	Tahiti to Tuamotu	Manihi 120 shells	Yen 1988
1968	Tahiti to Australs	87 trochus transferred.	Yen 1988
1968	Tahiti to Gambier	100 trochus transferred.	Yen 1988
1969	Tahiti to Tuamotu	Tikehau 60 shells, Fakarava 170 shells, Takaroa 64 shells, Anaa 60 shells, Pukapuka 100 shells, Rangiroa 355 shells	Yen 1988
1972	Tahiti to Australs	500 shells transferred.	Yen 1988
1972	Tahiti to Tuamotu	Arutua 160 shells, Apataki	Yen 1988
1972	Tahiti to Gambier	300 shells transferred.	Yen 1988
1973+ ?	Aitutaki to Palmerston	Several transplants but not successful like earlier transplants to Aitutaki.	Powell, pers. comm.
1981-1983	Aitutaki to Southern Cook Islands	Palmerston Is, 3000 shells transferred, abundant at date of report; Manuae, 500 shells, uncommon in 1985; Mitiaro, 300 shells, rare / extinct; Mangaia, 300 shells, rare; Rarotonga, 200 shells, rare / extinct.	Sims 1984
1982	Aitutaki to Rakahanga and Manihiki	Shells carried on deck in wet sacks. Unsuccessful; all dead before arrival.	Sims 1985
1983	Yap to Woleai	2000 trochus transplanted. All died in transit.	Fagolimul and Price 1987
1984	Yap to Woleai	4,708 shells transferred, 12 died en route.	Fagolimul and Fachaulap Price 1987
1984	Somewhere in Marshalls to Ebon, Aur, Maloelap	Done in conjunction with trolling resource survey.	Y. Elanzo, pers. comm
1985	Yap to Ifalik and Eaurpik	1979 shells transferred; 90 died en route.	
1985	Aitutaki to Northern Cook Islands	Penryhn, 439 shells, carried 6 days in bait tank; Manihiki, 398 shells, carried 9 days in bait tank; Rakahanga, 693 shells, carried 10 days in bait tank; Pukapuka, all dead, carried 13 days in bait tank.	Sims, 1985
1985	Aitutaki to Suwarrow	460 shells carried for 3 days in flooded skiff; very low mortality.	Sims, pers. comm.
1985	Fiji (Viti Levu) to Funafuti	181 shells transferred in 3 air shipments; successful; larger transfer planned.	Parkinson 1984
1986	Aitutaki to Northern Cook Islands	1200 trochus shipped using flooded skiff on domestic vessel. Very good survival rate.	Dashwood, pers. comm.
1986	Fiji (Viti Levu) to Tokelau	1029 shells transferred; 584 sent by ship via Western Samoa; 161 flown to Western Samoa to join original shipment; 284 flown direct to Fakaofo and parachuted. One juvenile found December 1987.	Gillett 1986, Gillett 1988a
1986	Yap to Eaurpik, Elato, Lamotreck and West Fayu	3125 shells transferred, 22 died en route	Fagolimul and Price 1987
1987	Aitutaki to Suwarrow	1,000 shells transferred via flooded skiff, no mortality.	Sims, pers. comm.
1987	Fiji to Funafuti	200 trochus transported on commercial aircraft, 20 died in transit.	Petaia, pers. comm.
1987	Yap to Fais, Ifalik, West Fayu	2504 shells transferred, 77 died in transit.	Fagolimul, pers. comm.
1988	Aitutaki to Tokelau	578 shells transferred to Fakaofo using aircraft and parachute.	Gillett 1988b
1988	Aitutaki to Tuvalu	1336, 2672, and 844 shells transferred to Nukulaelae, Funafuti, and Nukufetau respectively using military aircraft and parachutes.	Gillett 1988c

1989	Aitutaki to Tokelau and Tuvalu	1000, 600, 1200 and 1080 shells transferred to Nui, Nanumea, Atafu respectively using military aircraft and parachutes.	Gillett 1989
1989	New Caledonia to Loyalty Islands	5709 juveniles transplanted from Grande Terre to Lifou Island	Hoffshir et al. 1990
1989	Ponape to Nukunonu and Kapingamarangi	500 shells transferred to each island, about 6 died in transit. Used flooded skiff on deck.	Curren, pers. comm,
1990	Fiji to W. Samoa	40 trochus transported in September using commercial aircraft and released at Namu'a Island in Aleipata area, some large shells kept at Fisheries Division in Apia for spawning.	Gawel pers. comm.
1990	Fiji to W. Samoa	78 trochus (many were juveniles) transported in October using commercial aircraft and released at Namu'a Island in Aleipata area.	Zann, pers. comm.
1990 (?)	Ponape to Pingalap	125 one-inch trochus transplanted.	Gillett, pers. comm.
Aug 1992	Fiji to Tonga and Niue	545 shells collected in Lakeba Island, Lau Group and flown by commercial aircraft to Tongatapu. 250 of these were flown to Vava'u and placed on reef west of Tapana Island. 260 were transported by naval vessel to Niue; 213 eventually placed on reefs at Hakapu (99 shells), Namakulu (77) and Tamakautoga (47).	Gawel, pers. comm., Gillett 1992

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Trochus shell exports in Fiji

by Yunus Rachid

The two following articles, written by Yunus Rachid, are extracted from The Fiji Times *and were published in December 1992.*

Tip-off stops shell export

Last December customs officers in Suva confiscated about F$100,000 worth of under-sized shells bound for Japan. The trochus shells were discovered in two containers opened by Customs officers after a tip-off. The law prohibits the export of trochus shell under nine centimeters in length. Fisheries Director Peniasi Kunatuba said the shells would be destroyed.

'It would be foolish of us to sell these shells when we have stopped other people from getting them (from the sea)', Mr Kunatuba said.

Mr Kunatuba said the Fisheries Department had authorised the exporter to export normal shells and had sealed the bags to be exported. However, Mr Kunatuba said that after the fisheries officers had completed their work and went away, other bags were filled with under-sized shells and hidden

behind the ones sealed. The Fisheries Department yesterday opened the containers and separated the under-sized shells from the acceptable shells. Most of the shells were under-sized. According to Mr Kunatuba the shells sell for US$10 a kilogram. The containers contained nine tonnes of trochus shells.

Mr Kunatuba said the confiscation showed that other exporters might be getting away with the same offence because of flaws in the Fisheries Department's checking system. 'From now we will be present when the containers are sealed and taken to the wharf. We will target the exporters with strict export regulations to deter them from buying under-sized shells from villagers', Mr Kunatuba said. He said since the fisheries department was under-staffed, it would be easier to place control on exporters than people who fetch the shells from the sea.

Mr Kunatuba said many villagers did not know the laws governing the collection and selling of shells and it was the duty of exporters to inform them about acceptable sizes.

He said that if he was convicted, the exporter could lose his licence, pay a fine of F$ 1,000 or go to prison for one year, or face all penalties.

Government imposes ban on trochus shell export

The Ministry of Primary Industries has slapped a ban on the export of trochus shell for one year. This follows the confiscation of nine tonnes of under-sized trochus shells by the Customs Department in Suva in November 1992.

Fisheries Director Peniasi Kunatuba said investigations by his department revealed that under-sized trochus shells had been exported to Japan for the past five years. 'Without harsh action, exporters would have made the shells extinct', Mr Kunatuba said.

He also added that fisheries officers would continue their crackdown on exporters and those found contravening the Fisheries Act will have their licence revoked permanently. Mr Kunatuba said one exporter had already lost his licence for trying to export almost nine tonnes of trochus shells to Japan. Mr Kunatuba said the ban would help prevent the extinction of the trochus shell.

Two ailing local button factories have been running at half capacity because exporters were concentrating on sending shells to Japan rather than supply to the local factories.

'The two local factories have had to lay off workers because they could not get enough shells to process. This will hopefully change with the ban in place', Mr Kunatuba said.

Mr Kunatuba said shells which are confiscated will be dumped at sea.

Info on recent trochus harvest/export figures

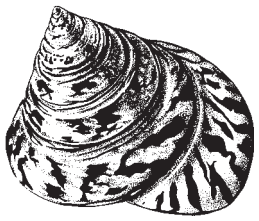
by Tim Adams
South Pacific Commission
Noumea, New Caledonia

- Last Pohnpei (+ the three closest islands) harvest in 1992 was 36 tons (short tons) and was taken in 8 hours. Buying price: US$ 1.50–1.85 per lb. Stock assessment for next harvest has already been completed and, if there is to be a trochus season declared in 1993, it will probably be 8 hours or less (Source: Tashiro Ludwig).

- Fiji 1992 trochus raw shell exports were 71 tonnes for F$705,000 (previous exports: 1991: 103.38 t, F$901,010; 1990: 225.77 t, F$3,266,760; 1989: 235.55 t, F$1,928,670; 1988: 398.47 t, F$2,010,420). Fiji also exports shell buttons and blanks (1992: no quantities, but value F$335,138; 1991: F$639,246; 1990: F$1,008,837). Ban on exports in 1993, but presumably buttons still allowed.

- Palau 1992 harvest was worth US$ 1,100,000 at export and 229 tonnes harvested (one of the highest catches since trochus fishing started in the 1920s) following a moratorium of 2 years. The Palau trochus open season has been one month in duration since Japanese mandate times.

- Aitutaki (Cook Islands) harvest in 1992 was 28 tonnes.



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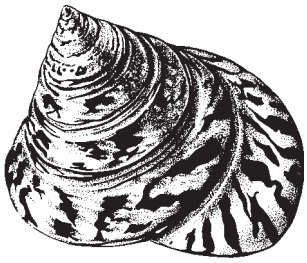


This new section will present articles published in several regional magazines (*Pacific Islands Monthly*, the *South Pacific Bulletin*) some years ago. It is interesting to point out that some present-day problems have a parallel in history

The trochus: a peep into its private life

Source: **The Pacific Islands Monthly**
(19 July 1932)

'Notes on *Trochus niloticus*' is the title of a short monograph written by Mr F. W. Moorhouse, B.Sc., marine biologist to the Government of Queensland, dealing with an article exported from several parts of the Pacific.

A pamphlet confined to the subject of 'a primitive gastropod belonging to the Phipidoglossa' does not promise much interest to a non-scientific reader, but, as a matter of fact, one becomes absorbed at once in reading of the habits of the fish, and, considering its economic value and the very useful information that Mr. Moorhouse supplies, we feel it should be in the hands of everyone who is connected with the trochus industry.

The pamphlet is published by the British Museum at 1/-, and, in all probability, copies could be obtained from the Department of Marine Biology, Brisbane. Mr. Moorhouse's work on the trochus is an example of the effective way in which science assists in business development. The salient points of his investigations are herewith given.

The trochus was given the specific name of Niloticus in error. The first specimen brought to England undoubtedly came from the South Seas, but, by some mistake, it was supposed to inhabit the waters of the Nile, and was named accordingly.

The trochus is, however, only found in the Western Pacific and Eastern Malayan region, such as the Arafura and Coral Seas, Barrier Reef channels and along the coasts of New Guinea, Solomons, Fiji and New Caledonia. It is not found in the Eastern Pacific.

It prefers the windward (south-east) side of the reef, avoiding sandy, muddy or grassy localities. An important fact, as stated by Mr. Moorhouse, is its confinement to shallow water, not greater than three feet in depth at lowest springs, which was proved by the author at Low Island, where the subject was especially studied. This avoidance of deeper waters is not, however, in accordance with the experience of the trochus fishers of Torres Strait, who are accustomed to retrieve shell from four to six fathoms.

At Low Island, many specimens were found in water that dried off between tides, when it creeps under boulders, and the fish can exist for long periods out of water altogether – revival having taken place after two days ashore.

Small specimens are found at the level of high water neaps, and they increase in size to a depth of half a fathom at low water springs. Wherever their usual food (a seaweed growing along the fringes of the coral reefs) is found, the trochus congregates in great numbers.

That the fish is given to wandering is a well-known fact among divers; at Low Island a marked specimen was found to have moved over 50 yards in one night.

Of more practical importance is the 'age–size' ratio as worked out by Mr. Moorhouse, which is measured by the diameter of the base of the shell. Animals of one inch are considered to be about one year old, and they increase by one inch approximately for each year of life. The official limit of 2.5 inches therefore represents at least two-year-old fish.

The sexes are separate, and reproduction takes place during the second year of life. The eggs are

freed in the water a few at a time during the laying season, which is a long one, lasting certainly from March to July and probably much longer.

During the winter months, there is a slackening off in the amount of shell deposited by the animal, and the trochus passes through a period of true hibernation, feeding but little and remaining under the rocks or crevices in the coral. This explains the assertion sometimes made that the fish 'migrate' in the winter.

Trochus farms possible

It has been stated several times by scientists, who have worked at trochus investigations on the Barrier, and who ought to know the economics of the matter, that there is a living to be made in the culture of this shell – in short, a trochus farm. So far, no one has been enterprising enough to go into the business, but it seems quite feasible, given good feeding grounds, plenty of clear moving water, and shallow basins for preventing straying.

It takes about 4,000 fish to make a ton of shell, which is usually worth £50, and the collection from stock would not cost a tithe of the present method of fishing and diving in open seas.

No doubt, excellent advice on the best methods of breeding up are available from those who studied this subject at Low Island, of whom Mr. Moorhouse is one. Perhaps it will be a recognised industry of the future, and Barrier Reef allotments will be as high in value as banana land.

Trocas under a cloud

***Source:* The Pacific Islands Monthly**
(September 1947)

The collapse of the trocas market (it is now about £60 a ton, Sydney) is due, according to experts, to the absence of the usual pre-war market for this commodity in Japan, France and Central Europe.

The Australian demand for trocas is limited owing to the very restricted button industry there. Unstable labour conditions in Australia do not favour the expansion of the industry. The sterling-dollar crisis seems to have made this already uncertain market even more dull.

A demand from the limited button-making factories in Australia and their needs seem to have been met. There is an enormous, world-wide demand for the finished article; but, with the limited factories available, the tendency seems to be to turn elsewhere – to plastics, for example – for requirements.

By the time Australian and American shell-workers have increased their capacity, or the European and Japanese factories come back into operation, the world-market for finished shell buttons, etc., may have been wiped out in favour of other products.

If the Australian Government had spent some of its lavish millions on establishing shell-button-making from trocas in New Guinea, some real and permanent good might have been achieved. As it is, the trocas industry, one of the best stand-bys of the Pacific planter and trader, is in danger of disappearing altogether.

To cut trochus in Fiji

***Source:* The Pacific Islands Monthly**
(December 1952)

A long overdue effort to establish in Fiji an industry for manufacturing of articles from trochus shell is being made by Mr. McCowan, of Levuka. It is reported that he has orders from the United States for millions of button blanks, and that he is now importing the necessary machinery from Europe. Experts believe that there is enough trochus shell in Fiji waters to provide all he will need.

The export of trochus shell has been an important part of the economy of several Island Territories for the better part of a century. It is cut and shaped for many purposes – mainly buttons. Until World War II, most of the manufacturing was done in Central Europe, Japan and, to a lesser extent, America. The war altered all that and, since 1945, there has been only a precarious sort of market in United States. Japan may soon be an important buyer again.

Fiji gains substantially because a large and increasing proportion of her copra is milled in Fiji instead of in Europe. Why should not the same procedure be followed in the much smaller, but nonetheless important, trochus industry?

Trochus studies in U.S. Trust Territory

Source: John R. McGowan
SPC Quarterly Bulletin
(April 1957)

Mainly in the 1930s, an extensive trochus transplantation programme was carried out by the Japanese in what is now the Trust Territory of the Pacific Islands, under United States administration. A main objective of the current Trust Territory Trochus Research Project is to determine whether or not those islands now have trochus in commercial quantities. Another objective is to introduce trochus to new areas. Below is a report on progress made with the project to date, by the officer in charge.

As an export item the trochus industry of the Trust Territory of the Pacific Islands is second only to copra in value. It has been harvested ever since German times (1898–1914) in Palau and Yap, but its development as an industry is fairly recent in the rest of the Trust Territory. At present there is an annual catch from Palau, Yap, Truk, Ponape, Saipan and occasionally small amounts from Majuro, Jaluit, Ailinglaplap and Arno.

The reason for this extension of range (about 2,500 miles) is that during the Japanese era (1914–1945) an extensive transplantation programme was carried out. Although detailed records are not at present available it appears that most of this work was done during the 1930s, and that trochus were introduced to many islands and atolls. The stock for these introductions came from Palau, where *Trochus niloticus* is indigenous. The animals were transported in the live bait wells of skipjack boats and placed either in the passes of barrier reefs or merely scattered on the outside of these reefs in about 10 feet of water.

Islands known to be planted are Truk, Ponape, Saipan, Majuro, Jaluit, Arno, Ebon, Mokil, Ngatik, Ailinglaplap, Pulawat, Ulithi, Ngulu, Nukuoro, Kapingamarangi and Pingelap. Some of these introductions were supervised by a professional biologist working for the Japanese Government, but others were not.

It is said that various companies as well as private individuals also introduced shell to many of the smaller, more isolated islands of the Territory. Several of these introductions were unsuccessful, according to the locals. One such attempt was made at Nukuoro where the adult trochus which were brought in managed to survive but the juveniles all died as soon as they reached a certain size. There are rumours from other islands that while the introduced trochus did manage to establish themselves, the population density is quite low.

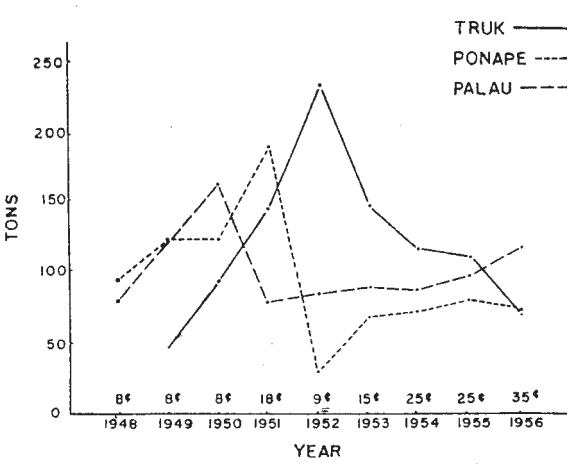
However, observations that trochus is either rare or abundant depend to a great extent on the observers' experience, and since the people from these islands have had no previous experience diving for shell, this statement must be open to question.

In order to resolve this difficulty, a survey technique has been developed by the current Trust Territory Trochus Research Project that will enable us to determine whether or not these islands have trochus in commercial quantities. It is one of the objectives of the Trochus Research Project to survey these islands, and if the results are favourable, to assist the inhabitants in developing this resource.

Another objective of the project is to introduce trochus to new areas. This aspect of the work is being delayed until we have a better understanding of the ecology of the larvae, juveniles and adults. It would also be desirable to have a knowledge of the growth rate of individuals and of populations. This would help us to predict at what point we could expect to begin harvesting the new population and at what level to harvest them, i.e. what percentage of the adult population we could safely remove every year.

The results of the Japanese work can give us some indication of what to expect when we introduce trochus. For instance, a total of 6,724 shells were planted at Truk in 1927, 1928, 1929, 1930 and 1931. According to Japanese reports there was no harvest until 1939, when 7 tons were taken. The following year a little more was taken, and then the war interfered and little shell was produced for commercial purposes until 1948.

The production curve for the years subsequent to 1948 (*see page 21*) indicates an extremely rapid rise in production, followed by an equally abrupt drop and then a tendency towards levelling off. Production curves such as this one are difficult to interpret because they are affected by both biological and economic factors. The price of a fisheries product often has a great influence on the intensity with which it is fished, and therefore the size of the catch does not necessarily reflect the size of the population available to the fishermen.



Production curves for the main trochus-producing islands of the Trust Territory. The price per pound paid to the diver is shown on the abscissa.

However, in the case of the Truk trochus catch curve, the peaks and troughs seem to have little relationship to the market price, and we must assume that at least part of the curve indicates, in a general way, what is really happening to the Truk trochus population.

The trends indicated by these curves are similar to many of the world's great fisheries, and although much of the information necessary to interpret them is lacking it is probable that they are similar for similar reasons.

Such curves are often explained in the following manner: at the beginning of the exploitation of a new fishery the catch is of course low, but as more and more fishermen become familiar with the most suitable techniques for catching their prey, as more and more of them enter the fishery, and as they discover the best fishing grounds, production shoots up.

This expansion is generally short-lived in the case of organisms whose population size is rather limited, as is the case with trochus. For up until this point (the peak of the curve) the fishery has depended on stocks of organisms that have been accumulating for many generations. From this point on, the growth rate of the animal and the rate of recruitment of new individuals to the population cannot keep pace with the rate at which the old ones are being removed from the population by the fishermen, and the real production, which is measured in catch per unit of effort, begins to fall.

It is from this point on that we may assume that our curves show what is happening to the population size. If sound conservation measures have been instituted, production does not continue to fall, but will level off at some equilibrium point. An equilibrium point is a level at which recruitment will balance the rate of removal. The yearly catch will now be fairly stable, although environmental fluctuations can cause ups and downs in the population size, which are usually relatively minor, but in some cases may be rather severe. There is reason to believe that the trochus catch at Palau and Ponape is now at, or approaching, equilibrium. Thus it seems that in areas where trochus is newly introduced we might expect the same sort of production curves if conditions are similar to those described above.

The problem of the equilibrium catch has intrigued fisheries biologists for years, and it has gradually become evident that much can be done by man to adjust this equilibrium to the most profitable level. He can, by manipulating the fishing regulations, drive the equilibrium level either up or down.

The size of a population of trochus depends on the rate of fishing, and this as a mortality factor determines to a great extent the age distribution of the stock. This in turn affects the total number of eggs spawned, since a large trochus (4 1/2 to 5 1/2 inches) produces many more eggs than a smaller one (3 to 4 1/2 inches). If we have more eggs produced we will have a better chance of getting more larvae, juveniles and adults.

This process cannot go upward indefinitely, however. Sooner or later we will reach a point where the number of eggs produced is so great that the proportion of them that finds room to grow becomes smaller and smaller. At this point, in spite of all our efforts, nothing can be done to increase the size of the population. Until we reach this point the population will either increase, decrease or stabilise at certain levels, depending on the number of eggs spawned and the rate of survival of these eggs.

The problem of equilibrium catch then is not merely one of allowing trochus to grow to size large enough to allow a super-abundance of eggs to be spawned, because in this way we may be robbing ourselves of many pounds of trochus each year due to the fact that the growth rate slows down as trochus gets larger. The problem is rather one of striking a mean balance between egg production, survival, growth rate and catch. In other words, what is the highest level at which we can fish and still leave enough organisms to re-populate the stock so that this high fishing level may be maintained?

Of course, it is necessary to have a great deal of biological and statistical information to predict the level at which we can achieve this. In many cases it is perhaps an ideal, which we can only hope to

approximate, but since the advantages in raising your equilibrium 10, 15 or even 20 per cent are great, it is obviously an ideal worth striving for. It is with this purpose in mind that a rather complex series of catch statistics is now being recorded in the Trust Territory. These data, in combination with certain biological information which it is hoped will be forthcoming from this study and that being made in New Caledonia, should give us a much better understanding of what will happen in the future should we decide to manipulate our fishing regulations in an attempt to increase our productivity.

At present the Trust Territory Code limits the taking of trochus to any 14-day period during the months of May, June or July. No trochus may be taken that are less than 3 inches in diameter. These regulations are a hold-over from Japanese times, and have apparently served to maintain the Palau and Ponape populations at fairly constant levels.

However, as was pointed out earlier, the Palau population is an indigenous one, while the Saipan, Truk, Ponape and Marshall Islands populations are not; therefore they may be subject to environmental pressures which are new to them as a species and to which they have not had time to adapt themselves. Conservation measures which may serve very well to protect a natural population may not be at all satisfactory for an introduced one. The persistent downward trend of the Truk population curve is an indication that this may be true.

A further indication that there are some basic differences in the indigenous and the introduced trochus populations in the Trust Territory is that there are different proportions of various age groups present in them. For example, a relatively small proportion of the Truk catch falls into the 4 1/2 to 5 inch category, while a much higher proportion of the Palau catch falls into this size group.

While man's fishing activities are probably responsible for this, it would seem that Palau ought to have a higher proportion of the younger shell, since it has been fished for a longer period of time. At any rate it is apparent from the Truk production curve that the population does not contain enough individuals of the proper size and age to maintain the stock at a high level of density. This may be due to factors that are entirely peculiar to Truk, however; a population in any other area, having a similar age structure and subjected to similar fishing intensities, might be able to maintain itself. Only more data of this type from other places will tell us.

Japanese follow-up studies on the Truk introduction showed that the proportion of young shell in the survey samples changed as the population became older chronologically. In 1936, five years after the last introductions, it was found that 67 per cent of the sample consisted of small forms (under 8 cm base diameter). Three years later, in 1939, 52 per cent of the sample falls into this category. It would be valuable if we had such data for a natural, undisturbed population for comparative purposes. Since this is not possible the next best thing is to compare it to an introduced population that has not been disturbed for a long period of time. Such a situation exists at Jaluit.

Trochus was introduced to Jaluit in 1939, and there has been only one real attempt to harvest it since then, in 1955. Measurements made on this 1955 catch show that only 17 per cent of it falls into the 8 cm-or-under category with all the rest being much larger. While these data are not adequate for describing the population's growth rate, they are indicative of the general trend.

A further indication of the trend is the 'mean annual growth rate' of the Truk population. We know that by 1931 the Japanese had planted approximately 1.7 tons of trochus at Truk, and that by 1952 there was at least 220 tons in the population. Using these figures we arrive at a mean annual growth rate of the population of 610 per cent.

However, it is obvious that this is only a minimum figure, for there was actually much more than 220 tons at Truk in 1952. The 220 tons figure is only the amount harvested, and represents an unknown fraction of the total population. The mean annual growth rate is merely an arithmetical, empirical description of the population growth rate but in our present state of ignorance it is useful as an index. More measurements of this nature are badly needed if we are to manage our trochus plantings in the most profitable manner.

Further critical measurements to be taken are: total size and age structure of the population, fecundity studies, rate of mortality on the larvae and juveniles, and of course growth rates. Direct measurements of some of these factors might be impossible, but approximations in combination with the other types of data discussed here should give us a reasonable chance of approaching the somewhat idealistic 'equilibrium catch'.

This type of knowledge will also assist us in determining suitable environments for new introductions. Preliminary surveys which have been made in the Trust Territory indicate that while adult trochus can manage to exist in quite a surprising

variety of environments, it will only flourish and reproduce well in certain areas. Exactly what the important physical and biological factors are in these areas is not known, but studies are being made and it is hoped that within a year we will have at least a working knowledge of the environmental requirements of trochus, both juvenile and adult.

1957 trochus transfer to Cooks apparently successful

Source: Louis Devambez
SPC Quarterly Bulletin
(October 1960)

Early in 1957, acting on the advice of the Commission's Fisheries Officer, the Cook Islands Administration arranged for two transfers of live trochus by air from Fiji to Aitutaki Island. Now, with the arrival at Commission headquarters from the Cook Islands of a young trochus shell comes probable proof that the original stock is in fact breeding.

Mr. Ronald Powell, Fisheries Officer of the Cook Islands, has recently obtained from Aitutaki a 2.5inch trochus shell of rather unusual appearance.

This shell was sent to the South Pacific Commission, where Fisheries Officer Mr. H. van Pel, expressed the opinion that it was most probably a young *Trochus niloticus*, although some juvenile characteristics were present which usually disappear in trochus of that size.

The specimen sent by Mr. Powell shows a well-defined series of tubercles along the suture of the whorls, a trait which usually disappears in the young trochus shell before it reaches 1.5 inch in diameter. Another characteristic of young trochus present in this shell is a series of spiral ridges on the base, faint but easily discernible to the touch. These ridges are quite visible in trochus up to 1 inch in diameter, but usually disappear as the shell grows bigger.

Finally, as was pointed out by M. Michel Angot, of the French Institute of Oceania, Noumea, the width of the whorls is noticeably greater than in specimens of comparable size collected in New Caledonia.

All this points to an extremely rapid growth, which may raise problems in connection with the determination of size at maturity, the establishment of a rational minimum size limit, etc.

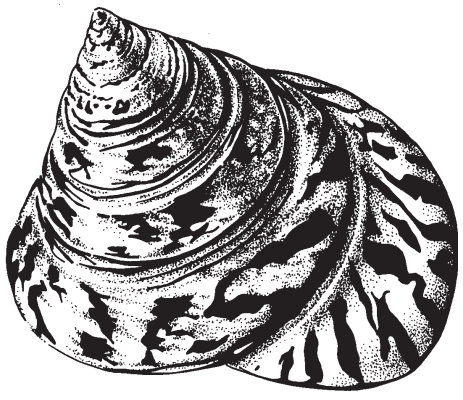
One of first trochus born in Cooks?

While these points are very intriguing from the biologist's point of view, the fact that this shell is probably a representative of the first generation of trochus born in the Cook Islands may be of more widespread interest.

The transplantation of trochus from Fiji to the Cook Islands took place early in 1957. Later reports stated that the rate of survival was good, that the trochus had progressed towards the edge of the reef and in some cases beyond the breakers, and that the shells were growing in size.

Since all the shells introduced by Mr. Powell and his assistant, Ioapa Marsters, were over 2" in diameter in February 1957, the discovery in April 1960 of a live trochus 2 1/2" in diameter proved that the original stock was breeding. That fact, plus the observations regarding the probable rate of growth of this particular shell, do not provide much to work on. More specimens have been requested from the Cook Islands, and it still remains to be seen whether young trochus are comparatively abundant on the reefs of Aitutaki, whether they all show the same growth characteristics, or whether this one specimen was just a freak.

With all due caution it can be said that, on the strength of results obtained in Micronesia by Japanese biologists, the success of this trochus introduction is already fairly apparent, and complete proof of it can be expected in the near future.



Shell polishing and carving

Source: Ronald Powell
SPC Quarterly Bulletin
(April 1961)

Using power tools improvised from scrap to polish and carve pearlshell into curios, ornaments, and costume jewellery, the author built up within a year a thriving business in gifts and island souvenirs.

In many islands of the Pacific the change from a subsistence to a cash economy is taking place slowly. Few people realise what an involved and complicated process this demands. A totally new way of thinking and an understanding of the value of 'time' is needed, which is a slow and sometimes painful process. Where there is a reasonable amount of ready capital available for investment and some technical competence, there is no doubt that the small power tools which are manufactured for the homecraftsman in England and America today would help make the change quicker and easier.

In so many islands that first, almost insuperable difficulty of buying the simplest machinery keeps craftwork at the very low level of hand production. Although some interest has been shown by many Pacific administrations in developing the native craft of shell and wood carving, any progress made is rarely permanent. The reason many attempts fail is that so much work goes into the preparation of the material that the labour of making even the simplest of objects is often hardly worth the effort, when other employment for money is offering. The weaving of hats, mats and baskets by hand, and the carving of artifacts from native timbers, seldom return as much as the basic wage in most territories.

In 1943 I faced this problem. In common with many other people I had lost almost everything I possessed in a hurricane, and had only the clothes I stood up in, plus a pair of rough sandals made from a sun-dried pigskin. After living outdoors for so long in the atolls, office work did not appeal to me, and I wanted a job where I could be as completely independent as one can ever be. Making wooden artifacts and curios from local materials seemed to offer a possible solution to my immediate problem of earning some money to pay the grocery bills.

It did not take me long to realise that the return for the effort of sawing timber by hand, and of polishing shells by rubbing them on a brick, was never going to return me enough to support a growing family. Buying power tools was out of the question. While improvising them seemed virtually impossible on an island that did not possess a town rubbish heap, I felt it worth while to make the attempt.

It would be a long story to describe the linking up of old Ford pistons, steering column, and sewing machine parts by belt to a rattletrap hopper-cooled engine. The effort soon proved worthwhile when production jumped a thousand per cent from the hand labour days, and it was not long before the obvious value of power tools allowed me to change from the business end of a pit saw to a primitive power workshop.

By the end of the first year the demand for woodwork and curios was still in excess of the supply, and what had started as an effort to earn money to pay the immediate grocery bills had turned into a business that had an obvious future beyond my former expectations.

Permanent demand for gifts

Every community needs an endless supply of gifts which are typical of the islands. Wedding presents, presentations to people leaving the islands, birthday parties, the never-ending procession of V.I.Ps visiting the islands – all result in a steady demand for gifts. And where steamships or aircraft bring tourists, this demand can seldom be met.

Most island reefs have a variety of shells which have a beautiful pearl-like lining. Careful grinding down of the bark brings out some quite surprising changes of colour. There are always the purists who feel that to polish a shell is as gilding a lily, but few people will deny that pearl shell is an excellent material for carving. There are no limits to the possible designs and decorations, and to complete one is but to suggest an idea for another, different and better.

Making ornaments from shell

When brooches, earrings and pendants are to be made from shell, or where local fishermen need pearl shell hooks, the rough shell can be cut with either a hacksaw or a metal cutting bandsaw blade, or a jeweller's saw, and filed to shape. Steel saws and files do not last long on shell, which dulls the best of tools in a few minutes' use.

A better method is to use a thin abrasive disc cutting wheel. These wheels are made in a variety

of thicknesses, diameters and grits. They need to turn at the maker's recommended speeds, and they must be driven with enough power to ensure that they do not slow down while cutting, or they are dangerous.

Guards must always be in place or a serious accident may happen. With all power tools it is never safe to work with interested onlookers passing comments, or at times when one's attention may be distracted in other ways. Otherwise missing fingers are inevitable.

Patterns for costume jewellery can be marked out on the nacre of the shell with pencil and the piece sliced out with a few straight cuts. The profile can then be ground to shape by using a grinding wheel which has been cut to a sharp V. This is quite easy to do with a grinding wheel burr – which is cheap to buy or make from ordinary washers – or better still with a diamond dresser – which is expensive.

This V-shaped wheel is made by mounting any standard wheel of 1/2" to 3/4" face on the spindle and shaping it with the dresser or diamond. (The operator should make sure to protect his eyes with safety goggles or a simple shield.) This V wheel will be useful to grind the profile of any pattern in a few minutes as long as the design does not have intricate shapes too thin for the V to enter, when a fine saw must be used.

Mounted grinding points can be used to advantage as long as they revolve fast enough, but most of the small electric grinders either run hot or do not have enough power to make much impression on pearl shell. In such cases, hand carving is often quicker.

The final carving is done with small hand chisels which are easily made on the grinding wheels from small files, or can be bought ready-made from any jeweller's supply house.

Muriatic acid has some use in etching a pattern on to a shell, in polishing in conjunction with ice water (which few island workshops have) and in cleaning out the bottom of deep cuts in shell. Acid is unpleasant in a workshop, and the fumes rust everything with which they come in contact.

Two types of carving

Carving patterns into large shells is the most fascinating part of shell work, as the shell changes colour as one cuts deeper.

Two distinct types of carving are possible. When the shell is to be viewed by daylight or by front lighting, a relief carving is usually preferable. In this work the shell is first ground down just enough to remove only the bark before the pattern is marked out. This can be traced or etched on, and the carving can be started with a grinding point or with a 1/2" wood chisel sharpened with a steel bevel.

Soaking the shell overnight softens it slightly, and the dust can be kept down using a wet sponge.

As the shell is removed the colour changes, and it is only a matter of experience to know when to stop. The deeper the cuts the whiter or lighter the shell becomes. It is finally polished with buffs.

When a shell is needed as a lamp shade, or with back lighting, a more pleasing and in some ways easier method is to mount the shell over a hole in a bench. A bright light is shown under the shell while the surface is comparatively dark. It is then possible to carve the shell down until it becomes translucent. The pattern then appears like a photographic print, with the shell varying in colour with each cut.

Some very striking results can be obtained, and the finished work can only be limited by the patience and artistic ability of the carver.

Most islands have some beautiful native timbers which are excellent for wood carving. Book ends, cigarette boxes, glass trays, lamps, etc., can all be made with a combination of well-polished shell. The common **au** timber *(Hibiscus tiliaceus)* can be changed by applications of coral lime to a beautiful green colour, while **miru**, **tamanu** and **tou** have few timbers to excel them.

When once a few power tools have been added to a workshop the process follows a natural course. From simple grinding tools to circular and bandsaws, wood lathes, planers – all can be made in the beginning from materials collected from junk piles which are around most towns, from pieces tucked away in old buildings and under floors, or in old wrecks lying on many reefs – some since the first missionaries and traders came to the Pacific.

I will not suggest that anyone who has ever worked in a modern workshop will not find this home-made equipment inefficient, inaccurate and frustrating at times, but the Islander who wants to progress from the bare subsistence level of craftwork to a comfortable standard of living will find that with a little effort and patience this can in fact be achieved.

Welcome to new members

by Jean-Paul Gaudechoux,
South Pacific Commission,
Noumea, New Caledonia

The Trochus Special Interest Group is growing. We had received additional completed questionnaires (as at 6/9/93) from the individuals listed below. The previous list of members is available in the first issue of the SPC *Trochus Information Bulletin*.

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 would like to be, fill in the form enclosed with the bulletin or write to us for a new one.

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