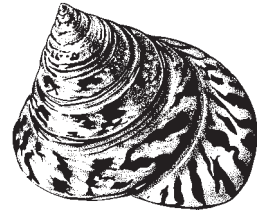




**FISHERIES PROGRAMME  
INFORMATION SECTION  
FISHERIES INFORMATION PROJECT**

**SOUTH PACIFIC COMMISSION  
PO BOX D5 - 98848 NOUMEA CEDEX  
NEW CALEDONIA**



# TROCHUS

*INFORMATION BULLETIN*

Number 3 — October 1994

**Editor:** Kelvin Passfield, Tongareva Marine Research Station, Penryhn, Cook Islands (Tel: 682 42009; Fax: 682 42089)  
**Production:** Information Section, Fisheries Programme, SPC, PO Box D5, 98848 Noumea Cedex, New Caledonia  
(Printed with financial assistance from the Government of France)

## EDITORIAL

Welcome to the third issue of the Trochus Special Interest Group (SIG) Information Bulletin. As you can see, this bulletin now has its own technical editor. This should reduce the workload of Jean-Paul and his staff. In fact, however, the workload associated with this bulletin appears to be quite low, if the number of articles I have had to review for this issue is any indication.

I would like to thank the contributors to this bulletin for their efforts. At the same time, I would like to ask some of you working in the field and receiving this publication to make some contribution. There must be some research going on within fisheries divisions of the region. Any reports, especially internal reports, will be gratefully received.

As you are aware, it is the 'grey literature' that is normally not distributed outside your own country that these SIG bulletins are trying to tap. Your contributions will add to the overall body of knowledge on trochus. And remember, the range of this bulletin has been increased to include other shells used in the mother-of-pearl (MOP) industry. This includes green snail, and others that some of us may be unaware of. Copies of any newspaper articles will also be welcomed. Knowledge shared in this way can benefit the whole region. (cont'd page 2)

## Inside this issue

**Trochus survey at Fakaofu atoll,  
Tokelau**  
*by R. Gillett* Page 2

**Trochus reseedling activities in Yap  
outer islands – an update**  
*by J. Fanafala and R. Clarke* Page 8

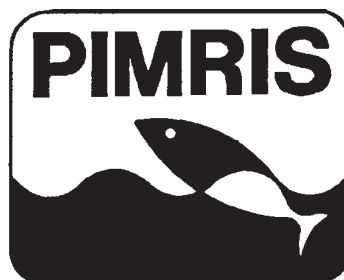
**Natural broodstock resources in  
Kosrae, Federated States of Micronesia**  
*by I. Tsutsui and R. Sigrah* Page 9

**Trochus niloticus propagation project  
in Kosrae, Federated States of Micro-  
nesia**  
*by I. Tsutsui and R. Sigrah* Page 11

**Recent trochus-related work by the SPC  
Coastal Fisheries Programme**  
*by Tim Adams* Page 17

**Trochus reseedling experiments in Aus-  
tralia and Vanuatu**  
*by Laura Castell* Page 18

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



Pacific Islands Marine Resources  
Information System

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

One particular aspect of trochus in the Pacific that has always interested me is the reported different quality of shells from around the Asia-Pacific region.

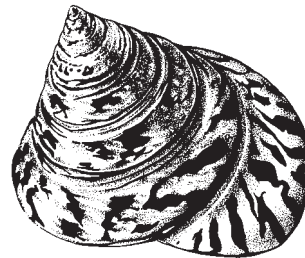
My main interest is whether the quality differences are real, or merely a ploy by some trochus buyers in order to pay lower prices. And if the differences are real, is there any genetic reason for this, or is it caused by environmental factors? If anyone has any information regarding grading of shell quality

used for button manufacture for shells from different countries, I would be pleased to hear from you.

In this issue we have contributions from Indonesia, Yap State, Tonga, Tokelau Kosrae and Vanuatu. I trust you enjoy reading these, and hope they will stimulate you to supply enough information to keep this bulletin a bi-annual publication.

Kelvin Passfield

# T R O C H U S I N F O



## Trochus survey at Fakaofu atoll, Tokelau

by Robert Gillett

### Background

In response to reports that trochus was becoming common at Fakaofu, the Office for Tokelau Affairs requested assistance from the South Pacific Commission in determining trochus abundance and in preparing management plans. SPC approved the request, a consultant was recruited, and a short trip was undertaken to Fakaofu Atoll in mid-June 1994.

### History of the transplantation of trochus to Tokelau

H. van Pel, SPC Fisheries Officer, visited Tokelau in September and October 1958. He commented on the favourable habitat for trochus in Fakaofu and Atafu lagoons. He released 'a small number of subjects' in Atafu and concluded that 'transplants of both blacklip pearl shell and trochus are, under the present circumstances, the only way which Tokelau islanders can be assisted towards a regular income in cash from marine resources' (van Pel 1958).

V. Hinds, another SPC Fisheries Officer, visited Tokelau in August 1971, primarily to investigate the feasibility of transplanting pearl oysters. He did mention, however, that 3,000 trochus shells would be required for a transplant (Hinds 1971). In 1985 an

SPC Fisheries Research Scientist visited Tokelau in conjunction with a tuna project; he prepared a list of potential fisheries development projects which contained the suggestion that a trochus transplant be undertaken (Gillett 1986).

In March 1986, 586 trochus were transferred from reefs near Suva to Fakaofu using air and surface transport. Three months later 283 more trochus from Fiji were parachuted from military aircraft to Fakaofu. Trochus from these operations were placed on the north-west, south-west, and south-east sides of the atoll (Gillett 1986). Huge surf hit Fakaofu in February 1987 and it was decided that, because the storm had probably destroyed many of the transplanted trochus, additional trochus should be obtained (Gillett 1987).

In April 1988 578 trochus obtained from Aitutaki in the Cook Islands were transported by military aircraft and parachuted to Fakaofu. These shells were placed on the northwest side of the atoll (Gillett 1988a). In October 1989, 1,200 and 1,080 trochus obtained from Aitutaki were parachuted from military aircraft to Atafu and Nukunonu respectively (Gillett 1989).

Twenty-three of the Nukunonu trochus died in transit (Pelasio 1989). All trochus transplanted to

Tokelau (with the possible exception of those brought by van Pel in 1958) were at least 8 cm in diameter at the base.

### History of trochus survey work in Tokelau

In December 1987 a survey of Fakaofu lagoon was carried out in which 17 divers searched approximately 190 man-hours for trochus. One dead 10.6 cm trochus, one live 9 cm trochus, and one dead 5.0 cm trochus were found during the survey period. Several dead trochus were reported to have been found after the February 1987 storm. The report of the survey concluded that some of the transplanted trochus had died, some were still alive, and, because a trochus smaller than those transplanted was found, some reproduction had taken place.

In June 1988 a survey was conducted in Fakaofu with several objectives, one of which was to 'assess the success of the last trochus drop'. During four hours of SCUBA diving time 'not one single specimen of trochus was recovered, neither dead nor alive'. The report of the survey stated that no conclusion could be drawn and that further hours needed to be spent in search of the molluscs (Mildner 1988).

Gaalofa (1991) gives the report of a survey at Atafu in December 1991 which utilised 17 divers for an unspecified length of time. The following results were obtained:

Location on Atafu	No. of live trochus found	No. of dead trochus found
Fogalaki I Matagi	0	0
Kena Kena	2	1
Tuagafulu	0	2
Hakea	7	11
Motu Vaelua	27	5
Fenualoa	3	0
Alofi	0	0
Papa Motumotu	0	0
Olopuka	2	0
Matalia	3	1
Ulugagie	0	0

A short survey in conjunction with environmental work was undertaken at the leeward side of Nukunonu in the period March to June 1994. Apparently no *Trochus niloticus* were found. A report of that work is now in preparation (Glendinning pers. comm.).

### Survey work after trochus transplantations in other areas

Information from surveys after trochus transplantations to other Pacific Island areas could be of value in assessing the Tokelau situation. Considerable effort was therefore taken to review historical material prior to arrival in Tokelau.

Trochus has been transplanted between Pacific Island countries on over 50 occasions (Gillett 1993). Documentation on how the trochus have fared in their new environments is, however, not readily available. Information on the progress of the 1957 transplantation to *Aitutaki* in the Cook Islands, although sketchy, is probably the most complete.

Trochus was introduced to Aitutaki in 1957. Three hundred trochus were transported from Fiji to Aitutaki, but mortality in transit and immediately after placement on the reef reduced the number to either 40 (Sims 1988), 44 (Powell pers. comm.), 'about 120' (Marsters 1975), or 280 (Powell 1957, cited by Nash et al. 1992). A single juvenile trochus (smaller than those transplanted) was found three years later and it was concluded that the transplant was 'apparently successful' (Devambeze 1960).

Sims (1985), on the basis of verbal discussion with R. Powell (the individual who transplanted the trochus), states that in 1965 trochus was 'plentiful'. Marsters (1975), however, gives details of a 1965 survey by the Smithsonian Institution which detected only 21 trochus on the north-east reef, six on the south-east reef, and none in the southern and western sectors.

J. Dashwood (pers. comm., June 1994) stated that trochus were abundant during his stay on Aitutaki from 1968 to 1971 and that a harvest could have taken place in 1972. A trochus survey was carried out in February 1974 in which 14,386 trochus were observed and measured, with the highest concentration on the north-western reef (Marsters 1975).

Marsters extrapolated the survey results to determine that 46,000 trochus or 12.11 tons were present in Aitutaki and concluded that trochus 'fishing is very much recommended'.

In 1979 the population was estimated at 470,000 individuals. The first harvest was in 1981; about 200 tonnes were taken over a 15-month period (Sims 1988).

Fagolimul & Price (1987) describe the results of a survey of *Yap outer islands* seeded with trochus:

Atoll	Year seeded	Amount seeded	No. of shells found in late 1986
Woleai	Jan. 1984	2,496	234
Fachaulap	Nov. 1984	2,200	28
Ifalik	Aug. 1985	924	14
Eauripik	Sept. 1986	875	14
	June 1986	1,021	not surveyed
Elato	June 1986	1,000	9
Lamotrek	July 1986	1,000	13
West Fayu	July 1986	82	not surveyed

It was concluded that (1) trochus seeding in Woleai had been successful, with high trochus density and the presence of trochus juveniles; (2) trochus density on Eauripik was average; and (3) Fachaulap, Ifalik, Elato and Lamotrek had at least one site with many trochus.

Asano (1963) gives information on the transplantations to *Truk* and *Saipan*. From 1927 to 1931, 6,724 live trochus were placed on the reefs in Truk. Surveys were carried out in 1936 and 1938. The earlier survey indicated that it was premature to begin trochus harvesting.

However, by the next survey, 'the number of shells collected as well as their breadth increased remarkably' and a harvest in Truk was recommended for 1939. In early 1938 2,974 trochus from Palau were released in Saipan. The situation was assessed after 13 months: four living and eleven dead trochus were found.

From lessons learned from these transplantations, Asano concludes 'after transplantation management should be left to the local authorities. The islanders should be well informed of the intention and fishing for trochus should be closed for the five years following transplantation. Timing for the opening of the trochus fishing should be determined according to survey results of the stock density and the size frequency of trochus found'.

Trochus was transplanted to Funafuti in *Tuvalu* in 1985 (181 shells) and 1987 (180). In 1988 and 1989 further transplants were made to Nukulaelae (1,336), Funafuti (2,672), Nukufetau (844), Nui (1,000), and Nanumea (600) (Gillett 1993). Anon. (1991) reports that 'visual scanning surveys have recently been carried out. Living adult trochus were found at all islands where they were introduced except at Nui'.

It should be noted that reports on the abundance of trochus a few years after a transplantation can be misleading. A total of 3,000 trochus was transferred to *Palmerston Atoll* in the Cook Islands in 1981 and

1982. Sims (1984) indicates the 1984 status as 'abundant'. In 1988 a formal survey concluded that only small numbers persisted in limited areas of Palmerston's northern reef. On the other hand, 200 trochus were introduced to *Rarotonga* in 1983. A 1984 survey concluded that the trochus were 'rare/extinct' (Sims 1984) but a 1993 survey gave 'an estimated stock of 154,700 individuals' (Marurai & Bertram 1993).

### Trochus survey methodology

Before the consultant's visit to Tokelau, he undertook some background research on appropriate survey techniques. Nash et al. (1992) discuss three common methods for assessing trochus abundance: strip transects, mark-recapture and change-in-ratio. They note that the latter two methods, although more precise than the transect technique, require substantial fishing effort. This requirement reduces their usefulness in determining trochus abundance after a transplantation in the period before fishing is allowed.

From a practical and logistical perspective, it should also be noted that in many areas where such post-transplantation surveys are likely to be carried out (Tokelau, outer islands of Tuvalu, outer islands of Yap), the amount of time available for such a survey is dictated by the length of stay of the inter-island vessel which is often less than one day.

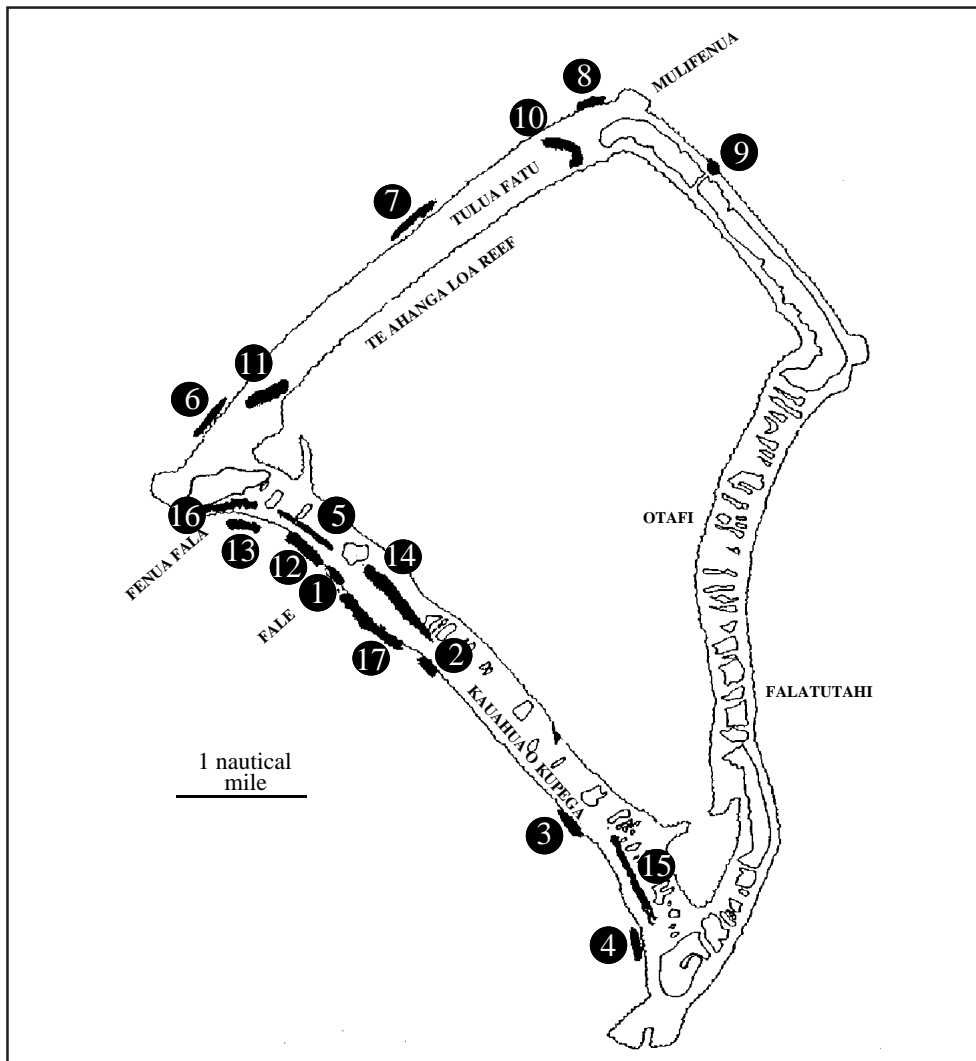
After an initial inspection of the Fakaofu reefs, it was decided that a quantitative assessment of the trochus population would be premature; a descriptive account of their occurrence and preliminary work on management was thought to be more useful to Tokelau. Tokelau officials concurred with this approach.

The field survey staff consisted of Robert Gillett (SPC consultant), Fofu Filipo, Logotahi Vili, and Iosefa Falanai.

### Summary of survey results

During four survey days 17 sites were inspected for the presence of trochus: one site on the north-east side of the atoll, five sites on the north-west, and 11 sites on the south-west. About half of the searching was on top of the reef flat and half was seaward of the surf zone. These areas are shown in the figure on page 5.

Due to the rough conditions it was not possible to search the south-east side, and for the same reason the one inspection of the north-west was not very effective.



**Map showing the areas where the trochus were searched by the survey team**

During the survey 94 trochus was found seaward of the surf zone and 81 were found on the reef flat. All trochus were found in the area between Nukumatini and Fenua Fala or the north-westerly half of the south-west side of the atoll. Trochus was markedly most abundant in the area between Fale and Te Ahua Tautahi, both on the reef flat and seaward of the surf zone (Sites 5 and 12).

All trochus except those from the first dive on Site 1 and that from Site 13 were measured. The trochus from the reef flat ranged in size from 3.0 to 9.2 cm, while those from seaward of the surf zone ranged from 8.3 to 14.2 cm.

**Discussion**

During the survey trochus appeared to be moderately abundant on the reef flat and in surge channels in the area to the north-west of Fale. They were far less common to the south-east of Fale. As no trochus were found on the north-west reef or the

south-east end of the south-west reef, it is likely that trochus are rare in those areas. Little can be concluded about trochus abundance on the windward reefs.

Anecdotal information from three additional sources gives additional information on the distribution of trochus at Fakaofu. Under a public works scheme, called the Gabion Project, thousands of flat coral rocks are being obtained from the reef flats from many locations on the south-west side of Fakaofu for placement in sturdy wire baskets to protect Fale from wave damage.

The men collecting the rocks have observed trochus attached to the undersides of the rocks in most areas where collection has taken place. Old women often probe the undersides of rocks for octopus. When interviewed during the survey, the women stated that they have noticed trochus in the intertidal areas to both the north and south of Fale. The lagoon side of Fale is popular for late afternoon

of the handicrafts made in Tokelau. It is likely that with the increasing abundance of trochus, people will start eating the flesh.

At the conclusion of the field survey the trochus project was discussed at length with the Council of Elders. Attention was focused on the need for a ban on the taking of trochus. Many Elders were unclear about the objectives of the project, but after clarification, endorsed the idea and supported the concept of a ban.

The Council requested that the Department of Agriculture and Fisheries prepare a recommendation for future discussion. In consultation with Tokelau officials a submission was prepared, in which a ban and a penalty for violating the ban were proposed. This has been discussed further, modified, translated into Tokelauan, and submitted to the Council of Elders.

It should be noted that at least some of the Council's rules concerning fishing are not well understood by Fakaofu residents.

For example, although there is a ban on the taking of *Tridacna* clams in the area from Nukumatau to Fenuafala, several residents questioned during the trochus survey were unaware of this regulation.

#### A member of the survey team showing a trochus

bathing. Several swimmers have reported seeing small trochus on the rocks in that fairly calm area.

In the eight years since trochus was first brought to Fakaofu, the transplantation exercise appears to be proceeding satisfactorily. Nevertheless, with trochus being confirmed common in only one area of Fakaofu Atoll, it is premature to contemplate harvesting. There is, however, an urgent need to begin management of the trochus resource.

At present there is no ban on the taking of trochus at Fakaofu. Because one of the factors contributing to the success of the transplant to Aitutaki in the Cook Islands was a prohibition on the harvesting of trochus, it is very important that such a measure be adopted in Tokelau. There have been reports that fishermen have discovered the pearlshell-like qualities of trochus shells and have manufactured lures. Trochus have been incorporated into at least some

After the Council of Elders establishes a trochus regulation, it is recommended that the Department of Natural Resources and Environment take measures to ensure that all Tokelau residents are aware of the rule and familiar with the objectives of the trochus project.

#### References

- Anon (1988). The marine resources of Palmerston Atoll, Cook Islands. Forum Fisheries Agency. *Research Coordination Unit Report no. 89/16*. 57 pp.
- Anon (1991). Trochus resources in Tuvalu. Paper presented at the Workshop on Trochus Assessment, Development and Management, Port Vila, Vanuatu. 2 pp.

- Asano, N. (1963). Studies on trochus ecology and its propagation in Micronesia. [An abridged translation]. Paper presented at the Workshop on Trochus Assessment, Development and Management, Port Vila, Vanuatu. 56 pp.
- Devambe, L. (1960). '1957 Trochus transfer to Cooks apparently successful'. *South Pacific Bulletin*, October 1960, South Pacific Commission.
- Fagolimul, J. & C. Price (1987). A survey of Yap outer islands recently seeded with trochus. Yap Department of Resources and Development. 32pp.
- Gaulofa, S. (1991). Polokalame O Te Hakiliga Alio Tehema 1991 Atafu. [Trochus survey on Atafu December 1991]. 5 pp.
- Gillett, R. (1986). *The transplantation of trochus from Fiji to Tokelau*. Report No.86-01, UNDP/OPE Integrated Atoll Development Project, RAS/81/080. 28pp.
- Gillett, R. (1987). A listing of various projects which might be beneficial to the fisheries/marine sector in Tokelau. FAO/UNDP. 3 pp.
- Gillett, R. (1988a). The second (1988) transplantation of trochus to Tokelau. FAO/UNDP. 5 pp.
- Gillett, R. (1988b). Tokelau trochus survey. FAO/UNDP. 6 pp. plus appendix.
- Gillett, R. (1989). The 1989 transplantation of trochus to Tokelau and Tuvalu. FAO/UNDP Regional Fisheries Support Programme and FAO South Pacific Aquaculture Development Programme. 2 pp.

**After all, this catch is not too bad !**

- Gillett, R. (1993). Pacific Island trochus introductions. *Trochus Information Bulletin*, No. 2, September 1993. South Pacific Commission, pp. 13-16.
- Hinds, V. (1971). A rapid fisheries reconnaissance in the Tokelau Islands. South Pacific Commission, 7 pp.
- Marsters, T. (1975). Annual Report. Department of Fisheries and Marine Development. 40 pp.
- Marurai, J. & I. Bertram (1993). The trochus (*Trochus niloticus*) of Rarotonga: a technical report of field research carried out in March, April 1993. Ministry of Marine Resources. 9 pp.
- Mildner, S. (1988). Marine survey at Tokelau. National University of Samoa. 11pp. plus appendices.
- Nash, W., P. Tuara, O. Terekia, D. Munro, M. Amos, J. Leqata, N. Mataiti, M. Teopa, J. Whitford, & T. Adams (1992). *The Aitutaki trochus fishery: a case study*. South Pacific Commission. 46 pp. plus appendices.
- Pelasio, M. (1989). Trochus distribution in Nukunonu October 1989. Office for Tokelau Affairs. 5pp.
- Pelasio, M. (1990). Trochus Distribution in Nukunonu January 1990. Office for Tokelau Affairs. 6pp.
- Sims, N. (1984). The status of *Trochus niloticus* in the Cook Islands: 1984. *Working Paper 18*, 16th Regional Technical Meeting on Fisheries. South Pacific Commission, 26 pp.
- Sims, N. (1985). The abundance, distribution, and exploitation of *Trochus niloticus* in the Cook Islands. *Proceedings of the 5th International Coral Reef Congress*, Tahiti, vol. 5, pp. 539-544.
- Sims, N. (1988). *Trochus. Cook Islands Fisheries Resource Profile No. 3*. Ministry of Marine Resources, 12 pp.
- Van Pel, H. (1958). A survey of fisheries in the Tokelau Islands. South Pacific Commission, 16pp.

## Trochus reseedling activities in Yap Outer Islands – an update

by Joe Fanafal and R. P. Clarke

Yap State is the second smallest of the four states that make up the young nation of the Federated States of Micronesia (FSM). It comprises 15 atolls and islands. The total population of the state is approximately 10,000, of whom 7,000 are concentrated on the main islands of 'Yap proper'.

Fisheries development activities in Yap State are increasing, and several fisheries projects predominantly aimed at pelagic species (i.e. tuna) are ongoing in Yap proper. These projects are expected to provide a number of jobs and economic benefits to Yap State's 'urban centre'.

However, in the outer islands, the prospects for economic development are less promising. One particular marine resource that may provide the basis of a 'fishery' for the outer islands is the harvesting of trochus or top shell.

The Yap State Marine Resources Management Division (MRMD) successfully implemented an outer-island trochus, *Trochus niloticus*, reseedling project in 1992. The primary objective of the project was to increase the number of islands and atolls on which trochus populations exist, thereby stimulating and

enhancing revenue-generating opportunities for isolated inhabitants of the outer islands of Yap State.

Currently, trochus harvests in Yap State are limited to Yap proper and the outer islands of Woleai and Ulithi. If sustainable populations of trochus are established, they can be harvested commercially, thereby enhancing income-generating opportunities in remote outer-island settings.

Presently such opportunities are scarce or dependent on government-provided jobs, copra, or handicrafts. A well-managed trochus fishery appears to be an ecologically and culturally viable mechanism for economic development in other Pacific Island states.

Project activity and accomplishments focused on seeding adult trochus on five outer-island sites (Elato, Lamotrek, Fachaulap, Sorol and Eauripik Atolls).

Three trips were taken on either regularly scheduled commercial merchant or chartered vessels. Adult trochus were provided from Ulithi and



Woleai Islands (N=2,500) with the assistance and permission of local Island councils. The trochus were maintained in holding tanks aboard each vessel for transportation to planned reseedling sites. Some mortality occurred during transit, but in most cases losses were not significant.

It is estimated that 1,607 adult trochus were successfully planted on four atolls, with an average of 321 individuals at each site (range 103–500). Average direct cost for each planting was approximately

US\$5,000 per site or US\$12.60 per seeded adult (excluding Eauripik where seeding was unlikely to be successful).

Monitoring will be required to determine both the relative and the economic success of the project. Data collected and reported here may assist in determining the economic and biological success of this type of development activity in the greater South Pacific region.

**Trochus reseedling for the Yap State Marine Resources and Management Division, 1991–1992**

Date seeded	Seedlings from	Island seeded	Number seeded	Mortality
21/11/91	Woleai	Elato	500	none
22/11/91	Woleai	Lamotrek	304	196
21/01/92	Ulithi	Sorol	500	none
22/08/92	Ulithi	Eauripik	103	397*
26/08/92	Woleai	Fachaulap	200	300*

\* Note: High mortality, probably due to diesel fuel contamination of flushing water

**Natural broodstock resources in Kosrae, Federated States of Micronesia**

*by Isao Tsutsui and Roland Sigrah,  
Marine Resources Division,  
Kosrae, FSM*

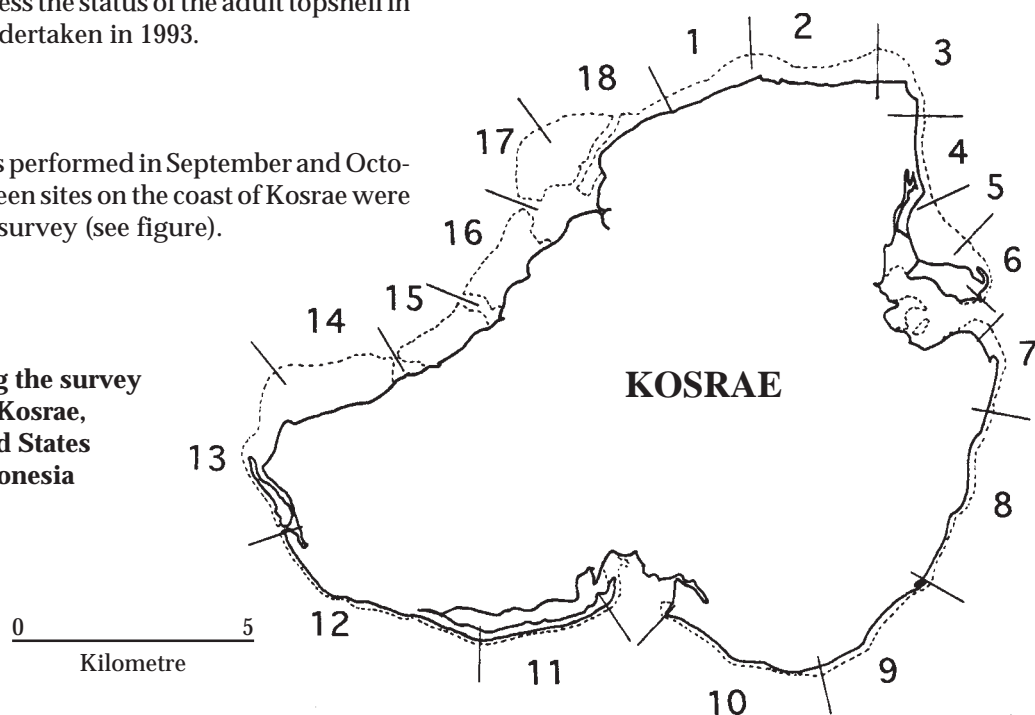
*T. niloticus* have not been harvested in Kosrae since 1987 because stocks have been reduced by over-fishing. Broodstock animals were distributed from a trochus sanctuary to other sites by the Kosrae State Marine Resources Division (KMRD) in 1988. A survey to assess the status of the adult topshell in Kosrae was undertaken in 1993.

The fixed-time swimming method was used for the survey (Nash 1985). The survey was limited to water 1–7 m deep on the reef slopes. This covered the ranges of water commonly accessible to free-diving topshell fisherman (Heslinga et al. 1984).

**Methods**

The survey was performed in September and October 1993. Eighteen sites on the coast of Kosrae were chosen for the survey (see figure).

Map showing the survey sites on Kosrae, Federated States of Micronesia



Several SCUBA divers carefully searched for live adult topshells (over 60 mm in diameter), and recorded the number of animals found in a given time interval. On average each diver searched approximately 7 m<sup>2</sup> per minute. The total area searched at each site was calculated by multiplying the number of minutes spent searching by 7 m<sup>2</sup> (area searched per minute):

$$\text{Area searched at each site (m}^2\text{)} = \text{no. of minutes spent searching} \times 7 \text{ m}^2 \text{ (area searched per minute)}$$

Trochus densities at each survey site were calculated from the number of *T. niloticus* found divided by the total area searched:

$$\text{Density of animals in each site (tr/m}^2\text{)} = \text{number of animals found} \div \text{area searched}$$

The physical dimensions of each site were measured. The depths (from 1 to 7 m) were measured directly underwater at each site. The horizontal lengths of the reefs were taken from the Kosrae Coastal Resources Atlas (Manoa Mapworks 1987). The area of each was then calculated as follows:

$$\text{Estimated site area (m}^2\text{)} = \text{water depth from 1 to 7 m} \times \text{horizontal length of the reef (m)}$$

The biomass of topshells at each survey site was calculated by multiplying the density value at that site by the estimated site area:

$$\text{Biomass of topshells} = \text{density of animals at each site (tr/m}^2\text{)} \times \text{estimated site area (m}^2\text{)}$$

The diameter of topshells collected and water depths were also recorded.

## Results and discussion

The results are shown in the table below. The density of *T. niloticus* on Kosrae was 0 to 0.129 tr/m<sup>2</sup>. The trochus sanctuary had the highest value in the site surveyed. This indicates that the regulation creating a trochus sanctuary on Kosrae is well worthwhile.

In Palau, Heslinga (1984) reported a density of 4 tr/m<sup>2</sup> on the Idekulules Reef. On Yap, densities of 2 to 33 tr/m<sup>2</sup> were reported (Fagolimul 1987). In the Cook Islands, densities of 1 to 25 tr/m<sup>2</sup> were reported, with a maximum density of 66tr/m<sup>2</sup>. The topshell density at Kosrae was considerably lower than the densities in the other Pacific Island countries. The environment at Kosrae appears to be suitable for *T. niloticus* to propagate.

### Density and biomass of *Trochus niloticus* at 18 locations on Kosrae in 1993

Site	Total survey time (min.)	Number of topshells found	Topshells density (tr/m <sup>2</sup> )	Estimated site area (m <sup>2</sup> )	Estimated biomass
1	60	8	0.019	334,400	6,370
2	60	16	0.038	180,000	6,857
3	60	5	0.012	241,500	2,875
4	60	2	0.005	132,300	630
5	60	3	0.007	81,270	581
6	60	6	0.014	423,150	6,045
7	60	5	0.012	114,000	1,375
8	60	0	0.000	258,020	0
9	60	0	0.000	197,470	0
10	60	2	0.005	135,750	646
11	75	6	0.014	339,010	4,843
12	60	0	0.000	454,020	0
13	60	18	0.043	260,010	11,143
14	60	4	0.010	220,400	2,112
15	60	24	0.057	223,290	12,759
16*	60	54	0.129	191,100	24,570
17	60	4	0.010	182,700	1,740
18	60	26	0.062	328,250	20,320
<b>Total</b>					<b>102,866</b>

\* present trochus sanctuary site

## References

- Fagolimul, J (1987). A survey of Yap outer islands recently seeded with *Trochus*. Yap State Marine Resources Division.
- Heslinga, J. A., O. Orak & M. Ngiramengior (1984). *Coral reef sanctuaries for Trochus shell*. Marine Fisheries Review.
- Manoa Mapworks (1987). Kosrae coastal resources atlas. Hawaii, USA.
- Nash, W. J. (1985). Aspects of the biology of *Trochus niloticus* and its fishery in the Great Barrier Reef region. Report to the Queensland Department of Primary Industries and the Great Barrier Reef Marine Park Authority.

### **Trochus niloticus propagation project in Kosrae, Federated States of Micronesia**

*by Isao Tsutsui and Roland Sigrah,  
Marine Resources Division,  
Kosrae, FSM*

The topshell, *Trochus niloticus* L, is one of the commercially important gastropods in the tropical regions. Its natural range is limited to a region from Ryukyu, through the Philippines, Indonesia, to Fiji, Vanuatu and northern Australia. However, its geographical range has been greatly enlarged by artificial distributions:

Five hundred topshell were introduced successfully from Pohnpei to Kosrae in 1959. Since then, the topshell population has propagated and become a common element of the reefs of Kosrae.

As the commercial value of *T. niloticus* has increased recently, it has become a significant source of supplementary income for the people of Kosrae. This trend is also apparent in the other states of FSM and other Pacific countries.

The resulting increased fishing pressure on the natural population of the topshell has caused numbers to decline (Heslinga & Hilmann, 1981).

Conservation and population management and/or release of artificially raised seeds appear to be efficient methods of preserving the topshell resources and enabling them to recover.

The *T. niloticus* propagation project, which is jointly administered by the Kosrae State Marine Resources Division (KMRD) and the FSM National Aquaculture Center (NAC), started in March 1992.

The final goal of this project is to allow recruitment and to releasing artificially produced seed to augment the natural increase. The project has three phases as follows:

1. Development of seed production techniques;
2. Development of re-seeding techniques;
3. Seed production, re-seeding and conservation.

During 1992–1994, the project dedicated its attention to the development of seed production techniques suited to Kosrae's economy, environment, culture and customs. Cost-efficient methods were developed to allow the project to function in the present economic situation.

#### **1. Efficient spawning induction in Kosrae**

Static-water stimulus was used for all spawning inductions of *T. niloticus*. The animals were kept in a small tank of static sea water filtered through one-micron mesh with strong aeration, for approximately 24 hours. After this spawning stimulus, all the animals were placed in the spawning tank with continuous filtered sea-water flow.

Nineteen spawning experiments were performed, and 66–90 percent of the broodstock were induced to spawn by this method. In Japan, ultraviolet (UV) is used to induce spawning of this species. However, this method is very expensive (Isa, 1991). Additionally, induced rates were almost identical to our result. In Fiji, warm-water stimulus is applied to broodstock. The sea water is warmed by direct heat via sunlight. However, this method is not suitable for Kosrae due to its frequent rainfall. The static-water stimulus is easier, cheaper and the most efficient method of inducing *T. niloticus* to spawn in Kosrae.

#### **2. Hatchery and nursery operations**

##### *2.1 Fertilisation and hatchery operation*

Each individual was sexed while gametes were being released. Males and females were placed in separate filtered sea-water tanks for collection of gametes. Artificial fertilisation was performed immediately after the eggs had been collected.

The fertilised eggs were placed in 40–50 litre hatchery tanks and reared in 1 micron filtered sea-water.

The stocking rate was 10–15 eggs/ml. Aeration was not used at the hatchery stage, because the water currents it created tended to lump eggs and resulted in the presence of bacteria.

Healthy trochophore larvae hatched and approximately 12 hours after fertilisation swam up near the water surface.

## 2.2 Nursery operation

Larvae were collected with a siphon at the veliger stage and placed in nursery tanks containing sea water filtered through a one-micron mesh. It would have been inappropriate to collect them at the earlier (trochophore) stage as trochophore larvae have not yet developed a complete larval shell and are therefore extremely fragile.

A stocking rate of 4–8 larvae/ml was used. The water was gently aerated to create an appropriate current. Water was changed at least once a day. The larvae were collected on 51 micron mesh screen during operations. A 70–81 micron mesh screen was also available for pediveliger (two-day-old) larvae.

Larvae were reared in the nursery until they reached the pediveliger stage, when they were transferred to the juvenile rearing tanks.

## 3. Juvenile rearing techniques

### 3.1 Algal cultivation

Algal cultivation started one month before the pediveliger larvae were transferred to the juvenile rearing tanks (800–1,000 l). The tanks were cleaned with sea water filtered through one-micron mesh. Plastic panels (40 x 30 cm) were set into the tanks at this time to increase the surface area available for the algae to grow.

Sea water filtered through 10 micron mesh flowed continuously through these tanks. The tanks were covered with 85 percent shade-cloth to promote growth of diatoms.

### 3.2 Rearing and growth of juveniles

The pediveliger larvae were transferred into the juvenile rearing tanks after algae had grown on the walls and plastic panels. The larvae settled onto this substrate 1–3 days after transfer. The result of survival experiments suggests that the optimum density is 0.2 pediveliger larvae/per cm<sup>2</sup> (e.g. 35,000 pediveliger larvae in a 1,000 l rearing tank with 44 sheets of plastic panels).

High density created high mortality due to lack of algal food.

Juveniles over 5 mm in shell diameter were transferred to the 5,000 l splasher pools, and reared with giant clams. Juveniles over 10 mm in shell diameter were reared in the 10,000 l concrete raceway tanks with giant clams.

The growth of juveniles during the first eight months is shown in the figure on page 13. Although, the growth rate of juveniles in the rearing tank on Kosrae was lower than the result in Palau (Heslinga 1981), it is similar to those of other tropical Pacific regions (Bour 1990; Isa 1991; Nash 1985).

The number and size of *T. niloticus* cultured in 1992–1994 are shown in the table on page 13.

The *T. niloticus* which were spawned at NAC from March to May 1992 grew to approximately 70 mm in shell diameter in two years. They also achieved maturity; gamete release was observed in March 1994.

## 4. Goal and objectives for next phases

The seed production technique (Phase 1) has been established. Two objectives remain for the completion of this project.

### 4.1 Development of reseeded techniques (Phase 2)

*T. niloticus* is very expensive to culture through to maturation in an 'on-land' aquaculture system. Reseeding the smaller juveniles would reduce the rearing cost. It would also allow a larger number of juveniles to be released and increase yearly seed production.

However, reduced survival rates would occur due to predations on small juveniles. To determine the correct propagation methods, it is very important to establish the cost balance between rearing juveniles in land-based systems and survival in the natural habitat.



**Size and number of *Trochus niloticus* produced (1992 – Feb. 1994)**

Size (mm)	Number	Age
1–5	23,000	< 4 months
5–20	6,000	< 8 months
20–40	5,500	< 1 year
40–70	105	< 2 years

Field observations and basic biological studies must be completed to obtain the required information. It is essential to have information on the predators, feeding habitat, movement and growth of the natural juveniles before starting re-seeding programmes in Kosrae.

**4.2 Seed production, reseeded and conservation (Phase 3)**

Seed production and re-seeding should be continued to enhance and preserve the topshell resources in Kosrae. The techniques developed in phases one and two of the project will be useful for seed production and re-seeding.

The ultimate aim of this project is to enhance the topshell fishery for all Kosraeans. Impartially, not just those people who own fishing apparatus (for example diving gears or vessels). To conserve the topshell resources and equalise income among the people of Kosrae, regulations governing topshell, including limits on the number and size of trochus to be harvested, location, and harvesting methods should be considered.

**References**

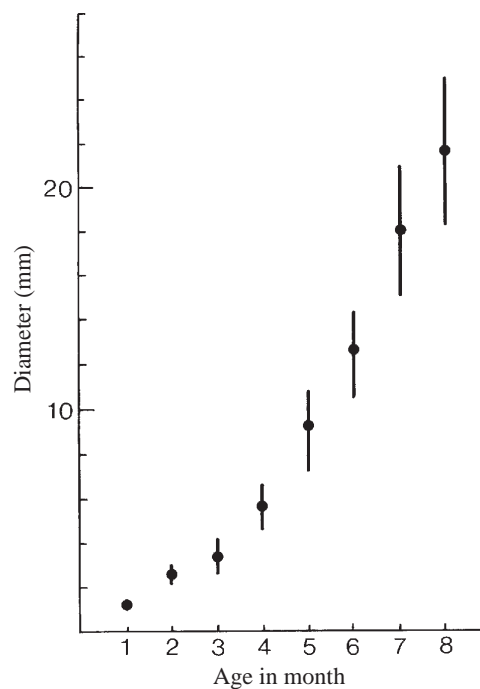
Bour, W. (1990). The fishery resources of Pacific Island countries. Part 3. Trochus. FAO.

Heslinga, G.A. (1981). Growth and maturity of *Trochus niloticus* in the laboratory. Proc. Fourth Coral Reef Symp.

Heslinga, G.A. & A. Hillman (1981). *Hatchery culture of the commercial topshell Trochus niloticus in Palau, Caroline Islands*. Aquaculture 22. 35–43.

Isa, J. (1991). Mass seed production and re-seeding of trochus in Okinawa. FAO.

Nash, W.J. (1985). Aspects of the biology of *Trochus niloticus* and its fishery in the Great Barrier Reef region. Report to the Queensland Dept. of Primary Industries and the Great Barrier Reef Marine Park Authority.



**Growth of *Trochus niloticus* juveniles in the rearing tanks at NAC, Kosrae. (Vertical bars indicate standard deviation)**

**Transplantation of trochus shell, *Trochus niloticus*, to the Kingdom of Tonga**

*by Naita Manu, Shigeaki Sone & Kazuo Udagawa, Ministry of Fisheries, Nuku’Alofa, Tonga*

**Introduction**

Transplantation of trochus is one of the schemes planned under the Aquaculture Research and Development Project started in October 1991. The aim of the scheme is to establish trochus resources in the unused space (niche) of the inshore reef zone and thus to earn foreign exchange in the future for Tonga.

Preparation for the transplantation began with a preliminary site selection survey (Sone, 1992), which was followed by an intensive release site survey (Kikutani et al., 1993).

Fiji was identified as the most suitable trochus source country because of the frequent flight schedule and the abundant resource. During the enquiry period, we learnt that an FAO–UNDP-funded

trochus transplantation to Tonga had been carried out in August 1992 (Gillett 1992). The release site was the Vava'u island group, some 300 km NNE of Tongatapu, and the number of trochus transplanted was 250.

The location of the release in Vava'u was not disclosed to the public to avoid poaching. Thirty-five trochus retained at Sopo Mariculture Centre, Nuku'alofa, had been used later for the land-based experiments such as spawning inducement. A release-recapture trial had been also carried out, using animals released at Vaini Liku beach on Tongatapu island.

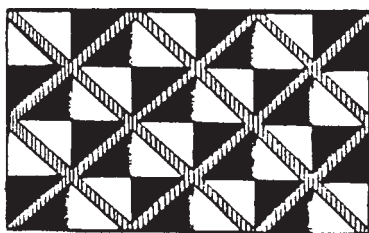
In our project, we have taken a different approach. We announced the release of trochus to the public through the mass media (radio, TV and newspapers), although we did not disclose the exact release points. We believe that the transplantation of the trochus shell is similar to an afforestation project, in which the future management of the resource will be uncertain without the people's cooperation and understanding.

We requested His Royal Highness Prince Lavaka to lead the trochus release ceremony, so that the people of the Kingdom will be aware of the importance of the project, and do not disturb the released stock until it is well established. This approach will also help to raise people's awareness of conservation of nature, including the marine environment.

## Trochus transplantation procedures

### *Collection and transportation*

Following a contract agreement, a consultant, Mr R. Gillett, did the preparatory work, which included obtaining export permission from the Fiji Government and contacting traditional Lau leaders on Lakeba Island, 300 km east of Viti Levu Island, Fiji. Approximately 100 villagers collected 1,119 trochus in 4 days (from 3 to 6 May 1994). A tentative minimum purchase size of 5 cm was set by the consultant, as very small trochus were brought by the villagers.



The trochus were removed from water at 9.30 a.m. (Fiji local time) on 6 May at Lakeba, and sent to Nausori by a chartered flight. They were then transported to Nadi by road, to catch an early morning flight to Tonga. The trochus arrived in Tonga at 9.30 a.m. (Tonga local time) on 7 May, and were placed in the sea-water tank at Sopo Mariculture Centre. They were out of water for a total of 24 hours, of which they spent 19 hours in airtight plastic containers (Gillett 1994).

### *Mortality during transportation*

Upon arrival at Sopo Mariculture Centre, we removed dead shells from the container and put live ones in a sea-water tank, keeping them in mesh bags. Counting and further inspection of the trochus was done at 3 p.m. on the same day. We found 22 dead shells and 1,070 alive.

During the following two days, 24 more shells were found dead, which reduced the number of live trochus to 1,046. No further mortality occurred before release of the trochus into the ocean. The mortality rate was therefore 4.1 per cent. Besides this, 27 trochus were lost during transportation for unknown reasons. It is suspected that small individuals dropped through the mesh of the bag while kept in the sea in Fiji.

### *Measuring and tagging*

Shell diameter was measured for all of the 1,046 live trochus. Then a small hole (4 mm in diameter) was drilled on the outer lip of the shell as a mark to distinguish between the first-generation trochus and their offspring. We constructed the size distribution for the whole consignment and then selected for tagging 100 trochus whose size distribution represented that of the whole. We attached individually numbered 'Dymo tape' to the shells, using quick-dry polyethylene filler. Weights were also recorded. The shells were 42 mm to 150 mm in diameter.

One hundred and forty-six juvenile trochus, whose shell diameters were less than or equal to 60 mm, were omitted from the release in case they should be mis-identified as the second generation. These small trochus were kept in the sea-water tanks at Sopo Mariculture Centre for future release and study. Therefore, a total of 900 trochus was released in May 1994.

### *The release*

The date of the release ceremony was uncertain until 10 May 1994. We decided to release 800 trochus

before the ceremony at the selected release site recommended by Kikutani et al. (1993) to avoid mortality of the trochus in the tanks due to disease or lack of food. The fishing vessel *Albacore*, which belongs to the Ministry of Fisheries, was used to transport the trochus for release. On 11 May 1994, the 800 un-tagged trochus were placed in 20 plastic containers with fresh algae and taken on board. Four hundred trochus were released on the reef of Fukave Island and the others on the reef of Euaiki Island.

*Release ceremony*

With his Royal Highness Prince Lavaka's attendance, the release ceremony of trochus took place on 30 May 1994. The Ministry of Foreign Affairs and Defence approved the use its patrol boat *Neiafu* for the ceremony. One hundred tagged trochus were released at the Fukave site.

**Future direction**

To make the transplantation successful, a regulation that bans the taking of trochus shell should be established. Follow-up surveys on the settlement and reproduction of the trochus should be conducted regularly.

To date, despite the numerous attempts to transplant trochus, there have been no records of adverse environmental, ecological or economic consequences (Nash 1993). However, in our trochus transplantation, the effects on the environment must be monitored carefully. It is also necessary to let the public know of the activities of the Ministry of Fisheries through various campaigns.

**References**

Gillett, R. (1992). The August 1992 transplantation of trochus to Tonga and Niue. FAO/UNDP Regional Fishery Support Programme, Suva, Fiji.

Gillett, R. (1994). The May 1994 transplantation of trochus to Tonga. Consultancy report.

Kikutani, K., N. Manu, T. Tu'avao & Y. Taniguchi (1993). *Feasibility study of trochus and commercially important species (green snail) transplantation to the Kingdom of Tonga*. In: Report of the JICA short-term expert, JICA/ARDP. pp. 25-54.

Nash, W.J. (1993). Trochus (Chapter 14). In: Wright, A. & L. Hill, eds., *Nearshore marine resources of the South Pacific*. Institute of Pacific Studies, Suva; Forum Fisheries Agency, Honiara; International Centre for Ocean Development, Canada. pp. 451-495.

Sone, S. (1992). Preliminary survey report on trochus and the CIS transplantation in Tonga. JICA/ARCP. 9 pp.



**Notes on trochus (Lola) shell production in South Sulawesi Province, Indonesia**

by Dr Rick Braley & Ir. Aspari Rachman,  
Marine Science Education Project,  
Ujung Pandang, Indonesia

In the last issue (Bulletin #2) the production of trochus shell was presented for Maluku Province, Indonesia for the years 1987-1991.

Here, we present data from annual statistics for South Sulawesi Province obtained from the Provincial Fisheries Department (Dinas Perikanan, Ujung Pandang).

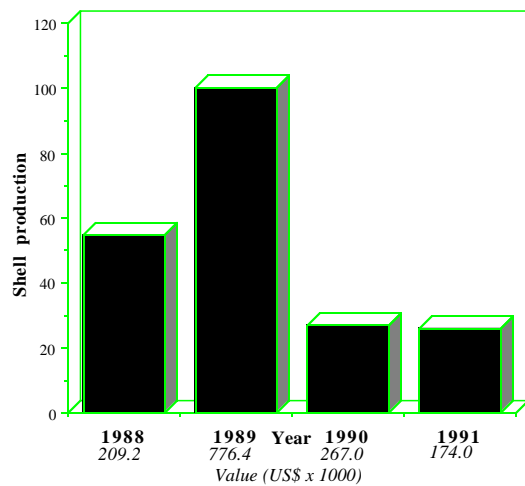
The figure on page 16 is based upon those records. Comparison with the Maluku records show a very similar pattern, with peak production in 1989 and a major plummet in 1990 and 1991.

The table is modified slightly from the Dinas Perikanan annual statistics to show the percentage

increase or drop in total shell weight from the previous year, and the annual value per tonne.

**Records of trochus shell production for South Sulawesi Province**

Year	% increase/decrease in total shell weight from previous years	U.S.\$/tonne
1988	-	3,830
1989	-85.2	7,764
1990	-73.0	9,890
1991	-3.7	6,690



**Trochus shell production (in tonnes) in South Sulawesi Province, Indonesia**

### Recent trochus-related work by the SPC Coastal Fisheries Programme

*by Dr Tim Adams,  
Resource Assessment Section,  
SPC, New Caledonia*

#### Commonwealth of the Northern Marianas

The final fieldwork of the Inshore Fisheries Research Project took place in May 1994. A rapid reconnaissance of the trochus resources of Saipan, Tinian and Rota was carried out by a team of marine resources staff from several countries, and options for future management of the resource were recommended to the Department of Natural Resources, Division of Fish and Wildlife.

Saipan was seeded with trochus in 1938, and trochus were probably transferred to Tinian and Rota in the early 1950s by local fishermen, alongside the transfer to Guam. No commercial harvesting of trochus has been allowed in the Northern Marianas since a period of particularly heavy exploitation at the end of the 1970s, and one of the aims of the survey was to see if a return to commercial harvesting was advisable.

The team, consisting of Tim Adams (SPC Fisheries Resource Adviser), Virgil Alfred (Marshall Islands), Ian Bertram (Cook Islands), Asap Bukurrou (Palau) and Tom Flores (Guam), together with a varying number of CNMI Fisheries Officers, ably led by Richard Seman, spent four weeks surveying the three islands and completing the recommendations.

Most of the work consisted of rapid area surveys using timed swims and transects, but a small mark-recapture experiment was performed on one small patch-reef to demonstrate the use of this method for estimating abundance.

The high price of shell per tonne in 1989 was certainly an incentive for increased fishing pressure here in South Sulawesi, and presumably also in Maluku.

However, the sharp decrease in total shell weight from 1989 to 1990 does indicate a serious reduction of stocks, especially considering that the value per tonne increased during this period.

This indication of serious reduction in stocks is reinforced by the ban on collection of trochus shell from 1992 onwards, by government regulation U.U. no. 5/1990. This ban includes other molluscs such as giant clams.

Tinian and Rota, with their narrow fringing reefs, proved to be poor habitats for developing dense populations of trochus, and most of the shells were found on the Saipan barrier reef. At the time of the survey many of the adult trochus on the Saipan reef-top demonstrated gonadal ripeness by oozing green eggs when picked up, and there were considerable numbers of approximately one-year-old juveniles in shallow water, particularly on areas of the reef remote from shore.

Formally, as with all IFRP country surveys, the report and its recommendations are confidential to the commissioning Government until we are given the all-clear, but SPC can correspond on methodological or scientific aspects of the survey. At this stage, any requests for the text of the draft report itself should be addressed to the Chief of the Division of Fish and Wildlife (fax (670) 322 3386).

#### Other trochus seeding news

A trochus survey was carried out on the island of Lifou, New Caledonia, recently under the auspices of the Université française du Pacifique and ORSTOM. Although the main island of New Caledonia is a prolific trochus-producer, *Trochus niloticus* appears to be completely absent from the offshore Loyalty Islands, and Lifou was seeded with trochus in 1989.

This particular seeding is interesting because it involved the transfer of juvenile shells resulting from aquaculture onto a reef where trochus was not already present – something that has apparently not been attempted anywhere else (the experimen-



tal seedings of aquacultured trochus in Palau and Vanuatu have been carried out in environments where trochus is already endemic).

Unfortunately, the survey did not find any *T. niloticus* on the island and, although it is too early to say that the seeding has not been successful (the

original seedstock would have to grow to sexual maturity before they could start proliferating, and would thus lag 2–3 years behind the seedings of adult shells that have taken place elsewhere), the experiment at this stage does not lend support to the concept of aquaculture as a management tool for natural trochus stocks.

**Trochus production notes**

*by Dr Tim Adams,  
Resource Assessment Section,  
SPC, New Caledonia*

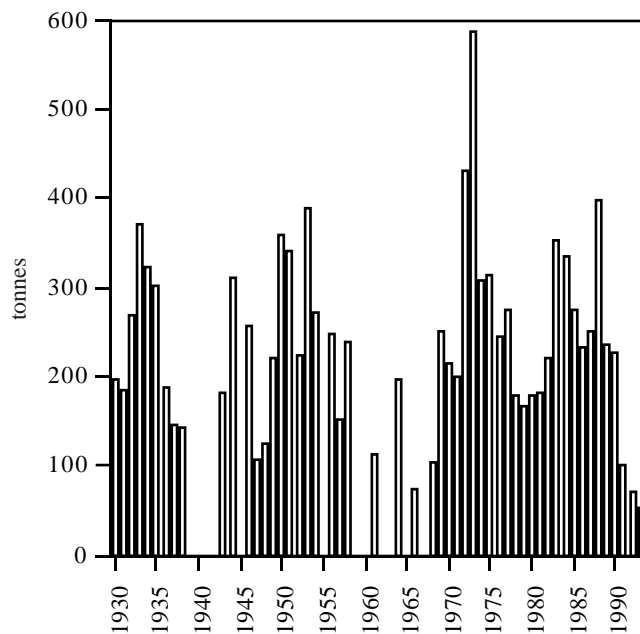
Little information is available at present (and we would be very grateful on updates from Trochus Special Interest Group participants), but few Pacific Islands appear to have exported trochus shell in 1993.

We hear that the 1993 export from *Palau* was only 7t or so, and this is apparently because the local price offered by private-sector buyers was the same as the 1992 price (Asap Bukurrou, pers. comm.). The fishing community had been expecting a substantial increase in the buying price for 1993 and Palauans were reportedly so disappointed with the US\$1.50 per lb on offer that very few people actually went out harvesting in 1993. Palau supplied over 200t of trochus shell to Japan in 1992.

In *Fiji*, legal restrictions on the export of trochus shell have now been gazetted as part of a package of measures to try and protect local investment in button factories. Exports of raw trochus shell from

Fiji dropped off again in 1993 (see histogram below), down to 52t from 71t in 1992 (Parmanand Singh, pers. comm.), and can now be expected to dry up altogether. The Customs-declared FOB export price per kilogram of trochus shell from Fiji in 1993 was F\$11.84 (around US\$8.30 per kg), up from F\$9.94 (US\$6.95) in 1992. The *Fiji Times* reports that the current local buying price for trochus shell at the factory gate is as high as F\$13 per kg.

In the *Federated States of Micronesia*, there has been no trochus harvest in Yap State for the past three years (1991–93); the last harvest, in 1990, exported 40t. FSM State Marine Resources Divisions normally perform trochus stock assessments yearly and decide on a harvest season and quota on the basis of these surveys. Trochus is not native to the other states, but has been introduced at various locations over the years. Pohnpei has had the highest average yearly production (71t) of the states since the 1970s.



**Trochus Exports from Fiji (raw trochus shell)**

*Solomon Islands* has traditionally been one of the major trochus exporters of the Pacific, averaging 387 t yearly in the period 1962–1991. In 1986, over 600 t were exported, but in 1991 this had dropped to 87.5 t (although 98 t or more was purchased by local button factories). The latest 'marine shells' export figures we have from Solomon Islands are for the period January–September 1992, by which time 79t had been exported. In 1991, trochus formed 47 per cent of the exports of 'marine shells'. If the percentage is similar in 1992, and scaling the estimate to allow for the missing final quarter of 1992, we estimate that the export of trochus shell from Solomon Islands in 1992 was approximately 49.5t. Customs export figures have not yet been compiled for 1993 (Wellington Piduru, pers. comm.).

*New Caledonia* is another traditionally major producer, averaging 347t per year of exports in the period 1962–1991, although there was an enormous peak of nearly 2,000 t in 1978. In 1992, 185.5 t of trochus shell were exported from New Caledonia at a local buying price of 250 FCFP per kg (around US\$2.50 per kg). In 1993, exports were 222.5 t, and the average 'farm-gate' buying price in the Northern Province was 238 FCFP per kg (US\$2.35) (Régis Etaix-Bonnin, pers. comm.).

Trochus shell exports from *Vanuatu* have averaged 76t per year over the past 20 years, with a peak of 220t in 1976. Vanuatu had five domestic button factories in 1993, each of which had a quota of 75t of raw shell per year. It is probable that most of the shell fished in Vanuatu is now locally processed, and thus it has become impossible to estimate production from the export figures for raw shell. Unfortunately, the Vanuatu Customs figures do not clearly categorise the export of raw shell, buttons or blanks, and scrap, so it is not possible to estimate production indirectly from the button export figures.

The other major producer in the Pacific Islands region is *Papua New Guinea*, which averaged 380t per year in the decade 1980–1990 (and exported over 1,000t in 1951). Unfortunately we have no recent figures on trochus exports from PNG.



### Trochus reseeded experiments in Australia and Vanuatu

by Laura Castell,  
James Cook University,  
Townsville, Australia

A collaborative project between Vanuatu Fisheries Department and James Cook University (Australia) is looking into the ecology of cultured juveniles *Trochus niloticus* shortly after released onto coral reefs, in particular the effects of seeding density, juvenile size and habitat on juvenile survival.

The project is funded by the Australian Center for International Agricultural Research (ACIAR). Field work has been done at Moso Island (Vanuatu) and Orpheus Island (Australia), following similar methods to allow comparison of results at a geographical scale and to determine how general are the processes occurring to juveniles on reefs.

Results of various experiments indicate that, after 3 days, 20–40% of the juveniles released are missing and predation is likely to be most important cause of mortality. We used seeding densities between 5–30 juveniles/m<sup>2</sup> and found no significant effect of the initial density on survival.

However, based on natural densities of wild juveniles on the reef, seeding densities no greater than 10 juveniles/m<sup>2</sup> are advisable. The tidal height at

which the juveniles were released did not have a significant effect on survival. The intertidal zones at both Orpheus and Moso Islands average more than 200 m wide and more than 1 kilometre in length.

We released juveniles at various tidal heights and found that juvenile survival varies highly both within one tidal height and among the various tidal heights. Although homogeneous over a broad scale the intertidal habitat where *trochus* juveniles live is highly heterogeneous on a small scale, i.e. in distri-



bution of pools at low tide, amount and size of rubble and sand, and density of predators. This suggests that to seed *Trochus* it is probably better to release juveniles over a large area than to concentrate the release in a small one.

Laboratory and field experiments at Orpheus Is. to examine the effect of juvenile size on survival suggest that juveniles larger than 24mm shell diameter survive better, mainly because at this size vulnerability to predation by Portunid crabs and stomato-

pods is minimal. At Orpheus Is. wild juveniles smaller than 20mm than shell diameter have a flatter base and more pronounced knobs than cultured juveniles obtained from adults on the same reef (L. Castell, personal observation). This may provide some protection against predation in wild juveniles.

Field work is continuing and we expect to produce more detailed information about our results by 1995.

## A study of the Enewetak trochus resource

by *Flinn Curren*

*A Project of the Pacific Island Network, University of Hawaii and Enewetak Ujelang Local Government Council, Republic of the Marshall Islands*

### Report summary and recommendations

*Trochus (Trochus niloticus)* resources on Enewetak Atoll, Republic of the Marshall Islands (RMI), were surveyed in July and August 1992. *Trochus* numbers appeared to be fewer than previously reported (Wright & Gillett 1989).

Samples of shells rejected by buyers were measured and potential reasons for their rejection were noted. Samples of live shells were also measured and inspected.

An opinion survey was presented to atoll residents concerning forms of trochus resource management. Shell and meat samples from three locations were sent for radionuclide testing to the Nationwide Radiological Survey in Majuro, RMI. A list (not exhaustive) of potential trochus-shell buyers was compiled using firms noted by Pacific Island governments. Two potential trochus meat-buyers were identified, although no buyers for trochus opercula were located.

The following recommendations were suggested for management and utilisation of trochus resources of Enewetak Atoll:

1. A trochus sanctuary should be established to encourage natural re-seeding of the reefs, and steps taken to protect trochus in those places before trochus season and until trochus shells are sold.
2. Some method should be found to establish trochus harvest quotas, limiting the total amount of trochus taken each season. This limit should

be appropriate for the current trochus resources of the island. The quota recommended by Wright and Gillett (1989), 100 tons/year, is an appropriate level of harvest for the trochus stocks as measured by this study.

3. Accurate trochus harvest records should be kept on the actual amount of trochus shell sold each season. Knowing the size of trochus harvests is very important in order to adjust future harvest sizes. The harvest size can then be changed depending on the abundance of trochus on the reefs.
4. Small and large shell-size limits should be set for live harvested trochus. The recommended size limits are 10.6 cm (3 in.) for the smallest size of trochus taken, and 14.2 cm (4 in) for the largest size of trochus taken.
5. Paid workers should be hired to work prior to and during each trochus season to implement trochus management. These workers would perform the following tasks:
  - a. Monitor the trochus resource with line transects at fixed locations and possibly conduct some tag/recapture efforts prior to and during trochus seasons;
  - b. Patrol trochus sanctuaries to discourage poaching;
  - c. Inspect live trochus for undersized and oversized shells and confiscate undersized and oversized trochus animals and return them to the reef;

- 
- d. Inspect trochus for undersized and oversized shells before sales, and confiscate undersized and oversized shells; and
  - e. Monitor sales of shells to buyers in order to determine total size of harvest.
6. A larger number of trochus buyers should be encouraged, to foster competition between buyers and thus promote higher prices to fishermen.
  7. Export marketing of trochus meat should not be promoted until a proper analysis of meat handling costs, shipping costs and costs of adequate ice-making and freezing facilities are taken into consideration.