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TROCHUS

incorporating molluscs and other shellfish

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INFORMATION BULLETIN

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Editorial

In *SPC Trochus Information Bulletin* No 8, I raised the idea of broadening the scope of the bulletin into a multi-species molluscs bulletin to make it more attractive to our readers. After much discussion, it was decided that in order to maintain 'brand recognition' and retain the same ISSN number for libraries around the world that receive the *SPC Trochus Information Bulletin*, the name of the bulletin needs to be retained. However, to make it broader, more interesting to readers and more attractive to contributors, the bulletin has incorporated a sub-title "incorporating molluscs and other shellfish" to its established name. As of this bulletin, the SPC Trochus Bulletin will now be known as "SPC Trochus Information Bulletin, incorporating molluscs and other shellfish". I wish to take this opportunity to thank many people, especially Aymeric Desurmont, Garry Preston, Tim Adams, Jean-Paul Gaudechoux, Warwick Nash and Barney Smith for their contributions to this discussion.

This issue includes a special trochus manual, *"Trochus hatchery and seeding techniques – A practical manual"*, published as an outcome of the ACIAR-funded trochus research in the Indo-Pacific region. All readers on the mailing list of the *SPC Trochus Information Bulletin* will also receive a copy of the trochus manual, and if there is a strong demand for it, SPC may consider publishing it again as a special publication of the *SPC Trochus Information Bulletin.*

Happy reading and I look forward to hearing and receiving some interesting contributions to the next bulletin from all of you.

Chan L. Lee

Inside this issue

Summary of data collected from a declared trochus season on Saipan, Northern Mariana Islands

Michael S. Trianni

Introduction

The topshell *Trochus niloticus* was introduced into the Mariana Islands during the Japanese mandate years, 1914–1944, when 2974 trochus were planted on Saipan in March 1938 (Asano 1938). The successful transplantation subsequently resulted in Saipan serving as a seeding ground for transplantation to other islands in the current CNMI and Guam (Asano 1939; Van Pel 1956; McGowan 1958). Trochus were not heavily harvested during the early Japanese mandate years, and not at all during the war years from 1942 to 1946 (Smith 1947). During the Trust Territories of the Pacific Islands period, McGowan (1958) reported on trochus harvests from various islands, and estimated the peak harvest from Saipan as being nearly 30.0 tons in 1956.

Regulatory background

Harvest during the Trust Territory period was restricted to any 14-day period during the months of May, June or July, with a minimum harvest size of three inches basal diameter (McGowan 1957). However, it was not clear how such restrictions were enforced. Following the establishment of the Commonwealth of the Northern Mariana Islands (CNMI) in 1976, unrestricted harvest continued until the Second CNMI Legislature introduced and passed Public Law 2-51 in 1981, which created the Division of Fish and Wildlife (DFW). Regulations were also passed in 1981 that gave DFW management authority under CNMI's Department of Lands and Natural Resources (DLNR). The regulations contained a moratorium on the harvesting of trochus — under the authority of the Secretary of DLNR's office — which were to be enforced by DFW. The moratorium provided the Secretary with the authority to open the trochus season under permit, set the minimum size limit at three inches basal diameter (the widest point), and establish two no-take trochus reserves, both on Saipan. One reserve was placed on the east side of the island at Tanke Beach, and the other was placed along a mile-long strip of the Saipan Lagoon barrier reef on the west side of the island, referred to as the Lighthouse Reserve (Fig. 1). DFW regulations also required a DFW export permit to accompany the export of any marine product harvested in CNMI waters. Export permit conditions allowed DFW personnel to sample catches, and obtain catch and export data.

The resource and fishery

In 1993, personnel from the former South Pacific Commission (SPC) and other SPC member countries conducted a survey of trochus resources on the islands of Rota, Tinian and Saipan with the goal of determining a sustainable harvest strategy (Adams et al. 1994). Based on their survey data, Adams et al. estimated that the range for sustainable yield of trochus from CNMI would be from 12.6 to 13.3 metric tonnes (t), with the sustainable yield from Saipan being 9.0 to 11.1 t. The authors of that report emphasised the uncertainty of those estimates, and concluded that the trochus density in CNMI was less than half of the optimally exploitable populations in other countries. In addition, the report suggested that any initial commercial harvest be set at no more than 5 t of dry shell. The report further concluded that the Tanke Beach sanctuary did not contain sufficient numbers of trochus or habitat to warrant its designation, but that the Lighthouse Reserve contained both considerable numbers of trochus and ample habitats.

In 1996 an open season from October to November was declared on Saipan. This was subsequently extended to December due to poor oceanographic conditions. The original time frame of the open season correlated with the recommendation from the Adams et al. (1994) survey. The fishery basal size limit was set at three inches or 76.14 mm, as per DFW regulation. The two existing trochus reserves on Saipan, under the DFW regulation, were the only areas designated as off limits for harvesting. Personnel from CNMI's DFW monitored the fishery opportunistically. Harvest per-

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mits were awarded to two companies, and DFW issued an export permit to one of the two companies.

Catch per unit of effort (CPUE) from the sampled catches ranged from 7.2 to 15.9 trochus per harvester-hour. A total of 1029 trochus were sampled from the two companies on five harvest dates during the first month of the fishery. Approximately 2.9 per cent of the trochus measured from the fishery were found to be below the minimum size (Fig. 2), and subsequently returned to the reef by the harvesters under the guidance of DFW enforcement officers.

An examination of the samples showed that all undersized trochus were harvested on the first day, with subsequent sampled catches having no undersized trochus (Table 1). Catch data were only obtained concurrently with the sampled catches, but indicated that harvest was occurring along the western and southern parts of the island (Fig. 1), although no further catch data were submitted by the companies or collected by DFW staff.

Figure 1. **The island of Saipan showing the trochus no-take reserves and sampled harvest areas**

A dry shell weight–basal diameter regression equation derived by Larcombe (1993) was used to approximate the total dry weight of the measured specimens, estimated at 0.36 t.

In December 1996, a local shipping company identified, for DFW's Enforcement Section, a shipping container that contained trochus shells. These shells could not be connected to an individual or company, and no DFW export permit for the shipment existed. The trochus had been harvested from CNMI, most probably Saipan, prior to the opening of the 1996 fishery. The shipment was confiscated, a total of 9007 trochus shells were counted and their basal width measured. The dry shell weight–basal diameter regression equation (Larcombe 1993) resulted in an estimated total dry shell weight of 1.75 t for the confiscated shells. Approximately 37.6 per cent of the confiscated trochus were found to be below the 76.14-mm basal diameter minimum size (Fig. 3).

The mean basal diameter of the 1029 legal trochus measured from the fishery was 105.84 mm, compared with the mean basal diameter of 83.82 mm from the confiscated container. The average basal diameter found by Adams et al. (1994) from the Saipan sample of 1060 was 86.15 mm, with fore-reef slope trochus averaging 92.12 mm, and reef flat specimens 76.94 mm. Based on survey results, Adams et al. (1994) estimated that 67.4 per cent of the visible trochus populations in the sampled islands were above the 76.14-mm minimum size.

Table 1. **Summary data from sampled harvests on Saipan.**

Date	Area	Depth(m)	# harvested	Mean (size range) mm	CPUE	% illegal
2 Oct. 96	A	2.8-6.1	297	104.31 (64.97–141.12)	12.4	6.06
2 Oct. 96	B	0-1.2	254	106.59 (58.37–139.59)	15.9	4.72
3 Oct. 96	DEF	2.4	86	118.27 (96.70–130.20)	7.2	0
4 Oct. 96	A	2.4	56	105.07 (77.66–138.07)	8.0	0
7 Oct. 96	BCD	4.6	336	103.30 (76.14–139.59)	8.4	0

In December 1996, a shipment of trochus shells were exported from CNMI. The shipment weighed 3972.5 kg, or 3.9 t, with a reported value of USD 4.00/kg for a total of USD 15,890. The port of destination was listed as Hong Kong. The average price per kg in 1995 was listed as USD 3.41, adjusted from various South Pacific countries (ICECON 1997).

Closing remarks

The mean size of sampled trochus from the fishery, 105.84 mm, corresponded to an age of about 4.5 years (Smith 1987). The mean sizes from the confiscated harvest, 83.82 mm, and the SPC survey, 86.15, corresponded to ages of about 3.2 and 3.5 years, respectively (Smith 1987). Trochus appear to attain sexual maturity at about two years of age, at a size range from 50 mm to 65 mm from studies in Palau (McGowan 1958; Heslinga 1981).

Adams et al. (1994) indicated that an upper basal diameter size limit of 114.21 mm might also be used, as trochus above this size are typically encrusted with algae or bored with polycheate worms and/or sponges (Nash 1993), and are of little use to button manufacturers. In addition, the comparative exponential increase in fecundity of larger trochus (McGowan 1958; Heslinga 1981) would be advantageous to recruitment.

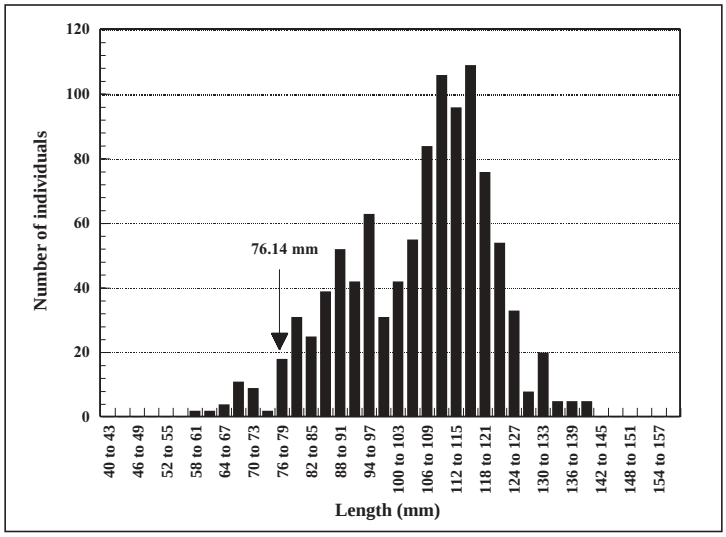

Figure 2. **Length frequency distribution of *Trochus niloticus* from fishery**

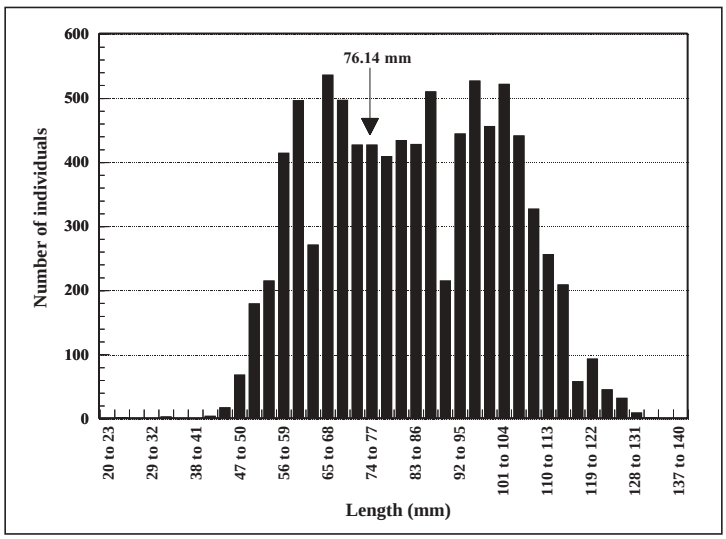

Figure 3. **Length frequency distribution of confiscated *Trochus niloticus***

Smith (1987) found trochus size segregation by reef zone, with larger trochus being found at deeper depths. Heslinga et al. (1984) found an inverse relationship of decreasing trochus density with increasing depth. All three of these factors would tend to restrict both recreational and commercial harvesting to shallower areas, although four of the five sampled catches (Table 1) indicated — by location and depth — that harvesting was occurring on the forereef slope.

The size frequency of trochus measured from the fishery indicated that the harvest companies probably adhered to the minimum size regulation during the beginning of the fishery, although subsequent basal diameter measurements of harvested trochus were not collected, and compliance was, therefore, unsubstantiated. The sample size of trochus represented only 9.2 per cent of the total weight of shells exported. It would have been interesting to observe basal diameter measurement as the fishery progressed over time. Such data would have provided a more complete record of harvesting locations and harvesting depths for future management and/or assessment considerations.

Acknowledgements

The CNMI DFW Conservation Officer Section is recognised for its commendable efforts in monitoring the fishery and measuring the confiscated shells. Dr Steven Purcell provided me with the literature citation for the regression equation of dry shell weight-basal diameter.

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Cultured vs wild juvenile trochus: Disparate shell morphologies send caution for seeding

Steve Purcell[1]

Summary

Wild juvenile trochus hide from predators and have spiked shell whorls until they reach 25–30 mm, when they begin feeding on the reef surface. In contrast, hatchery-produced juveniles begin producing smooth shell whorls at a much smaller size, 10–15 mm. In wild juveniles, the shift in shell morphology occurs at the same time as the behavioural shift. This suggests that hatchery-reared juveniles seeded onto reefs may be shifting to non-cryptic behaviour when they are not yet large enough to avoid predation.

Introduction

The success of seeding reefs with hatchery-produced juvenile trochus, *Trochus niloticus* L., depends on juvenile survival rates. Mortality of seeded juveniles is usually high due to predation from certain turtles, fish, crabs, octopus, stomatopods and carnivorous gastropods (see Nash 1993). Several studies have shown that trochus survival rates increase with juvenile shell size (Vermeij 1976; Castell 1996; T.P. Crowe, unpubl. data). A corollary of this relationship is that juvenile trochus should be cultured to a larger size for seeding onto reefs for restocking. Effects of rearing on trochus, however, may undermine this corollary because hatchery produced juveniles may have different predator avoidance behaviour to wild juveniles, resulting in higher mortality rates than wild juveniles of the same size.

Clarke et al. (in press) recently showed that the shell wall of juvenile trochus cultured in Solomon Islands was comparable to, or thicker than, the shell wall of wild juveniles. In a laboratory experiment, Castell and Sweatman (1997) found that wild and hatchery-produced juvenile trochus responded similarly to a gastropod predator. However, disparate shell morphology of hatchery-produced trochus may be important and little is known about the effect of hatchery conditions on behaviour or survival of juvenile trochus in field conditions. Studies on juvenile abalone (Schiel and Welden 1987; Shepherd et al. 2000) and queen conch (Stoner and Davis 1994; Stoner and Glazer 1998) have shown that hatchery-produced juveniles are more naïve in their behaviour (i.e. less cryptic) and suffer higher predation rates than wild juveniles. If these trends are similar for trochus, the release of juveniles that were maintained under hatchery conditions for long periods (i.e. >6 months), may have serious implications.

Findings and discussion

As part of an Australian Centre for International Agricultural Research funded project on methods for restocking trochus on reefs in Australia, Vanuatu and Indonesia, juveniles were produced in a hatchery in Western Australia (WA). There was a striking disparity in shell morphology between hatchery-produced juveniles and the few wild juveniles that were found in WA (Fig. 1). This finding is similar for juvenile trochus elsewhere, such as Vanuatu (M.J. Amos, pers. comm.) and Indonesia (S.A.P. Dwiono, pers. comm.).

In the wild, juvenile trochus shells have distinct spikes on the lateral edge of each whorl. In extensive surveys in WA, wild-caught juveniles of 25–30 mm basal shell width (BSW) consistently had shells that showed a recent shift from spiked whorl to smooth whorl formation. Trochus smaller than this size were rarely found on the reef surface in WA (Colquhoun 2001; Purcell and Lee 2001) and I believe that small juveniles generally dwell in holes and crevices under the reef surface, within the "reef matrix". When they reach 25 to 40 mm, they appear to shift their behaviour to foraging on the reef surface and hiding less in holes. This behavioural shift is accompanied by a shift in their shell morphology. The spikes on the outer whorl of the shell of small juveniles may increase trochus' defences against predators (cf. Donovan et al. 1999) and/or enable the animals to lock their shells into cracks for protection. Once large enough to venture onto the reef surface, the spikes are less useful and may hinder movement among macro-algae. The spikes are lost on successive whorls.

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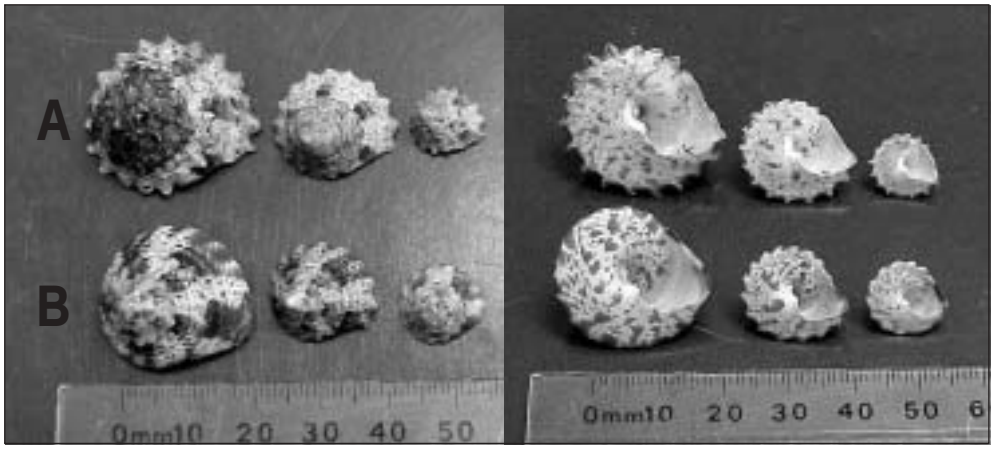

Figure 1.

Size series of wild-caught (A - top three) and hatchery-produced (B - bottom three) juvenile trochus. The largest of the hatchery-produced juveniles has prematurely produced a smooth-edged shell.

Juvenile trochus that were produced in the WA hatchery had shells with spikes, but this only occurred on very small sizes. At about 10–15 mm BSW, they began to produce further whorls with smooth edges. The precocious smooth-shell formation in hatchery-reared juveniles is a warning about seeding with 10–30 mm BSW juveniles. These animals may have shifted prematurely to a non-cryptic behaviour, perhaps due to an absence of predators or predator odours in the hatchery (see Olla et al. 1998), and fail to seek refuge once released onto a reef. It has been suggested that the onset of smooth-shell formation is age- not size-dependent and lower growth rates under hatchery conditions lead to the problem of small, smooth-shelled trochus (T. Komatsu, pers. comm.). Rapid culture of trochus in the hatchery to suitable sizes for seeding or intermediate culture in sea cages, may thus be a key factor for minimising disparities between cultured and wild trochus.

Vermeij (1976) showed that 30–40 mm BSW is a critical size for juvenile trochus; those smaller are prone to predation by crabs. High mortality of seeded juveniles, which do not hide and suffer high rates of predation by crabs and other predators, will result in poor restocking success. Thus, my caution is not related to high mortality due to different shell morphologies, *per se*, but rather that the precocious formation of smooth-shell whorls seems to indicate that hatchery-produced trochus shift to a non-cryptic behaviour at a size when they are quite vulnerable to predators. It is the shift in behaviour that is likely to undermine their survival after release. Until more information is available, releasing small juveniles <5 mm BSW (displaying cryptic behaviour and natural morphology) or sub-adults (40–55 mm BSW), after intermediate culture in sea cages (Purcell 2001) or raceways, may be more appropriate strategies for restocking with hatchery-produced trochus.

Acknowledgements

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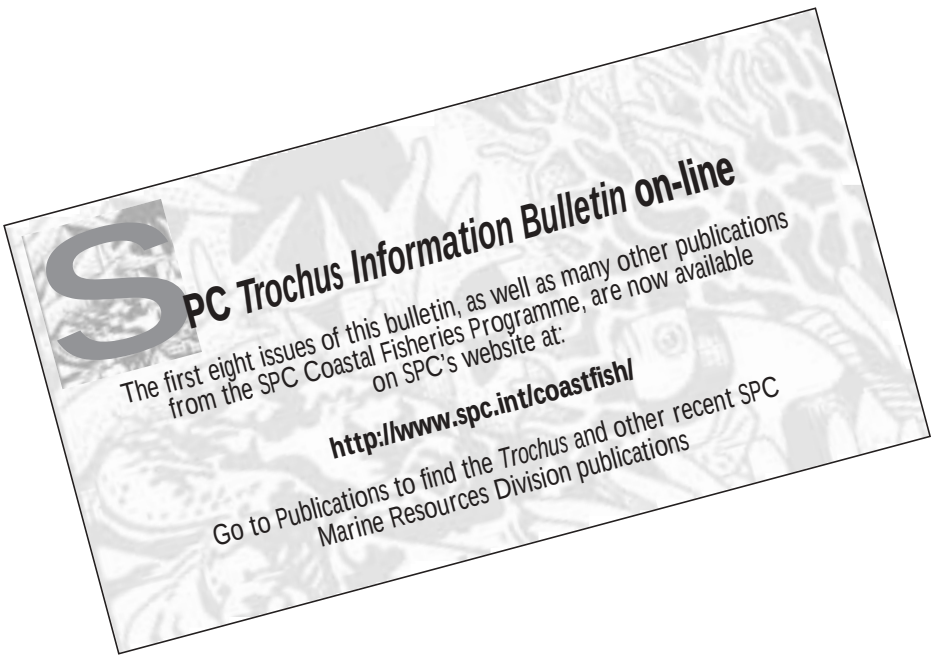

Pacific Islands trochus introductions 1927–1998

Robert Gillett[1]

Editor's note:
This is an updated version of the original paper, Pacific Islands trochus introductions, *written by Bob Gillett and published in the* SPC Trochus Information Bulletin #2 *in 1993. Since that publication, many additional translocations of trochus in the Pacific have taken place and it was believed worthwhile updating the paper. Many thanks to Bob for his effort in undertaking this job and producing this very important history of trochus enhancement in the Pacific.*

Date	Areas	Details	Source
Before 1927	Palau to Chuuk	Unsuccessful attempt Palau to Pohnpei	McGowan 1957
1927-1931	Palau to Chuuk	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 Islands	No details of transfer available; 1986 status unknown to Kiribati officials. Probably mistaken, Enderbury (Phoenix Islands) could have been confused with Enderby (Pulawat, Chuuk)	Bour et al. 1982; Onorio, pers. comm.
1938	Palau to Saipan	2974 individuals released	South Seas Government 1938
1939	Chuuk to Pohnpei	Skipjack vessel transported shells in 2 trips	Asano and Inenami 1939
1939	Chuuk to Jaluit	6143-tonne cargo ship carried shells in 4 water tanks	Asano and Inenami 1939
1939	Palau to Pohnpei; Palau to Satawal	6745 shells transferred; greatest harvest (1951) 180 tons; 5000 shells transferred; success not known	McGowan 1957; 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 Marshall Islands 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.; Smith 1986
1952	? to Hawaii	39 shells released in Kaneohe Bay	Katekaru, pers. comm.
1954	? to Kili Atoll	Unsuccessful	McGowan 1958

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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	Fiji to Tokelau	"Small number of subjects" placed in Atafu lagoon	Van Pel 1958
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; Powell 1960
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
1963	Tahiti to Bora Bora	660 shells transferred	Yen 1988
1964	Tahiti to Raiatea	400 shells transferred	Anon. 1972; Yen 1988
1968	Tahiti to Tuamotu Islands	Manihi 120 shells	Yen 1988
1968	Tahiti to Austral Islands	87 trochus transferred	Yen 1988
1968	Tahiti to Gambier Islands	100 trochus transferred	Yen 1988
1969	Tahiti to Tuamotu Islands	Tikehau 60 shells, Fakarava 170 shells, Takaroa 64 shells, Anaa 60 shells, Pukapuka 100 shells, Rangiroa 355 shells	Yen 1988
1972	Tahiti to Austral Islands	500 shells transferred	Yen 1988
1972	Tahiti to Tuamotu Islands	Arutua 160 shells, Apataki	Yen 1988
1972	Tahiti to Gambier Islands	300 shells transferred	Yen 1988
1973+ ?	Aitutaki to Palmerston	Several transplants but was not successful like earlier transplants to Aitutaki	Powell, pers. comm.
1981-1983	Aitutaki to southern Cook Islands	Palmerston, 3000 shells transferred, abundant at date of report; Manuae, 500 shells, uncommon in 1985; Mitiaro, 300 shells, rare / extinct; Atiu, 300 shells, rare / extinct; Mangaia, 300 shells, rare; Rarotonga, 200 shells, rare / extinct	Sims 1984a and 1984b
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	4708 shells transferred, 12 died enroute	Fagolimul and Price 1987
1984	Somewhere in the Marshall Islands to Ebon, Aur and Maloelap	Done in conjunction with trolling resource survey	Y. Elanzo, pers. comm.
1985	Yap to Ifalik and Eaurpik	1979 shells transferred; 90 died enroute	?

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	Aitutaki to Tuvalu	181 shells transferred in 3 air shipments; successful; larger transfer planned	Parkinson 1984; Pita 1985; Adams, pers. comm.; Batty, pers. comm.
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 Samoa; 161 flown to Samoa to join original shipment; 284 flown direct to Fakaofo and parachuted. One juvenile found December 1987. Juveniles common in 1994 in Fakaofo	Gillett 1986,1988a, 1994
1986	Yap to Eaurpik, Elato, Lamotrek and West Fayu	3125 shells transferred, 22 died enroute	Fagolimul and Price 1987
1987	Aitutaki to Suwarrow	1000 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 shells transferred to Nukulaelae, 2672 to Funafuti and 844 to Nukufetau using military aircraft and parachutes	Gillett 1988c
1989	Aitutaki to Tokelau and Tuvalu	1000 shells transferred to Nui, 600 to Nanumea,1200 to Atafu and 1080 to Nukunonu using military aircraft and parachutes	Gillett 1989
1989	New Caledonia (Grande Terre to Loyalty Islands)	5709 juveniles transplanted from Grande Terre to Lifou	Hoffshir et al.1990
1989	Pohnpei to Nukunonu and Kapingamarangi	500 shells transferred to each island, about 6 died in transit. Used flooded skiff on deck	Curren, pers. comm.; Gawel, pers. comm.
1990	Fiji to Samoa	40 trochus transported in September using commercial aircraft and released at some large shells kept at Fisheries Division in Apia for spawning	Zann, pers. comm.
1990	Fiji to Samoa	78 trochus (many were juveniles) transported in October using commercial aircraft and released at Namu'a Island in Aleipata area; In Sept. 1998 the owner of a small resort on Namu'a stated that he had seen, during the last year, a few trochus that were "different and much harder than the local species" (can't break it on rocks and eat it).	Gillett, pers. comm.
1990 (?)	Pohnpei to Pingalap	125 one-inch trochus transplanted	Gawel, pers. comm.
Nov. 1991	Woleai to Elato and Lamotrek	500 and 304 shells transported respectively	Fanafal and Clarke 1994
Jan. 1992	Ulithi to Sorol	500 shells transported	Fanafal and Clarke 1994
Aug. 1992	Uliti to Eauripik	103 shells transported	Fanafal and Clarke 1994
Aug. 1992	Woleai to Fachaulap	200 shells transported	Fanafal and Clarke 1994

Aug. 1992	Fiji to Tonga	545 shells collected on 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; 223 eventually placed on reefs at: Hakapu (99 shells), Namakulu (77) and Tamakautoga (47). In early 1998 several juveniles were found by Fisheries and by JICA near the Pangaimotu causeway; Additional 384 shells transferred from Tongatapu to Vava'u in July 1998	Gillett 1992, Gillett pers. comm.; JICA pers. comm.; 'Ulunga, pers. comm.
May 1994	Fiji to Tonga (Tongatapu)	1172 shell collected on Lakeba Island. 1070 delivered alive to Tongatapu. Majority eventually placed on reef on NW Tongatapu; some juveniles reported by JICA in mid-1998	Gillett 1994; Manu et al. 1994; JICA pers. comm.
Jan. 1995	Fiji to Tonga (Ha'apai)	594 shells collected at Lakeba Island and transplanted to Uoleva Island, Ha'apai; Additional 350 shells transferred from Tongatapu to Uoleva in July 1998	Gillett 1995; 'Ulunga, pers. comm.
Aug. 1996	Tonga to Niue	311 shells (progeny of an earlier transplant to Tonga) placed at Namakulu and Tamakautoga	Pasisi, pers. comm.
Late 1990s	Fiji to Kiribati	Unknown number of shells transplanted to a quarantine facility in Tarawa and to an outer island	Mentioned by Kiribati representative at SPC/ACIAR aquaculture meeting July 2001
Late 1990s	Tonga to Samoa	Unknown number of shells transplanted from Tongatapu hatchery to Samoa	Mentioned by Samoa representative at SPC/ACIAR aquaculture meeting July 2001

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Successful induced spawning of the top shell, *Trochus niloticus*, at SEAFDEC/AQD, Philippines

R.S.J. Gapasin[1], W.G. Gallardo[1] and B. Polohan[1]

The top shell, *Trochus niloticus*, with its mother-of-pearl shell and edible meat is one of the most heavily exploited marine gastropods in the Indo-Pacific region. In the Philippines, the unregulated commercial harvest of trochus has reduced the natural population to near extinction. Studies on the reproductive biology and ecology of trochus have led to the development of spawning and hatchery techniques to produce seeds for aquaculture and possible restocking programmes to help regenerate depleted natural stocks.

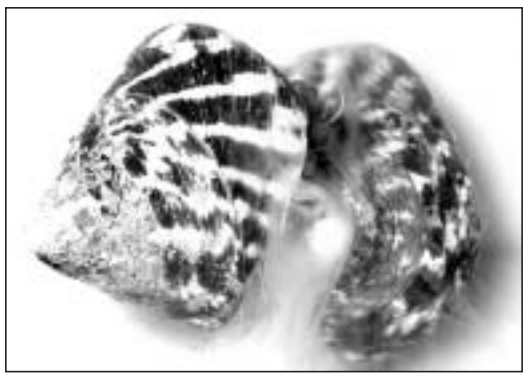
Induced spawning and seed production of trochus was done in the 1980s, notably in the South Pacific region and subsequently in Australia, Indonesia and elsewhere. The Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC / AQD) successfully spawned gravid trochus on 1 February 2002 with the objective of mass-producing top shell juveniles for stock enhancement. Forty mature trochus (50–80 mm basal diameter) of mixed sexes were subjected to combined static-water stimulus and thermal shock. Of the 2.3 million eggs spawned and incubated in flow-through, UV-treated seawater, about 337,333 developed to become veligers.

In our second spawning trial (27 February 2002), a batch of 80 gravid trochus was divided into two groups. The first group received static-water stimulus while the second group was subjected to thermal shock. Both groups received UV-treated, flow-through seawater thereafter. The first group responded first giving 1.5 million eggs, of which, 391,000 became veligers. The second group, responding only after the second thermal shock attempt, produced 480,000 eggs, of which, only 46,000 became veligers.

Our third spawning trial (13 March 2002) was similar to the second one, except we compared the effect of sand-filtered seawater as a flow-through medium with UV-treated seawater. This was done, after the stimuli were delivered, to determine the cost-effectiveness of the two rearing methods. Only static-water stimulus with UV-treated, flow-through seawater was effective, producing 1.2 million eggs, of which, 437,000 developed into veligers. Both groups given the static-water stimulus and sand-filtered, flow-through seawater and those treated with thermal shock and UV-treated, flow-through seawater did not respond. In the group given thermal shock and sand-filtered, flow-through seawater, only the males spawned.

Veligers produced from the three spawning trials were stocked in our settlement tanks (i.e. provided with corrugated plates covered with diatom growth). They are being monitored for growth and survival.

As a result of the success in induced spawning, funds are being requested to support our seed production and stock enhancement research programme.



Male *Trochus niloticus* spawning

1. Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC), Tigbauan, 5021, Iloilo, Philippines

Recent news and publications on trochus

ACIAR Funding

ACIAR has approved funding of a community management phase of the trochus project *'Integration of broodstock replenishment with community-based management to restore trochus fisheries'*. The three-year project will run from 2002 to 2005 involving Australia, Vanuatu and Samoa. More information on the project will be provided in the next bulletin.

Philippines commences work on trochus

The Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC / AQD) based in Iloilo, Philippines has commenced with trochus hatchery work with the aim of producing large numbers of juveniles for stock enhancement trials on its depleted reefs. We look forward to hearing more about the progress and future development of this project.

Recent publications

The following are some recent publications resulting from ACIAR-funded trochus research projects.

Amos, M.J. and S.W. Purcell. 2000. Caging strategies for reef based grow-out of *Trochus niloticus* (Gastropoda) in Vanuatu. Abstracts, 9th International Coral Reef Symposium, Bali, Indonesia, p. 225.

Colquhoun, J.R. 2001. Habitat preferences of juvenile trochus in Western Australia: Implications for stock enhancement and assessment. SPC Trochus Information Bulletin 7:14–20.

Crowe, T.P., G. Donson and C.L. Lee. 2001. A novel method for tagging and recapturing animals in complex habitats and its use in research into stock enhancement of *Trochus niloticus*. Aquaculture 194(2001):383–391.

Crowe, T.P., M.J. Amos, S.A.P. Dwiono, G. Dobson and C.L. Lee. 2002. Trochus hatchery and seeding techniques – A practical manual. Contract report No. 1, Department of Fisheries, Western Australia, Perth, 36 p.

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Lee, C.L., S.W. Purcell and G. Maguire. 2001. Farming trochus. Aquaculture WA, No. 8. Department of Fisheries, Western Australia, Perth.

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