Trochus research in Australia

Part 1. Hatchery and nutrition research

by Dr Chan Lee [1] *– Project Coordinator*
ACIAR Trochus Reseeding Research Project

A Trochus Hatchery and Nutrition Research Project funded by the Department of Employment, Education, Training and Youth Affairs (DEETYA), Canberra, and involving the Northern Territory University (NTU), Darwin, Australia and the University Nusa Cendana (UNDANA), Kupang, Indonesia, was successfully completed in June 1996. An end-of-project conference funded by DEETYA and the Australian Centre for International Agricultural Research (ACIAR) was conducted at NTU on 6–7 June 1997. Some 50 participants, including research scientists from Australia, Indonesia and the Pacific, attended the two-day conference. During the conference, the major findings of the three-year research project were highlighted. In addition, contributions were made on trochus research carried out by countries in the region. A total of 29 papers was presented during the conference; the titles and abstracts of some are given below.

Design and operation of a land-based closed recirculating hatchery system for the topshell, *Trochus niloticus* using treated bore water

by C.L. Lee

Saline bore water high in iron was successfully treated and found to be ideal as a source of seawater supply for a land-based research hatchery for trochus. After aeration, sedimentation and dilution with freshwater, the treated saline bore water was successfully used to maintain trochus broodstock to produce juvenile trochus in the hatchery of the Northern Territory University (NTU). Wild trochus collected from King Sound, Western Australia were successfully translocated and maintained in the closed recirculating tank system developed at NTU. The wild broodstock spawned and the F1 matured and produced F2 successfully after 2.5 years, thereby 'closing' the life cycle. The closed recirculating hatchery system developed for producing juveniles was highly efficient in water utilisation and low in labour input. The system was adequate for producing the juveniles needed for the nutrition and related growth rate and reseeding studies. Over a three-year period, several hundred thousand juveniles of different size classes ranging from 1 to 25 mm were produced in the NTU hatchery. Average estimated cost of production for the smaller 1 to 3 mm size-class juveniles varies from <1.0 cents to 3.3 cts/juvenile.

Hatchery of the topshell (*Trochus niloticus*) in eastern Indonesia

by S.A.P. Dwiono, P.C. Makatipu and Pradina

The topshell (*Trochus niloticus* L.) is one of the most valuable marine resources in Indonesia. Due to fishing pressure, trochus is categorised as a threatened species. In order to enhance its population, seed production of this topshell was initiated in eastern Indonesia in 1994. Seven batches of trochus have been produced artificially. Strong aeration followed by UV-treated seawater proved effective in inducing the broodstocks to spawn. The larvae and juveniles are fed mainly on a cultured sessile diatom,

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Navicula spp. Growth rate is relatively high but the survival rate is low. In spite of good growth of the seeds, improvements of rearing techniques for this species are needed. The result of the seed production techniques is presented and discussed.

Current status of topshell, *Trochus niloticus*, hatcheries in Australia, Indonesia and the Pacific – A review

by C.L. Lee & M. Amos

One private and five institutional hatcheries for trochus, *Trochus niloticus,* are currently in operation. The research hatcheries are located at (i) the Northern Territory University (NTU), Darwin, Australia; (ii) the Indonesian Institute of Science (LIPI), Ambon, eastern Indonesia; (iii) the island of Barrany Lompo belonging to the University Hasanuddin in Ujong Pandang, eastern Indonesia; (iv) the Fisheries Department, Port Vila, Republic of Vanuatu; and (v) Sopu field station in Tonga. The sole private hatchery is located on Seram Island, eastern Indonesia. The oldest hatchery currently in operation is located in Port Vila; it has been in operation since the late 1980s. The other hatcheries were established in the early to mid-1990s. The hatchery in NTU is unique and is the only one that uses saline bore water for its water supply; all the other hatcheries pump seawater directly from the sea to supply their need. The NTU hatchery is also the only one currently in operation that uses a closed recirculating hatchery system for producing juveniles. The other hatcheries use flow-through or semi-flow-through systems for producing their juveniles. All the hatcheries have successfully produced juveniles in the last few years. It is encouraging that a private trochus hatchery is currently in operation in Indonesia. Occupying a floor space of 600 m^2, it is the largest trochus hatchery currently in operation in the world.

Fatty acid composition and proximate biochemical composition of wild and hatchery held broodstock of the marine topshell, *Trochus niloticus* (Mollusca: Gastropoda)

by F. Rebhung, S.M. Renaud, D.L. Parry & C.L. Lee

The fatty acid composition and proximate biochemical composition (carbohydrate, lipid, protein and ash) of foot tissue of adult *Trochus niloticus* (Gastropoda: Archaeogastropoda) collected from King Sound, north-west Australia (Group 1), were determined. Results were compared with those for animals from the same collection maintained for a year in the hatchery at Northern Territory University Aquaculture Centre (Group 2). The animals were mature broodstock and there was no significant difference in the total live weight of Group 1 and Group 2 at harvest. Foot tissue of Group 1 was composed of carbohydrate (3.8 % dry weight), lipid (6.1 %), protein (77.7 %) and ash (5.4 %). Animals of Group 2 had ash and protein contents similar to those of Group 1, but there was significantly lower lipid (5.3 % compared to 6.1 %; $p < 0.05$) and higher total carbohydrate (5.0 % compared to 3.9 %; $p < 0.05$). There was no significant difference in proximate composition between male and female for either group. The principal fatty acids (greater than 5% total fatty acids) were palmitic acid [16:0], stearic acid [18:0], oleic acid [18:1(n-9)] and arachidonic acid [20:4(n-6)]. Percentages of eicosapentaenoic acid [20:5(n-3)] and docosapentaenoic acid [22:5(n-3)] in Group 1 animals were lower than percentages reported for other archaeogastropods. There were changes in the fatty acid composition of Group 2 animals which included significant increases in the percentage of polyunsaturated fatty acids 16:3(n-6), 18:2(n-6), 20:5(n-3), 22:5(n-3) and 22:6(n-3) and significant decreases in the percentage of saturated fatty acids 16:0 and 18:0. The results for 16:0, 18:0, 16:3(n-4) and 20:5(n-3) reflected the fatty acid composition of the hatchery-mixed microalgae feed.

The food preference of the tropical topshell, *Trochus niloticus* fed on algae from Darwin Harbour

by G. Lambrinidis, J. Luong-Van & S. Renaud

Food preference of adult trochus, *Trochus niloticus* L., was investigated by estimating the feeding index and food consumption for ten species of seaweeds (*Halimeda borneensis*, *Symploca* sp., *Dictyota ciliolata*, *Padina australis*, *Padina boryana, Rosenvingea nhatrangensis*, *Sargassum* sp., *Acanthophora muscoides*, *Tolypiocladia glomerulata* and *Hypnea* sp.) and a mixed microalgal diet. It was found that trochus ate larger amounts of the soft filamentous forms (e.g. *Symploca* sp., *Hypnea* sp., and *Tolypiocladia glomerulata*) and the corticated *Acanthophora muscoides* than the leathery brown *algae (Rosenvingea nhatrangensis,*

Sargassum sp. and *Padina* spp.) and the calcareous green algae (*Halimeda borneensis*). When food preference was expressed as feeding indices, it was found that there was no correlation between structural characteristics of the diets and feeding index. The mixed microalgal diet scored the highest index.

A study on density, abundance and distribution of juvenile trochus and its associated small molluscs in Kei Besar Island, Indonesia

by J.C. Dangeubun & S. Haumahu

Juveniles of top shells, *Trochus niloticus*, occurred in 20 per cent of the observations on the intertidal zone of the East Coast of Kei Besar Island, having density and abundance of 0.55 snails/m^2 and 1.83 snails/m^2, respectively. Juvenile trochus were found mostly underneath rocks or rubble along the coast at the low-tide-exposed area of the intertidal zone. There are 37 species of small mollusc (33 species of gastropods and 4 species of bivalves) occupying the same habitat as juvenile trochus. The highest densities of associated species, in decreasing order, are *Cellana radiata*, *Rissonia spirata*, *Natica sertata*, *Mitra* sp. and *Rhinoclavis* sp., while the highest abundances of associated species, in decreasing order, are *Mitra* sp., *N. sertata*, *C. radiata*, *Rhinoclavis* sp., *Notonister* sp., *R. spirata*, and *Pyramidella terebelloides*. Species that were found in the highest frequency of occurrence, in decreasing order, are *C. radiata* (85%), *R. spirata* (40%) *Epitonium lamelosa* (35%), and *Nerita albicila* (35%).

Management policy for trochus fisheries in the Pacific

by M.J. Amos

Commercial trochus fisheries started throughout the Pacific in the first decade of this century. The harvest of trochus has provided a significant source of revenue and employment in the Pacific region. Trochus has also played a significant role in fishery development in the Pacific. Its introduction into a number of Pacific Island States represents one of the more successful facets of fishery development. While the development of trochus fisheries has been successful in a number of areas, the effectiveness of management policies has been less clearly demonstrated. The status of trochus fisheries in some countries is not known because of inadequate or non-existent catch statistics. Information from fishermen or shell buyers often provides some indication of overfishing. The vulnerability of trochus to overfishing suggests that trochus fisheries may best be conserved by implementing conservative management regimes in the early stages of fishing.

Potential of remote sensing data for identifying trochus re-seeding sites

by W. Ahmad & G. Hill

During different stages of their life cycle, trochus exhibit preferences for different reef habitats. Likewise, within any reef complex there will be variation in the availability and distribution of these preferred habitats. Satellite remote sensing is able to identify and map the relevant reef types. Knowledge of the habitat base available within any proposed reseeding area will be an important consideration in reseeding activities. Where local knowledge is unavailable, or the area is remote, satellite remote sensing offers a reliable means of assessing the habitat base for trochus.

Establishing a relationship between habitat and abundance of trochus in King Sound, North-western Australia

by K.L. Magro

The habitat and abundance of trochus have never been investigated for the commercial trochus fishery in King Sound, north-western Australia, which has been operational since 1979. Estimates of trochus habitat and abundance were established from strip transect sampling of reef edge and reef flat habitats. Cluster analysis of habitat data separated the transects into 4 groups: algal pavement (56 transects), macroalgal pool (22), rubble pavement (4) and exposed rock (9). The maximum basal diameter was variable between reefs, especially between fished and non-fished reefs. Although the majority of variation was explained by reef site, larger shells were found on reef edges, and reef flats were dominated by smaller shells. There were very few trochus above the maximum legal size of 100 mm. The mean density

of trochus within legal size limits (65 to 100 mm) on the reef edge (4.03 ± 0.630 se per 156 m^2, n=35) was significantly greater than on the reef flat (0.39 ± 0.107 se per 156 m^2, n=56). The high occurrence of small shells possibly indicates growth over-fishing of the trochus resource. The results from this study can be utilised (in conjunction with satellite images) to estimate the total area of habitat, standing stock and biomass of trochus in King Sound.

The papers from the conference have been published as an ACIAR Proceedings entitled: Trochus: Status, hatchery practice and nutrition. *For copies of these proceedings please contact:*

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Part 2. ACIAR Trochus Reef Reseeding Research

by Dr Chan L. Lee

Following the successes achieved in the Trochus Hatchery and Nutrition Research Project (see Part 1), the Australian Centre for International Agricultural Research (ACIAR) is funding another phase of the trochus research involving reef reseeding of juvenile trochus. The ACIAR-funded project involves three countries and six institutions; a three-year research budget of AU$ 680,138 was provided. The commissioned organisation for the project is the Northern Territory University with Dr Chan L. Lee appointed as project co-ordinator and Dr Tasman Crowe as research associate. The Australian component also involves the Western Australian Fisheries Department and the Aboriginal communities of King Sound. The two other countries involved in the research work are Indonesia and the Republic of Vanuatu. The Indonesian institutions involved in the research project are the Indonesian Institute of Sciences, University Pattimura and University Nusa Cendana with Dr Dwiono, Miss Dangeubun and Dr Rebhung respectively as country co-ordinators. Vanuatu is represented by Mr Moses Amos of the Department of Fisheries as the country co-ordinator.

There are many reasons for carrying out the trochus reseeding research over such a wide geographic region. Although there have been several preliminary studies into the potential of reseeding as a tool for the management of trochus fisheries over the last 13 years, no clear consensus has emerged. To date, the success of reef reseeding has been variable. In some cases there have been encouraging results, but hatchery-reared juveniles released into the wild have not always been recaptured in large numbers. Mortality or loss of juveniles can act to limit the impact of hatchery-reared individuals on adult populations. The preliminary nature of the studies, however, limits the scope of the conclusions that can be drawn from them. The results have been variable, there have been some methodological problems, and some issues, such as temporal variation in success of reseeding, have not yet been investigated. The study commissioned by ACIAR under the Trochus Reseeding Research Project should help to resolve some of the issues. For further discussion on the potential of reseeding with juveniles as a tool for the management of trochus fisheries, see Crowe, Amos & Lee (**In:** Trochus: status, hatchery practice and nutrition, ACIAR Proceedings, June 1997).

According to Mr Barney Smith, ACIAR Fisheries Programme Co-ordinator 'the ACIAR-funded Trochus Reef Reseeding Research Project is at the cutting edge of research on stock enhancement. It also involves training in hatchery work and on research to standardise the spawning and mass production of trochus juveniles'. Since the commencement of the research project, numerous benefits have already been derived by the institutions and staff involved in the research. Some of these are:

1. Upgrading of the trochus hatchery in all participating institutions;