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REPORT ON THE ACIAR GIANT CLAM PROJECT

INFORMATION PAPER

South Pacific Commission

Eighteenth Regional Technical Meeting on Fisheries

REPORT ON THE ACIAR GIANT CLAM PROJECT

SUMMARY

The structure of the project is outlined and the current research activities of the five collaborating institutions are listed. Recent research at James Cook University, the Commissioned Organisation, is described in more detail. Mariculture research at JCU is concentrated on Tridacna gigas. New techniques for assessing reproductive condition and spawning induction have been developed. Intensive and extensive methods of rearing the larvae have been used with success. Progress has been made in overcoming heavy mortality of recently settled juveniles. Various methods of holding juvenile clams in their ocean-nursery phase have been tested. As a result, there will be a major research effort to develop an intertidal system for the ocean phases of T. gigas mariculture.

PROJECT STRUCTURE

The giant clam mariculture project (Project No. 8332), funded by the Australian Centre for International Agricultural Research, commenced in mid-1984 and is planned to run for three years. The main objectives of the project are to :

(1) assess giant clam stocks at various localities;

(2) study growth rates in natural populations and the effects of environmental factors;

(3) elucidate the reproductive biology of giant clams;

(4) determine the optimum conditions for development of larvae and juveniles;

(5) apply the results of this research to the development of large-scale mariculture techniques.

The organisations participating in the project are :

1. Commissioned Organisation

James Cook University

Overall project leaders - A/Prof. J.S. Lucas
Dr. J.L. Munro (ICLARM)

Current research - (i) reproductive biology and chemistry

(ii) intensive versus extensive rearing of larvae (concentrating on Tridacna gigas in this and iii and iv)

(iii) optimising nursery-phase survival and growth

(iv) comparative study of methods for ocean-nursery phase

(v) growth studies through shell-sectioning and field measurements

(vi) development of a micro-encapsulated diet for larvae

2. Collaborating Organisations

A. Fisheries Division, Ministry of Primary Industries, Fiji

Project leader - Dr. A.D. Lewis.

Current research -(i) survey of giant clam stocks on Fiji's reefs (75% completed)

(ii) estimation of natural growth rates of T. derasa

(iii) new Tridacna species, cf. T. derasa

(iv) preparation of quarantine seawater system to import T. gigas juveniles from JCU to re-establish this species in Fiji

(v) monitoring commercial harvesting and sale of giant clam meat

B. University of Papua New Guinea

Project leader - Dr. J.C. Pernetta

Current research - (i) chemical analysis for nutritional value of fresh clam products

(ii) chlorophyll content versus size and growth rate

(iii) seasonal reproductive cycles

(iv) extensive culture of larvae (T. gigas, T. squamosa, H. hippopus)

(v) environmental influences on growth and survival in nursery and ocean-nursery phases.

C. Silliman University Marine Laboratory (Negros Island, Philippines

Project leader - Professor A.C. Alcala

Current research - (i) completion of survey of giant clam stocks in the south-central Philippines

(ii) extensive culture of larvae (T. squamosa, H. hippopus, H. porcellanus)

(iii) environmental influences on growth and survival during the nursery-phase

(iv) predators of giant clam juveniles and adults

(v) restocking protected reefs in cooperation with fishermen's associations.

D. University of the Philippines Marine Science Institute

Project leader - Professor E.D. Gomez

Current research - (i) stock surveys at selected localities in the Philippines

(ii) analysis of utilization of giant clam resources in the Philippines

(iii) propagation of conservation measures

(iv) growth of T. derasa and H. hippopus

(v) spawning and larval development of T. squamosa

This ACIAR Project arose from an initiative in 1983 by Dr. John Munro, ICLARM, to develop an international collaborative program of research on giant clams : the International Giant Clam Mariculture Project. James Cook University accepted an invitation to join the IGCMP and Dr. Munro is an overall joint leader of the ACIAR Project with A/Prof. John Lucas.

ICLARM is involved in the development of a pilot hatchery for giant clams in the Solomons (see the separate information page **ICLARM TO OPEN NEW PACIFIC REGIONAL AQUACULTURE CENTRE**), and in stock assessment, product development and socio-economic aspects of giant clam mariculture. Results of mariculture research by the collaborating institutions of this Project will be implemented at the pilot hatchery, which represents another step in the process of developing the commercial mariculture of giant clams.

RESEARCH AT JAMES COOK UNIVERSITY

Research at the five collaborating institutions is coordinated through exchanges of personnel and regular meetings of the Project Leaders. The Project Leaders recently met in the Philippines, being hosted by the University of the Philippines Marine Science Institute and Silliman University Marine Laboratory, to prepare the two year report and to plan research activities in 1986/87. Each institution is researching aspects of the project and species of giant clams that are appropriate to their country and facilities.

The remainder of this Information Paper will describe the research taking place at James Cook University (JCU) in particular.

Mariculture research at JCU is concentrated on T. gigas. Although rapid growth rate is obviously not the only criterion in assessing suitability for mariculture, it is very important, and T. gigas is the fastest growing (and largest) tridacnid species. Other species being reared and studied are T. derasa, T. squamosa and H. hippopus. The mariculture research is conducted at the JCU Orpheus Island Research Station, north of Townsville.

Reproduction

Histological studies of T. gigas from Great Barrier Reef waters show an annual reproductive cycle with the greatest proportion of ripe eggs during summer months. It appears that there may be repeated partial spawnings during summer. This leads to spawned-out animals with no evidence of a second onset of gametogenesis during the spawning period.

T. derasa spawns earlier in summer than T. gigas in the Townsville region and it differs from T. gigas in that, while T. gigas (and other tridacnid species?) is usually hermaphroditic, T. derasa tends to be dioecious.

Spawning

Brood-stock clams are induced to spawn by an injection of serotonin (a neuro-transmitter substance) into the gonad. Using this technique on a group of giant clams, it has been possible to regularly obtain eggs and sperm from T. gigas brood-stock.

This is a major advance for mariculture of T. gigas as previously gametes could only be obtained from occasional spontaneous spawnings.

Giant clams shed sperm soon after stimulation and then eggs an hour or so later (apparently to reduce selfing of gametes). The sperm and eggs are collected as they are released: eggs are collected in large plastic bags placed over the clam's excurrent aperture as it expels the gametes.

Hatchery phase

Giant clam larvae has been cultured using intensive and extensive methods. Intensive methods are those used in

commercial bivalve mollusc hatcheries : micro-filtered seawater, daily water changes, feeding with cultured unicellular algae and controlled temperature, etc. Good survival through larval development has been obtained with this method. It is more reliable than extensive culture, but it has the disadvantages of requiring much greater imputs of labour and technical facilities. Giant clam larvae have also been cultured extensively, i.e. large numbers of eggs are added to outside tanks with static seawater and essentially left to develop. The only management is some additions of unicellular algae for food and a water change if bacteria bloom excessively. Some batches of extensively cultured larvae are lost through virtual total mortality.

The period of larval development of giant clams is short (about 7 days) compared to other commercial bivalves such as oysters and scallops. This is a distinct advantage for their mariculture, as the period of larval development is the most technically-demanding of the bivalve life-cycle. The larvae have quite modest requirements of algal food. Thus they appear to be good candidates for development of an artificial diet, which would obviate the need for algal culturing facilities. Artificial diets (microencapsulated food particles) have been developed for penaeid larvae, but not yet for bivalve larvae; so the development of a microencapsulated diet for giant clam larvae would be a major breakthrough.

Nursery phase

The late-stage larvae, pediveligers, are transferred to outside tanks from intensive culture or allowed to settle in their hatchery tanks in extensive culture. The newly-settled juvenile clams are 0.2 mm shell length and it is some months before they are visible on the tank surfaces where they have settled. The juvenile clams must commence their symbiotic relationship with zooxanthellae soon after settlement and the recently-metamorphosed juvenile clam are "inoculated" with zooxanthellae obtained from pieces of mantle tissue of adult clams. (This saves having to maintain cultures of zooxanthellae.)

In the first batch of T. gigas juveniles reared in early 1985 there was very heavy mortality between settlement and 5 mm shell length. Less than 1% of the original pediveligers survived this period. The minute size of the juvenile clams compared to the dimensions of the nursery tanks made it impossible to observe the occurrence of this mortality and to identify the casual factors. Overgrowth by benthic algae, which thrive in the strong sunlight conditions required by the juvenile clams with their autotrophic zooxanthellae, was suspected of reducing light and water exchange for the juvenile clams. Some benthic predatory invertebrates were also suspected.

Survival through this period of early juvenile development was markedly improved for a batch of T. gigas this year by use of a particular substrate and by a regular cleaning regime to control the growth of benthic algae.

Ocean-nursery phase

Juvenile clams of 20+ mm shell length are transferred from the land-based nursery tanks to the field. At this size they are ready food for predators and must be held in protective containers (ocean-nursery phase). A variety of methods has been tested with *T. gigas* juveniles, including floating trays, trays on racks above the bottom, and trays on the bottom subtidally and intertidally. The results reveal that floating systems are technically problematical and show poor survival and growth of clams; racks are best for growth, but expensive; while survival is high in the subtidal benthic trays, and growth and survival (excluding equipment failures) are high in the intertidal zone. Mariculture of giant clams in the intertidal zone has obvious advantages, especially where SCUBA facilities are unavailable or inappropriate. Thus, a major research effort will be made to develop an intertidal system for the ocean-nursery and later grow-out phase of *T. gigas*. Larger protective containers, such as boxes approximately 3 m long, made from sheets of steel mesh, are being assessed as alternatives to trays.

Other recent findings for *T. gigas* juveniles are their tolerance of moderate levels of water turbidity - they don't have to be reared in pristine reef conditions; their particular intolerance of low light levels; and their intolerance of disturbance, such as from wave action.

Grow-out phase

The largest juveniles reared are now greater than 100 mm and later this year will be transferred to the grow-out phase, i.e. removed from the protective containers and placed on the bottom. At what size they are large enough to be virtually free of predators will thus be determined. The shells of *T. gigas* in this size range are thinner than those of *T. derasa* and this may well require that the former species be reared to a larger size before the grow-out phase.

Related research

The presence of a group of research staff and graduate students at JCU engaged in giant clam mariculture research has generated research interest in giant clams in other departments and institutions. Giant clams are, after all, intrinsically novel and interesting animals by virtue of their symbiosis with zooxanthellae and exceptional size.

We can expect to see a marked increase in knowledge of giant clams in the next years from the studies outlined in this report and from research in other parts of the Pacific region. This is a development which is overdue.

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