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**Giant Clams in the Sustainable Development
of the South Pacific**

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Giant Clams in the Sustainable Development of the South Pacific

Socioeconomic Issues in Mariculture and Conservation

**Editor
C. Tisdell**



Australian Centre for International Agricultural Research,
Canberra, Australia, 1992

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Preface

THIS monograph is based upon research undertaken over the period 1989–1992 and financed primarily by the Australian Centre for International Agricultural Research (ACIAR) through its Research Project No. 8823, 'Economics of giant clam mariculture'. The University of Queensland was the commissioned organisation. The project for which I was the team leader involved considerable cooperation with those involved in ACIAR Project No. 8873, The culture of the giant clam (Tridacnidae) for food and restocking of tropical reefs, for which James Cook University was the commissioned organisation. I wish to thank all members involved in Project No. 8873 for their cooperation and assistance, particularly the team leader, Dr John Lucas.

The contributions to this book are based principally on an edited selection of working papers that appeared in the series Economics of Giant Clam Mariculture between November 1989 and May 1992. The series was distributed by the Department of Economics of the University of Queensland. By presenting this selection in revised and edited form, it is hoped that these research contributions will be of more lasting and comprehensive value as reference material. The papers selected for inclusion here are only a portion of those completed. However, they are the papers which relate most directly to the southwestern Pacific. It is hoped to publish, at a later time, an additional monograph including papers with a different geographical focus.

I wish to thank all those who have contributed to this volume for their support of the project. I am especially grateful to Dr Kenneth Menz, Economics and Farming Systems Coordinator with ACIAR, for his encouragement with this project and all the staff of ACIAR who have assisted with it, especially Peter Lynch, Publications Manager, for his contributions to the production of this book. Over a period of time, several typists assisted in the preparation of the typescript on which this book is based. These included Deborah Ford, Jeannine Fowler, and Susan Tooth. Thanks are due to them, as well as to my immediate family members, Mariel, Ann-Marie, and Christopher who had to get used to Clem's distraction by giant clams. I am also particularly grateful to all those Pacific islanders who through their contributions and cooperation have made this book possible.

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Part I

Background

1

Giant Clam Farming and Sustainable Development: an Overview

Clem Tisdell
Kenneth M. Menz

Introduction

Giant clams, or tridacnids, occur naturally in only the tropical or subtropical marine waters of the Indian and Pacific Oceans. However, they are confined to the western portion of the Pacific Ocean and do not, for example, occur on the western coast of the Americas or in Hawaii. They are well adapted to tropical clear waters such as those which favour the growth of corals, e.g. coral atolls. Eight species of tridacnids have been identified, one of which, *Tridacna tevoroa*, was officially classified only in the 1990s. Members of one species, *Tridacna gigas*, can grow to over one metre in length, making it the world's largest bivalve mollusc. This species is sometimes called the true giant clam, or the killer clam, the latter name arising from its reputation (mostly unwarranted) for closing on divers so preventing them from returning to the surface. Members of the species *Tridacna derasa* are the second largest. The various species of giant clams, their natural distribution and general ecological requirements, have been described by Lucas (1988) with *Tridacna tevoroa* being described at a later time (Lucas et al. 1990).

Within their natural range, many species of giant clams have become locally extinct, mainly a result of their overharvesting for human use. The flesh of giant clams is eaten by many communities and the shells are used either as ornaments or for utilitarian purposes. In recent times, giant clams have become significant specimens for the aquarium trade.

Because of the severe reduction in natural stocks, which resulted in giant clams being listed under the Convention on International Trade in Endangered Species (CITES) in the 1980s, and the apparent economic advantages of producing meat from them for food in ecologically suitable areas, scientific attempts were made to develop techniques for their aquaculture. Efforts were already under way in this regard at the Micronesian Mariculture Demonstration Center (MMDC), Palau, for the aquaculture of *Tridacna derasa*, in southern Japan for the culture of *Tridacna crocea*, and elsewhere, when the Australian Centre for International Agricultural Research (ACIAR) decided to support a project coordinated by James Cook University in northern Queensland to foster the aquaculture of giant clams for the supply of food and the restocking of tropical reefs. Funding for this project commenced in 1983–84 and continued to 1991–92.

Map 1.1 indicates the main centres in the South Pacific and Southeast Asia which have been involved in recent scientific research into giant clam mariculture. They include MMDC in Palau, James Cook University in Townsville and at Orpheus Island, associated research at the University of the Philippines and Silliman University in the Philippines, and at the Ministry of Primary Industries in Fiji, and at the South Pacific Center for Aquaculture of ICLARM (The International Center for Living Aquatic Resources Management) near Honiara, Solomon Islands.

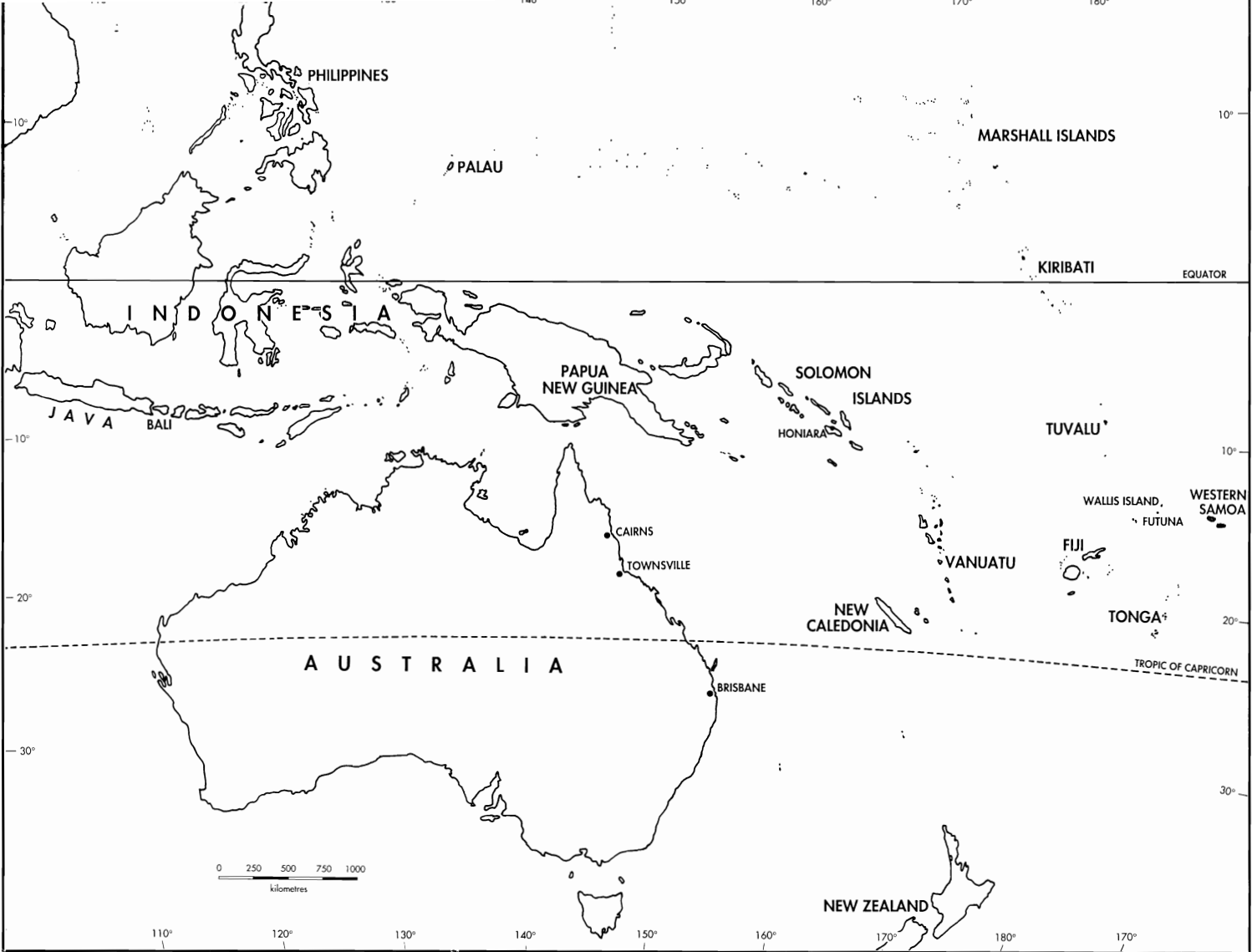
The species primarily targetted by the ACIAR-sponsored project was *Tridacna gigas*, the largest of the clams. This species had not previously been aquacultured successfully. Of all the clams, it appeared to have the greatest capacity for meat production because of greater biomass gains than any of the other species. This is partially a consequence of this species entering its female cycle (clams become hermaphrodites at this stage) at an older age than other clam species. On this basis, it seemed to be a good choice for aquaculture from the point of view of supplying food, particularly since the meat of giant clams is high in protein.

Why Australian assistance for giant clam mariculture through ACIAR?

There were a number of reasons why Australia found it appealing to support a research project to develop techniques to aquaculture giant clams, especially *T. gigas*, as part of its development assistance program. In particular, it seemed a very suitable project for support through ACIAR, a centre intended to take advantage of Australian research skills and expertise in cooperation with researchers from less-developed countries to develop techniques to promote agricultural and related production in those countries.

Reasons favouring this project included the following:

1. The presence in Australia, especially at James Cook University, of expertise in tropical marine science and aquaculture.
2. The presence of relatively abundant natural stocks of giant clams, especially *T. gigas*, in Australian tropical waters, particularly on the Great Barrier Reef.



Map 1.1 The southwestern Pacific region.

- Thus, broodstock were available naturally in Australia and ecological conditions were suitable for the rearing of giant clams.
3. Success in developing aquaculture techniques promised economic benefits for less-developed countries in tropical and subtropical latitudes with suitable marine areas, as well as providing possible technical assistance for the development of an Australian industry for mariculture of giant clams.
 4. Less-developed countries expected to make the greatest economic gains from the culture of giant clams are located in the western Pacific, especially the South Pacific and Southeast Asia. Many are small economies and most are island or archipelagic countries. These countries have been targetted to receive special treatment from Australia's development assistance program.
 5. Many small island economies in the South Pacific are heavily dependent on development assistance for the maintenance of the economic welfare of their inhabitants. They have few opportunities for augmenting their economic production because of their limited resource-base. This is especially so of atoll countries, such as Tuvalu, but also applies to portions of other countries, e.g. Ontong Java in Solomon Islands and islands in the Lau Group in Fiji. Ecological conditions on such atolls are suitable for the culture of giant clams, and it was felt that techniques for this culture could add to production and employment possibilities in such areas.
 6. Another anticipated appealing feature of the culture was the low quantities of inputs needed for culturing giant clams. Unlike many other species used for aquaculture, it was realised that giant clams could be grown without artificial feeding or the use of fertilizers. This is a particular advantage for less-developed countries with chronic balance of payment difficulties as well as international transport problems.
 7. The ocean growout phase of giant clam farming promised to be relatively simple. No problems were envisaged from the point of view of technology transfer.
 8. The mariculture of giant clams promised to be environmentally friendly. The type of environmental damage caused by prawn (shrimp) farming was absent.
 9. While markets were not fully explored, pre-existing markets and consumption based on natural stocks were known to exist. On remote Pacific islands and countries with transport difficulties in gaining access to markets, it was believed likely that clams would be used for local subsistence purposes. Giant clams are high in protein and provide a useful standby source of food. They may, for example, be stored in shallow water as a food larder to be drawn on when other food is unavailable, e.g. when it is impossible to go fishing because of heavy seas. Groups of clams stored in this way by villagers are sometimes referred to as clam gardens.
 10. The farming of giant clams was also envisaged as a means of promoting ecological sustainability and maintaining biodiversity. In 1990, for instance, a publication of ACIAR (Anon. 1990) stated that 'While Australia is benefiting from the giant clam research..., the ACIAR project is a part of the Australian Official Development Assistance Program and aims primarily at assisting the

economies of less-developed South Pacific and Southeast Asian countries and preserving giant clams from extinction'. The mariculture of clams has allowed species to be reintroduced to countries where they have become extinct. For example, it has been possible to reintroduce *T. gigas* to Fiji as a result of the ACIAR-sponsored research project.

A brief overview of production methods

Methods for culturing giant clams continue to evolve, and a wide range of production techniques is now available. Information about these is available from several sources (e.g. Heslinga and Fitt 1987; Braley 1992; Calumpong 1992). However, it may be useful to provide a general overview of methods.

In this presentation, we have classified production methods by the degree of their reliance on land-based as compared with ocean-based operations. First of all, the longest established method is described, which involves clams spending their first 7–12 months in land-based aquaculture facilities and then being transferred to the ocean. Second, a method involving a completely land-based operation is covered, followed by consideration of one involving only a short land-based phase.

Considering now the first case: clam broodstock are held, at least temporarily, in land-based broodstock tanks, spawned and the eggs collected and fertilized by mixing with the sperm. After the eggs hatch, clams pass through a motile stage of a about 7 days. At Orpheus Island Research Station, the first 2 days were spent by the young clams indoors, in the hatchery, after which they were shifted to settlement tanks outside. After they become sufficiently visible on the settlement tanks or raceways, they may be collected by hand, placed in fish trays and transferred to other land-based holding tanks or raceways and held there until they are transferred to the ocean. In the case of *T. gigas*, ocean transfer is likely to be when they are about 2–2.5 cm in size. The seed clams may spend between 7 and 12 months in the land-based phase if this method is followed.

The seed clams are then moved to the ocean and placed in protective cages. This is the ocean-nursery stage. In the case of *T. gigas*, the ocean nursery would usually be located in an intertidal area, e.g. on a rock platform, as was the case at Orpheus Island Research Station of James Cook University. This has a number of advantages: there is less fouling of cages than when they are placed subtidally, predation on clams seems to be less severe, and there is easier human access for farm management (Braley et al. 1988). However, not all species of giant clams are suitable for intertidal culture—*T. derasa*, for instance, is a subtidal species.

After 12–18 months in the ocean-nursery phase, the cultivated giant clams of around 20 cm in size may be transferred to the ocean growout phase. Protective cages or lines are no longer required for their protection but enclosures made of nylon netting attached to floats (so providing a floating fence) may be useful in excluding large predators of clams and in marking the boundaries of the farmed area. Clams may be left in these growout positions until they are harvested, possibly after a period of several years.

It is also possible to culture clams entirely in land-based operations. For example, Reefarm, (a Cairns-based commercial giant clam farm with aquaculture facilities at Fitzroy Island) has done this mainly for *T. crocea*. *T. crocea* have been grown in land-based tanks for 2–3 years and then marketed mainly to supply the aquarium trade. Specimens of this age are also suitable for the *sashimi* trade.

The South Pacific Center for Aquaculture of ICLARM has been pioneering techniques intended to minimise the land-based phase of giant clam mariculture. This centre has been experimenting with floating cage culture. The aim is to transfer seed clams 3–4 months old to floating cages in the ocean and raise the seed in the floating cages until they reach a size considered to be sufficiently large to transfer them to the ocean floor. There have also been experiments to culture giant clams entirely in the ocean. The now defunct commercial company, Pacific Clam, tried this as one possibility but, as yet, no commercially successful technique based entirely on ocean culture seems to exist. The three main existing methods, classified according to the relative contribution of land-based versus ocean-based operations, are shown in Figure 1.1.

There are other possible variations in techniques for the production of giant clams. An important consideration is whether or not there is any artificial feeding or addition of fertilizer to aquaria in which giant clams are held. While giant clams can be grown successfully without artificial feeding or the addition of fertilizer to water in

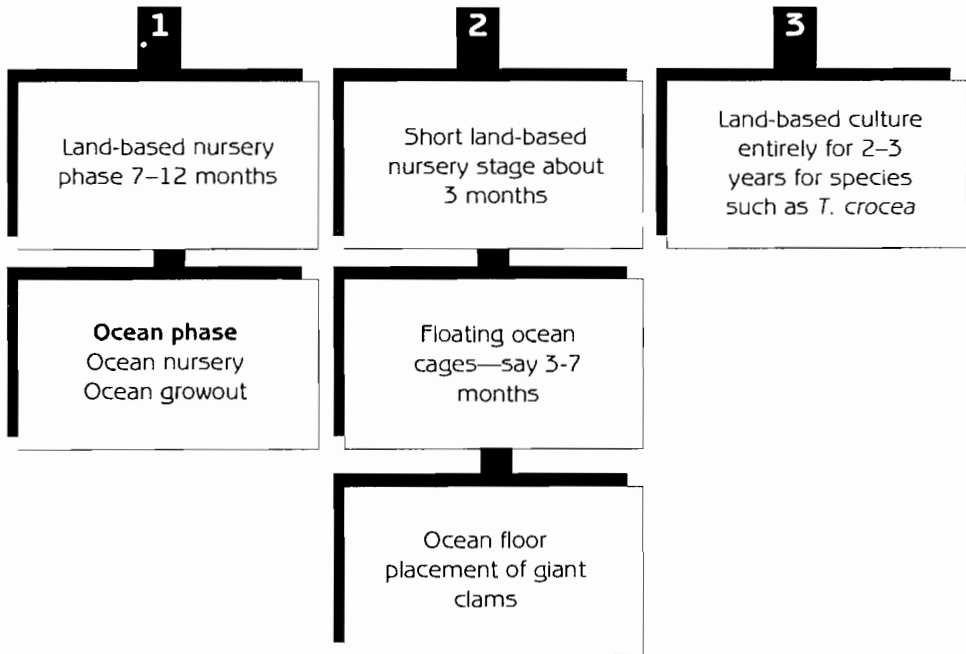


Figure 1.1 Three different methods of culture of giant clams involving different degrees of reliance on land-based and ocean-based operations.

tanks holding them, their growth does respond favourably to fertilizer additions and their survival rate can often be enhanced by food supplementation in their motile stage. In particular, the growth rate of settled clams responds very favourably to the addition of nitrate to their water-medium e.g. by additions of ammonium nitrate. Some positive response has also been observed as a result of additions of phosphate but this is relatively small compared with response to nitrate additions.

Because giant clams are in symbiosis with the algae (zooxanthellae) contained in their mantle, they are able to survive and grow without food enhancement by farmers. Early experimental culture at, for example, MMDC, was based on the absence of food supplementation. At James Cook University, food supplementation in the motile stage of clams was introduced. In recent years, the addition of nitrate to tanks containing settled clams has become more common and appears to be economic. Reefarm, Cairns may have been the first organisation involved in giant clam production to make such additions, the effectiveness of which was subsequently followed up by organisations researching the aquaculture of giant clams.

In relation to the hatchery/early nursery phase of giant clam culture, using any of the methods denoted in Figure 1.1, Braley (1989, p. 13) distinguishes between three methods of culture of giant clam larvae. These are:

1. *Extensive*, fertilised eggs added to seawater which has been allowed to develop a local phytoplankton bloom (3000–10000 litre tanks);
2. *Semi-Extensive*, swimming larvae stocked and fed cultured unicellular algae (3000–10000 litre tanks);
3. *Intensive*, selected swimming D-stage veligers stocked into 500–2000 litre tanks and fed cultured unicellular algae, later released to settlement/nursery tanks.

In the past, MMDC has used the extensive method. The ACIAR giant clam project at James Cook University relied mainly on the semi-extensive method. Survival rates of clam larvae tend to be higher the more intensive the method used.

There may also be variations in the diets fed to clams prior to settlement. After settlement, variations in production techniques include the use or non-use of fertilizer (nitrate or phosphate additions) and variations in the quantity of those additions to the seawater medium and the timing of such additions.

As the number of techniques for producing giant clams and the range of possibilities for varying these has increased, the number of possible technological combinations for giant clam production has risen rapidly. This means that the economics and the economic possibilities for production have altered quickly.

Aspects of production economics

The economics of the aquaculture of giant clams can be expected to depend on the costs of production and the availability of markets, or—in semi-subsistence

economies—on the demand for their direct use by families growing them. Since techniques for the culture of giant clams have evolved rapidly and continue to do so, costs of production are altering also. The general tendency is for technological progress to reduce the costs of production. Furthermore, in a new industry, the economics researcher finds the difficulty that time-series of data on costs are of very limited duration and, because techniques are changing, identification problems are severe.

Research to date indicates that there are considerable economies of scale in the land-based phase of giant clam production as a function of the volume of production (Tisdell et al. 1990; Hambrey 1991a). From an economics point of view this tends to favour a few large-sized hatchery/nurseries rather than many small ones. Australian data indicate that the full cost of producing 100000 seed clams of about 10–12 months in age in land-based operations would be around A\$1.50 each, falling to about A\$0.50 each for an annual production of half a million seed clams, and to around A\$0.30 for annual production of one million seed. The research results are summarised in Table 1.1 (Tisdell et al. 1992).

Table 1.1 Per unit cost (\$A) of producing giant seed clams under Australian conditions as a function of volume of annual output.

Type of cost	Number of seed clams per year		
	100000	500000	1000000
Operating cost	1.01–1.22	0.29–0.35	0.18–0.23
Full cost (5% interest)	1.31–1.77	0.37–0.48	0.24–0.31
Full cost (10% interest)	1.43–2.01	0.41–0.54	0.26–0.35

Economies of scale may not be present or may be small in relation to ocean growout of giant clams. This phase of production is much less capital-intensive than land-based production. The economics of ocean growout, assuming that technique (1) in Figure 1.1 is followed, is heavily influenced by rates of mortality of giant clams in the ocean, the cost of each seed clam and, where meat production and sale is the main purpose, by the extent of drip-weight loss in the meat tissue after harvest. Drip-weight loss of up to 50 per cent may occur in the mantle of giant clams and 40 per cent drip-weight loss in flesh may be common given current technology (Hambrey 1991b). The development of techniques to reduce this loss would be advantageous.

Another important cost in giant clam production, especially when the main aim is to produce meat biomass and supply traditional adductor muscle/mantle markets, is the period of time for which capital and resources must be tied up in production prior to sales. Quick returns are not possible when such a market is supplied, because the giant clams have to be grown for a number of years. Thus, there are considerable capital costs involved in farming giant clams, either in terms

of interest that has to be paid on loans, or interest forgone as a result of having one's own capital tied up in the enterprise. Nevertheless, taking account of all these factors, scope exists even under Australian conditions for farms to make at least a modest profit from the cultivation of giant clams solely for the sale of their meat. Institutional restrictions are one of the main barriers to marketing giant clams in Australia. In Queensland, for example, a government licence (for which a fee must be paid) is needed to market giant clams legally.

Estimates of internal rates of return on the ocean phase of clam farming to supply clam meat are set out in Table 1.2 for alternative scenarios. More details are available in Tisdell et al. (1992). A return of about 11 per cent appears to be most likely under Australian conditions when this market is targeted. Estimates of returns to be expected in Fiji are given later in this monograph.

Table 1.2 Maximum internal rates of return for the ocean phase of farm *Tridacna gigas* for meat under Australian conditions for alternative meat prices with and without drip loss.

Farm-gate price per kg of meat in \$A	Without drip loss	With 40% drip loss
	IRR (%)	IRR (%)
3	11.25	6.03
5	18.00	11.25
7	23.50	15.40

Markets for and uses of giant clams

The giant clam has possibly a wider range of end uses than any other species produced by aquaculture. 'End' markets for giant clam products include the following:

- 1 Meat for human consumption (Shang et al. 1991). In larger clams this can consist of separate markets for the adductor muscle (a highly valued product) and the rest of the flesh, mainly mantle. Smaller clams are of special value for the sashimi trade.
- 2 A market exists for giant clams as specimens for the saltwater aquarium trade (Tisdell 1989a, 1991; Tisdell and Vinnicombe 1992).
- 3 A market exists for giant clam shells (Tisdell 1989b).

Clam meat can also be used for the production of fish meal as an input to animal production, but this is a relatively low value product. Aspects of the three end-markets listed above have been discussed elsewhere. In this monograph, particular attention is given to the prospects of marketing giant clam meat from the South Pacific islands, and the prospects for use of giant clams for subsistence purposes.

The largest potential market in terms of volume would appear to exist for meat, followed by shells and the market for aquarium specimens. However, the aquarium market has been particularly valuable in assisting Reefarm and MMDC to approach commercial viability. Although a market exists for seed clams, this is not an end-market except possibly in those cases where the purchases are by governments for the purposes of reseeding wild stocks or to reintroduce stocks to the wild. Sale of seed has constituted a significant sales outlet for MMDC.

Marine property rights as an issue

The success of giant clam farming in the South Pacific will depend not only on market demand and costs of production, but also on sociological factors, including systems of marine property rights. Techniques which can be successfully used when private property rights apply under socioeconomic conditions prevailing in developed countries may not be easily transferable to less developed countries with different sociological systems and different systems of property rights, such as occur in the South Pacific islands. This issue is investigated in this monograph, with particular reference to the possibilities for culturing giant clams in the Pacific islands.

Sustainable development in the South Pacific and Southeast Asia

Today there is increased emphasis on the importance of achieving sustainable development. There is increasing recognition that economic growth in the short term may be achieved at the expense of sustained production in the longer term. Short-term production may be increased, for instance, by exploiting renewable resources such as marine living resources at a faster rate than can be sustained. As a result, populations of economically valuable species may be overexploited from an economic point of view and some may be driven to extinction at least locally. In many areas in the South Pacific, economic exploitation of giant clams has exceeded sustainable levels and they have become locally extinct. The farming of giant clams provides a means of sustaining and increasing economic supplies of giant clam products, and of potentially reducing demands on natural stocks. This is particularly so since there is no barrier to giant clams completing their whole life cycle under human-controlled farming conditions. This means that future clam broodstock can be provided by clam farms so that the industry can sustain itself without drawing on stocks of wild clams. The industry can, in other words, become self-sufficient and independent of natural clam stocks.

For many Pacific islands, the aquaculture of giant clams seems to be one of the few self-sustaining production activities available. This is particularly so for the ocean growout phase of giant clam culture. It is less so for the hatchery phase.

Giant clam farming is potentially a means for Pacific island countries to reduce their dependence on development assistance. Most Pacific island countries are

heavily dependent upon development assistance and remittances from emigrants as means of sustaining their incomes (Bertram 1986; McKee and Tisdell 1990). Any profitable production opportunities which can be secured by these economies will help to reduce this dependence. This monograph will describe the extent to which the aquaculture of giant clams provides such an opportunity in the Pacific islands and in parts of Southeast Asia.

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Part II

Giant Clam Farming at Village Level for Subsistence, Commercial Use and for Development

2

Giant Clams, Socioeconomics and Village Life in the Lau Group, Fiji: Prospects for Farming Tridacnids

Veikila Vuki

Clem Tisdell

Luca Tacconi

Abstract

This chapter reports the result of a survey of villagers on the islands of Lakeba, Tuvuca, Cicia, Balavu and two islands of Ono-i-Lau, in the Lau group, Fiji. Information was gathered about the presence of giant clam species, and changes in their abundance, uses, harvesting methods and gender roles in harvesting. Other matters investigated were taste for clams, rules on harvesting and exchanging clams, interest in clam farming, likely role of men and women in clam farming, especially in subtidal versus intertidal farming, and the prospects for giant clam farming in the village communities. This contribution reports the results on a village-by-village basis and overall.

Background

Giant clam populations in the Pacific have decreased because of over-exploitation from both commercial and subsistence fishing. Although biological research has made possible the culture of giant clams, thus opening the way to eventual commercial and subsistence farming, successful implementation of clam farming projects at a village level depends not only on the economic viability of the enterprise but also on social factors. Traditional patterns of fishing rights, rules for fishing and exchanging the catch, taboos, gender roles and social commitments are some of the factors that could affect the outcomes of a project.

Field research was undertaken on the islands of Lakeba, Cicia, Tuvuca and Ono-i-Lau in the Lau group (Fiji) during the period June–October 1990 in order to ascertain the species of giant clams present in the islands and their abundance, and social and economic factors that could affect giant clam farming in the area. The actual survey was conducted by Ms Veikila Vuki in the Lauan dialect using a questionnaire suggested by Clem Tisdell. Ms Vuki was born and grew up in Ono-i-Lau, knows the people and the language and still has close relatives there.

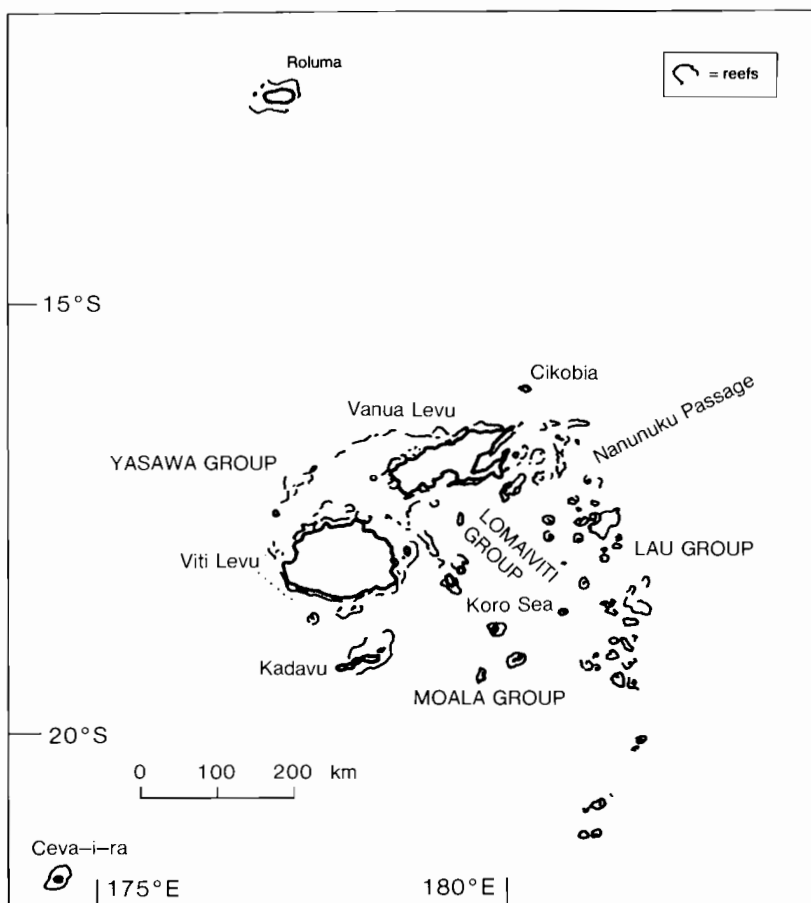
This chapter presents the findings from the survey conducted in the villages of Tubou, Levuka and Waitabu on Lakeba island and some results for other islands, including Ono-i-Lau, in the Lau group. The nature and location of the survey is described in the next sub-section. The results for Lakeba Island are presented (first

some results for the whole island and then results for particular villages). This is followed by results for other islands in the Lau group and, finally, results for the whole Lau group are pooled. Detailed results for Ono-i-Lau are given separately in the next chapter.

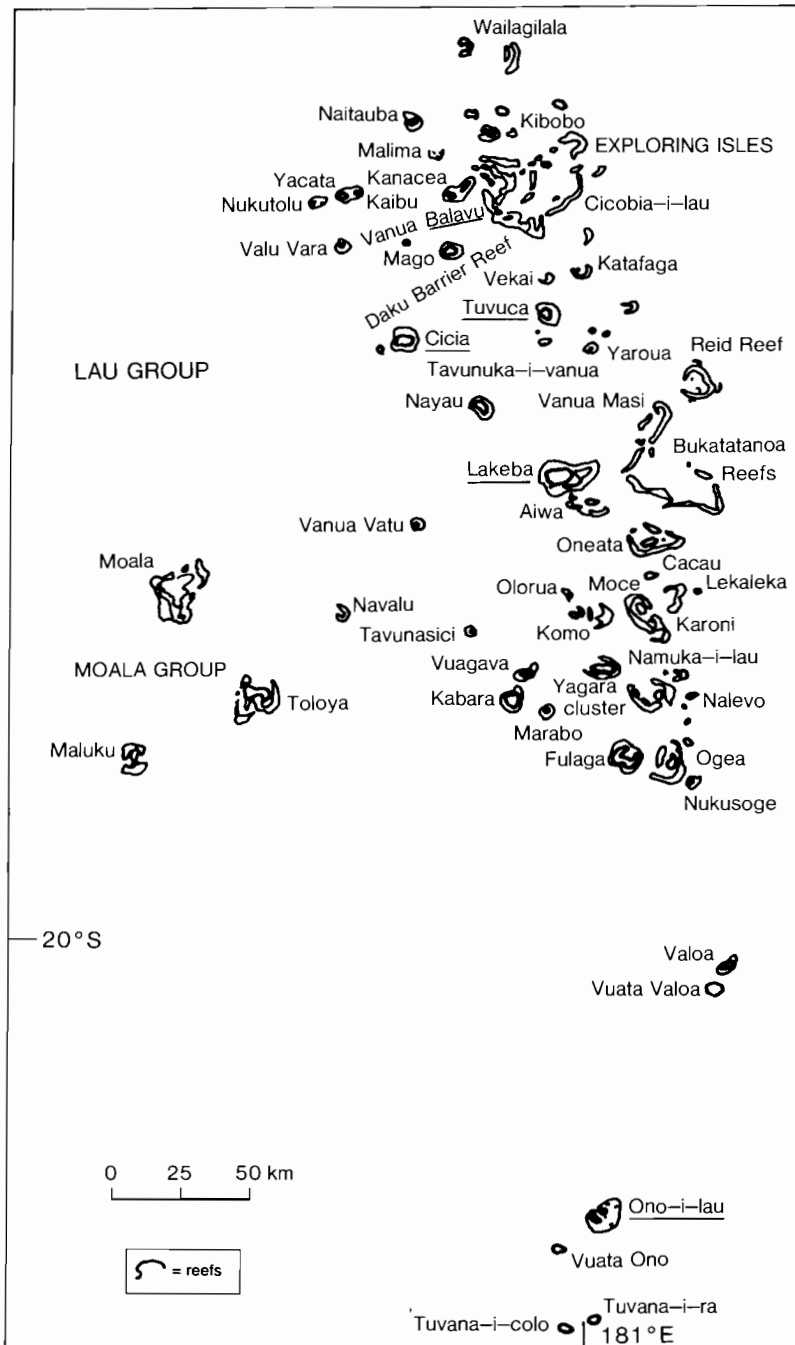
The survey covered abundance of clams in the area, traditional fishing rights and exchange rules, use of clams, consumption of clam meat, clam meat preparation, gender division of clam harvesting, and prospects for clam farming. The English version of the questionnaire is given as an Appendix to this chapter.

Location and nature of the survey

The Lau archipelago is situated in the eastern part of Fiji and consists of about 40 islands and over 250 islets. The total area is approximately 440 km², distributed over 113900 km² of ocean, between 16°30'–20°S and 178–180° W (Maps 1.1, 2.1 and 2.2).



Map 2.1 Fiji showing the Lau group.



Map 2.2 Lau group, Fiji. Islands included in the survey are underlined.

The survey was conducted in the period June–October, 1990. The archipelago is isolated and boats and planes to the islands are infrequent so this dictated the timing of the survey. Fijians with considerable experience in fishing and gleaning on Lauan reefs were selected with the help of the Fiji Fisheries Extension Officers (Lau). But difficulty was encountered when villagers were out gardening or fishing when the boat arrived on their island. Only those who were in their village at the time could be interviewed, since the boat stayed only a short while.

Surveys were conducted on the islands and in the villages in the Lau group indicated in Table 2.1. In Map 2.1 the names of the islands where interviews were conducted are underlined. As can be seen from Table 2.1, 48 persons were interviewed most of them on Lakeba: 18 were females and 30 were males. While the numbers seem quite low in relation to other islands, there are only small populations on a number of the other islands: e.g. at the 1986 census Matokana Village had 20 households and a population of 132.

Table 2.1 Location of persons interviewed in the Lau group.

Island	Village	Number of respondents
Lakeba	Tubou	10
	Waitabu	10
	Levuka	13
		33
Tuvuca	Only village	2
Cicia	Tarukua	2
Balavu	Deliconi	1
	Namalata	1
		1
		2
Ono-i-Lau	Nukuni	1 (chief)
	Matokana	8
		9

Let us consider the results broadly from Lakeba island first and then those from particular villages on Lakeba before discussing the results from other locations. Before doing so, however, some background on the island may be useful.

Lakeba island lies in the central part of the archipelago, has a population of about 2435 people and is the largest island of the group. It is an emergent island of 55.9 km² land area and total lagoon area 82 km². The lagoon around the island is 0–10 m deep with a sea surface temperature range from 27.9° to 29.3°C. The

villages of Lakeba consist of fishing communities. Villagers often visit Bukatatanoa reefs (a major reef just off Lakeba) and the surrounding barrier and fringing reefs of Lakeba and Aiwa. The major production activities are fishing and agriculture (copra and growing of root crops like yam). Fishing vessels, such as the Food and Agriculture Organization (FAO) designed 8.5 m (28 ft) vessels, and fibreglass punts are among those normally operated by fishermen.

Seaweed farming is no longer undertaken in the villages surveyed. Jayant Prakash, a past Fisheries Officer who was initially involved in seaweed farming in the Lau group believed that, due to the isolation of the Lau group, it was better to redirect his program of seaweed farming to other parts of Fiji, such as the Western Division and the Lomaivito group (Prakash pers. comm.1990).

Results of the Lakeba island survey — general features

Clam species

Four species of giant clams are present in the waters of Lakeba island. The local people distinguish them by their shape and size. They can also distinguish the different species by determining whether the clam species is firmly attached to the coral substrate or not. The name 'katavatu' (*Tridacna maxima*) literally means 'firmly attached to coral substrates' and 'cega' (*Tridacna squamosa*) means fluted clam. The species are:

- *Tridacna maxima*—Katavatu
- *Tridacna squamosa*—Cega
- *Tridacna derasa*—Vasua dina
- *Tridacna crocea*—Vasua lokaloka

While the first three species were reported by all respondents, *T. crocea* was reported by only one respondent (from the village of Levuka) who said that this species of clam is now very rare.

Fishing rights

Fijian communities hold tribal ownership of fishing rights on customary fishing areas (see Chapter 9). This traditional ownership was recognised by the interviewees in Lakeba island. Respondents reported that the villages' 'fishing rights' fall within the Lakeba customary ground and are not divided'. This seems to imply that within Lakeba island there is not a division of fishing rights between villages. Also, it was pointed out that families might have exclusive rights to particular reef areas. Note that a family in this context is probably a land-owning unit. It is usually smaller than a *mataqali*.

The *mataqali* is a social unit of the *yavusa* and is usually the principal group in land occupation in Fiji. The *yavusa* is a subdivision of the *vanua*, the largest grouping of Fijian kinsmen. These kinsmen pay allegiance to a titular chief and

thus form a large 'tribe'. *Vanua* also refers to the land belonging to the group. See for example Ravuvu (1988, Chapter 1 and Glossary). There appear not to be set rules for clam harvesting as almost all respondents affirmed that 'everyone can take as many clams as needed'. Nevertheless, it was observed by one respondent in Tubou village that clam harvesting is supposed to be for subsistence purposes and not for commercial exploitation.

As far as the Native Land and Fisheries Commission Registry is concerned, the fishing ground is communally owned and is registered under the 'vanua' (land) of Lakeba. This simply means that it is registered as belonging to the people of Lakeba. In reality, each village has a boundary. Members of one village cannot just go and fish on reefs close to the next village. Boundaries are like unwritten laws and are a mark of respect for those in the next village. It is like a territory, 'you fish in yours and I fish in mine'. If one member of one village decides to go fishing in the next village's reefs then he has to follow protocol. Before going fishing he has to present whale's tooth (tabua) or kava to the chief of the next village to ask for permission. If protocols are not followed then there can be problems of fighting between villages. However, greater problems arise due to conflicts of interest between commercial and subsistence fishermen.

In Lakeba island, particular sharing rules or taboos on consumption of clam meat were not observed; it was usually stated by the villagers that 'you might share the catch if you wish'.

Traditional harvesting

Both women and men collect giant clams, but women limit their activities mostly to the reef flats whereas men fish in deeper waters. It was reported, however, that women, too, dive to collect giant clams. Women usually collect *T. maxima* and *T. squamosa* from the reef flats and tidal pools, while men gather *T. derasa* from deeper waters. The smaller size of clams collected by women (reported by some interviewees) appear to be due to the different species harvested by the two sexes.

Two methods are used to harvest giant clams in deeper waters: free diving and the clam fishing line method. Free diving, practised by women and men, requires goggles or a mask and a knife to take the meat out of the shell which is normally left at the bottom of the sea. The fishing line method involves a rope with a piece of metal or rock tied to one end while the other end is tied to the canoe. The diver takes the rock and drops it onto a clam which then closes on the line. The fisherman can then pull the rope up into the canoe with the clam.

Use of giant clams

Giant clam meat is very much appreciated by the majority of the islanders, who consume it raw or cooked. All three species are appreciated, but some people prefer *T. maxima* and *T. squamosa*, eaten as 'kokoda' (marinated in lemon juice), for their 'sweet taste'.

In the Lauan group, giant clams may be cooked in any of the following ways:

- (i) By wrapping giant clam meat in banana leaves, baking it in an underground oven and then simmering it in coconut milk.
- (ii) By boiling the meat in coconut milk or water with salt and onions added.
- (iii) By boiling the meat in thick coconut milk with curry added for flavour.
- (iv) By cooking the meat in coconut milk with edible leaves added such as those of cassava and sweet potato. Other seafood such as trochus and fish may be added so as to provide a seafood stew.
- (v) Giant clam meat may be boiled in water and then cut into cubes and served with lemon and chillies.
- (vi) Giant clams may be cooked with ripe bananas or plantains in coconut milk.
- (vii) Giant clam meat may be wrapped in banana leaves and boiled in coconut milk.

Giant clam meat is also eaten raw, either with or without preparation. Cubed raw clam meat may be marinated in lemon or lime juice with salt added according to taste. Alternatively, it may be served with thick coconut milk.

Giant clam gardens are a common feature of Lauan villages. Clams harvested using the fishing line method are in fact often placed in clam gardens ready for consumption when weather conditions are poor or when there is a ceremony or feast in the village. Clams are also much appreciated as 'take away' food by the villagers when out fishing in grounds distant from the village. Fisherwomen and fishermen often take cassava and lemon with them when they go fishing. Whenever they are hungry, they simply take giant clams and, using their knife, extract the meat from which the kidney is then removed. Lemon juice is squeezed onto the meat, the clam meat is then cut into pieces and marinated in the juice for a few minutes—it is then ready for a meal (a fisherman's delight).

The shells of the clams have several uses in Fijian villages. They are useful for terracing Fijian 'bures' or houses, as ornaments and ash trays, serving dishes for pigs and chickens, for flower gardens and to make fish fences.

Results of the Lakeba island survey by individual villages surveyed

Tubou village

Tubou has a population of approximately 704 people and ten interviews were conducted. Four respondents were males and six female. The ages ranged from 23 to 60 years with six interviewees having a fishing experience in the area of more than 10 years and up to 40 years.

Abundance of clams and taste for clam meat

All the respondents recognised that giant clams are now less abundant than in the past. An increase in fishing activities, both for consumption and for commercial purposes, was cited as the cause of the decrease in clam stocks.

Probably due to the scarcity of clams on the reef close to Tubou village, only one respondent out of seven had noticed juvenile clams on the reefs. Another respondent indicated that she had seen 'small fish' eating clams.

From Table 2.2 we can see that 70% of the respondents like clam meat and that perception of supply being scarce is not strictly related to a 'taste factor'. Two of the three respondents who said they had sufficient supply of giant clams turned out to be the largest consumers of clam meat in the sample, with one consuming 2 kg once a week and the other consuming 2 kg twice a week. The other respondents who liked clam meat consumed it once a month and ate 1–2 kg each time.

All the three clam species are appreciated by the villagers. However, one respondent indicated that 'Cega is nice because it is sweet'.

Table 2.2 Taste for clam meat and scarcity of supply: number of responses—Tubou.

	Yes	No
Do you like clam meat?	7	3
Do you have enough supply ^a ?	3	6

^aOne interviewee did not answer the question as she did not like clams.

Rules on harvesting and exchange of clams

It was reported by some respondents that the village marine tenure rights 'fall within the Lakeba customary ground and it is not divided'. This appears to imply that there is no division of rights between villages. It was also pointed out that 'families' might have exclusive rights to particular reef areas. But families—land-owning units—may have exclusive rights only to the area because they own an island which is surrounded by coral reefs. The reefs are owned communally and it is out of respect for the owner of the island that others do not have the right of access to the reefs around the island. Some owners of the island may not allow people to fish in the area because of people stealing coconuts or crops from the island when they are meant to be fishing. However, these rights appear not to influence clam harvesting as all respondents asserted that everybody in the village can take whatever quantity of clams they wish.

In Tubou there are no set rules for exchange or sharing of clams and some respondents reported that 'you might share if you wish'. Only one respondent said that clam collection was supposed to be for consumption and not for commercial purposes.

Traditional clam harvesting, implications for clam farming and interest in clam farming.

Traditionally, both women and men collect giant clams but women limit themselves to the reef flats where they collect *T. maxima* and *T. squamosa* (and other shellfish and fish) from shallow tidal pools. Women also dive but this is rare. Men dive for spear-fishing and to collect clams, mainly *T. derasa*.

Most of the respondents (7 out of 10) agreed that if intertidal clams were being farmed then women would look after them. Only one respondent (male) suggested that men might be more involved in farming clams than women. However, the reason for this was not made clear. It was probably not for his own interest (as a male) because he suggested that the village was not interested in clam farming.

Subtidal clam farming (*T. derasa*) does not appeal to the villagers. In fact six respondents out of nine saw it as disadvantageous to the village. Only three women suggested that subtidal farming would not be a disadvantage for the village and men could look after the clams. Their answers appear not to take into account the time schedule that men have to follow in their working of gardens, fishing and social activities. In fact, men indicated that subtidal farming would take a lot of time and would be a constraint on their activities.

From the sample interviews, it seems that in Tubou there is not much interest in farming giant clams. Sixty percent of the respondents (seven respondents) expressed no interest in clam farming, claiming that it would involve a lot of work and might disrupt community life. Those who thought clam farming could be a worthwhile operation noted that it would increase the depleted clam stocks and in one case that 'it would be an income source for our children' (female respondent).

From this small sample, it is difficult to ascertain the reasons for low interest in farming clams. Interest may depend on a combination of factors. Three respondents who did not like to eat clams expressed no interest in farming them. Out of six respondents who had insufficient supply of clams, three expressed interest in farming them. Only one of three respondents, having enough clam meat was interested in clam farming. Also, there does not appear to be any clear relationship between relative dependence on land or sea resources and willingness to farm clams.

Factors such as perception of the amount of work involved in clam farming, need to increase cash income and social and family commitments might all play a role in villagers' interest in farming clams.

Waitabu village

Background

Waitabu has a population of approximately 146 people and ten interviews were conducted. Seven respondents were male and three were female. Their ages ranged from 23 to 68 years. All interviewees had been living in the village since childhood.

Abundance of clams and taste for clam meat

All respondents in Waitabu village indicated that giant clams were no less abundant than in the past and 7 out of 10 respondents had seen juveniles on the reef. Consequently, clam supply was reported to be sufficient to satisfy village needs. The average consumption of clam meat is higher in Waitabu than in Tubou, where clams are scarcer than in the past. In Waitabu, clam meat is consumed in up to three meals per week, whereas in Tubou it is eaten, on average, only once or twice a month. In Waitabu, all respondents but one liked clam meat.

Traditional clam harvesting and implications for clam farming, and interest in clam farming

In Waitabu, as in Tubou, no special rules exist for harvesting and exchange of giant clams. Both women and men collect clams; women from the reef flats and men from deeper water.

All respondents suggested that intertidal farming of giant clams would be best suited to women. Subtidal farming is not seen as a disadvantage for the community (as it was in Tubou). Four men out of six thought that both women and men should look after subtidal clams (*T. derasa*) whereas two suggested that men should look after the clams as they do 'lots of diving'.

Two women out of three regarded subtidal farming as best suited to men and only one suggested that both men and women should look after the clams. The answer is probably influenced by the inclination of the individual woman to dive. A woman that does not dive would see men as best equipped to attend subtidal clams.

In Waitabu village, even if supply of clam meat is considered sufficient, all respondents (nine out of ten interviewees) answered positively to the question 'is your village seriously interested in farming giant clams?'. The reasons given for the interest are reported in Table 2.3. A woman also said that 'interest in farming and its success will be to the future generations' advantage'.

This overt interest in clam farming does not assure success of any eventual clam-farming project. People lack knowledge of clam farming and a deeper assessment of village needs and constraints (e.g. time allocation) would be required before starting a project.

One of the factors that could explain a greater interest in clam farming in Waitabu compared with Tubou is the fact that Waitabu people appear to be more dependent on sea resources than Tubou villagers. In Waitabu, six respondents indicated they were more dependent on sea resources than on land resources, and four interviewees were dependent on both. In Tubou, only three respondents depended on sea resources and six on both land and sea resources.

Table 2.3 Reasons for an interest in clam farming—Waitabu.

It will increase clam stock for subsistence use	Interested in seeing how it is done	It will increase income
✓		
✓	✓	
✓	✓	
✓		
✓		
✓		
	✓	
✓		✓

Levuka village

Background

Levuka has a population of approximately 162 people. Thirteen interviews were conducted, nine with males and four with females ranging in age from 23 to 63 years. Only two interviewees had had less than ten years fishing experience in the area.

Abundance of clams and taste for clam meat

One respondent indicated that *T. crocea* can be found in the area but is very rare—this was the only indication of the presence of *T. crocea* in Lakeba island.

All respondents observed that giant clams are less abundant now than in the past. Increased fishing activities for subsistence purposes seem to be the major cause of depletion (indicated by all respondents but one), but fishing for commercial reasons has also contributed to stock depletion according to four respondents.

Clam meat is very much appreciated (10 out of 13 villagers liked clam meat) but because of stock depletion, consumption is much lower than in the past. One villager pointed out that his family used to consume clam meat daily (1–2 kg) but now they have clam meat only once a week. However, the majority of the respondents (9 out of 13) consume clam meat only once a month (2 kg per meal). This change in diet (it would be interesting to analyse what they substituted for clam meat) has obviously been brought about by reduced availability of clam meat. In fact all interviewees stated that clam supply was insufficient to satisfy them.

like giant clams, the only three in the sample, and were mostly dependent on land resources, again the only three in the sample. The reason given for the lack of interest in clam farming was that such activity would be time consuming and could 'coincide with other village activities'.

Interest in farming clams was justified by the respondents on the basis that it would boost local stocks for subsistence consumption. One villager indicated that excess production could also be sold and provide an extra source of income.

In implementing a project to develop giant clam culture, account should be taken of the fact that the villagers sometimes use poison to fish and this could jeopardise the smooth running of the project (as indicated by one villager). Moreover, concern was expressed that the organisational structure should be appropriately identified. It would be a mistake to assume that the village community (broadly considered) will take care of the project. Specific groups should be considered for project implementation, such as a women's group, fishermen's group or others to be formed.

Results for villages other than those on Lakeba island

Tuvuca island

Background

There is only one village on Tuvuca island: its population is 196 people. The island is surrounded by a barrier reef. The main sources of income are fish, rootcrops and handicrafts. The people of Tuvuca are coastal dwellers and are a fishing community.

Two villagers were interviewed (one female and one male). Both of them had a long period of fishing experience in the area.

Clam species present and abundance

Three species were reported: *T. maxima*; *T. derasa*; and *T. squamosa*. Clams are less common than in the past, especially *T. derasa*. The reason for the reduced availability, as stated by the respondents, is overfishing.

Clam meat consumption is low, in fact in one case meat was consumed only once a month (2 kg) and in the other case meat was consumed on a weekly basis (1-2 kg).

Fishing activities and methods

As in Lakeba island, women collect on reef flats and men fish in deeper water

Abundance of clams and interest in farming

Both respondents agreed that clam meat was scarce and both were interested in farming giant clams. Both villagers depend mostly on marine resources for income even though some farming is done.

Subtidal farming of *T. derasa* did not appear to pose a problem for the villagers. However, the male respondent asserted that subtidal farming should be undertaken by men, whereas the female villager thought that both men and women should be involved in subtidal farming. These opposing views could reflect gender interest on the control of resources. Nevertheless, in relation to intertidal farming, both villagers agreed that women would be better suited to culture intertidal species.

Villagers were interested in clam farming to increase the supply of clam meat for subsistence purposes and also to benefit future generations.

Cicia island—Tarukua village

The population of Tarukua is 203. Cicia island has a total population of 1283. The island is surrounded by a barrier reef and a few fringing reefs.

Cicia has one of the major copra stations in the Lau group. The islanders work on the plantation, which covers a large part of the island. Fishing activities include gleaning by women, hand-lining and gill netting. The major sources of income are copra, trochus, fish and root crops. Income from these is used mainly for education and medical expenses.

Two interviews were carried out, one with a male and the other with a female. Both had a long period of fishing experience in the area. Giant clam species present are *T. maxima*, *T. squamosa*, *T. derasa* and *T. crocea*. All species are less common than in the past because of overfishing. The villagers use poison to kill fish and this could have an impact on clams. The female interviewee did not like clams but both villagers agreed that supply of clam meat is insufficient. However, meat consumed appears not to be a good indicator of the scarcity of clams. The female villager consumed clam meat monthly (2 kg) whereas the other respondent, who liked clams, was eating clams weekly.

Both villagers expressed interest in clam farming, and thought that subtidal farming would not be a problem and said that both women and men should look after the clams. They felt that use of fish poison on the reef could cause problems for clam farming. Both respondents were mostly dependent on land resources for their income. The male was interested in clam farming for subsistence purposes, whereas the female was interested both for subsistence and commercial purposes.

The reef is owned according to 'Native customary rights' and families and individuals have no exclusive rights to it.

Balavu island

Two persons only from this island were interviewed—one from Deliconi village and the other from Namalata village. The respondent from Deliconi village was a male, 66 years old. He said all species (*T. maxima*, *T. squamosa*, *T. derasa*) are less common than in the past and have almost disappeared. Supply is not sufficient. He would like 8/10 kg per week of giant clam meat.

He suggested that men look after a clam project as women are already busy (with children and cooking, etc). 'Interest should be directed not on farming for short-term objectives, but rather for long-term ones: future generations.' He suggested that it would be best to start with a pilot project.

In Namalata village the sole respondent was a male. As in the previous village, clams were said to be less abundant. He thought women would be better suited to looking after giant clams. He was interested in clam farming as an alternative source of income to provide cash in order to educate children.

Ono-i-Lau group

Nukuni village

There was one respondent, a 72 year-old chief. He said clams were still common, although less abundant than in the past. In summary, his remarks were:

- women should look after an intertidal project;
- young men could be involved in a subtidal project;
- he was interested in commercial farming of clams because the price of copra is not adequate; and
- a taboo could be introduced to prevent anyone from fishing cultured clams. He said, however, that theft could be a problem for farming of giant clams.

Matokana village

In Matokana (Ms Vuki's home village), eight interviews were conducted (four women and four men). All villagers interviewed had many years of fishing experience (more than ten years experience each). Species reported to be present are *T. maxima*, *T. derasa*, *T. squamosa*, and *T. tevoroa* (Lucas et al. 1991). Clams are less abundant than in the past but are still common. *T. derasa* is probably the least common species. It was reported that *T. derasa* is now less common because of commercial exploitation.

All villagers interviewed agreed that clam supply was sufficient though some (four) noted that they would like to have even more clams. Clam meat consumption is relatively high, ranging from one meal a week (2 kg) up to three-five meals when the weather is poor and villagers are unable to go fishing.

All respondents believed that women would be better suited to intertidal clam farming than would men. It was recognised that subtidal farming could be a problem as it involves a great deal of time and only one group (young men) could take part in it. Even if giant clams are still common in the wild, all the villagers interviewed (eight) expressed interest in farming clams. However, only one villager expressed interest in farming them for subsistence purposes. Two interviewees (women) explicitly explained that there were enough clams in the wild for subsistence purposes.

Interest in clam farming is mostly explained by the fact that clams are considered a good possible alternative source of cash income, especially because of low and fluctuating copra prices. One respondent expressed some concern about the difficulties of selling clams, as their island is isolated from the market. Any eventual clam farming project on this island only appears to have prospects for success if it is supported by an adequate marketing infrastructure, but it is doubtful that such an infrastructure can be economically provided. Cost of production, storage and transport of giant clams should be analysed and compared to the market price for clam meat, possibly in Suva.

Marine rights are recognised and regulated by native land rights. However, one villager said 'exclusive rights might be recognised especially for chiefs and if someone has land near the reef, but usually there is free access by the villagers'.

In Matokana village, sharing of products is a practice still observed: a respondent observed, 'you share, like it or not'.

Results of the survey for the whole Lau group

Forty-eight interviews were completed: 18 females and 30 males. All the respondents had significant fishing experience in their area: 41 had more than ten years' experience, with some up to 50 years. Most of the villagers interviewed were heavily dependent on the sea for their livelihood. Of the 48 respondents, 27 depended almost entirely on marine resources, 13 were dependent both on marine and land resources and 6 depended on land resources.

Abundance of clams

Thirty-eight of the 48 respondents stated that clams are less abundant than in the past. The abundance of giant clams has not changed in the village of Waitabu (Lakeba island), in the opinion of the ten villagers interviewed there. But in all other villages (the remaining 38 respondents), clam populations were said to have declined.

Taste for clam meat

Thirty-nine of the 48 respondents said that they like clam meat. In percentage terms about 80 per cent of respondents liked clam meat, and about 20 per cent did not. Most of those not liking clam meat lived on Lakeba island. The overall results are summarised in Table 2.6.

Supply of clams

Twenty-one respondents said that their supply of giant clams is sufficient. Of these, ten were from the village of Waitabu (Lakeba island), and seven from Matokana (Ono-i-Lau).

Table 2.6 Frequency of responses by respondents to the question 'Do you like clam meat?'

Island	Village	Yes	No
Lakeba	Tubou	7	3
	Waitabu	9	1
	Levuka	9	4
	Total	25	8
Tuvuca		2	0
Cicia	Tarukua	1	1
Balavu	Deliconi and Namalata	2	0
Ono-i-Lau	Nukuni	1	0
	Matokana	8	0
	Total	9	0
All islands	Total villages	39	9

Collection of clams

All respondents confirmed that both men and women collect clams. Women collect clams mainly from the reef flats but sometimes also, according to ten respondents, from deeper waters. Men collect clams only in deeper waters.

Farming of clams—intertidal

Forty-four respondents stated that women are better suited than men to intertidal farming of clams. Only three respondents (male) suggested that men should look after intertidal farms.

Farming of clams—subtidal

Sixteen interviewees thought that subtidal farming of clams could cause disruption to village life. On the whole, this method of farming was less favoured than intertidal farming.

Interest in clam farming

Except in Tubou (a village on Lakeba island) most respondents expressed an interest in giant clam farming. Overall, 79 per cent of respondents (see Table 2.7) were interested in clam farming. Although the sample is small, interest on Lakeba island in clam farming, a larger island, seems to be less than on the smaller islands in the Lau group. This may be because villagers on Lakeba are less dependent on marine resources than those on smaller islands. The main reason given for lack of interest in clam farming is that it may be too disruptive of village life. This may be interpreted to mean that its opportunity cost could be too high—men may have to

Table 2.7 Number of respondents expressing an interest in giant clam farming.

Island	Village	Number	Total number of respondents
Lakeba	Tubou	4	10
	Waitabu	0	10
	Levuka	10	13
	Total	23	33
Tuvuca		2	2
Cicia	Tarukua	2	2
Balavu	Deliconi	1	1
	Namalata	1	1
	Total	2	2
Ono-I-Lau	Nukuni	1	1
	Matokana	8	8
All islands	Total villages	38	48

sacrifice time now spent tending their gardens or women may need to give up time used for gleaning on the reef. Three reasons were given for interest in clam farming:

- 1 to provide supplies for subsistence;
- 2 to provide commercial possibilities; and
- 3 to ensure a stock of clams for future generations (bequest value).

Commercial possibilities tended to be given more emphasis on the smaller island in the Lau group perhaps because the villagers have very few opportunities for earning cash. However, the desire to earn cash is not necessarily an individualistic selfish one. Sharing and community goals still remain strong on the smaller islands in the Lau group.

Implications of the socioeconomic study for giant clam mariculture developments in the Lau group

What is the motivation for Lauans to farm giant clams? Is it for money? The village way of life is based on sharing and not necessarily on whether one has acquired material possessions. If a goal is set—for example, building a church, community hall, scholarship funds, housing projects—it could perhaps create an incentive to farm giant clams. There are some exceptions of course, like the entrepreneur who would jump at an opportunity to farm giant clams. Several pilot projects need to be set up to assess the viability of clam farming in the Lau group.

The lessons learnt from seaweed farming in the Lau group should be considered. How successful was the venture? What were the problems encountered in trying to establish those farms and getting them going?

Issues that need to be addressed are:

- the remoteness of the island group and consequent transport constraints;
- market reliability and the ability of farmers to provide a continuous supply of giant clam meat to the market; and
- alternative products to fresh or frozen clam meat, such as smoked or dried meat, and possibilities for clam shell products which might support cottage industries in the villages.

Other factors which will have to be considered include supply of finance for purchase of clam seed and equipment for farming, such as boats or diving equipment if subtidal farming is adopted.

There are still many questions to be answered about the economic viability of giant clam farming in the Lau group of islands. There is clearly interest in the possibility of such farming in the islands but the economic viability of subsistence and commercial farming in the area has yet to be proven. In that respect it should be noted that villagers in many of the smaller islands in the Lau group are especially interested in the commercial prospects for such farming. Study of these prospects would seem to require an investigation of the potential urban market for giant clams in Fiji and a study of transport systems and costs. It might also be noted that intertidal clam farming is likely to be more suited to the villages than subtidal farming, e.g. using *T. derasa*. There is also a need for more careful study of prospects for farming at the village level taking into account village customs, current economic activities, sociological factors and existing demands on available time. The next chapter, which deals in particular with Ono-I-Lau, gives special attention to these matters.

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Appendix

English version of a questionnaire used in a survey of villagers in the Lau group, Fiji, in connection with research into the socioeconomic aspects of giant clams and prospects for farming them.

Name and location of village	
Respondent(s) Name and status	
Age:	
When did you start fishing in your area?	
1 What species (types) of giant clams are available to the village? Please list and describe these.	
2 How abundant or common are the above species? Are they less abundant than in the past?	
3 Have any species of giant clam disappeared from your village or almost so? If yes, please indicate species and indicate why this has happened.	
4 How often does your family eat clam meat? How much does it eat? Please indicate quantity daily, weekly or monthly.	
5 Are you fond of clam meat? Yes/No If yes, can you indicate how fond you are of it, say in relation to other sea food?	
6 Which species of clam do you prefer to eat? Explain.	
7 At present do you get as much clam meat as you would like for consumption by your family? Yes/No If No, how much greater supply would you like to have? What types of clam would you like to have more of?	
8 How do you prepare clams for eating? What recipes are used in your village for preparing clam meat for eating?	
9 Who collects clams? Men or women	
	or both? If both, is there a difference in the size, type or species of clam harvested by the sexes or in the places from where they are collected?
	10 Do women in your village generally confine their marine harvesting activities to the reef flats and shallow areas? Do they only take clams from these areas? Please explain your answer.
	11 In your village are there any rules or customs governing the harvesting of giant clams? Please explain your answer.
	12 What rules if any govern the exchange or sharing of giant clams harvested in the village area?
	13 What marine land rights (property rights) does your village claim?
	14 Can families or individuals have exclusive rights to particular reef areas?
	15 Do men in your village like to dive and work under water? Explain.
	16 Do men sometimes take giant clams from deeper water? If yes, how do they obtain them?
	17 Giant clams, depending upon the species, can be grown intertidally or subtidally. Do you think in your village women rather than men might be more involved in looking after farmed clams on the reef flats? Yes/No. Explain.
	18 The farming of some species of clams involve a lot of diving, e.g. <i>Tridacna derasa</i> . Would you see that as a

<p>disadvantage in your village? Please explain. If such a species was to be farmed would you see it as being looked after by men or women or both?</p> <p>19 Is your village seriously interested in farming giant clams? Yes/No. Why? In particular, if yes, do you see the clams as principally being for local subsistence use?</p> <p>20 Do you consider that the amount of interest and the social arrangements in your village are likely to make the farming of giant clams a success? You should remember that there may be several years between the time when clam seed is grown out in the ocean and the time when these clams can be harvested? Please explain your answer.</p> <p>21 Is the village involved in any farming? Yes/No. Please state types of farming if any. Is the village involved in seaweed farming? Yes/No. Why?</p> <p>22 Are there any factors that we might have overlooked that would have a bearing on the likely success or otherwise of clam farming in your village? Please indicate these.</p>	<p>23 Please forward any additional information on use of shells and of giant clams in the past (or present).</p> <p>24 Any stories or legends about giant clams?</p> <p>25 Is there any taboo on giant clams at certain times of the year?</p> <p>26 Did you hear any stories or hear of old people talking about a species of giant clam that has become extinct?</p> <p>27 Have you seen juvenile giant clams in your reefs?</p> <p>28 Have you seen anything eating giant clams?</p> <p>29 Why do you call species of giant clams their different names?</p> <p>30 Are you more dependent on fisheries resource or land resources as your main source of income?</p>
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3

Subsistence Economic Activities and Prospects for Clam Farming in Ono-i-Lau, Fiji: Socioeconomic factors

Veikila Vuki

Clem Tisdell

Luca Tacconi

Abstract

Local interest in, and the potential contribution of giant clam culture to village economy in Ono-i-Lau, Fiji, was investigated. Villagers are interested in the possibility of giant clam farming, particularly in terms of its potential to add to their cash income. They are particularly on the lookout for such possibilities because the main source of their cash income now (apart from remittances) is copra, prices for which are unstable and have fallen. As clam stocks in the wild are still sufficient for local consumption, villagers are not interested in farming clams for subsistence purposes. However, the isolation of the Ono-i-Lau archipelago may make the commercial farming of clams there uneconomic. Also, if the objective of clam farming is to increase village income, it might be less effective than alternative fishing projects.

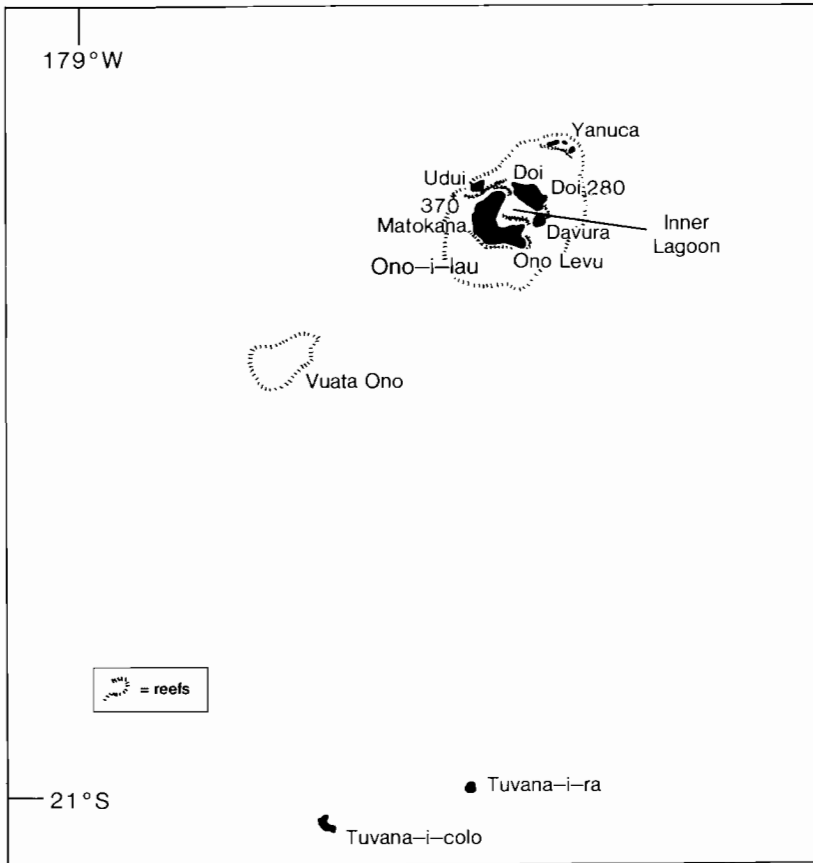
Introduction

This chapter presents detailed results of a survey undertaken in the Ono-i-Lau Group, Fiji. The survey was carried out in order to ascertain the species of giant clams present in the islands and their abundance, as well as the social and economic factors that could affect giant clam farming in the area.

The survey undertaken in the Ono-i-Lau group was part of a survey covering the Lau Group, of which Ono-i-Lau is a part (see Maps 2.1–2.2 and 3.1).

Field research was undertaken during the period June–October 1990 by Ms Veikila Vuki (who was born and raised in Ono-i-Lau) and interviews were conducted in the Lauan dialect. The isolation of the group restricted the number of the interviews that could be undertaken as travellers to the islands have to rely on a government inter-island vessel which takes a week to reach the islands and stays for only a few hours to unload and load cargo. Charter flights are available but very expensive. Their use is restricted to emergencies, such as ‘up-lifting’ a sick person from the islands, funded by the Fijian Government.

There were several reasons for the decision to undertake a survey in the Ono-i-Lau group. A survey carried out by the Fiji Fisheries Department, Giant Clam



Map 3.1 Ono-i-Lau, Lau group, and the outlying reefs and stacks.

Project, on the reefs of Ono-i-Lau in 1985 and 1986 showed that there were still large populations of *Tridacna derasa* there but that they were subject to continuous artisanal exploitation. Small clams were found closer to villages and larger ones further away. However, abundant populations of *T. derasa* were found in Vuata-Ono, a non-emergent atoll about six miles to the southwest of Ono-i-Lau (see Map 3.1). The distant location of this site from the villages has probably helped to maintain the clam population. Commercial exploitation has had an important impact on clam stock in the area. Heavy harvesting was undertaken in the area in 1984 and 1985 by commercial operators before the export of giant clams was banned by the Government.

Because natural stocks of clams have been greatly reduced, giant clam farming could eventually boost local consumption of giant clams and their commercial

exploitation. Villagers in the Ono-i-Lau group rely mainly on marine resources as a source of income, given the meagre availability of other local resources. Increasing income through aquacultural projects therefore seems to have some potential. However, isolation from main markets is an obstacle to commercial developments in Ono-i-Lau.

Background to Ono-i-Lau

Ono-i-Lau consists of six main islands situated within a barrier reef. Ono-Levu, Doi and Davura are volcanic in origin and are part of the rim of a breached crater. Including all the islets and stacks, there are over one hundred islands covering a total land area of 7.9 km² within a reef system of 80 km² (see Map 3.1).

Ono-Levu, the principal island, is elbow-shaped with two hills joined by a neck of low land. Matokana village, in which eight out of the nine interviews were conducted, is situated on this island.

At the 1986 census, Matokana village had 20 households and a population of 132. The village has undergone substantial change. The population has decreased (present population 132 compared with 300 as reported in the Appendix to this chapter). Marine resources (mainly pearl oyster shells) have replaced copra as the major source of income. Cash remittances from relatives who have migrated represent an important contribution to household income.

The Ono-i-Lau group is the most isolated of the islands in the Lau archipelago and it can take up to one month for cargo to reach Suva, the capital of Fiji, by sea. This poses serious problems for the exploitation and marketing of marine resources. If living marine products are to be exploited on a commercial basis, refrigerated vessels will have to be used for transportation. The market prices received for marine products in Suva will need to be sufficient to recoup the cost of refrigerated transport.

Results of the survey

In Matokana, eight interviews were conducted with four women and four men aged between 40 and 90 years. All respondents had many years (more than 10 years each) of fishing experience. One interview was also conducted with the chief of Nukuni village.

The species reported in the area are *T. maxima*, *T. derasa*, *T. squamosa* and *T. tevoroa* (Lucas et al. 1991). Giant clams are still common but less abundant than in the past (apart from *T. tevoroa*), with *T. derasa* probably being the species least available. Previous commercial exploitation, as mentioned above, appears to be the main factor accounting for the reduction of numbers of this species.

Despite the exploitation of clam stock carried out for centuries by villagers for subsistence purposes, and for commercial reasons by commercial operators in recent years, the present stock of clams appears to be sufficient for subsistence consumption. All the villagers interviewed agreed that the present supply of clams was sufficient, although four respondents stated that they would like an increase in supply. The present consumption of clams varies between 2 kg per week and 6–10 kg per week per household when the weather is poor and people are unable to go fishing. Clam 'gardens' are still common in Ono-i-Lau and provide security because they are a stock of food that can be used in periods of scarcity, e.g. after a cyclone.

All the respondents liked clam meat. But finned fish seems to be preferred to shellfish by most Pacific Islanders (see Appendix to this chapter, and cf. Pollock 1989). This suggests that an increase in the supply of clam meat (through clam farming) might lead to only a marginal increase in the consumption of clam meat. This could limit the scope for subsistence farming. However, we cannot be definite about this because insufficient research has been done to identify with any degree of precision, food preference functions for islanders, e.g. to establish indifference curves.

All respondents indicated that women were better suited to intertidal clam farming than men. Traditionally it is the women who spend time gleaning the reef flats for shellfish. Intertidal clam farming appears to be more appropriate than subtidal for various reasons. Villagers thought that subtidal farming could be a problem because it involves a great deal of time and only one group of villagers (young men) could take part in it. Note, however, that the amount of time (labour) required for intertidal or subtidal giant clam farming is still uncertain. A further problem in subtidal culture of giant clams could be the eventual need for deep-sea (scuba) diving equipment. This would add to project capital investment costs, with the added shortcoming of having to rely on distant sources for spare parts and supplies. Thus, the farming of an intertidal species such as *T. gigas*, *T. crocea*, *T. maxima* or *H. hippopus* is likely to be more suitable than the farming of the subtidal species *T. derasa*.

All villagers interviewed expressed an interest in farming clams. This interest appears to be due to the need for an alternative source of cash income. Due to a decline in copra prices, marine resources have replaced copra as the major source of income. Villagers in Ono-i-Lau therefore see clam farming as a possible source of cash income. Only one respondent expressed interest in subsistence farming of giant clams. Two women stated explicitly that there were enough clams in the wild for subsistence purposes.

When asked if there were any factors that might have a bearing on the success or otherwise of clam farming, one villager expressed concern about the difficulties in marketing clams which would arise from the remoteness of the island and the irregular transport to the capital Suva. Another respondent stated that clam farming would not create conflicts of interest as there are quite a lot of fisheries resources to be exploited.

Comparison of Ono-i-Lau survey results with those of Lakeba island

Local consumption of clam meat appears to be dependent on local availability of giant clams at the village level and probably on the amount of time that villagers dedicate to collecting clams. In Lakeba island, villagers of Tubou and Levuka described clams as less abundant than in the past and indicated that their supplies of clam meat were insufficient. In Waitabu village on Lakeba island, giant clams are no less abundant than in the past and supply of clam meat is said to be sufficient.

Differences between villages on the same island in the availability of clam meat for consumption could indicate that inter-village trade in giant clam meat is infrequent. This could be why villagers of Lakeba Island consider giant clams to be subsistence food and not a cash-crop. In Waitabu and Levuka, respondents indicated that they were interested in clam farming for subsistence purposes but Tubou villagers were not interested in giant clam culture. Of the three villages, Tubou appears to be the least dependent on marine resources.

The interest in clam culture expressed in Waitabu is in marked contrast with the results from Ono-i-Lau. In both cases the availability of clams for local consumption seems to be satisfactory, but Waitabu villagers are interested in clam culture for subsistence reasons, whereas Ono-i-Lau villagers explicitly indicated that they see clam farming as a source of income. This may raise some doubts about whether the interest in clam farming in Waitabu village is genuine. People sometimes like to have development projects as a possible means of raising the status of the village, or think they can gain, even if indirectly, from the existence of a project provided with development assistance (Tisdell 1991a).

A further interesting comparison can be made between results from Tubou and those from Ono-i-Lau. People in Tubou are much less reliant on marine resources than in Ono-i-Lau. In Tubou, six respondents out of ten expressed no interest in clam farming whereas all respondents from Ono-i-Lau were interested in clam culture as a source of cash income.

The above leads one to doubt whether clam farming would be viable as a subsistence activity (Baker 1988) in the Ono-i-Lau group given present levels of clam stocks there and alternative means available to islanders of earning a livelihood.

Factors likely to influence the adoption of clam culture as a subsistence activity are input requirements, taste preferences and clam stocks in the wild. Implications of these variables for subsistence activity will be considered in the next section, together with issues involved in commercial clam farming.

Socioeconomic discussion of clam culture

Labour requirements for clam culture have often been assumed to be minimal. This might be the case when clams are old enough to be left in the ocean without protection (e.g. without enclosures). However, the early stage of the ocean grow-out phase (e.g. when clams need to be kept in cages to be protected from predators) can be quite labour-intensive. The amount of labour required varies with the method of protection used and the age of clams grown out (John Hambrey, pers. comm. with L. Tacconi). Thus, if wild clam stocks are sufficient for local consumption, it is reasonable for the villagers to collect giant clams from the wild instead of farming them.

Subsistence farming seems more likely to be undertaken if natural clam stocks are dwindling. However, variables other than just clam stocks have to be considered. Input requirements for clam farming will have to be compared with input requirements for other subsistence activities, such as fishing or gardening. The higher the input requirements for clam farming compared with fishing, the less likely are villagers to undertake such farming. Taste preferences will also affect clam farming. If clam meat is highly appreciated by villagers, then they could be interested in clam culture even if it requires greater input than fishing. However, finned fish seem to be preferred to shellfish, at least in Ono-i-Lau. Clam farming also has the added disadvantage of requiring considerable capital investment at the beginning of the project, with benefits only accruing after some years. In the case of subsistence fishing, capital investment is still required (e.g. boats, outboard motors) but benefits are immediate and there is less risk of 'crop' or supply failure, given that fish continue to be abundant in the Ono-i-Lau archipelago.

The villagers in Ono-i-Lau are looking for an alternative source of cash income to that obtained from copra. One alternative might be a giant clam project for commercial purposes. However, a number of issues need to be considered before deciding on such a project.

If the aim is to increase village income, returns from a clam project should be compared to those from alternative projects, such as a fishing project targeting commercial exploitation of local fish resources.

The disadvantage of a clam project would be the risk involved. While both clam and fishing projects would require an initial capital investment, benefits gained from a clam project would start only after some years. This presents a risk for the villagers, as well as a possible cash-flow problem. In the Solomon Islands, experience with clam farming at the village-level shows that clam losses due to predation and natural causes can reach high levels (up to 80 per cent) during the first two years of grow-out (John Hambrey, pers. comm. with L. Tacconi). A fishing project is unlikely to involve so much risk.

Both projects would face the same transport problem. Ono-i-Lau is isolated and current transport is irregular. Given the long distances that separate the archipelago from Suva, cold-storage facilities may be required on Ono-i-Lau. The

market price for fish and clams will affect the profitability of such projects. At present, data on transport costs and expected market prices are not available (some data on possible prices are given in Chapter 14) and further research is needed to assess the viability of establishing development projects in an isolated archipelago such as Ono-i-Lau.

To ensure the viability of commercial clam farming, a regular supply of clam meat to the market should be assured. This might require the establishment of large clam farms that could provide a substantial supply of clam meat. Village farms could supplement output of clam meat from larger farms. However, when village farms are located on isolated islands such as those in Ono-i-Lau, a substantial supply of meat is likely to be needed if transport and storage costs are to be covered. That might require the villagers to specialise in clam farming and this specialisation could conflict with their current livelihood strategies and social life (see Appendix to this chapter).

In developing commercial farming, the fact that wild clam stocks *could* be threatened by commercial exploitation should be taken into account. At least the possibility of *such* conflict should be recognised (cf. Tisdell 1991b) and should be allowed for. Natural stocks of giant clams may be adversely affected by the collection of broodstock from the wild for clam farming, by appropriation of their natural grounds for commercial farms and in other ways.

Conclusion

Villagers of Ono-i-Lau are interested in increasing their cash income which has been adversely affected by a decrease in copra prices. This need is reflected in their interest in clam farming as a possible alternative source of cash income.

Whether clam culture projects are economically viable in Ono-i-Lau depends on several factors. Limited access to markets appears to be a severe constraint to such development, as transport costs could prove to be very high. On the other hand, the fact that natural giant clam stocks from Ono-i-Lau were heavily exploited for commercial purposes in the past may indicate that the transport cost barrier is not insuperable. Nevertheless, the economics of farming giant clams and of harvesting natural stocks differ. Isolation of Ono-i-Lau also limits the availability of extension services required to start and carry out a project. The cost of such assistance would obviously be increased by isolation.

Although labour requirements for giant clam culture are not yet known perfectly, these can be high in the early stages of clam farming. Labour needs should be compared with labour availability. It is often assumed that some excess labour is available in subsistence economies but as can be seen from the Appendix to this chapter, the people of Ono-i-Lau already devote a considerable portion of their time to productive activities such as gardening. Little free time is available for other work. A detailed time-allocation study is needed to supplement this evidence.

In order to maximise benefits to the local community from a giant clam development project, returns from a clam project should be compared with an alternative project, such as one targeting commercial fishing, before a decision is made. Also required is a study of village economies in relation not only to their locality but also to their wider connections with urban and other areas through migration and remittances received from migrants (Bertram 1991; Sofer 1991). This is a wider subject but village development in the Pacific islands needs to be seen in its wider interdependent economic context. There has been net migration out of Ono-i-Lau. One alternative to additional local employment and development can be migration to, for example, urban areas even though the desirability of such migration remains a contentious issue (cf. Sofer 1991).

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Appendix

The Subsistence Fisheries of Ono-i-Lau and the Respective Roles of Men and Women^{*}

Veikila Vuki (née Vakamole)

Matokana has a population of about 300 people excluding those who have settled in Suva or other parts of Fiji. The area covered by the village is about 300 m by 250 m.

Its regular source of cash income is from copra. Both men and women are involved in cutting copra and it is usually done once a week by each household. Money obtained from cutting copra is used to purchase sugar, tea, and similar items from the village co-operative store. Other sources of income are cash transfers from relatives with salaried positions in towns, but these apply to only a minority who have close relatives in the towns.

Some young village boys who have left school and some middle-aged men engage in seasonal casual work. Such seasonal casual work includes harvesting sugarcane in Vanua Levu and on the western side of Viti Levu, and planting cocoa as part of the Tavenni cocoa project. These jobs are available only on a seasonal basis. Those who undertake such work retain only half their wages. The other half is used for village development, such as building more water tanks, for extending the church, for the village hall, and other communal facilities.

Villagers working in Suva usually donate money to be used in village project development, e.g. towards buying items such as an electricity generator for the whole village.

Sales of mats, coconut oil, tapa, and other items bring a little extra income into the village, but it is a meagre addition. Most of these items are 'lost' on their way to Suva where they are usually sold by relatives.

Subsistence fishery

Fishing has always been vital to the people and in the past they relied upon the sea for most of their protein. Today they continue to rely heavily on fish.

^{*}This is an edited version of an assignment completed by Veikila Vuki in 1983 when she was an undergraduate at the University of the South Pacific in Suva. Veikila is originally from Matokana, Ono-i-Lau. (Clem Tisdell)

Fish remains the protein staple. Chicken, pork, canned beef etc. may be eaten only on special occasions, for example during a wedding feast. Therefore, subsistence fishing is essential to the coastal community, especially on a small island like Ono-i-Lau.

The subsistence fishery is concentrated on lagoons, mangroves, coral reefs and mud flats. Very little offshore fishing has ever been conducted by the villagers, and only by villagers at Vuata Ono on their way to Tuvana islands.

However, both finned fish and shellfish are both important in the diet of the villagers. Finned fish is much preferred. Shellfish is usually exploited only when rough seas or bad weather prevents fishing or when the members of the household want a change in their diet from finned fish.

Finned fish preferences vary because individual tastes differ, but usually lagoon snapper is liked by nearly everybody in the village.

Fishing craft

In the past, people of Matokana built canoes (dugouts) from two coconut trunks tied together using sinnet. Building of such 'waqa ma' demands a great deal of craft knowledge and skill. Coconut dugout canoes do not last long, so villagers prefer outrigger canoes which are usually constructed on Ogea, Fulaga, Kabara and Namuka, the islands traditionally famous for canoe building.

These smaller outrigger canoes, which were used mainly by subsistence fishermen, have now they have been replaced by introduced craft. At present, there are two outboard motor-powered craft owned by the people of Matokana and about three are owned by individuals in the village.

However 'it is disturbing to witness the passing of an art and tradition of navigation, seamanship and craftsmanship and with it increasing dependence by the once independent island people on the technology of the Western World' (Zann, undated, p. 2).

Subsistence fishermen in the village were formerly self-sufficient, but today they rely on outside suppliers for fishing gear, motors, punts, fuel and repairs. Their craft (motorboats) require careful maintenance and demand a basic knowledge of mechanics in order for simple repairs to be done on the island. If spare parts are needed, these have to be ordered from Suva.

Roles of men and women

The people of Matokana are hard-working people. Men and women support one another in cleaning the village in order to live in a tidy environment.

A man is always praised for the size of his garden whether it is a vegetable garden, or whether it grows yams or cassava. Women do not in any way get involved in gardening, but they usually visit the gardens to fetch vegetables.

Men usually visit their gardens very early in the morning, for example at 5.30 am. Each man in the village is expected to have a garden and usually spends the whole day in it, except on occasions when he has to help build a house in the village or on village ceremonial occasions. Men also help in preparing food. For example, they make 'lovo' nearly every afternoon after returning from their gardens.

A man has to be skilled in both land and sea activities in order to be liked by the elders, and to be called a 'hard-working guy'. A man who is well known for being an expert in spearing fish and for going fishing nearly every day, and who does not own a garden, is termed a 'lazy guy' because one has to learn good management in order to manage a household well.

Women work as hard as men. They have to ensure that food is always available for the household and they also decide on what the household has to eat, today and tomorrow. Therefore family budgeting is done by women. They have to consult with the men only on what to bring from the garden.

The women's club in existence in the village is typical of village women's clubs everywhere in Fiji. Its activities include sewing sessions and the occasional fund-raising effort for the church or school. It is usually effective in getting action when an occasion requiring women's co-operative effort arises.

Men go fishing only occasionally at nights when they want to or when there is a special occasion. Usually men go fishing on Saturdays so that the fish caught can be eaten on Sunday, a day that we respect and strictly honour. It is a day of rest and religious worship.

Women engage in a great deal of fishing for reef-fish, shellfish, and crabs and other crustaceans. For example, a group of women sometimes spends two or three nights in Udui fishing and processing their catch before they return to the village. If account is taken of all the fishery products included in the household diet, women contribute more in quantity than the men. However, men contribute a lot in terms of fish catch/unit effort even though women fish more frequently.

Fishing techniques and gear

The fishing techniques and gear used in Matokana are mostly of a primitive type. Many exhibit traditional skills in their design and operation, and indicate that local people have considerable knowledge of the habits of the particular fish or crustacean sought. Techniques used include the following:

Use of bare hands

This fishing method is common among women. They use their bare hands to catch crabs in mangrove areas, take crawfish and to collect all kinds of shellfish.

In the old days, women wrapped tapa around their right hands to protect themselves from injuries while collecting crawfish. They know that the favourite haunts of crawfish are holes in the rugged seaward face of the reef, below the level of

breaking rollers. 'Qoli muji', which literally means reef fishing when the tide is low, is very common among middle-aged and older women. Fishing gear includes a piece of sharpened wood for piercing octopi, an iron rod to break coral reef and use of bare hands. Trigger fish, butterfly fish, groupers and other reef fish are usually caught. However, sometimes hand nets are used on the reef but it is not as common as 'Qoli muji'.

Poisoning

This fishing method is being abandoned due to the fact that the government has declared it to be illegal. When it is done at night, men are involved, and during the day it is usually women and children. Nursery grounds are first located and then 'derris' is used to stupefy the fish. This fishing method is usually done by two households combining.

Spearing

Of all the fishing methods practised in Matokana, spearing is most popular among men. Young village boys practise with miniature spears near the shore. The shafts of miniature spears are made from reeds and the spearheads are made from umbrella ribs. This is done so that when they become men they will be experts in spearing fish from the shore, or from boats.

Spearing is done not only during the day but also at night when men are free from working in the gardens. Torches of dried coconut leaves are often used. Sudden exposure of fish to bright light helps the fishermen to spear them.

Traditional spears are usually made of wood to which wooden spearheads are tied with sinnet. But nowadays steel barbed spearheads are being sold in the village store.

Use of fish traps ('kawa')

Trapping was one of the most common fishing methods in the past, but now only about three households use it. The traps are woven by old men but it is the women who use them. Baits used are usually crushed crabs and sea stars. Women use outrigger canoes to set these traps by rowing to suitable places. Fisherwomen know suitable places as a result of their experiences or by being told by their elders. Coconut husks are used as marker floats and white stones as sinkers.

Fish caught are usually snapper and other large fish attracted into the trap by the smell of the crushed bait. When it is time to lift the trap, women know that there are plenty of fish in it if it feels light. This is because fish thrust the trap upwards as it is pulled up.

Nets

Hand nets are usually used by women. These consist of a rectangular length of netting tied or laced at each end with a pole placed transversely to the length of the net.

In communal fishing, large surround nets are used to catch goat fish near the shore. This is done only by women.

Hooks and lines

Females do not go fishing using hooks and lines. This is only done by men usually on Saturday or week nights. Bait used includes land hermit crabs, fragments of octopus and small fish such as goat fish, with octopus most favoured.

Light lines, sinkers and small hooks are used effectively in lagoons and shallow areas. Two hours of fishing in the lagoon usually provides enough food for a household. Small snapper are an especially esteemed lagoon fish caught by this method.

Fish drives ('yavirau')

Fish drives are undertaken only before Christmas, New Year or Easter in order to provide the villagers with fish for feasting. They are used only on important occasions because they demand so much organisation and preparation.

Each household has to contribute its share of the scare-line as ordered by the 'Tuinidau'. A scare-line is made up of 'wa' knotted together and is wrapped spirally with the longitudinally split halves of coconut leaves. A very long scare-line is used to enclose an area of water near the reef flat with a view to driving all the fish into the 'bag'.

Everybody takes part in the fish drive. Sharks are allowed to escape as they would devour some of the fish or break the bag. Big fish are speared whenever possible, once again so as not to damage the scare-line.

By tradition, the fish catch is normally shared among all the households in the village. However, in some cases only those contributing to the scare-line obtain a share.

Everybody enjoys being involved in a fish drive. It provides a rare social occasion for all the people of the village to come together to fish.

Potential commercial fishery

Ono-i-Lau's only available resources for commercial exploitation (apart from copra) are its aquatic resources. It is surrounded by fringing reefs with extensive reef slopes. Its fishery potential is considerable.

Nevertheless, commercial fishing does not exist, residents using fishing as a source of food for direct household consumption only. Although the exploitation of fishery resources could offer village people good commercial prospects, there remains the problem of marketing and transport because Ono-i-Lau is distant and isolated from the main markets. Transportation costs to market alone are likely to

be very high and the chances of fish reaching the market in good condition may be low.

Above all, the boat entrance to the lagoon is intricate and extremely difficult unless tide and wind are favourable and can only be used by small boats. However, a small airstrip could be considered, though air transport is costly and planes usually visit Ono-i-Lau once a fortnight.

The above factors concerning barriers to commercial fisheries should be taken into account before a potential fishery product is chosen by Ono-i-Lau for commercial supply.

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4

Mariculture of Giant Clams in Tuvalu: Prospects for Development

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Abstract

Prospects for giant clam culture in Tuvalu are examined. Although stocks of giant clams in Tuvalu have been considerably depleted and although Tuvalu has a favourable natural environment for the growing of giant clams, socioeconomic prospects for their cultivation either for subsistence purposes or for commercial gain currently appear to be poor. Alternative local sources of food for subsistence use, such as from the capture fisheries, are more readily available than from giant clam cultivation and it would seem that Tuvaluans do not have a preference for giant clam meat strong enough to induce them to make an extra effort to grow clams rather than alternative methods of obtaining food locally. Furthermore, Tuvaluans may not, in any case, have a strong preference for locally produced food. They currently run a very large internal trade deficit on account of food, and while development assistance continues at current levels, this situation is unlikely to change. While more ready availability of giant clam meat would contribute to local diets, it is only likely to be a minor amount. On the commercial side, Tuvalu's existing and prospective home markets for giant clam meat seem small. As for exports, markets for export of clams remain uncertain but in any case Tuvalu would suffer a transport cost disadvantage in export markets compared with a country such as Fiji. In the light of this and other problems, the decision of the Fisheries Division of Tuvalu to defer the development of giant clam mariculture in Tuvalu seems warranted.

Introduction

Tuvalu is a small island country in the Pacific, with limited land resources and a high population density. Marine resources appear to be plentiful but are largely unexploited. The Tuvalu Government is interested in fostering aquaculture activities and for this reason Tuvalu was included in the multi-country research project on giant clams sponsored by ACIAR.

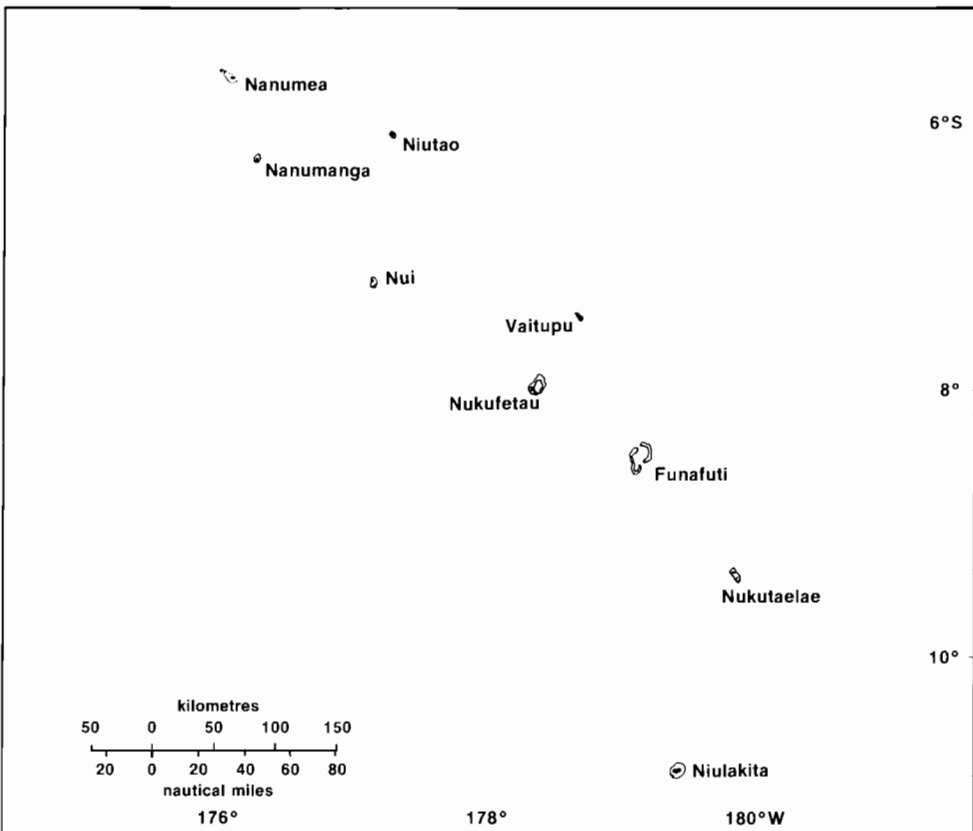
In this chapter, the prospects of giant clam mariculture in Tuvalu are considered and some lessons are drawn from this case study. A brief outline of the environ-

mental and economic characteristics of the country is given, followed by consideration of the status of giant clam stocks and their exploitation. The scope for development of mariculture of giant clams in Tuvalu is considered against the background of its fisheries sector as a whole.

The country

When it became independent on 1 October 1978, Tuvalu—previously known as the Ellis Islands—adopted its present name which means ‘Eight Standing Together’. The archipelago is actually formed by nine atolls, but one—Nulakita—was not permanently inhabited at the time of independence.

The country is located between latitude 5° and 10° South and longitude 176° and 179° East (see Maps 1.1 and 4.1).



Map 4.1 Tuvalu.

The atolls range over a distance of 560 km on a line running from north to south. The total land area of Tuvalu is 25.0 km² and its marine area 900 000 km². Its climate consists of a rainy season (November–February) and a dry season. Temperatures vary between 22° and 38°C. The rainfall varies considerably between the islands and from year to year, with an average of 3000 mm for the islands furthest to the south. Tuvalu is subject to cyclones and, given the low altitude of the land above sea level (maximum altitude 6 m), there are fears that global warming and rising sea levels, aspects of the greenhouse effect, may eventually have a disastrous impact.

The people of Tuvalu are mainly Polynesians, with a minority of Micronesians. Tuvalu's total population was estimated to be around 9000 people in 1990. Its population in relation to land area is amongst the highest in the world (350 persons/km²). Its average annual population growth rate was 1.7% between 1982 and 1987 (SPC 1989). This growth rate is not high by developing country standards, but it obviously poses serious problems for a country poorly endowed with natural resources and with an already high population density. SPC (1989) estimates that the total population of Tuvalu in the year 2000 will be 10900. This will result in a population density of over 400 persons/km².

The economy

Tuvalu, together with the Cook Islands, Niue, Tokelau and Kiribati, has been defined as a MIRAB economy in order to stress its dependence on remittances from abroad, on migration, on development assistance and on wage employment in government bureaucratic sectors (Bertram and Watters 1985). 'MIRAB' is an acronym derived from M (migration), R (remittances), A (aid) and B (bureaucracy). Per capita development assistance to Tuvalu was A\$561 in 1985, an amount almost equal to its per capita GDP of A\$614 in the same year (SPC 1989). Two-thirds of employed Tuvaluans work overseas (Connell 1988) and remittances are estimated to represent about 30 per cent of Tuvalu's foreign revenues, of which a further 40 per cent comes from philatelic sales. In 1985 Tuvalu had a negative trade balance of A\$3 969 000. This amounted to about 80 per cent of GDP. This negative trade balance was more than offset by an inflow of development assistance funds amounting to A\$4 601 000.

The above economic features have led Bertram (1986) to argue that the development problem faced by governments of Pacific microstates is not one of promoting capitalist goods-producing activities, but how rent income, such as that obtained from development assistance, can be made more secure and predictable and how it should be allocated among members of the island community. This rent-seeking behaviour should be paralleled, according to Bertram, by the promotion of the informal sector; that is, of village-made production. The maintenance of traditional production systems would allow villagers to revert to subsistence life in case of a reduction in, or drying up of aid and remittance funds.

However, there are some problems with this approach. Economic dependence on foreign countries also implies political dependence and this might not be

acceptable for independent states. With this motivation, Kiribati has renounced budgetary aid (Pollard 1987), but it is fair to say that this was possible partly because of the existence of income from the Revenue Equalisation Reserve Fund, established from phosphate revenues. The establishment of a fund tends to reduce the degree of political dependence on other countries and uncertainty in financial flows.

Tuvalu has been successful in having a Trust Fund established by traditional aid donors. The fund, established in 1987, amounts to A\$27 million and is administered by Westpac (a banking company) through a board that has representatives from the United Kingdom, New Zealand and Australia (Connell 1988). While the existence of the fund no doubt reduces Tuvalu's political dependence in the short term, it is not obvious that this will also apply in the long term. A rising population implies a decreasing per capita annual income from the fund and changing needs of the people, requiring higher income, and might require a continued dependence on donors to increase the capital component of the fund (cf. Tisdell 1990, Ch. 10).

A more subtle effect of reliance on development assistance is its sociological and psychological impact. There is some (dated) evidence that households have a relatively high degree of resilience to external conditions which allows them to shift between cash and subsistence activities (Lawrence 1983). The long term impact of aid, however, may be to reduce this resilience, thus leading to increased dependence on aid. The negative social and cultural implications of this aid dependence are often underestimated in economic circles but they should be taken into account (e.g. Wendt 1987).

Some questions that should be asked when deciding if and how to implement Bertram's strategy of informal-sector promotion are: What are the needs of the villagers? What are their aspirations? What nowadays actually is the 'village-mode of production' and what are its features? In the debate about the future of the Pacific islands, it is often assumed that planners and academics have answers to these questions. They do not. Clarke and Morrison (1987), for example, state that not much is known on the livelihood strategies and decision-making processes of rural Fijians.

Individualistic capitalist modes of production are not the only ones that can be adopted for production of goods. Community projects and cooperatives are also possible modes of production but they are often thought of as having a poor development record in the Pacific. This is, however, a generalisation and does not help the debate much.

The performance of a community project depends on several factors, such as cultural values, community cohesion, leadership and type of activity. There are certainly community development initiatives that have failed but there are also others that have been successful because they have paid attention to the above factors (Schoeffel 1983). Tuvalu has a strong tradition of community work and many different groups are active in all aspects of community life (Chambers 1984) and could be involved in new economic projects.

In the following sections the status and prospects of giant clam farming in Tuvalu will be analysed at a general level. It should be understood that, if the Government of Tuvalu, through the Fisheries Division, intended to pursue clam farming at the village level, *a detailed analysis of local conditions would be needed.*

Background on the fisheries sector¹

The fish stock of Tuvalu is thought to be one of the highest in the Pacific. However, the island nation's exploitation of its sea resources is constrained by its limited infrastructure and by the isolation of the country and the logistics of accessing distant export markets.

The Fisheries Division, which is part of the Ministry of Commerce and Natural Resources, relies heavily on foreign assistance. Lack of equipment (e.g. the Division does not have its own means of transport) and of skilled personnel are major constraints on its operation.

The Division has identified major areas for special attention. Included in these are resource assessment, commercial fisheries development and aquaculture.

Tuna is an important but almost unexploited resource. Costs incurred in export of tuna to foreign markets may hinder the development of tuna fishing. Bêche-de-mer is another unexploited resource. The last recorded exports of it occurred in 1980. A survey of the stock is being planned by the Division as bêche-de-mer has increased in price and commercial exploitation of stocks will be attempted in the near future. Other resources being assessed are deepwater snapper and resources of the seamount.

Of particular relevance to this chapter are developments in coastal subsistence and artisanal fisheries. A large proportion of fishermen on outer islands use traditional fishing methods and the Division is trying to integrate traditional methods with new techniques in order to increase catches. This initiative is paralleled by the establishment of community fishing centres on several atolls. These centres have the specific task of concentrating on the production of dried and smoked fish in order to develop a small-scale export industry, targeting countries like Fiji, the Marshall Islands and New Zealand. If possible, fish drying will be carried out using solar energy and energy derived from agricultural waste.

Possible resources which may be developed for aquaculture are milkfish, pearl oysters, seaweeds and giant clams. The outlook for giant clams will be discussed in detail later. Trials of seaweed culture started in 1988 with stock imported from Kiribati but, due to the occurrence of strong seasonal winds, have not been particularly successful. It is interesting particularly to note that Kiribati recently reached an agreement with a Danish company that will buy all the seaweed Kiribati can

¹ This section draws upon Herr (1990).

produce. More than ten islands across Kiribati have been targeted for cultivating seaweed, this being part of a farming project (sponsored by New Zealand) that uses locally available resources such as sticks and coconut fibre, thus minimising capital investment and need for import of capital (Anon 1991a). This example obviously provides an incentive to Tuvalu to develop seaweed farming.

Giant clams in Tuvalu

In order to assess giant clam stocks and the potential for clam mariculture in Tuvalu, two field assessments have been undertaken by scientists. Braley (1988) surveyed the atolls of Nukufetau, Nukulaelae and Funafuti. Langi (1990) surveyed the northern atolls of Nanumea and Nui.

The species reported to be present at the time of Braley's survey were *Tridacna maxima* and *T. squamosa*. Shells of *T. gigas* were also found but no live animals were located. Estimates of densities of *T. maxima* were 'quite modest' at Nukufetau and Funafuti (63 and 101 clams per hectare respectively), and 'very low' at Nukulaelae (3.1 clams per ha). *T. squamosa* was not found in the lagoon of Nukulaelae and estimated densities at Nukufetau and Funafuti were reported to be 'very low' (0.68 and 1.4 per ha).

The attributes 'modest' and 'very low' were defined by comparison 'with other islands in the South Pacific and the Great Barrier Reef region' (Braley 1988, p. 3). As Braley's was the first quantitative survey done in Tuvalu, numerical estimates of past clam densities are unavailable.

His analysis of size, frequency and distribution of *T. maxima* at sites varying in distance from the villages, and the analysis of fresh dead shells, provided evidence of harvesting pressure on natural stocks of this species.

Interviews with villagers were also undertaken by Braley in order to obtain their personal opinions about the past and present use and availability of clams, knowledge of basic ecology of reef animals, need for restrictions on clam harvesting and their interest in the possible involvement of the Government of Tuvalu in clam mariculture. Approximately 30 people were interviewed in each atoll; women and men in the same proportion and distributed relatively evenly across three age groups—old, middle-aged and young. The results of these interviews are summarised in Table 4.1, together with the results of Braley's stock assessment.

Clam meat consumption appears to be modest, especially in Funafuti (Table 4.1). While the survey did not find *T. squamosa* in Nukulaelae, respondents in this atoll reported that they have eaten this clam species. That could mean either that *T. squamosa* is very rare in Nukulaelae and therefore though unlikely to be found by the survey team, it is occasionally found and eaten by villagers, or that it has recently become locally extinct. As *T. squamosa* was found in very limited numbers in Nukufetau and Funafuti, lack of restrictions on collection of this

species could lead to its extinction in Tuvalu, assuming that other unsurveyed atolls have equally low densities of this species.

Giant clam meat was not mentioned as a food item by Chambers (1984) who did an anthropological study in the northernmost atoll of Nanumea between 1973 and 1975. Chambers also reports that shellfish was marginal in the diet of Nanumeans and comprised only a small part of their food intake.

Table 4.1 Summary of the findings of Braley (1988).

	Atoll		
	Nukufetau	Nukulaelae	Funafuti
Existing stock			
<i>T. maxima</i>	quite modest	very low	quite modest
<i>T. squamosa</i>	very low	not found	very low
Consumption			
Quantity(clam/person)	1-2 weekly	1 monthly	irregular
Species	<i>T. maxima</i> (mainly)	<i>T. maxima</i> / <i>squamosa</i>	<i>T. maxima</i> / <i>squamosa</i>
Shell length (cms)	12-18	12-30	12-35
Price	\$1-2/plate	n.r. ^a	\$2/plate
Perceived scarcity			
Male: Total	93% not scarcer	75% not scarcer	40% not scarcer 53% scarcer
By age: old	6.7% scarcer	scarcer	n.r.
middle	no change	scarcer	n.r.
young	no change	n.r.	n.r.
Female: Total	100% no change	66% not scarcer	33% not scarcer 60% scarcer
By age: old	33% scarcer	n.r.	n.r.
middle	no change	(some) scarcer	n.r.
young	no change	n.r.	n.r.
Ecology			
Does collection affect clam numbers?			
Yes	93% men 44% women	60% men 40% women	n.r. n.r.
Effect: increase	majority	6.7% men	13% men 13% women
decrease	old men	'some' men & women	70% men 66.7% women
no relation	n.r.	n.r.	20% men
Yes: men	100%	100%	100%
women	93.3%	100%	93.3%

^aLegend n.r.= not reported

Source: Based on Braley (1988)

The atolls of Nanumea and Nui were surveyed by Langi (1990). The only species found was *T. maxima* and clam populations per hectare were much lower than those recorded by Braley (1988). For Nanumea, Langi reports 0.59 clams/ha and for Nui 2.72 clams/ha. These low densities suggest that a certain degree of depletion may have occurred, even if the exact extent of depletion due to human activities is uncertain. That a sizeable reduction in availability of giant clams is occurring, is confirmed by the fact that villagers interviewed suggested that populations of clams have decreased over time, resulting in an increase in the relative importance of fish in their diets. *T. squamosa*, which the inhabitants of Nanumea report was found on the reefs of the atoll in the past, is now apparently extinct there.

Braley (1988) reports market prices for clam meat in Nukufetau and Funafuti. However, the marketed quantity of meat must be a very small proportion of the total consumption. In Nukulaelae, none of his respondents had ever bought or sold clams. In Nukufetau, only some young and middle-aged men had sold clams and only some old men had bought clams. Women had not entered the market. In Funafuti, 93 per cent of men and 88 per cent of women have never sold or bought clams; 6.7 per cent [1] of men have never bought, but have sold clams for \$2/plate; 12.5 per cent [2] of women have never sold but have bought clams (\$1-5/clam; 30-50c/small clam)' (Braley 1988, p.27). This limited activity in marketing clams should be taken into account in considering the possible role of giant clams in the economy of Tuvalu and of the villages. In fact, given that young people do not perceive giant clams as becoming scarcer their limited exploitation of the resource is possibly due to lack of marketing opportunities or their low desire for clam meat.

As far as perceptions of respondents about increasing scarcity of clams is concerned, in Nukufetau and Nukulaelae a large proportion of females and males alike think that clams are not becoming scarcer. However, older people appear to perceive that a decline in clam stocks is occurring. In Funafuti, the majority of the people interviewed recognised that clams are scarcer than in the past. Braley (1988) traces this lack of recognition of decrease in giant clam stocks to a lack of knowledge about the ecology of giant clams. He asked the respondents whether they saw a link between collection of giant clams and future availability of clams. In Nukufetau, the 'majority' of respondents thought that gathering of clams would increase future clam numbers, an answer dictated by the local belief that some juveniles will be recruited in the area where the clam was collected *if* the shell and part of the byssal attachment are left on the reef. However, only one man in Nukulaelae and two men and two women in Funafuti, believed that the latter would actually occur. Therefore, Braley's suggestion that lack of knowledge by villagers of the ecology of giant clams affected their perception of changing scarcity of clams may not be completely warranted.

It is interesting to note that Vuki et al. (1991, see also Chapter 2), in a survey conducted in the Lau Group (Fiji), found that perceptions of availability of clams did not vary significantly within villages, and was not influenced by age as in Braley's survey. It is possible that villagers' perceptions of scarcity of giant clams

vary according to *their* demand for them or their use of them as a fishing resource. Their answers may therefore not relate solely to the absolute size of clam populations or their abundance. Therefore, one variable that should be considered in analysing scarcity perception is personal 'interest' in clams, i.e. as a fishing resource and/or as a consumption item.

Finally, Braley asked the interviewees if they would like to see the Tuvalu Government experiment with giant clam farming. All but three respondents answered yes. It is unfortunate that respondents were not asked if *they* themselves were interested in farming giant clams. The interest of individuals in farming giant clams *themselves* depend on its costs and benefits to them. However, they may see government experiments on farming as having no cost to them. Thus, their answers to this question would be a very approximate measure of their own real interest in clam farming. If they have to invest their own resources this might change their 'perceived' interest in clam mariculture. If the government invests in giant clam farming, there is no economic risk for the villagers. They may either gain or not gain but they *do not lose* directly if they do not contribute to the cost of the experiment.

Based on the evidence just summarised and the favourable environmental conditions in Tuvalu, Braley's report concludes that Tuvalu has good ecological potential for culturing *T. squamosa* and eventually *T. gigas*. *T. maxima*, the most common species in Tuvalu, is not considered useful by him for mariculture because it is slow growing.

Economic considerations were not considered in Braley's report. The next section will look at economic potential for clam mariculture in Tuvalu. However, before doing so it is useful to briefly summarise recent experience regarding clam culture in Tuvalu.

ACIAR (1991) reports that, in October 1988, one thousand *T. derasa* (a non-autochthonous species) were introduced to Tuvalu from the Micronesia Mariculture and Demonstration Center (MMDC) in Palau. Survey in 1990 revealed that only 146 had survived to that time. It should also be noted that Tuvalu, because of limited staff available to the Fisheries Division and its commitment to other, higher priority projects, has deferred establishing a clam hatchery.

Prospects for giant clam culture

Given the above, it is probably not surprising that the Fisheries Division of Tuvalu has suspended for the time being the start-up of giant clam culture in Tuvalu.

Marine resources are plentiful in Tuvalu. Lack of capital and technical expertise, and difficulties of gaining access to distant markets, at present inhibit fuller exploitation of its sea resources. In an environment of limited technical resources, it may be preferable for Tuvalu at this time to concentrate its effort on improving its capacity to exploit its sea resources for local use (e.g. subsistence and artisanal

fishing) which have a better understood market, than concentrating on a totally new enterprise such as giant clam culture with a large degree of uncertainty about its profitability. Nevertheless, giant clam culture is an option that could be taken up in the future by the Fisheries Division, and some factors likely to affect its viability are therefore considered here.

Hatchery techniques for giant clam culture have been developed by several research centres: The International Center for Living Aquatic Resources (ICLARM), Solomon Islands; the Micronesia Mariculture Development Center, Palau; and ACIAR through commissioned organisations in Australia, Fiji and the Philippines. Hatchery techniques are now well known but it may be more economic for Tuvalu to import rather than produce its own seed clam. If it follows this path, research in Tuvalu would be needed mostly to adapt the ocean-growout phase of clam farming to its local environmental conditions.

Whether or not clam farming would be adopted as a subsistence activity in Tuvalu is unclear. Some factors that could make clam culture unsuitable for the Lau group in Fiji for subsistence have been discussed by Vuki et al. (1991; see also Chapter 2). They may also apply to Tuvalu. The people of Tuvalu do not suffer from food shortages and giant clams are not sufficiently preferred to other food to warrant considerable effort and investment in increasing their availability compared to other fish supplies. As in the Lau group (Fiji), local people are likely to be more interested in clam culture as a possible source of cash income than as a means of subsistence.

The potential for commercial clam culture depends on several factors. Obviously, a very important one is the level of market demand. Tuvalu's domestic market for clam meat has not been surveyed but from Braley's (1988) limited data it seems to be fairly small.

Tuvalu has a considerable external trade deficit on account of food (see Table 4.2). Whether giant clam meat produced as a result of mariculture could replace a portion of the nation's food imports is a matter for speculation. However, it seems likely that its impact on Tuvalu's food imports would be small.

Overseas market prospects for clam meat, both fresh and preserved, are still uncertain. Stanton (1990) could not draw any firm conclusion on the potential market for giant clam meat as the available international trade statistics for marine products, for which clam meat could be a substitute, were not sufficiently disaggregated. Shang et al. (1991) reports that markets for clam meat exist in Okinawa (Japan), Taiwan and Australia. The Okinawa market may absorb up to 300 tonnes of giant clams in the shell for sashimi and sushi dishes. The preferred species is *T. crocea* but *T. squamosa* might also be consumed, if it had a price lower than that of *T. crocea*. Air-freighting to satisfy the Japanese market from Tuvalu would be both expensive and risky. Clams may have to be transhipped *en route* and may therefore be damaged.

Table 4.2 Tuvalu's imports and exports (1982, '000US\$).

	Imports	Exports
Food and beverages:	692	27
Fresh fish, simply preserved	1	
Tinned fish, prepared	57	
Industrial supplies	664	
Fuel and lubricant	493	
Machinery	240	
Transport equipment	186	
Consumer goods	406	10
Others	259	
Total	2940	37

Source: United Nations (1987).

Okinawans prefer giant clams of about six centimetres in size, in the shell. Possibly this market could eventually be satisfied by on-shore based facilities thus reducing to a minimum the natural advantage of Pacific countries in clam farming using natural environmental conditions. Also, *T. crocea*—the favoured species in Okinawa (Japan)—does not occur naturally in Tuvalu. However, *T. maxima*, which does occur naturally in Tuvalu, could be an acceptable substitute.

In Taiwan, a market exists for fresh or frozen clam adductor muscle, estimated to have the potential to absorb 240 tonnes per year (Shang et al. 1991, p.10). The species most suitable for this market, in order of preference, are *T. gigas*, *T. derasa*, *H. hippopus*, *T. squamosa*, and *T. crocea*. At present, clam products other than fresh or frozen adductor muscle are not available in Taiwan and a market for giant clam mantle meat does not currently exist there. Giant clam products are said to be unknown in Hong Kong, but based on interviews with seafood dealers, Shang et al. (1991) have the impression that it is worth while attempting the development of a market for giant clam products in Hong Kong. Other potential markets are those of New Zealand (Tisdell and Wittenberg 1990; see also Chapter 17) and possibly the west coast of United States where many Pacific island migrants live.

Can Tuvalu gain access to these markets? Transport costs are against it. Cargoes from Tuvalu to major destinations have to go via Fiji. Thus, the developing clam industry in Fiji certainly has an advantage over that of Tuvalu as far as transport costs are concerned.

Conclusion

The Government of Tuvalu is determined to make fuller use of the country's marine resources. Priority has been given to development of those resources for which

traditional technologies are already available and/or to development of those with existing markets.

The development of giant clam culture has been deferred in Tuvalu because of poor market prospects and because the Fisheries Division is short of technical and human resources.

The size of the market for clam meat remains uncertain. If an export market opens up, Fiji is favoured in entering that market in comparison to Tuvalu. This is because Fiji has a more advanced food-processing industry and has lower transport costs. Exports from Tuvalu have to go via Fiji and this clearly means higher transport costs. Because of the structure of the transport system in the Pacific, it is perhaps not desirable to attempt to induce the growth of the same industry (e.g. clam production) in two countries one of which has a decisive advantage in production and transport costs.

A further lesson, not a new one, is that development assistance can become a burden for the recipient country, especially when it has limited human and technical resources, as is the case for Tuvalu. On the other hand, it can be difficult for donors to provide what the recipient country actually needs, as scarce technical and human resources also mean a limited capacity to identify needs and establish a program of action.

Finally, clam stocks in Tuvalu appear to be dwindling, and continued exploitation could lead to the disappearance of *T. maxima* and *T. squamosa* as seems to have already occurred for *T. gigas*. Government intervention to regulate clam collection is required to protect clam stocks because the local communities do not recognise this need.

Acknowledgments

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5

Giant Clams in Wallis: Prospects for Development

Nancy J. Pollock

Abstract

This chapter examines the possibility of harvesting clams for sale, either within the island of Wallis or beyond. An outline of the environmental, social and economic characteristics of the country is provided, together with an assessment of the role of Wallis in the Pacific that is likely to affect the potential for marketing clams. Clam usage and harvesting practices are described, along with local views on the size and location of clam stocks. These data allow representation of the views of Wallisians about the social and economic possibilities for marketing clams.

Introduction

Wallis is a single island with a wide encircling reef, situated in the central Pacific; its people are Polynesian. The country has no export economy so is entirely dependent on financial support by France as one of its overseas territories (Territoire d'Outre Mer). The island is rich in subsistence resources. For a cash income, however, the people migrate to work in the nickel mines or other labouring jobs in New Caledonia, with the result that there are 8000 Wallisians living there and another 8000 living on their home island. The annual per capita income on Wallis is \$46 (South Pacific Commission 1987).

Several development plans have been proposed by French administrators in the past, but so far the greatest achievements have been in the areas of road building, electrification and telecommunications. The lack of jobs for young people has been addressed recently by plans to create 100 or more six-month and year long jobs to enable school leavers to gain some work experience (see Pollock 1991). Plans to develop agriculture in the past have focused mainly on the planting of pine forests behind L. Lano (see Map 5.2) in order to arrest soil erosion in this area of *tuafa*, or scrubland. Fisheries developments have taken the form of support for boat building. The most recent French development plan (Institut d'Emission d'Outre Mer 1991) has been rejected by the members of the Territorial Assembly (for Futuna and Wallis) who are anxious that any planning for their future should be carried out by Wallisians and Futunans themselves using models appropriate to the

Pacific, not those derived in Paris. This raises the question of the kind of development appropriate to Wallis and its neighbouring island of Futuna (see Maps 1.1, 5.1 and 5.2).

In this discussion we will examine the possibilities of harvesting clams for sale, either within the island or beyond. An outline of the environmental, social and economic characteristics of the country is provided, together with an assessment of the role of Wallis in the Pacific that is likely to affect the potential for marketing clams. Clam usage and harvesting practices are described, along with local views on the size and location of clam stocks. These data allow representation of the views of Wallisians as to the social and economic possibilities for marketing clams.

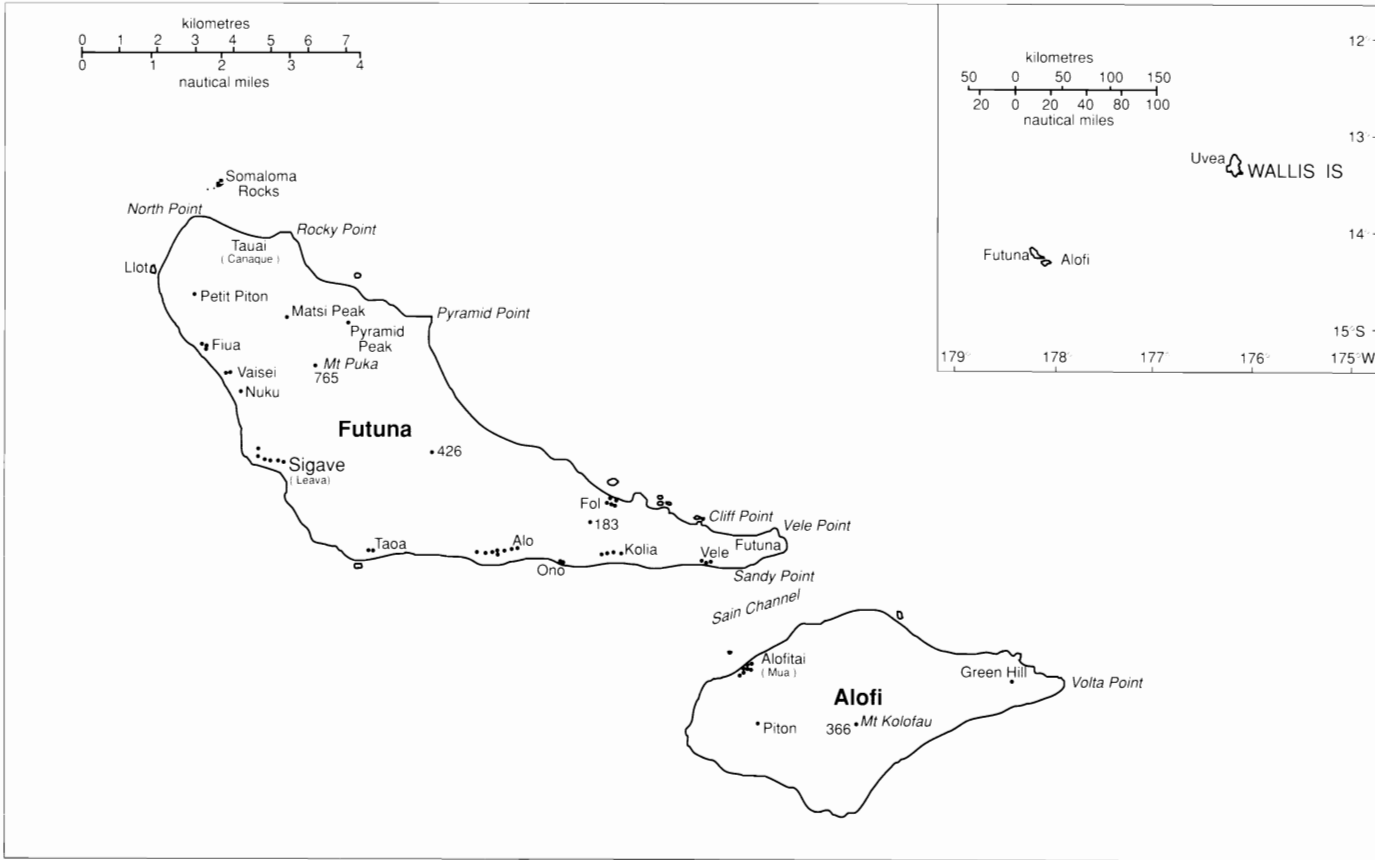
Geography of the island of Wallis

The island of Wallis, formerly known by its Polynesian name, 'Uvea, is situated in the central Pacific, half way between Fiji and Samoa. It consists of a single island of volcanic origin, its highest point being 145 m above sea level, surrounded by a barrier reef enclosing a lagoon up to 800 m wide, with a muddy bottom inshore. There are numerous small islets on the eastern outer reef, together with two passes deep enough for traffic by large, keeled shipping (see Map 5.2). Ships must anchor in the lagoon as it is too shallow inshore.

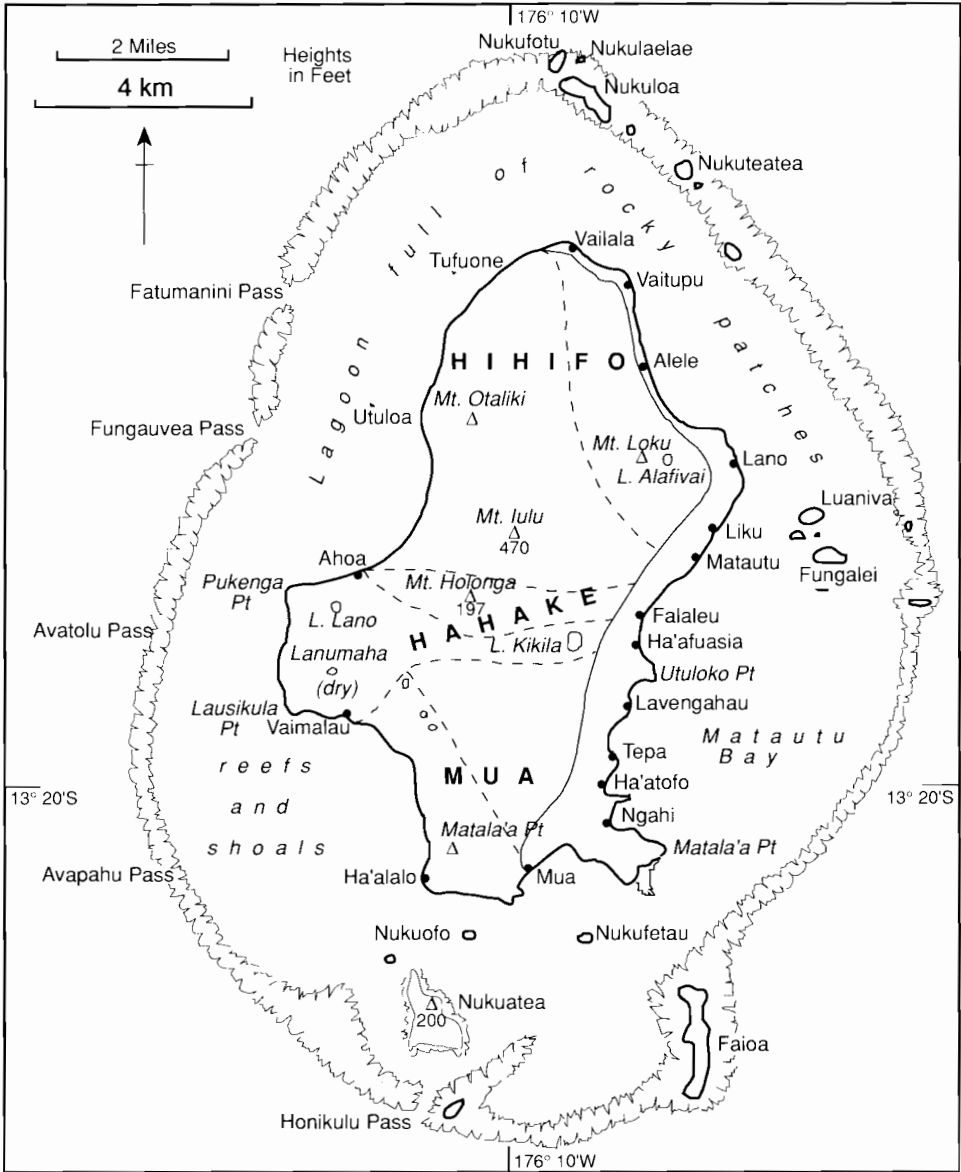
The people live on the eastern side of the island in some 14 villages arranged in three districts: Mu'a, Hahake and Hihifo. Each of these districts is considered a very distinct political and geographic entity, with its own history. Mata'utu, the capital and port, is located in Hahake, the central district, as are all government offices. It has the only wharf suitable for lightering materials in small craft from ships anchored in the lagoon. The airport is located in the northern district of Hihifo.

The island is serviced by a supply ship from New Caledonia once a month, as well as by French naval craft as they carry out routine duties across the Pacific. Lying between New Caledonia in the west and French Polynesia in the east, Wallis provides a strategic base for French operations in the Pacific. Since 1991 air services have also linked the three territories, so that French tourists and administrators can now fly across the Pacific using French bases.

There were 8973 people living on 'Uvea at the last census in 1990 (Maesse 1990). This represents a total increase of only 10 per cent since the last census in 1983, when the population was 8084, one of the reasons being a high rate of emigration to New Caledonia. Forty-two per cent of the population is under 15. Another 9500 Wallisians live in New Caledonia to where they have been migrating since 1952 when their labour was first needed in the nickel mines. Since 1983, the Wallisian population in New Caledonia has been larger than that on Wallis; some of these Wallisians are New Caledonian born. Many migrants do visit their home island, either by air, which is very expensive, or by the regular shipping service, which is cheaper, but much slower. They also send money to their relatives on special occasions such as a First Communion or a funeral



Map 5.1 Wallis and Futuna islands.



Map 5.2 Wallis Island.

Even though Wallisians speak a Polynesian language and practice many Polynesian customs, France has chosen to administer Wallis, and Futuna, its neighbour, through New Caledonia since 1888, rather than through Papeete, the capital of French Polynesia to the east. As one political unit, Wallis and Futuna are a Territory controlled from Paris by their Department of Foreign Affairs (see Pollock 1990a for a detailed history). The two islands achieved the status of a Territory rather than a Department in 1962. French administrators arrive through Noumea, spending a three-year term on the island. They are responsible mainly for the links between Wallis and Futuna and the exterior world.

Futuna is administered from Wallis, receiving its budgetary allowance and its main social services, such as the health service, education and public works, from Mata'utu. The population was 5000 at the latest census, resident in two kingdoms, Sigave in the west and Alo in the east. Historically and culturally, Wallisians consider themselves to be very distinct from Futunans, though both are Polynesian speaking. Futuna has been more closely allied with Samoa, while Wallis is closely allied with Tonga. The 200 km between the two islands serves only to accentuate that divide, even though there has been considerable intermarriage and residential interchange between the two populations over several hundred years. The future of the two islands may be very distinct.

Traditionally, the islands have been controlled by a hierarchy of chiefs at island, district and village levels. Wallis is run by a Lavelua who is the paramount chief, together with a Council of Ministers; Futuna is divided into two kingdoms each with its paramount chief (or 'Sau') responsible mainly for the power over land and thus over social and economic affairs of the people.

The Territorial Assembly is an elected body consisting of Wallisians and Futunans chosen to represent their people in order to make internal decisions affecting their people. The members work closely with the Lavelua and his Council of ministers on Wallis (and the two Sau in Futuna). It has remained somewhat quiet for most of its existence, but recently has begun exerting its influence more forcibly. Economic development has become a key concern, particularly that any planning should be subject to local discussion, rather than emanating from Paris. The issue of the relative powers of Wallis and Futuna is another significant latent issue.

Together with France and the traditional local leadership, is a third political force of some strength, the Church. Wallis is totally Roman Catholic, under the care of a Bishop who is Wallisian. He not only maintains a watching brief over his parishioners through his priests, but also links Wallis and Futuna into the Roman Catholic Western Pacific Archdiocese, along with Catholics in Tonga, Samoa and Fiji. The Church remains responsible for running an education system first set up by the Missionaries in the 1840s. The three secondary schools are staffed mainly from France.

France subsidises the Territory's public finance. The budget of 2702 millions FCFP in 1989 (Rallu 1990:3) comes mainly from France. Imports are high, and exports almost nil, handicrafts sent to New Caledonia yielding the main export revenue. There is no tourism or commercial agriculture or fishing on the islands. The five hotels/guest houses serve the needs of visiting French administrative staff.

The income of the Wallisian people is derived from three sources: subsistence farming and fishing (60 per cent); cash income (13 per cent); and gifts and exchanges (17 per cent). In 1980, subsistence income was valued at \$A9391 per household per year, while total annual income was \$A19800 per household per year (1980 census, Notes et Documents No. 16). The result is an income of \$US46 per capita per annum. According to the 1990 census, 1385 Wallisians (12 per cent) had jobs, 1053 of these in administration and teaching, and 335 working in the private sector, mainly construction. An unspecified proportion of the population receives a pension either from their work in the nickel mines in New Caledonia or because they are over 60 years of age. Thus, in those households where one or two persons have an income there is a wider range of material goods than those totally dependent on their subsistence livelihood. Many households survive with no cash income other than that sent by relatives in New Caledonia send for special occasions (see Pollock 1988).

The main subsistence crops are Colocasia taro, yams, bananas and breadfruit, together with some Alocasia taro, sweet potatoes and cassava. All of these traditional crops grow well on the volcanic soils around the shoreline, with irrigation where necessary. Pigs are the main form of wealth, very visible in 1989 when they were allowed to run loose everywhere, including the lagoon shore where they rooted for small shellfish. They are fed with coconut each day by a member of the owning household, are used for feast and ceremonial occasions, and may be exchanged. While they have a cash value, very few are sold. Chickens abound in most households, being used to accompany the starchy foods on Sundays and special occasions. The whole subsistence support system is extremely vulnerable to the cyclones which periodically destroy this and other Pacific island tree and root crops, as well as houses and public buildings.

The main daily diet consists of one or more of the starches, such as taro or breadfruit, cooked in the earth oven or on a stove, eaten with a small accompaniment of fish, shellfish or coconut. Most people eat a starch and its accompaniment once a day, filling in with bread and coffee in the morning and evening; young men expect to have a second 'meal' in the evening, which they make of rice and canned meat or fish. Men do all the cooking. Beer and spirits are consumed in many households that have some income; drunkenness is becoming a serious problem amongst the young men.

Assessed by Western measures of income and wealth, the Wallis economy is stalled. The subsistence sector is very active, more land being planted in taros, manioc and yams in Hihifo villages in 1991 than in 1988 (Pollock 1991), but the level of cash income is still very low. Wallisian people want more money to spend on the wide range of goods in the supermarkets, as well as on capital items such as durable houses, furniture, cars etc. Young people are very frustrated at the lack of opportunities for them once they leave secondary school.

The only tertiary education facility—a two-year polytechnic—was opened on Wallis in 1990. Otherwise, a small number of students are selected each year to pursue tertiary qualifications in Noumea. With only 36 per cent of the population in

1990 having secondary education, and no development on the island itself, the bright lights of Noumea, and the support of relatives established there, are a strong attraction. For young men, a year's military service for France enables them to travel abroad, gain a small amount of cash, and whets their appetite for further acquaintance with the wider world beyond Wallis.

Development planning has been seriously neglected on Wallis. The Dijoud Plan (Dijoud 1979) aimed to develop the agrarian economy, in order to diversify the level of self-sufficiency in food. However, there are no local markets for food, and little attempt has been made to develop an export market to supply those Wallisians in New Caledonia who would like to be able to buy taros etc. from their own island. The Development Plan proposed in 1991 identified the customary system as very lively, with strong customary exchange of produce persisting. The lack of produce available for marketing in Wallis, and the more rapid evolution of needs than available means are being increasingly admitted. Customary land rights are considered to be a major deterrent to development. The result is a high level of food imports, which include much cheap liquor, and an overall dependency on France to provide the finance for the total infrastructure. Planners have identified agricultural production, exports, protection of vegetation, the pork industry, reafforestation and fishing as areas for development priority action in the 1990s. For fishing, the main priorities stated are provision of collectively owned craft, professional fishing, privatising construction of boats, and artisanal fishing with an aim to develop eventually a semi-industrial fishing sector (Institut d'Emission d'Outre Mer 1991). Several of these activities do not suit local needs according to Wallisian views.

The latest development plan, while comprehensive in addressing some fundamental issues not raised by previous plans, was rejected by the Wallisians as they had no input into its formulation. They put up an alternative plan through the Territorial Assembly. This was taken to France by the two delegates representing Wallis in Paris and the President of the Territorial Assembly. There is no outcome as yet.

The difficulty with development planning in Wallis, as in other island societies of the South Pacific, is the issue of the degree to which a capitalistic system with emphasis on profit, wealth, individual enterprise, and economic growth is likely to provide the kind of lifestyle islanders envisage for themselves, particularly if the system alienates the people from their traditional means of support, including the land and their kin ties. An alternative system that emphasises a more communalistic lifestyle, is achieving some success in islands such as Tonga, where projects involve a number of extended family members, and even stretch to pooling land for banana plantations, for example (Fleming et al. 1990).

The commercialisation of any clam industry may well fall within the general plans for developments in fishing. It would have to be talked through with both the leaders of the Territory Assembly, and the Lavelua and his Ministers, as well as with the *pule* of the individual villages. The issue will have to be carefully handled so as not to fall between the three main political forces, which each have a different agenda. The traditional and modern elements will have to be locally motivated

rather than driven from outside. The search for marketable resources is recognised by all three parties as the next crucial step, but how, when, where and by whom will be decided locally, with French finance. This dilemma is the main deterrent to development.

Wallis in the Pacific

The place of Wallis—and Futuna—in the Pacific has largely been overlooked. The two island societies are frequently omitted from discussions of other Polynesian societies, and may even be left off maps made by westerners. Nevertheless the two societies have played an important part in the early development of the Pacific. They were part of the early Tongan empire in the sixteenth and seventeenth centuries, participating in exchanges of personnel and resources (see Pollock 1990b). In addition, they were the source of out-migrations that led to the settlement of two islands in Melanesia: West 'Uvea off the east coast of New Caledonia, and West Futuna off the east coast of southern Vanuatu. These out-migrations preceded by some 200 years the migration to New Caledonia that began in 1957. Wallis and Futuna thus have broad traditional ties to other Polynesian societies in the east, and to Melanesian societies in the west.

Wallis is part of western Polynesia where its closest neighbours are Futuna to the southwest, Samoa to the northeast and Tonga to the southeast. Fiji is just an hour's flight away to the south. Proximity generated the close political ties between these five islands in the early history of the region.

France established its interests in Wallis and Futuna partly to protect its Catholic mission, one missionary having been murdered in Futuna in 1837, and partly to provide a buffer against the expansion of British interests in the central Pacific. French political control was not formalised until 1888 when the post of French Resident was established to provide outside protection for the islands and to promote French colonial interests. Nevertheless, the French language was not formally accepted until the 1930s, because the Catholic Mission which maintained control of education encouraged its missionaries to use the local language, in part as an expression of its power relative to the Resident (Pollock 1990a).

The Catholic Mission formed part of the Western Pacific diocese which, under Monsignor Bataillon as Bishop, was based in Wallis, but was transferred in the 1930s to Tonga. Close ties have been maintained up to the present between the various branches of the Catholic Church in the Pacific, regardless of colonial and ex-colonial affiliations to Europe. These ties, and the propensity for Wallisians to depart the island in their local craft for other destinations, led the French Resident to impose strict regulations preventing Wallisians leaving their home island. They were waived, however, so that Wallis could provide the work force needed for the development of the nickel industry in New Caledonia. These restrictions have placed severe and persisting sanctions against off shore expeditions, including deep water fishing.

Trading ties with nations other than New Caledonia have also been curtailed by regulation. Some trade existed between Fiji and Wallis in the early 1900s, when an English trader established himself in Wallis, obtaining his supplies from Fiji. Furthermore, having no resident doctor on Wallis at this time, Wallisians went to Fiji to seek medical care, a few taking up residence there. The absence of a resident doctor on Wallis was a major contentious issue between the Lavelua and the French naval authorities who had the responsibility of supplying the French Resident and the Wallisians with such services.

Copra was traded, again mainly through Fiji, until the 1930s when rhinoceros beetle killed off the trees, and there ended the main source of cash. No other form of trade has been developed in the interim, except for items needed for immediate household use, including construction materials and alcohol. The major importers today are French agencies, allowing little room for the development by Wallisians of even small trading stores. Recently formed unions are attempting to gain some control of commerce for local personnel.

The clam fishery in Wallis

Given this political and economic background to present day life in Wallis, an investigation was made of the role of clams (*Tridacna* sp.) in the household life in Wallis, with a view to assessing their potential as a means of economic development. We knew that Wallis fell within the zone of the Pacific in which clams had been well established (Keith Reid 1991). However, the size of the local clam population and the degree to which it had been overexploited whether by commercial or subsistence interests was unknown. Neither was there any information on how clam meat or shells were used by the local population, or how collection processes were affected by traditional reef and lagoon tenure policies.

Field research was conducted by the author and a research colleague and research assistant, both Wallisians in September and October 1991. Enquiries were addressed to local cultural authorities, prominent men in the community, and local householders who fished for clams. Specific information was sought from households in both Hihifo and Hahake districts, employing a questionnaire based on that used by Vuki et al. (1991) for the Lau (Fiji) survey (see Appendix A of Vuki et al. 1991, or Appendix to Ch. 2). Questions were posed in Wallisian by the researcher, the answers translated into English by the research assistant and recorded by the author. Further points of elucidation were sought from those informants who had more information to share. Twelve of these household interviews were recorded. Twelve males and seven females responded to the questions; their ages ranged between 26 and 54. Three young people under 15 were asked whether they liked clam meat.

The household interviews about clam use were conducted in conjunction with a follow-up survey of daily dietary patterns conducted in 1988 as part of a study of the social aspects of obesity (Pollock 1988). The occasional use of clam meat had been noted in the records. The 1988 interviews were followed-up in 1991 by revisiting 22

per cent of the households to record daily food intake, in order to establish whether dietary patterns and/or health had changed.

In addition, the owner of a restaurant situated on the wharf, and generally rated as the best on the island, was interviewed about the use of clam meat in his menus which specialise in seafood. He was asked about supply, price, expressions of interest for or against clam meat and any deterrents to serving clam meat in his restaurant.

Questions regarding reef and lagoon tenure practices were posed to several prominent cultural leaders, including the Director of the Wallis Cultural Association. Local development issues were also discussed with Wallisians, both those in employment and those engaged in subsistence agriculture and fishing, following up on conversations on similar topics in 1988.

Current usage

The clams found in Wallis are *Tridacna maxima*, known locally as *tokalalu* and *Tridacna squamosa*, known locally as *ga'ega'e* (Rensch 1984:131). These are known in French as benitiers. *Ga'ega'e*, which are qualified by the local people as large (*lahi*) or small (no qualifier), were the most commonly referred to by our informants. In Futuna, *Tridacna* clams are known by one term, *vaisua*. Occasionally, the Wallisian term *vaihua* was used as a general term for clam/benitier¹, adapted from the Futunan term.

No scientific survey has been conducted of the population size of these two species in either Wallis or Futuna. Informants responded that there were plenty available in the right places. The numbers have not diminished over the last 10–15 years. Informants were divided as to whether the cyclones of 1986 and 1989 had a serious effect on clams.

Consumption

The meat of the clam may be eaten as a snack or at a formal meal. Informants stated that most frequently the women eat clams on the spot when fishing for them. If they do take some home they form the accompaniment to the starch, such as taro or banana, at the main meal for all members of the family [see Pollock (1985) for a discussion of food concepts in Pacific societies]. Children as well as adults eat it, but there is wide variation in its acceptability. If a family gathers more than it needs it will give some away to relatives, or to the priest or sisters. One informant suggested it was good for the digestion.

Clam meat must be eaten fresh, after removal of the inky sac. If it is served at home, it is marinated in lemon juice, a process known as *ota*. French cuisine considers this a form of cooking, so the clam cannot be described as being served raw.

¹Benitier is French for giant clam, and also means a 'holy-water font'.

All informants stated they eat clam meat infrequently, when it happens to be available. It adds variety to the diet, but is in no way special. It is not usually used at feasts. There are no tapu against any sector of the population eating the meat.

The amount eaten is very variable. A woman on the reef may eat two small ones, and bring back two or three of whatever size she finds for the family. Small ones average 0.4–0.7 kg, while large ones average 1.2 kg or more. Relative to fish, clam meat is a very incidental addition to the diet.

Gathering clams

The bottom of the lagoon around Wallis varies in depth, making it difficult for people to gather clams in any but the shallowest places at low tide around the small islets. On the eastern side of Wallis, the inshore lagoon bottom is very silty along the shore line; at low tide it comprises more mud than sand, due mainly to run-off from the land. However, at the lagoon's widest points there are deep pools in the reef. This is where most people fish for clams.

Women are the most frequent gatherers of clam meat, though young men may also dive for them. Women gather them only at extremely low tide, while standing in shallow pools with the water up to only their knees. They prise the shell open using a machete or big knife or piece of metal. The shells are hard to open so the collector has to be both quick and adroit. If the small ones can be prised loose and the boat is close then they may bring the whole shell home, but generally the meat is taken out and the shell left in the reef.

Clams are gathered only around the islets on the outer edge of the reef in the district of Hihifo (see Map 5.2). It could not be ascertained if the people in Mua gather clams around their islets, but since these are close inshore they are likely to be both overfished and covered in mud and silt. The northern islets are a considerable distance (up to 1 km in some places) from the shore, so a boat is needed to reach them. Only some families in Vaitupu and Vailala (where these data were collected) have boats with an outboard engine, so not everyone can go out to collect clams. Paddling a canoe is too difficult as the wind and tide can be strong even in the lagoon.

Since all the villages are on the eastern side of the island, a boatload of people will go out to one of the islets close to their village. Off Vaitupu there are several such islets (see Map 5.2). The island of Nukuteatea was cited as the favourite place to gather clams, as the waters between it and the neighbouring islets become very shallow at low tide. Maintenance by the people of Vaitupu parish of a church and statue built on Nukutapu (NE) formerly required regular monthly visits by parishioners, as rostered by the priest. Families designated by the mission to clean the land around the church would take their boat and use the occasion for a picnic after the work was completed. Then the children would swim and paddle and the women would collect clams if the tide was right. However, the church and the statue were demolished in the cyclone of 1990 so families no longer have to make regular visits to the islands. Thus, fewer clams are being collected.

Clams are also to be found in the open ocean, *tai*. There the shells are rolling round loose on the bottom, so they are easier to access, but more difficult to open. They can be obtained only by diving in deep water, a sport of young men.

According to informants there are plenty of clams to be found on the south and western sides of the island, off the area of land known as Muli (see Map 5.2). However, this area is difficult to reach by either sea or road as no one lives there, and the track is subject to washouts. So the clam populations there are virtually untouched. It is an indication of the lack of great interest in clam meat that few people visit these clam beds. Since there are no villages there, the clams would be completely free of bacterial contamination from runoff or sewage. The reef is slightly narrower, with less distance from shore to cover, but there are no islets north of Nukutapu to use as a base while fishing, or as shelter in a storm.

Women can be seen on the reef near the villages at low tide searching for small fish and shellfish, but they rarely find *Tridacna* clams because the inshore bottom of the lagoon is muddy and has been fished out. Muddy conditions are ecologically unsuited to giant clam mariculture. However, large untouched beds of clams are reported to exist in the southwest corner of the reef of Wallis island, far from habitation.

Shells

The shell is most often found embedded in the reef, so is difficult to extricate, and is not considered worth the effort. They are not carried back to shore, unless specially requested. Sometimes young men who have been out diving beyond the reef will bring home several shells they have found rolling loose on the sea floor, if they have been asked to do so.

The most common use for the shell is as ornamentation around the border of a garden. Alternatively, the shells may be used as ash trays. A church may use a large one as a baptismal font. Shells may also be found embedded in the coral that is used to build walls around gardens located on the shore line.

Several years ago, one of the priests wanted shells to line the garden around the presbytery, so the parish organised several expeditions to bring back enough shells to complete that job. Otherwise, there is no call for the shell today. In former times, *Tridacna* shell was highly valued for making adzes necessary for construction work with timber, whether for building houses or canoes (Kirch 1976). They were prized because the shell is so hard.

Rights of access

The reef on Wallis is considered a public place, even though people's family tenure rights extend in principle to the edge of the reef. People are free to cross the water and to fish anywhere in the lagoon and to gather shellfish. People of one district can visit an islet in another district and can collect clams there. There is, however, a strict restriction on taking sand from the lagoon, except in front of a collector's own village.

Each district is the main controlling entity, but even those boundaries are not as strictly delineated on the lagoon as they are on land.

Hihifo people said that Mu'a people can and do come to fish off the six islands in the north, and they may collect clams while they are there. Hihifo people seldom go south. People do not often make a special expedition for clam meat; it is only incidental to the diet. Rather they will collect clam meat if out on a picnic, or some other expedition.

The restriction on gathering sand anywhere but in front of one's own village is indicative of possible complications arising from any aquaculture endeavour using the lagoon. If clam farming were introduced it might prove difficult to introduce a new restriction and to keep out 'visitors' who did not have rights to the farm. The question as to whether a nuclear family or an extended family would share rights to a farm and its produce was too hypothetical for informants to be able to answer. They no longer have fish parks or weirs for holding fish, as they did in the past. These would have the closest analogy for a clam farm. Pearl farming has not been practised here.

Commercialisation

Clams appear to Wallisians to be a very insignificant resource, so they could not conceive that they might be farmed, or have commercial value. Only two of the men interviewed were remotely interested in the idea of farming clams for export, and they saw more difficulties than benefits.

The need for wider support for such a farm, such as might be given by a Department of Fisheries, has no precedents here; rather it is to be feared as a case of the state interfering in village life. However, the Territorial Assembly might impose taxes and the Lavelua and ministers extract their form of taxes. The farmer would have little power over his own enterprise.

Without such support, an individual would find it difficult to succeed. Boats and engines, and their maintenance, are all very costly, and subject to family skills rather than any centralised infrastructure. Also needed would be a shore base and facilities including trucks and refrigeration. Since fresh water is metered on Wallis this could prove an additional expense.

Finally there is the question of markets for the clam meat, and for the shell. There is little demand on Wallis for the meat. A small proportion of the resident French expatriate population might buy some on occasion. Otherwise the restaurants are the only other likely local purchasers. Their clientele is irregular. The restaurateur we spoke to saw little demand in his business for clam meat. He can obtain all he can sell already by just asking relatives and neighbours to supply it as he needs it, and he sells very little. He was not interested in the commercial development of clam meat.

Overseas markets are thus the only option as an outlet. The viability of clam meat sales in New Caledonia would need further exploration. Wallisians there, as well as other island communities, may be interested in buying clam meat on an irregular

basis. If that did not produce a return adequate to compensate for shipping costs, including refrigeration, then the Taiwan, Malaysia or Japanese markets being evaluated (Tisdell et al. 1991) would have to be assessed for feasibility. Shipping costs would have to be calculated via New Caledonia, unless a precedent could be set for shipping through Fiji, which is much closer.

Development possibilities

It is clear that, unlike other Pacific islands, the stocks of clams around the coast of Wallis may be abundant, though the exact size of the population needs to be verified. As such, clam farming may be a venture well suited to the development of this underdeveloped island nation.

The highest return would come from investment in clam farming on the southwestern reef area of Wallis, if an onshore infrastructure could be developed to the people's satisfaction. There is a precedent in this southwest corner of Mua where another venture has been established. The involvement of the Wallisian people themselves at the levels of the Territorial Assembly, the District and the village would be vital.

Several individual Wallisians are looking for ventures that can help their families to gain a cash income, using skills and know-how gained in New Caledonia. But there is suspicion of all such ventures, as little has been tried and even less has succeeded. As Cancian (1966) noted in his assessment of the three groups of people likely to take risks with a new enterprise in Mexico, the poorest and the richest groups each have too much to lose if the project fails, whereas the moderately well to do who have experienced a little success, as well as failure, are more willing to try a new project. This middle group is most likely to take the risks of a new development.

Wallis has had very few such risk takers, certainly on their home island. Such a middle level group would be identified as families in which one or more persons have experience of business either in New Caledonia or Vanuatu, others have skills such as teaching or building on which family members can fall back if necessary, and yet others are ready and willing to learn new skills such as marketing.

In such a case a project such as clam farming may well be worthy of consideration by one or two such modest risk-takers. They may have the money to invest, and the vision of lateral benefits that may derive from the success of such a project.. But they have to be assisted to overcome the obtuseness of the hierarchies in the traditional, modern and colonial social systems. Also, they may find it difficult to survive the lag time (10 years according to Tisdell et al. 1991) before such a venture becomes profitable.

If such a venture were to be mounted it would necessitate close cooperation between the various sectors of the Wallisian polity, by negotiators fluent in French and with a trusted Wallisian colleague who is respected in the community.

Members of the South Pacific Commission may well be useful adjuncts to such a project as they have French-speaking members of their Fisheries section who have carried out projects in Wallis

Such a project would be the first of its kind for Wallis. The timing is right, in that the Territorial Assembly is concerned to formulate a plan of its own for the people's benefit. The main stumbling blocks are that the clam is not currently regarded as a resource of note, and with a 10-year lag time to any profitability, the people may lose interest in maintaining any investment in clam farming.

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6

Mariculture as Part of Indonesia's Economic Development Strategy— Seaweed and Giant Clam Culture as Cases

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Abstract

Mariculture is a growing economic activity in Indonesian coastal areas. The level of investment required for much of this activity in Indonesia (especially seaweed farming) is lower than in capture fisheries and in the agricultural sector. However, in considering the development of mariculture activities account must be taken both of direct economic benefits and of social and environmental spillovers, with a view to achieving a more sustainable degree of economic development.

After outlining the economic significance, development and adverse environmental effects of mariculture activities in Indonesia, this chapter examines the economics and socio-economic benefits of mariculture, taking seaweed culture as an example. The potential economic return from seaweed farming appears to be high in Indonesia, as can be judged from an estimated internal rate of return on investment of 47 per cent.

Socioeconomic prospects for giant clam farming in Indonesia are also considered. Issues discussed are: the current status and utilisation of giant clams; the environmental advantages of clam farming; the market for products from giant clams; and possible socioeconomic benefits of clam culture.

Introduction

Indonesia faces several structural problems in its economic development. These include a high incidence of rural poverty, especially in coastal areas, and a very high degree of dependence on exports of minerals (especially oil and natural gas) for foreign exchange earnings. In 1982, minerals accounted for 83.6 per cent of the value of Indonesia's exports, the highest degree of export dependence on minerals of any ASEAN country (McKern and Koomsup 1988).

In its development policies, the Indonesian Government is aiming to diversify its exports so as to reduce dependence on oil and natural gas, and to reduce rural poverty. The development of mariculture in rural coastal areas may contribute to the achievement of these goals. It is well recognised that mariculture can increase

income, employment and foreign exchange earnings and add to protein supply (Chua 1986; Collier 1981; Directorate of General Fisheries 1988, Eidman and Suprpto 1988). Furthermore, as an archipelago, Indonesia has a long shoreline (relative to its land mass) suitable for seafarming.

The World Commission on Environment and Development (1987:138) recommended that the expansion of aquaculture should be given high priority in developing and developed countries because of an expected increase in the gap between demand for fishery products and catches of conventional fisheries. More generally, some researchers have argued that growth in supplies from agriculture, domestic livestock and capture fisheries will be unable to meet the growing protein demand of expanding population (Korringa 1983: 17-29; Allen et al. 1984:1).

However, expansion of aquaculture is no panacea for the problem of decreasing food supplies. Aquaculture can have, depending upon the species cultured and the methods used, adverse environmental impacts and unsatisfactory consequences for income distribution (Pullin 1989; Tisdell 1989). For instance, the intensification of aquaculture activities through the conversion of mangrove areas to brackish water fish and shrimp ponds has not only depleted the valuable mangrove resources but has also impaired the ecological balance in the estuarine ecosystem where mangroves are generally located. In addition, it is argued that the current implementation of brackish water pond intensification programs (INTAM) in Java has solely benefited owners of middle- and larger-sized ponds thereby increasing inequality of income (Hannig 1988: 5-6). Hence, it is necessary to be selective in supporting aquaculture/seafarming activities if the Indonesian goal of economic development with equity and sustainability, as stressed in the Indonesian Five-Year Plan, is to be achieved.

In the light of the above, this chapter first outlines, using official statistics, the economic significance and development of seafarming activities in Indonesia. Secondly, some environmental and sustainability effects of seafarming are highlighted. Thirdly, the possible socioeconomic contributions of seafarming activities to coastal rural people are discussed, taking seaweed culture as a case. Finally, clam farming is considered as a new possibility for Indonesian coastal areas.

Mariculture in Indonesia: present status and its economic contribution

Present status

Mariculture (also known as 'seafarming') is defined as the culture and husbandry of marine organisms (animal and plants) in marine and/or brackish water. Aquaculture is a more general term that includes organisms farmed in freshwater.

Unlike other activities (capture fisheries, agriculture and domestic livestock), seafarming is less dependent on availability of land since it is undertaken in the coastal areas. The level of investment required for this activity is lower than in the

capture fisheries and in the agriculture industry (Chua 1986: 4). This suggests that seafarming may be economically advantageous for countries facing land availability problems but having significant marine resource areas.

The potential area for aquaculture in Indonesia is very large. According to DGF (1988: 2) about 70 per cent of the Indonesian territory consists of water (marine, brackish and freshwater) and it has more than 81000 km of coastline. The potential area for seafarming, however, is estimated to be about 97150 ha. This consists of 29000 ha for finfish culture, 17000 ha for cockle culture, 19700 ha for mussel culture, 7500 ha for oyster culture, 2850 ha for pearl oyster culture, and 21100 ha for seaweed culture.

To say that there is much potential for seafarming activities does not mean that it will be easy to realise it. The Indonesian Government has given attention to the development of seafarming nationally since 1980. The Government, through Presidential Decree No. 23 of 25 May 1982, took steps to regulate mariculture development. Also, it issued implementation and technical guidance through Ministerial Decree No. 473 of 8 July 1982 and Directorate General of Fisheries letter No. IK-210/D4. 5055 of 4 September, 1982 (Abdul Malik and Rahardjo 1988: 2).

Mariculture development is occurring in many coastal rural areas. It is hoped that, through seafarming activities, the prevalence of poverty in coastal rural areas, as widely highlighted in the literature, can be reduced (Mubyarto 1988; Tjondronegoro 1988; Bailey et al. 1986).

Mariculture activities already engaged in and/or being developed in Indonesian waters include shrimp culture in brackish water ponds, fish culture (groupers, rabbit fish and snapper) in nets and cages in the coastal areas, and seaweed culture in floating cages and/or by bottom methods in coastal areas. Species cultured and the number of seafarming units in Indonesia is presented in Table 6.1, from which it can be seen that seaweed culture is the most frequent form of seafarming in coastal rural areas. The next most frequent seafarming activity is shrimp culture in brackish water ponds. Shrimp culture, however, is adopted mostly by wealthier groups in coastal areas and by city-based entrepreneurs because it has high capital requirements. Farming of groupers and rabbit fish has not yet developed to any great extent in rural coastal areas since it largely depends on the availability of natural seed.

Shellfish (cockles, mussels and oysters) are least frequently maricultured in coastal rural areas. Coastal rural people or fishermen have not cultured these species to any great extent since the bulk of supplies can still be collected from nature. In addition, few Indonesians like to eat shellfish and rumours of high contamination reduce the rate of development of shellfish farming (Eidam and Suprpto 1988: 5). Culture of giant clams has not yet developed in Indonesia but research is being carried out in the Seribu Islands and in Karimun Java (Pasaribu 1988: 44; Romimohtarto and Sutomo 1988: 258). As will be discussed, culture of giant clams may provide economic benefits to coastal rural areas and have little adverse environmental impact.

Table 6.1 Species farmed and the number of mariculture units in Indonesia, August 1988.

Province	Seaweed	Groupers	Rabbit fish	Snapper	Sea cucumber	Shrimp	Pearl
DKI Jakarta	361	95	10	1	-	204	-
Lampung	10	-	-	-	-	-	-
North Sumatra	185	-	-	-	-	-	-
South Sumatra	-	40	-	-	-	-	-
East Java	44	-	-	-	-	-	-
Bali	111104	-	-	-	-	-	-
East Nusatenggara	22	-	-	-	10	-	9
West Nusatenggara	1860	-	-	-	-	-	-
South Sulawesi	2171	-	-	-	21	-	-
Total	115757	135	10	1	31	204	9

Source: DGF (1988), Appendix 3.3.

Contribution of seafarming to Indonesian economic development

While seafarming activity in Indonesia has increased it is not yet well developed. Reliable production statistics for mariculture are not easily available and are included in aquaculture production statistics. Despite this, some useful information is available on the development of seafarming in Indonesia.

According to the DGF (1988: 7), production from seafarming rose from 134.1 thousand tonnes to 186.2 thousand tonnes between 1983 and 1987, that is, by 38.9 per cent, or at the rate of 8.6 per cent per year. In the same period the number of fishfarmers rose from 121023 to 209000, that is, by 72.7 per cent, or at the rate of 14.6 per cent per year. In addition, the area used for seafarming rose from 220563 ha to 249000 ha, that is, by 12.9 per cent, or at an annual rate of 3.1 per cent. The average production per hectare from seafarming rose from 608 kg/ha to 749 kg/ha.

Compared with other fisheries subsectors, the average growth rate of production from seafarming (brackish water) activity was almost twice the average increase in catches of conventional fisheries in the period between 1983 and 1987. In terms of the average growth rate in production and its absorption of labour, seafarming (brackish water and cage activity) had a higher average growth rate than capture fisheries (Table 6.2 and Table 6.3).

In terms of exports, between 1983 and 1987 weight of fishery commodities exported from Indonesia increased by 58.9 per cent. In 1983, 88365 tonnes of

fishery products were exported, valued at US\$257.084 million. Corresponding figures for 1987 were 140378 tonnes and US\$457.524 million. Seaweed is the major non-food fishery item exported from Indonesia. However, it ranks fourth in terms of volume among fishery exports following shrimp, tuna, and other fish (Table 6.4). Total production of seaweed in 1985 was estimated to be 5446 tonnes,

Table 6.2 Indonesian fishery production ('000 tonnes) by sub sectors 1983–1987.

Description	1983	1984	1985	1986	1987	Average growth/ year (%)
Marine fishery	1682	1713	1822	1923	2029	4.8
Inland fishery	532.5	548.1	573.8	607.0	640.8	4.7
Open water	265.5	269.3	269.3	273.0	278.0	1.2
Brackish waterpond	134.1	142.4	156.4	170.3	186.2	8.6
Freshwater pond	80.7	76.5	84.2	88.7	96.5	4.8
Cage	1.0	1.0	0.7	0.5	0.9	5.4
Paddy field	51.2	59.8	63.2	74.5	79.2	11.1
Total	2214.5	2260.9	2395.5	2529.8	2669.8	4.8

Source: DGF 1988, page 7.

Table 6.3 Number of persons employed in fisheries sector, 1983–1987.

Activity	1983	1984	1985	1986	1987	Average growth/ year (%)
A. Capture fisheries						
Marine fishermen	1226643	1294472	1286448	1357279	1456600	4.4
Open waters fishermen	424726	438953	434290	450382	472700	2.7
B. Culture fisheries						
Freshwater fish farmers	968337	1018909	1147195	1327742	1421800	10.1
Brackish water fish farmers	121023	131385	134900	162266	209000	14.6
Total	2740729	2883719	3002833	3297669	3560100	6.8

Source: DGF 1988, page 19.

increasing to 9882 tonnes in 1987. The main markets for seaweed products are in Hong Kong, Singapore, Denmark and Japan.

Table 6.4 Indonesian food and non-food fisheries exports ('000 tonnes) 1983-87.

Commodities	1983	1984	1985	1986	1987	Average growth/ year (%)
Food items	78268	66392	72629	92579	122270	13.4
Prawn	26166	28025	30980	39101	44267	14.0
Tuna/ skipjack	20311	14702	17889	24236	33995	17.5
Other fishes	13661	8623	9158	10611	18902	15.8
Frog thigh	3296	2200	2802	3752	3078	-2.5
Sea cucumber	1274	1318	3123	2362	2517	30.6
Jellyfish	4108	2556	1875	4762	3372	-15.1
Crabs	2419	2143	1749	1944	2049	1.3
Others	7033	6823	5053	8811	13730	25.4
Non-food items	10097	9303	11868	14866	18108	16.7
Ornamental fish	197	204	235	859	530	61.5
Seaweeds	3402	3061	5446	7111	9882	34.4
Seashell	2302	2603	2832	2389	2.740	5.2
Others	4196	3435	3355	4507	4956	6.0
Total	88365	75695	84497	107443	140378	13.8
Total value (FOB US\$ 000)	257048	248063	259444	374117	475524	18.1

Source: Central Bureau of Statistics, Jakarta 1987.

It should be noted that the available statistics are in terms of volume rather than value. While one can learn something from such statistics, it would be useful from an economic point of view to have the data expressed in value terms.

Although Indonesia exported a large range of fishery commodities, it still imported fishery products. However, as can be seen by comparing the last lines of Table 6.4 and Table 6.5, Indonesia has an extremely large net surplus of export income from fishery products. In 1987, the value of its exports was more than seventeen times its imports, and the trend has been for imports to fall relative to exports. The main item imported is fish meal or fish flour which is used as a raw material for livestock feeds. In 1987, the imported fishery products to Indonesia

amounted to 65371 tonnes worth US\$27.8 million. Preserved fish, fish oil and fish feed imports have shown large growth rates in the period 1983–1987 (Table 6.5).

From the foregoing data, it seems clear that in the 1980s seafarming activities in Indonesia have added to income, to foreign exchange earnings, to employment opportunities for coastal rural people and to the supply of animal protein. From the statistics, one cannot judge the extent to which seafarming has resulted in import substitution in Indonesia but reduction in imports of agar-agar (which is produced from seaweed) (Table 6.5) suggests that some import substitution has occurred.

Table 6.5 Indonesian imports of fisheries products ('000 tonnes) 1983–1987.

Commodities	1983	1984	1985	1986	1987	Average growth/ year (%)
Preserved fish	23	22	208	259	52	196.4
Canning fish	1177	788	730	2015	508	15.2
Fish oil	300	286	454	4166	9152	247.8
Molluscs	36	52	79	42	42	12.4
Agar-agar	350	163	170	165	140	13.4
Fish flour	51593	41853	47792	44107	52476	1.6
Fish feed	11	37	816	823	213	567.1
Others	4399	7505	4854	6672	2788	3.6
Total	57878	50669	54287	57426	65371	3.6
Total value (CIF US\$ 000)	34347	28789	23891	28177	27832	4.1

Source: Central Bureau of Statistics, Jakarta 1987.

Environmental effects and sustainability impacts of seafarming

Although seafarming activities can contribute to economic development, they may have adverse impacts on income distribution and the coastal environment.

The possible adverse consequences of seafarming for the environment depend upon the type of culture system used, the type of product grown, the techniques used to grow it, and the location in which it is grown. For example, farming techniques using cages, sticks, rafts, pens, etc., may (a) present a navigational hazard; (b) be incompatible with use of the area for recreational purposes and for fishing; (c) have an adverse visual impact; (d) lead to destruction of wild species because of habitat change; and (e) cause hardening of bottom sediment due to build up of

waste and possibly the formation of insoluble phosphate compounds (Tisdell 1989: 10; Pullin 1989: 11; Folk and Kautsky 1989: 237-238). The use of pesticides (chemical substances) against parasites in intensive and/or semi-intensive culture systems may cause lethal and sublethal effects on the local environment, and accumulate in the marine food web, and degrade the quality of reared fish (Folk and Kautsky 1989: 239).

Furthermore, intensification of seafarming activities, particularly the conversion of mangrove areas or wetlands to brackish-water fish and shrimp ponds, can have the following adverse environmental impacts: (a) destruction of natural ecosystems, especially mangroves; (b) salinisation and acidification of soils/aquifers; and (c) the release of effluents/drainage high in biological oxygen demand (BOD) and suspended solids. Such projects tend to increase income inequality since brackish water shrimp and fish ponds involve low labour-intensities and high capital plus land ratios (Tisdell 1989: 9; Pullin 1989: 12).

In Indonesia, the impact of seafarming activities on the coastal environment has been recognised. For instance, large scale conversion of mangrove areas to shrimp ponds in the Marunda area and Tanjung Karawang, east of Jakarta has rapidly depleted valuable mangrove resources. Environmental impacts on mangrove swamps include coastal erosion, changes in shoreline configuration and destruction of habitats for fish, shrimp and other marine organisms. As a consequence, the Indonesian Government, through the Directorate of Forest Protection and Nature Conservation has limited the expansion of pond culture in these areas and other areas along the north coast of Java, and has established coastal nature reserve areas (Atmawidjaja 1987: 3-4).

Apart from its negative impact on the environment, intensification of culture of shrimps in brackish water ponds in Java may increase the concentration of wealth. This culture appears to benefit only owners of middle- and large-sized ponds. The small owner-cultivators are therefore induced to sell their ponds to this group (Hannig 1988: 6).

As previously mentioned seaweed is the most frequent item maricultured in Indonesia. Seaweed is cultured mostly on reef flats and is dependent on natural productivity. It is an extensive rather than an intensive form of mariculture. So far there are no reports of adverse chemical effects of water quality and on the environment. However, one problem arising from this farming in Nusa Penida (Bali) is that it restricts tourists who want to go surfing and diving, because of the stakes or floats used in the culture.

The evidence presented here suggests that, in considering the development of seafarming activities, one needs to consider not only direct economic benefits, but also social and environmental spillovers, with a view to approaching a more sustainable degree of economic development (Barbier 1987). In the Indonesian context, this possibility means that seafarming systems should benefit the bulk of coastal rural poor and, to the extent possible, minimise resource depletion, environmental degradation, cultural disruption, and social instability. In this respect, seaweed farming is a very suitable coastal farming system for Indonesia.

Seaweed farming: economic and socioeconomic benefits

Culture system and current status

Seaweed farming is the most common marine culture adopted by coastal people in Indonesia. Increasing demand for, and the rising price of seaweed have resulted in a rapid expansion of seaweed farming in recent years. In addition, this farming system requires little capital compared with other aquaculture activities. It requires few commercial inputs, and does not need pharmaceuticals, chemicals, or supplementary feed to sustain production. It also has few adverse environmental effects. Consequently, the majority of the coastal rural poor can afford to adopt this culture as their main source of income.

Six genera of seaweed are of economic importance in Indonesia: *Gracilaria*, *Gelidium*, *Laminaria*, *Sargassum*, *Euचेuma*, and *Hypnea*. The products of these seaweeds are agar (*Gracilaria* and *Gelidium* spp), algin (*Laminaria* and *Sargassum* sp) and carrageenan (*Euचेuma* and *Hypnea* spp).

These products have applications as stabilising agents in milk and ice-cream products, suspending agents in paint, thickening and gelling agents in canned products, as ingredients in ointments, jellies, dental impressions, shampoos, waterproof paper, cloth and glue, as a clarifying agent in the manufacture of wines, beers and coffee and as a covering for pharmaceutical capsules (Shang 1976: 1; Veloso 1988: 2).

Euचेuma is the most extensively cultured because it has the highest market price. For example, it was determined from interviews conducted in December 1988, that the Bali farm-gate price of dried *Euचेuma cottonii* and *Euचेuma spinosum* was Rp. 400¹ per kg (Indonesian currency unit), whereas the price of dried *Gracilaria* and *Gelidium* species was only Rp. 250 per kg.

Most seaweed is cultured using raft or off-bottom methods, depending on the nature of the coastal site. The raft method has higher costs than the off-bottom method. However, seaweed grown by the raft method has a higher average growth rate and the raft can hinder fish predators of the crop (Marine Fisheries Research Institute 1979: 60).

The main area in Indonesia where seaweed is cultured is in Jungut Batu village, Nusa Penida (Bali). Here seaweed farming is now the main economic activity, supplanting fishing and the collecting of corals. Data collected in 1988 (Table 6.6) indicates that 513, or about 72 per cent of total household heads are engaged in seaweed farming.

Due to the success of seaweed farming in Bali, and increasing demand for *Euचेuma*, many other coastal rural dwellers in Pulau Seribu (DKI Jakarta),

¹Rp., rupiah; US\$≈1725 rupiah.

Sibolga (North Sumatra), and South Sulawesi have been attracted to seaweed farming. However, these areas are supplying low quality seaweed that commands a price much lower than that obtained for the Bali product.

Table 6.6 Occupations of heads of households in Jungut Batu, Nusa Panida (Bali) in December 1988.

Occupation	Number of household heads	Percentage
Cassava/corn farmers	69	9.7
Seaweed farmers	513	71.8
Small traders	12	1.7
Handicrafts	43	6.0
Transportation	25	3.5
Rural banking	1	0.1
Government officer	51	7.2
Total	714	100.0

Source: Village Head Office, Jungut Batu.

Economics and socioeconomic benefits of seaweed farming

The cost of farming seaweed varies depending on the size of the planting area available and the type of culture used. However, compared with the cost of a brackish water pond for shrimp and milkfish, seaweed farming is less costly per unit area. Shang (1976:6) argued from his study in Taiwan that seaweed (*Gracilaria*) farming requires lower initial operating expenditure than many types of aquaculture. Annual profits can reach \$1399–\$2413/ha. By comparison, profits from milkfish culture are \$250–\$500/ha. In addition, seaweed farming involves labour-intensive production. Seaweed is ready to be harvested in 6 weeks, whereas milkfish need 6–9 months to achieve market size.

Based on information collected by C. Firdausy in December 1988 from a seaweed farmer² in Nusa Penida (Bali), the initial capital cost of culturing seaweed on a 1 hectare farm using the off-bottom method is about Rp. 8.2 million (US\$4753). An analysis of the costs and return for this 1 hectare farm is presented in Tables 6.7–6.10.

From Tables 6.7, 6.8, 6.9 and 6.10, it can be seen that seaweed farming has the potential to give high returns to growers (see also Firdausy and Tisdell 1991). A

² This farmer has a one ha 'model' farm. It is larger than the average farm. His returns are indicative of the *potential* return from seaweed farming in Indonesia.

Table 6.7 Cost and return analysis for a selected 1 hectare seaweed farm (*Eucheuma cottoni*) in Bali, 1988

A.	Initial investment	Cost (Rupiah)	Life (Years)
	20000 kg seed stock at Rp. 50/kg	1000000	
	1000 kg nylon plastic (4 mm)	4000000	2
	100 kg nylon plastic (8 mm)	400000	2
	8000 pcs bamboo at Rp. 200 each	1600000	2
	300 kgs rolls plastic at Rp. 1000/kg	300000	1
	2 bull hammers at Rp. 5000 each	10000	10
	1 iron bar at Rp. 3,000	3000	10
	1 knife at Rp. 500	500	5
	15 pairs of gum boots at Rp. 5000/pr	75000	1
	2 pcs mask at Rp. 25000	50000	1
	15 basket at Rp. 1000	15000	6 mths
	2 scoop net at Rp. 3000	6000	1
	100 gunny sacks at Rp. 400	40000	6 mths
	1 axe at Rp. 4000	4000	5
	1 wood saw at Rp. 5000	5000	5
	50 m net at Rp. 2000/m	10000	2
	Initial set up labour cost e.g. setting up the bamboo posts	750000	
	Total initial capital cost	8268500	
B.	Operating costs		
	15 labourers at Rp. 30000 for a year	55400000	
	license	50000	
	Depreciation (derived from initial investment)	3549200	
	Total production cost	8999200	
	Revenue		
C.	(There are six harvests in a year 48000 kgs/year at Rp. 400/kg)	19200000	
D.	Profit (C-B)	10200800	
E.	Profit (C-B) without depreciation	13750800	
F.	Payback period (A/E)	.60	
G.	Rate of return (D/A)	123%	

Note: Cost data are based on existing 1988 prices; seedlings for subsequent plantings are obtained from initial first planting. Thus, it is included in initial capital cost.
Payback period (see Tisdell, 1972) and rate of return method after Shang (1976)
Source: Personal communication with seaweed farmer in Nusa Penida, Bali, December 1988.

Table 6.8 Estimates of annual capital and operating costs (values are Rp.'000) for a selected 1 hectare seaweed farm in Bali, 1988.

Costs	Year										
	0	1	2	3	4	5	6	7	8	9	10
Capital costs											
Seed	100	-	-	-	-	-	-	-	-	-	-
Nylon plastic (4 mm)	400	-	-	400	-	400	-	400	-	400	-
Nylon plastic (8mm)	40	-	-	40	-	40	-	40	-	40	-
Bamboo	160	-	-	160	-	160	-	160	-	160	-
Net	1	-	-	1	-	1	-	1	-	1	-
Plastic rolls	30	-	30	30	30	30	30	30	30	30	30
Gum boots	7.5	-	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Mask	5	-	5	5	5	5	5	5	5	5	5
Basket	1.5	1.5	3	3	3	3	3	3	3	3	3
Scoop net	0.6	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Gunny sacks	4	4	8	8	8	8	8	8	8	8	8
Bull hammers	1	-	-	-	-	-	-	-	-	-	-
Iron bar	0.3	-	-	-	-	-	-	-	-	-	-
Knife	0.05	-	-	-	-	-	0.05	-	-	-	-
Axe	0.4	-	-	-	-	-	0.4	-	-	-	-

Table 6.8 (Cont'd)

Wood saw	0.5	-	-	-	-	-	0.5	-	-	-	-
Costs of tying up seeds and setting up bamboo	75	-	-	-	-	-	-	-	-	-	-
Total	826.85	5.5	54.1	655.1	54.1	655.1	55.05	655.1	54.1	655.1	54.1
Operating cost											
Labourer wage	-	540	540	540	540	540	540	540	540	540	540
License		5	5	5	5	5	5	5	5	5	5
Total		545	545	545	545	545	545	545	545	545	545
Revenue	0	1920	1920	1920	1920	1920	1920	1920	1920	1920	1920
Net income (Rp. 1000)	-8268.5	13695	13209	7199	13209	7199	13199.5	7199	13209	7199	13209

Assumptions: Economic horizon of seaweed farming is 10 years or cycle of 10 years
 No change in real annual operating cost
 No change in real price

rate of return of 123 per cent per annum is calculated using a method of the type employed by Shang (1976). This exceeds by far the opportunity cost of capital in Indonesia (Table 6.7). The yield provides an income of Rp. 19200000 in the first year. This is more than twice that of annual operating costs, and the initial investment can be paid back in less than a year. However, the method used to calculate the returns given in Table 6.7 is deficient from an economic viewpoint, since returns and costs are not considered as a stream over the life of the project. Padilla and Lampe (1989) estimated a return of 78 per cent for the Philippines, but it is not clear what method was used to derive this estimate.

By assuming the economic life for a seaweed farming project to be 10 years, it is found that the internal rate of return (IRR) of this activity is 47 per cent. This indicates the maximum interest that this activity could pay for the resources used if the activity is to recover its investment and operating costs and still break even (Table 6.10). The net benefit-cost ratio for seaweed farming is estimated at 7.59 (Table 6.9) using a discount rate of 12 per cent. Thus, the potential economic returns from seaweed farming in Indonesia appear to be high.

Table 6.9 Net present value and benefit cost ratio assuming economic horizon of farming of 10 years of selected seaweed farm.

Year	TC	TR	NI	DF 12%	DNI
0	8268.5	0	-8268.5	1.000	-8268.5
1	5505	19200	13695	0.893	12229.6
2	5991	19200	13209	0.797	10527.6
3	12001	19200	7199	0.712	5125.7
4	5991	19200	13209	0.636	8400.9
5	12001	19200	7199	0.567	4081.8
6	6000.5	19200	13199.5	0.507	6692.1
7	12001	19200	7199	0.452	3253.9
8	5991	19200	13209	0.404	5336.4
9	12001	19200	7199	0.361	2598.8
10	5991	19200	13209	0.322	4253.3
Total					62500.1

Net Present Value at 12%* = Rp. 62500100 (excluding initial capital outlay) Net Benefit-Cost Ratio at 12% = 7.59

Note:TC = Total Cost; TR = Total Revenue; NI = Net Income; DF = Discount Factor; DNI = Discounted net income.

No residual value since capital assets assumed to be used up in 10 years;

*Net present value (NPV) = discounted revenue-discounted cost. NPV assumed a constant cash flow over a 10 year period with a 12% discount rate;

The size of the holding of small seaweed farms in Jungut Batu varies between 0.05–0.25 ha and the average product harvested per varies between 200–1500 kg/area holding. Labour is the largest operating cost, accounting for 60 per cent of total annual expenses. This cost includes seeding, weeding, harvesting and drying. For some farmers, labour expenses (actual outlays) are low, since they employ members of their own family, the opportunity cost for whose employment may be low. Seedlings are sometimes obtained free from neighbours, relatives, or from natural stocks. The initial investment for a farmer planting 0.25 ha, for example, is about Rp. 1 000 000 (US\$580). Funds to meet the initial capital cost are usually obtained from credit institutions or informal financial sources available in rural areas. The average gross revenue of small farmers with farm sizes less than 0.25 ha is Rp. 200 000 per month, whereas for farmers with farms of 0.25 ha and greater, it is about Rp. 500 000 per month. Nevertheless, small farmers feel that seaweed culture gives good returns and the initial investment can be paid back in less than one year.

Table 6.10 Internal rate of return calculation(values are Rp.'000) for selected seaweed farm.

Year	NI	Discount rate	PV	Discount rate	PV
		(45%)		(50%)	
0	-8268.5	1.000	-8268.5	1.000	-8268.5
1	13695	0.690	9449.5	0.664	9134.6
2	13209	0.476	6287.5	0.444	5864.8
3	7199	0.328	2361.3	0.296	2130.9
4	13209	0.226	2985.2	0.198	2615.4
5	7199	0.156	1123.0	0.132	950.3
6	13199.5	0.108	1425.5	0.088	1161.6
7	7199	0.074	532.7	0.059	424.7
8	13209	0.051	673.7	0.039	515.2
9	7199	0.035	251.9	0.026	187.2
10	13209	0.024	317.0	0.017	224.6
Total			17138.9		14940.8

IRR = $45 + 5 (17138.9/32079.7) = 47.67\%$

Note: NI = net income; PV = present value of net income stream.

To find the first approximate discount rate, the initial capital is divided by the average annual profit. The result of this division lies at a discount rate of 45% in the discount rate Table. The true internal rate of return can then be interpolated using Gittinger's method. (Gittinger 1982 333–336).

In summary, seaweed farming in Indonesia appears to be economic under reasonable management conditions, and is ecologically and socially suited to many coastal areas. Seaweed farmers interviewed in December 1988 in Jungut Batu, Bali, stated that seaweed farming has led to an improvement in the standard of living in their coastal areas. As a result of seaweed farming, they claim to have increased their material possessions and to have improved their housing. In addition, there is reduced unemployment of household heads and a more optimistic attitude towards the future. It is therefore suggested that the Indonesian Government should encourage seaweed farming in other coastal areas of Indonesia which are economically and ecologically suitable for this activity.

Socioeconomic prospects for clam farming in Indonesia

Giant clams (Tridacnidae), locally known as 'Kima', have in the past been an important source of income to some groups of coastal people in Indonesia. However, because of the serious depletion of natural stocks, giant clams have been listed as protected species since 1987 under a decree of the Minister of Forestry of the Republic of Indonesia (Atmawidjaja 1987: 2).

Although such regulation is important for conservation purposes, it is no less important to ensure that rural coastal dwellers have alternatives to maintain their income. Since few alternatives to giant clam collection exist, coastal people dwellers still collect clams illegally and appear to be prepared to go to jail if necessary.

Development of clam farming may be one way to overcome this problem. Such farming may assist in maintaining natural stocks and provide an additional source of income. As Tisdell (1986: 87), following a study on the economic and socioeconomic potential of giant clams in the western Pacific region, suggests:

Clam farming as a possible economic activity is of considerable interest as a potential contribution to the economic development of atoll economies and coastal communities in areas ecologically suited to giant clams. The cultivation of giant clams appears to be relatively simple, does not seem to be capital intensive and unlike many other forms of aquaculture, does not require artificial feeding of the stock, except possibly for a very short time in the veliger stage.

The following sections assess the socioeconomic potential of giant clam farming in Indonesia.

Current status and utilisation

Giant clams occur in almost all Indonesian coastal areas (Romimohtatro et al. 1987, cited in Pasaribu 1988: 44). The size of the natural stocks of these species in Indonesia is not known in detail. However, investigations show that populations of *T. gigas*, and *T. derasa* are low, while *H. porcellanus* is extremely rare if not extinct. While *T. crocea*, *T. squamosa* and *H. hippopus* are still found, their populations

are rapidly declining (Brown and Muskanofola 1985: 25; Romimohtarto and Sutomo 1988: 258.). A similar situation has occurred in other countries, such as the Philippines, Japan and the Federated States of Micronesia (Lee 1988: 27). Australian waters, particularly on the Great Barrier Reef, now hold the largest stocks of giant clams in the world, but these are not available for commercial harvesting (Tisdell 1986: 76).

Natural stocks of these species have been seriously depleted in Indonesia, mainly because of rising demand as a result of human population increase and transportation advances which have widened the market. Coastal rural people utilise clams for many purposes: the meat is used as food, and their shells are utilised traditionally for ornaments, ashtrays, washbasins, jewellery and for the floor tile industry.

Increasing demand from the tile industry has been a major contributor to the depletion of natural tridacnid stocks (Sya'rani 1987; Romimohtarto 1987) In Karimun Jawa, for example, almost all coastal rural dwellers collect shells of giant clams for income. They sell these products to the middlemen in Jepara who in turn sell these shells to floor tile manufacturers in Jakarta, Central Java, East Java and Bali. The supply of giant clam shells at Jepara market over the period 1980–85 is shown in Figure 6.1.

From Figure 6.1 it can be seen that the supply of clam shells to Jepara has declined since 1982. The decline in supply seems to be accompanied by an increase in prices. The price of dead clam shells was Rp. 25 per kg in 1980, but by January 1989 it had increased to Rp. 125 per kg.

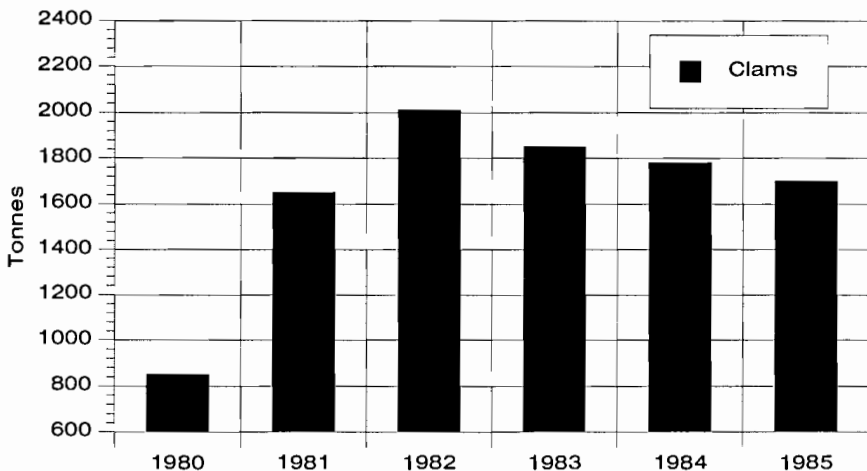


Figure 6.1 The supply of shells of giant clams at Jepara, 1980–1985 (Source: after Sya'rani, 1987).

Clam farming and its environmental advantages

Clam farming technology has advanced rapidly in recent years (Copland and Lucas 1988). Major scientific research centres have been located at the Micronesian Mariculture and Demonstration Centre (MMDC) in Palau, and at James Cook University in northern Queensland, Australia. Research has also been conducted at other locations: for example, in the Philippines, at Silliman University and at the University of the Philippines; in Fiji by the Department of Primary Industry; in Papua New Guinea at the University of Papua New Guinea; and in the Solomon Islands by the International Center for Living Aquatic Resources Management (ICLARM).

In Indonesia, clam farming has not yet developed, but research efforts to culture these species have been under way since 1984. This research is carried out in the Seribu Islands and Karimun Jawa, northern Java (Pasaribu 1988: 45; Romimoharto and Sutomo 1988: 258). However, due to limited funding and water toxicity, which has killed mature clams, this research program has not been very successful (Pasaribu, pers. comm.).

Basically three phases are involved in the farming of clams: (1) the hatchery phase, (2) ocean nursery phase and (3) grow-out phase. In the hatchery, which is typically located on the ocean foreshore, clams are bred and their progeny reared in saltwater tanks. At about 9 months of age, the seed clams are then transferred to a position in the ocean where they are protected by some type of covering (e.g. plastic mesh) from predators. This is the ocean nursery phase. At about 2–3 years of age the clams can be moved to unprotected ocean situations to commence their grow-out phase. The farming methods can be done intensively or extensively (Tisdell 1986, 1989: 16–17).

Unlike prawns, oysters, abalone or other bivalves, clams do not need fertiliser and feeding (except during the first week in the larvae stage).³ Clam farming does not require continuing capture of broodstock from the wild or the taking of seed from the wild. The ocean grow-out phase appears technically simple and requires little capital investment beyond the purchase of juvenile clams. In addition, clam farming appears in many respects to be less environmentally damaging than many other forms of seafarming and its self-sustainability is appealing (Tisdell 1986, 1989).

However, many other issues need to be considered. For example, which groups are likely to operate clam farms? What is the appropriate culture method to use and what are the costs and returns of the operation? What sized farms should be operated and where should nurseries be located? Should low production cost technology (extensive farming methods) be adopted in preference to high technology production cost methods (intensive methods)?

³Nevertheless, they do respond to additions of fertiliser, especially nitrogenous fertiliser, e.g. ammonium nitrate.

A decision to implement one or other of various operational alternatives requires an understanding of their possible biological and financial implications over time. This will allow maximisation of the economic benefits of the farming operation. Furthermore, by appropriate application of management tools in decision making, the risk in operating clam farming can be reduced.

Market and socioeconomic potential benefits of clam farming

Having assumed that it is technically and ecologically possible to culture clams in Indonesia, market potential and socioeconomic profitability must be considered.

Sales of Indonesian clam products have been limited mainly to domestic markets, though considerable quantities of shell have been exported to the Philippines. The domestic market for clams is dominated by the tile manufacturing industry, whose products are in high demand for modern construction in Indonesia. Little information exists on the market of clams for food consumption. Information on local demand for clams by seafood retailers, tourists, hotels and restaurants is not available. What is known is that clam meat is eaten by some coastal people. A survey is therefore needed to determine supply and demand for clams in Indonesian markets (see Chapter 7).

There is potential for export of clam meat to Taiwan, Hong Kong, Singapore, Japan and the USA. The price of clam meat in these countries appears to be high. Top grade, dried clam adductor muscle can retail for up to \$100 per kilogram in Taiwan and Japan (Lee 1988:27). It is about US\$120 per kilogram in Hong Kong (Munro 1983, cited in Brown and Muskanofola, 1985:37). In the Philippines, a pair of large shells about a metre in length will fetch more than US\$100 (Lee 1988:27).

To supply international markets, clams have to be collected, prepared and packed. The muscle must be separated from the mantle and the kidney discarded. Clam products usually have to be frozen and packed for shipment, and stored under controlled cold-room conditions until shipment or sales. The exporter needs skills in arranging international exchange. This suggests that the successful operation of an export-oriented market requires an adequate infrastructure to support it. The economic benefits of exporting clam meat from Indonesia need further investigation.

It is clear that the economic success of clam farming in Indonesia will depend on many factors. Further study is needed of the economic and socioeconomic potential of clam farming, as well as of its likely environmental impacts in Indonesian coastal areas, before an informed decision can be made of the economic potential of tridacnid clam culture in Indonesia.

Conclusions

Mariculture is an expanding economic activity in Indonesian coastal areas. There is considerable potential for it to contribute to economic development, to increase coastal rural incomes and to earn foreign exchange. However, in assessing the socio-economic benefits provided by seafarming activities, possible negative impact on the environment must be considered. Mariculture should be assessed not only in terms of economic gains, but also in terms of environmental and social effects.

Seaweed farming seems especially suited to Indonesia and has the potential to give high economic returns with few adverse social and environmental consequences. The effects of seaweed farming on coastal rural poverty and income inequality in Indonesia need further study. However, a study by us of seaweed farming in Bali (Firdausy and Tisdell, 1992) indicates that it has reduced poverty and income inequality in the villages where it has been adopted compared with villages where traditional farming activity continues. While there is no firm basis at this time for deciding whether clam farming is likely to be a profitable economic activity in Indonesia, it does seem to have economic potential and to be environmentally less damaging than many existing mariculture activities, e.g. shrimp farming. It may also be possible to grow clams in conjunction with seaweed thereby providing a source of animal protein, but the economics of mixed farming schemes such as this have not yet been assessed.

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7

Status of, and Demand for Giant Clams in Indonesia: a Survey of Four Coastal Villages in Bali and Java

Carunia Firdausy

Clem Tisdell

Abstract

This chapter examines the status of, and potential demand for giant clams in four coastal villages in Bali and Java, Indonesia. Data were obtained from direct interviews with 228 household heads during the period April–July 1990 using a standardised questionnaire. It was found that in the areas surveyed natural stocks of giant clams have been severely depleted due to overexploitation. Results indicate that the demand for giant clam meat by Indonesian coastal dwellers is substantial and that they are interested in adopting giant clam mariculture for subsistence, semi-subsistence and small-scale commercial purposes. However, they have little or no knowledge about the techniques involved. Given the favourable attitude of interviewees to clam mariculture, its economics in Indonesia merit further investigation so as to determine farming methods suitable for local conditions. In the absence of giant clam mariculture in Indonesia, it is difficult to see how adequate supplies of giant clams for direct use and for traditional industries such as tile manufacture can be found and sustained.

Introduction

Giant clams (Tridacnidae) have been an important traditional source of food and income for many coastal Indonesian people. Since 1987, however, exploitation of natural stocks of giant clam has been prohibited by the Indonesian Government. This is because natural stocks, particularly of those species growing to the largest size (*T. gigas* and *T. derasa*), have been seriously depleted as a result of over-harvesting (Atmawidjaja 1987; Brown and Muskanofola 1985; Panggabean 1987).

Interest has been expressed in Indonesia in the mariculture of giant clams, both for reseeding depleted areas and for farming for food production (including commercial purposes). Biological research in support of the farming of giant clams is being conducted at Diponegoro University, Central Java and the Indonesian National Institute of Oceanology, Jakarta. Information on markets and likely costs and returns, and on the willingness of coastal dwellers to become involved in giant clam mariculture in Indonesia, is scarce and the viability of giant clam farming will depend on socioeconomic factors such as these.

This contribution aims to:

- (1) investigate the potential demand for giant clam products in Indonesia with particular reference to coastal dwellers in the four villages surveyed;
- (2) examine the willingness of coastal dwellers to establish giant clam mariculture; and
- (3) determine socioeconomic factors which might favour or interfere with the establishment of clam mariculture in Indonesia.

The information presented is based on a survey carried out in four coastal villages in Indonesia in the second quarter of 1990. The survey was made by Carunia Firdausy and local research assistants, using a questionnaire designed by Tisdell.

Method and nature of the survey

Four coastal villages were selected for in-depth study. They were Jungutbatu and Ped in Nusa Penida Sub-district, Bali; and Bulu and Ujungbatu villages in Jepara Sub-district, Central Java. The four villages were selected on the basis of prior information¹ about the suitability of these locations for giant clam mariculture. Furthermore, coastal dwellers in these villages were known to have been involved in giant clam harvesting for many years.

The data were collected by direct interviews using a standardised questionnaire (Appendix 1) designed to determine:

- (1) how much villagers know about giant clams;
- (2) the abundance of giant clams in these locations and changes in their abundance;
- (3) quantities of clam meat coastal dwellers are prepared to buy;
- (4) acceptable prices and the type of product sought; and
- (5) the extent to which villagers would be willing to mariculture clams and for what purposes (e.g. subsistence, market purposes etc.).

About 15 per cent of all household heads in each sample village in Bali were chosen randomly.² Household heads were grouped on the basis of their occupation. Only households with seaweed farmers and fishermen were interviewed using the clam questionnaire. A total of 228 household heads in Indonesia were interviewed using the clam questionnaire. This consisted of 195 seaweed farmers in Bali and 33 fishermen in Jepara, Central Java.

¹This information was obtained from a pilot survey carried out between November 1988 and January 1989.

²For the two villages Ujungbatu and Balu at Jepara, Central Java, a total of only 33 household heads was interviewed due to time limitations on the visit of Carunia Firdausy to Indonesia.

Information was also obtained from:

- (1) interviews with two biological researchers of giant clams, namely Dr Lachmuddin Sya'rani at Diponegoro University, Semarang, Indonesia and Mrs Maria Panggabean at Indonesian National Institute of Oceanology, Jakarta;
- (2) interviews with sellers of giant clam meat at Jepara market; and
- (3) interviews with a clam shell collector, souvenir shopkeepers and clam shell street retailers.

Background information on villages surveyed

The villages of Ped and Jungutbatu are situated on the islands of Nusa Penida and Nusa Lembongan, respectively, off the southeast coast of the main island of Bali (see Maps 1.1, 7.1 and 7.2). They can be reached by boat from Sanur Beach, Bali (a two-hour journey) or from Pandang Bai (a one-hour journey).

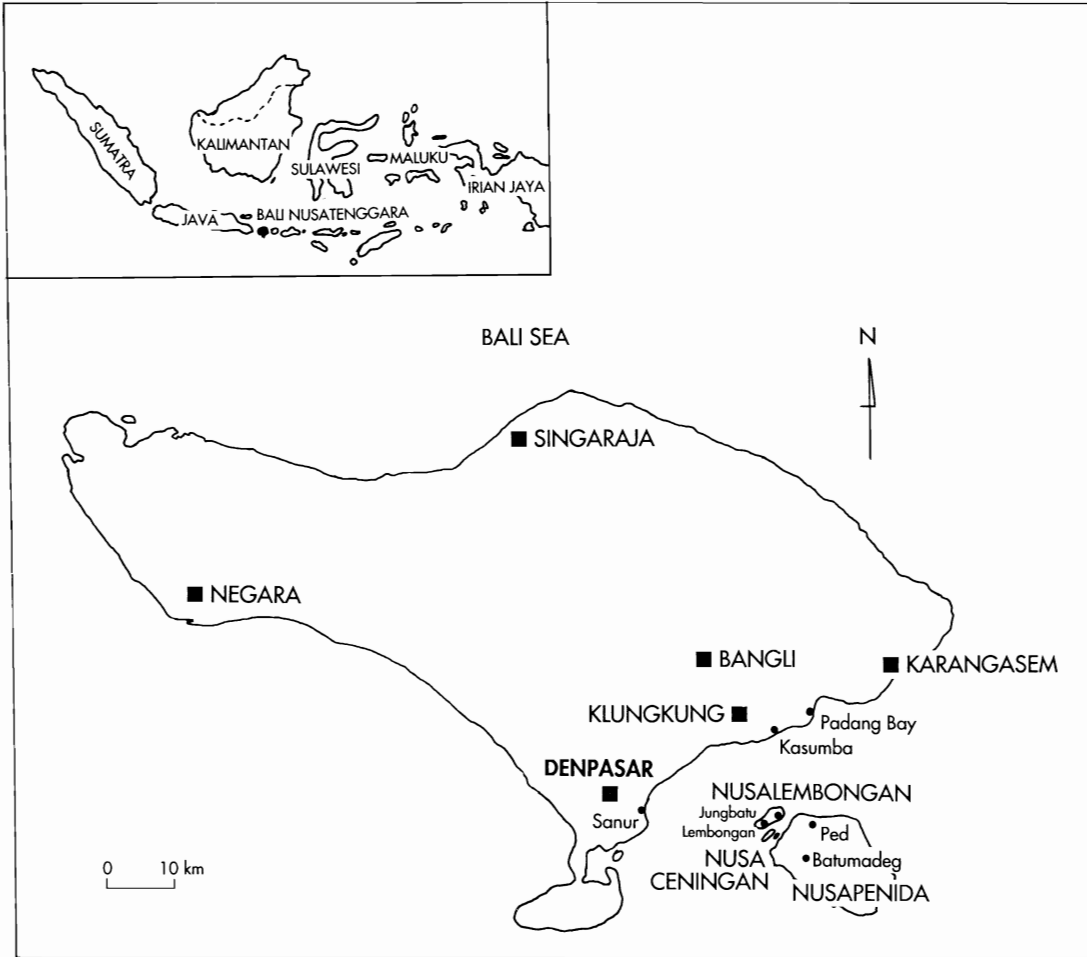
At the time of survey, the main economic activities of households in these two villages were seaweed mariculture (particularly cultivation of *Eucheuma cottonii* and *Eucheuma sponosum*) and, to a lesser extent, land-based farming and tourism. Almost 90 per cent of households in these villages engage in seaweed mariculture. Seaweed farming is the only form of aquaculture that has been practised in these villages.

These Balinese communities have utilised natural stocks of giant clams for their meat and shells in the past. Clam meat was eaten, while clam shells were sold to collectors for the terrazzo (tile) industries. However, following the commencement of seaweed culture in 1983 giant clam collection was discontinued. This is because seaweed cultivation is a more profitable activity for coastal dwellers and takes most of their available working time. Seaweed cultivation has brought coastal dwellers higher incomes and increased employment opportunities.

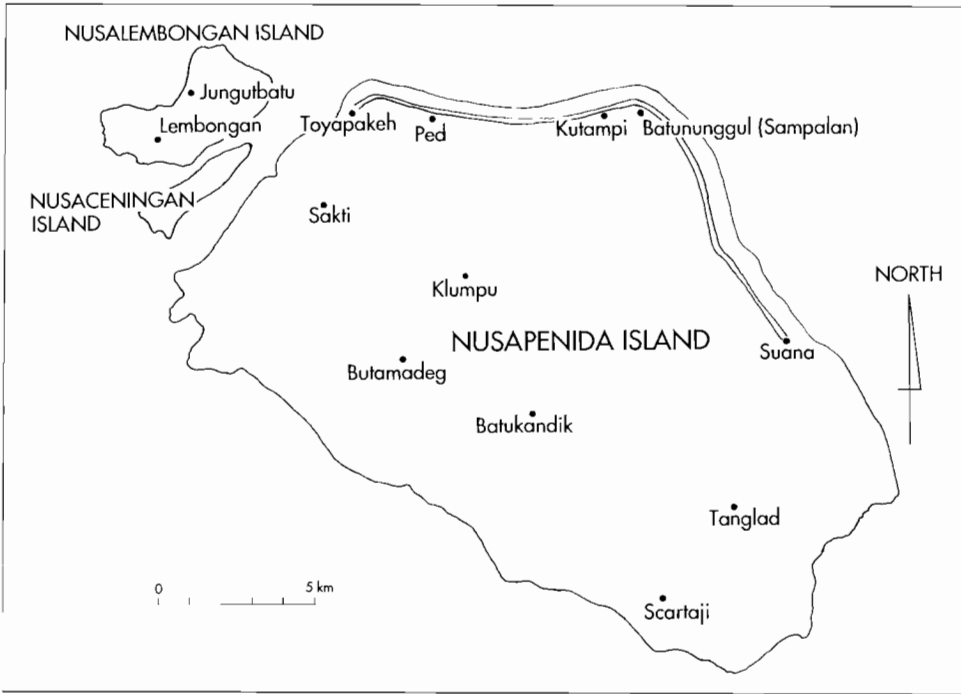
The other two villages surveyed (Ujungbatu and Bulu villages) are located on the north coast of Central Java, near the small town of Jepara which is about 80 km east of Semarang, a major centre (see Maps 7.3 and 7.4).

No seaweed cultivation occurs in these villages. The major economic activities in these villages are fishing and collection of giant clams. Recently, however, further development of prawn aquaculture has occurred, providing limited extra employment opportunities for these coastal rural villagers.

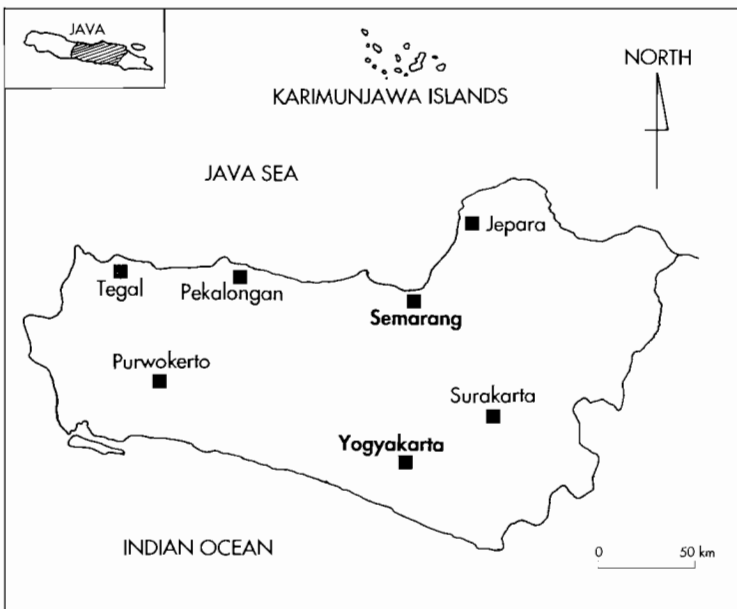
Because of the heavy exploitation of giant clam stocks in the vicinity of Jepara, collection has moved from this area to grounds in Karimun Jawa, a group of islands about 100 km north of Jepara (Map 7.3). In addition, these villagers sometimes travel as far as Bangka and Belitung islands in South Sumatra to collect clam shells. Collectors are formed into many groups, 5–10 persons in each group and financed and employed by a professional clam collector (middleman), to whom they must sell their clam shells.



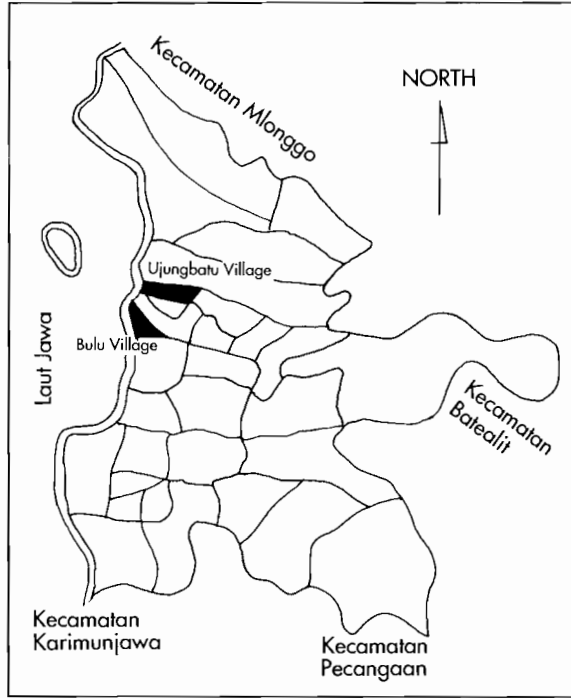
Map 7.1 The island of Bali, showing the location of Nusapenida islands.



Map 7.2 Location of the survey villages, Jungutbatu and Ped, in the Nusapenida subdistrict of Bali.



Map 7.3 Central Java, showing the location of Jepara and the Karimunjawa islands.



Map 7.4 The survey villages of Ujungbatu and Bulu in the Jepra subdistrict, Central Java.

Knowledge of giant clams and their natural availability in villages surveyed

Giant clams, known locally as 'Kima', appear to be well recognised by only coastal dwellers in Indonesia. From the survey, it was found that the majority of the household heads in the coastal villages sampled are familiar with giant clams. They know giant clams because they once used both their meat and shells.

Only those seaweed farmers who were formerly non-coastal dwellers in Bali asserted that they did not know of giant clams (Table 7.1). This group had recently migrated to coastal areas of Nusa Penida, to work as seaweed farmers. From this it may be inferred that giant clams are not well known to Indonesians from inland areas.

Giant clams were reported to be very scarce in the survey areas at the time of the survey. In two coastal villages in Bali, for example, more than 47 per cent of households responding felt that giant clams had become rare compared with 5–10 years ago. Also, it was stated that it is now necessary to go further afield and into deeper water to collect giant clams. Only small (10–15 cm in length) live clams can now be found.

Table 7.1 Percentage distribution of responses to the question 'Do you know giant clams?' and 'Are giant clams still available in your village?'

Village	Do you know giant clams?		Are giant clams still available in your village?			
	Yes	No	Yes	Rare	No	Do not know
Nusa Penida, Bali						
Jungutbatu N = 101	80.2	19.8	21.0	47.5	11.7	19.8
Ped N = 94	73.4	26.6	15.9	47.9	9.6	26.6
Jepara, Central Java						
Ujungbatu N = 18	100.0	–	5.6	27.8	54.4	12.2
Bulu N = 15	100.0	–	13.3	26.7	53.3	6.7

Note: N is the number of household heads responding
 Source: Based on survey data collected April–July, 1990

Extreme depletion of clam stocks was evident from two coastal villages in Jepara. More than 50 per cent of households responding believed that clams were no longer available in the vicinity of these villages (Table 7.1). This indicates that giant clams have been grossly overharvested in these areas.

The utilisation of giant clams by villagers: past and present

Traditionally (prior to 1970), clam meat and clam shells were utilised solely for subsistence purposes by the villagers surveyed. Coastal dwellers harvested clams for food consumption, particularly when the fish catch was low or the weather was unsuitable for fishing trips (the non-fishing season). They collected live giant clams (both small and large) as needed for immediate consumption, or sometimes stored them in shallow water near the beach until they were required. Very many clam shells can be seen in the villages surveyed, presumably discarded after the meat was removed for consumption.

Clam shells are also collected for use as water containers for livestock and people. Coastal dwellers keep large clam shells near wells, or outside their houses to collect rainwater. They have also used clam shells for building house walls and fences.

Beginning in the 1970s, villagers started trading clam meat and shells in local coastal markets. Market trading continues in Jepara (though quantities available

for trading are now small compared with the past), but not in Bali. Coastal dwellers in Bali stopped harvesting giant clams from natural stocks in 1983 after seaweed culture was adopted.

Clam meat is sold in dried forms in Jepara markets (Central Java). At the time of the survey (January 1989), clam meat which had been salted and partially dried sold at 2500 rupiah (Indonesian currency unit) per kg (1 US\$= Rp.1825) in the wholesale market and retailed at Rp. 3000 per kg. This product is supplied mostly from Karimun Jawa. Fresh clam meat does not appear to be available in Jepara markets or elsewhere (Bombat shopkeeper, pers. comm.), indicating that substantial stocks of giant clams no longer exist in this area. As will be apparent later, coastal villagers who know giant clams prefer to eat its cooked fresh meat. Buyers of salted 'dried' clam are households in Jepara and its surrounding areas. The demand for salted 'dried' clams is said to be weak.

Shells of giant clams are still collected for a variety of purposes, such as ornaments, ashtrays, jewellery, teraso and teralux floor-tiles. Four collectors (traders) sell clam shells to the floor-tile industry in Central Java, Jakarta, and East Java. According to Mr Asik (a trader engaged in selling clam shells for more than 20 years), demand for giant shell clams by this industry has risen. Every fortnight, about 10–20 tonnes of processed clam shells³ are sought by the floor-tile industry in Jakarta. The price of these processed clam shells was Rp. 250 per kg at the time of the survey.

Other market outlets for clam shells are beach area souvenir shops and retailers catering for tourists. These outlets sell clam shells, other seashells and corals. Domestic tourists and local householders are the main purchasers of these products in the Jepara area. They buy clam shells for decorating their homes gardens, ponds, and aquariums, and for ashtrays and ornaments in the house. At the time of survey, the retail price of clam shells varied from Rp. 500 to Rp. 5000 each, depending on the species and the size and appearance of the shells.

Shells of the following species are being sold: *T. gigas*, *T. squamosa*, *H. porcelanus* and *H. hippopus*. *T. gigas* shells are usually purchased for outside landscaping e.g. around ponds.

Preferences for giant clam meat and methods of preparing it for eating

The meat of the giant clam can be divided into two components: the adductor muscle and the mantle. Most household heads surveyed like to consume the whole of the clam's meat except the kidney. However, the muscle and the gonad are preferred and sought after. More than 70 per cent of households sampled like to eat the muscle and the gonad of giant clams (Table 7.2). Household heads prefer these

³The clam shells are separated, broken into tiny pieces, and sorted prior to sale.

two parts because they are not hard or rubbery, and have a similar taste and texture to squid. Nevertheless, more than half of the respondents said that they also like to eat the mantle of giant clams. It is clear that in these villages the whole clam would be eaten.

Not all coastal household heads sampled have eaten and/or like to eat giant clam meat (Table 7.2) Where it has not been eaten, it has mostly been because of lack of opportunity. A proportionately higher number of households in Bali compared with those in Jepara have not consumed clam meat. This is because some household heads responding in Bali previously worked in the non-coastal agricultural sector, migrating from inland areas relatively recently to operate seaweed farms. However, these households might be willing to try clam meat if it were available and, if they liked it, to purchase it in the future.

Table 7.2 The percentage of household heads responding who have consumed clam meat and their preferences.

Villages	Have you ever consumed clam meat?		Do you like it?		Which part of clam meat ^a do you like the most?		
	Yes	No	Yes	No	Mantle	Muscle	Gonad
Nusa Penida, Bali							
Jungut-batu N = 101	77.2 (78)	22.8 (23)	88.5 (69)	11.5 (9)	62.8 (49)	73.1 (57)	88.5 (69)
Ped N = 94	68.1 (64)	31.9 (30)	89.1 (57)	10.9 (7)	59.4 (38)	76.6 (49)	89.1 (57)
	(78)	22.8					
Jepara, Central Java							
Ujung-batu N = 18	83.3 (15)	16.7 (3)	86.7 (13)	13.3 (2)	53.3 (8)	66.7 (10)	86.7 (13)
Bulu N = 15	73.3 (11)	26.7 (4)	81.8 (9)	18.2 (2)	63.6 (7)	81.8 (9)	90.1 (10)

Note: N is the total household heads responding.

^athe percentages across do not add up to 100 because some households sampled like more than one part of the clam's meat. Figures in brackets are the number of households responding.

Source: Based on survey data collected April-July 1990.

On the other hand, there are household heads who have tried clam meat and now reject it. This may be because they dislike its taste or because they experienced an allergic reaction to its consumption.

The way in which Indonesian coastal people prepare giant clams for cooking is as follows: first, sand and dirt and foreign matter are removed by washing, and the

byssal attachment and kidney are discarded. The flesh is then cut into pieces, boiled and further cooked according to various recipes. Coastal dwellers of Indonesia apparently never consume clam meat raw:⁴ it is always boiled before further cooking. Boiling is said to be required to soften meat and to reduce its strong odour and bitterness. If more clam meat than needed is collected, household heads dry and salt the extra quantity and sell it in the markets.

Four main recipes are used for preparing the boiled clam meat, it is:

- (1) included in soup with mixed vegetables;
- (2) fried on its own with some salt;
- (3) fried and mixed with some additions (soy bean sauce, chillies, onions, and tomatoes); or
- (4) grilled with added sauces.

All these dishes are eaten with rice.

Demand for giant clam meat by coastal household dwellers

Demand for giant clam meat and shells was formerly directed to natural stocks. Information was sought on whether coastal dwellers would be willing to purchase maricultured clam meat should it become available at the market. Household heads in the survey villages were asked:

If clam meat is available at the market through clam mariculture, would you like to buy it regularly? Yes/No. If yes, how many clams would you like to buy? If not, why not?

The results indicate that most household heads would be willing to purchase farmed clam meat (fresh and/or dried) if it were available in the market (Table 7.3). In Jungutbatu village, for example, the percentage of household heads would be willing to purchase giant clams (both small and/or large) was about 83.2 per cent (84 household heads out of 101 samples). Some household heads who never consumed clams because of their unavailability, would be willing to purchase clam meat if it were available in the markets. The number of clams which would be consumed regularly would depend very much on their price, and the family's size and needs. A family with 6 children, for instance, was prepared to purchase 5 small clams (15 cm in length) or three big clams regularly (2–3 times a week).

Purchase of clam meat, as mentioned above, would be affected by its price. If the unit price of clam meat were higher than that of fish, many household respondents would rather buy fish. Thus the relative price of clam meat may be critical to demand for it. Fish sells in the villages at an average price of 1500

⁴Note that this differs from the practice in Polynesia where consumption of clam meat is often preferred raw (Tisdell and Wittenberg 1990, and Chapter 17).

Table 7.3 Percentage distribution of household heads according to the number of giant clams which will be consumed regularly if clams are commercially available at the market through clam mariculture.

Villages	The number of giant clams which household heads would buy regularly						Would not buy clam meat at the market
	Small			Large			
	1	2	up to 5	1	2	3	
Nusa penida, Bali Jungutbatu N = 101	18.8	22.8	4.9	26.7	6	4	16.8
Ped N = 94	15.9	25.5	7.4	22.3	5.3	3.2	20.2
Jepara, Central Java Ujungbatu N = 18	–	27.8	11.1	33.3	11.1	–	16.7
Bulu N = 15	13.3	20.0	–	20.0	20.0	–	26.7

Note: N is total household heads responding. Percentages do not add up to 100 due to rounding.

Source: Based on survey data collected April-July 1990.

rupiah/kg (US\$1 = Rp. 1825). Thus, if the price of clam meat is Rp. 3000/kg, as was the case in Jepara markets at the time of the survey, most household heads would rather buy fish than clam meat.

In brief, there is a demand for giant clam meat among the Indonesian coastal dwellers surveyed. However, the extent of their purchases would be strongly influenced by price. A high market price for clam meat relative to that of fish would lead to low demand for giant clam meat. The situation might be similar for Indonesia as a whole, but the extent to which this is so requires further investigation.

Knowledge of giant clam mariculture and interest in pursuing it

While knowledge of giant clams was widespread, no household sampled in the villages surveyed had heard that they can be maricultured. This is not surprising, since the extension workers on whom most coastal rural dwellers in Indonesia rely heavily for information about innovations in agriculture and fisheries did not themselves know of clam mariculture.

Once household heads were told by the interviewers that giant clams can be maricultured, they showed great interest in involvement such activity. Household surveyed in Bali asserted that they would be prepared to mariculture clams, either

in conjunction with seaweed cultivation or separately. More than 80 per cent of household heads said that they would be willing to establish clam mariculture in a semi-subsistence operation, i.e. for both their own consumption and for commercial sale. A small number of household heads sampled, however, wanted to culture clams for small-scale marketing only. These household heads were those who were allergic to clam meat. The percentage distribution of household respondents interested and not interested in establishing clam mariculture is presented in Table 7.4.

Table 7.4 also shows that there are some coastal household heads who are not interested in mariculturing clams. These individuals are mostly those over 60 years old, many of them feeling that they are no longer strong enough to culture clams. Household heads with small families are also uncertain about culturing clams because of fears that they have insufficient family labour to manage it well. Although a large number of villagers surveyed said that they would be willing to try giant clam culture in principle, their actual behaviour would be determined by many considerations. These would include costs of production, level of returns, market size, management factors and location and availability of suitable grow-out areas. In summary, household heads would be prepared to try culture of clams if the costs of its establishment were not too high i.e.were comparable to the costs of seaweed culture.

Table 7.4 Percentage distribution of responding household heads interested in clam mariculture for various purposes.

Village	Are you interested in mariculturing clams? (%)		What would be the purpose of such mariculture? (%)		
	Yes	No	Own consumption	Commercial sales	Both purposes
Nusa penida, Bali Jungutbatu	93.1	6.9	–	11.7	88.3
N = 101	(94)	(7)	Nil	(11)	(83)
Ped	94.7	5.3	–	15.7	84.3
N = 94	(89)	(5)	Nil	(14)	(75)
Jepara, Central Java Ujungbatu	88.9	11.1	–	18.8	81.2
N = 18	(16)	(2)	Nil	(3)	(13)
Bulu	93.3	6.7	–	14.3	85.7
N = 15	(14)	(1)	Nil	(2)	(12)

Note: N is the total household heads sampled;
The number in brackets is the number of household heads responding.
Source: Based on survey data collected April-July 1990.

Socioeconomic issues of giant clam mariculture in research villages: some observations

The development of giant clam mariculture seems possible in the areas surveyed, especially those in Bali. The marine areas at Jungutbatu and Ped in Nusa Penida, Bali seem to be technically, biologically and environmentally suitable. In these areas, the seawater is clear and salty (no rivers flow into the surrounding sea) and adequate sunlight is received. In addition, the extent of water pollution appears to be minimal compared with the villages in Jepara. Seaweed⁵ can grow relatively well in Bali and it is worth investigating the likely benefit of mixed farming involving clams and seaweed.

However, the success or otherwise of giant clam farming will depend on a wide range of factors. These include economic, ecological and social factors (for more details see Tisdell 1986, 1989, 1990; Firdausy and Tisdell 1989, 1990; Tisdell and Menz 1988).

Economics is the factor most likely to restrict the establishment of clam farms in the surveyed areas. This includes, for instance, consideration of markets, production costs, management, technology and infrastructures. Should low production cost technology (extensive farming methods) be adopted in preference to high technology production cost methods (intensive methods)? Also, should the tourist industry which exists in these areas be moved to other locations? There is some competition between tourism and aquaculture for coastal space.

Although the opportunity cost of labour at the village level might be low or negligible, farmers would have the costs of purchasing juvenile clams, placing juveniles in grow-out positions, protecting them initially, checking and removing predators and harvesting. Furthermore, they will initially have to hold their clams for several years before they are sold and they obtain returns. This situation contrasts with that for seaweed in which cash inflows from sales occur after only a few weeks. Furthermore, the waiting time involved in clam mariculture raises the question of whether successful clam mariculture may require investment from outside the village and if so, how villagers can be involved in clam growing operations.

Coastal property rights in Indonesia are not complex because marine areas do not have traditional owners (tribal, village, family owners) recognised by the Indonesian Government. All marine areas officially belong to the Indonesian Government so that it is possible for investors to lease areas from it. Nevertheless, if investors do invest in aquaculture near a village, the success of the enterprise may be dependent on village involvement e.g. through arrangements for sharing of production, or share-farming. However, village cooperatives like those operating in relation to seaweed culture could also be effective in overcoming capital and other economic constraints on individual villagers wishing to grow clams.

⁵Seaweed grows rapidly if the seawater is free from pollution. This might also be the case for clams.

Concluding remarks

While the demand for giant clam meat by Indonesian coastal dwellers appears to be substantial judging from the responses of those interviewed, these results cannot be unquestioningly extrapolated to Indonesia as a whole. Furthermore, the exact relationship between the demand of villagers for clam meat and its price is not known; neither are the species likely to be favoured for consumption in Indonesia nor the species likely to be most suitable for production at different locations in Indonesia.

While Indonesian coastal dwellers are very interested in the possibility of farming giant clams, which culture method(s) would be most appropriate for villagers to adopt is uncertain. The costs and returns which villagers in Indonesia can expect from their cultivation is also still unclear. The economics of including giant clams in polyculture (e.g. with seaweeds, or with other molluscs) is worthy of investigation in the Indonesian context.

The results of this study encourage optimism about the long-term possibility of giant clam mariculture in Indonesia. Both subsistence and market demand exist for giant clam meat, shells are in demand locally, some forms of mariculture such as seaweed farming have been successful in Indonesia and the coastal villagers interviewed were interested in principle in trying giant clam mariculture. Given the depleted natural stocks of giant clams, farming in Indonesia seems the only possible way to sustain supplies of giant clam meat and to provide shells for the tourist industry, for general use and for the tile trade.

Acknowledgments

We wish to thank the Australian International Development Assistance Bureau (AIDAB) and the Australian Centre for International Agricultural Research (ACIAR Project No. 8823) for financing the survey and this research. Also, we thank the Indonesian Government and the Heads of villages surveyed for allowing the investigations to be carried out in Bali and Jepara, Central Java. Special thanks go to all respondents in the villages surveyed for their kind cooperation in answering questionnaires and to our three field research assistants, I Made Suryantha, Gusti Puja and I Ketut Suta.

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Appendix

Questionnaire for coastal dwellers in survey villages regarding giant clams

- | | |
|---|---|
| <p>1. Do you know giant clams? Yes/No.</p> <p>2. Are there any giant clams in your area? Yes/No.
If yes, do you consider them to be common or rare?
Are they less common than in the past? Why is that so?
If No, were giant clams present in the past? When? Were they common?</p> <p>3. Do you use giant clams? Yes/No.
If yes, for what?
If not, why not?</p> <p>4. Do you ever eat giant clams? Yes/No.
If yes, do you like them? What part of the giant clam's meat do you like the most? How do you cook it?
If No, why don't you like giant clam meat?</p> <p>5. If giant clam meat were available at the market through clam mariculture, would you like to buy it regularly? Yes/No.
If Yes, how many clams would you wish to purchase?
If not, why not? Please explain.</p> | <p>6. Have you heard that it may be possible to mariculture giant clams? Yes/No.
If yes, where did you obtain your information from?</p> <p>7. Giant clams can be maricultured in conjunction with seaweed. Are you interested to culture giant clams and seaweed jointly? Yes/No.</p> <p>8. If you wish to culture giant clams, why do you want to do it?
a. own consumption
b. commercial sales
c. both a and b
d. other.</p> |
|---|---|

Part III

Institutional Factors and Marine Property Rights

8

Marine Property Rights in Relation to Giant Clam Mariculture in the Kingdom of Tonga

T'eo I.J. Fairbairn

Abstract

Marine property rights in the coastal waters of the Kingdom of Tonga are fairly uncomplicated. Ownership of Tonga's reefs and lagoons—as well as its territorial waters as a whole—is vested in the Crown and has been so since the late 19th century. While such an arrangement effectively took away the traditional and customary rights of local groups over these waters, it allows open access to all Tongans for purposes of fishing, both subsistence and commercial. The main exceptions are certain restricted areas set aside as marine parks.

Leases over reef sites for giant clam and other forms of mariculture can be negotiated with the government. The Fisheries Act of 1987 and the Fisheries Regulations of 1989 provide the basic legislative framework for such leases. Specific terms and conditions relating to leases are negotiated under the auspices of the Ministry of Agriculture, Forestry and Fisheries.

Under existing legislation, the Minister of Agriculture, Forestry and Fisheries has fairly wide regulatory powers to ensure, among other things, that mariculture, and fisheries in general, proceed along sound lines.

Tonga appears to possess many favourable features for giant clam mariculture. The country's many constituent and widely scattered islands support extensive reef and lagoon areas; the necessary legislative and tenurial framework is in place; while public awareness on the potential of clams as a major industry seems to be growing (Tonga's 'giant clam circle' project has contributed in this respect). The Ha'apai Group, with its large reef areas and generally favourable social environment, appears to be particularly well-placed to support a major clam project.

For purposes of establishing a commercial clam project, including one with foreign participation, the collaboration of local groups seems to be a vital prerequisite. The involvement of local villagers can be particularly valuable for the policing of project sites to prevent poaching. Collaboration with other local groups also seems necessary, for example, the Fishermen's Association and local government officials.

Introduction

Reef and related coastal property rights in the Kingdom of Tonga are relatively straightforward. This situation stems from the fact that ownership of territorial waters (including inland waters) is vested in the Crown—an arrangement that goes back to a Royal Proclamation in the late 19th century and subsequently enshrined in formal legislation. Among other things, Crown ownership of Tonga's territorial waters effec-

tively took away any customary rights the local tribal or community groups may have had over offshore fishing grounds. It also conferred on all Tongans a system of free access allowing them to fish anywhere in the Kingdom's territorial waters.

This chapter reviews the system of reef property rights in Tonga and implications for the development of clam culture and other types of mariculture. It also examines customary forms of sharing arrangements and suggests possible approaches for successful mariculture developments in Tonga.

Background

The Kingdom of Tonga is located in the central South Pacific region, 900 km southwest of Western Samoa and 700 km east of Fiji. The island group is widely scattered and contains a total of 171 islands of which only 37 are inhabited (see Maps 1.1, and 8.1). Most of the islands are small, low-lying, coral atolls but there are few of volcanic origin, with mountains reaching 900 m. Tonga's land area totals only 700 km² but its territorial waters amount to 700 000 km².

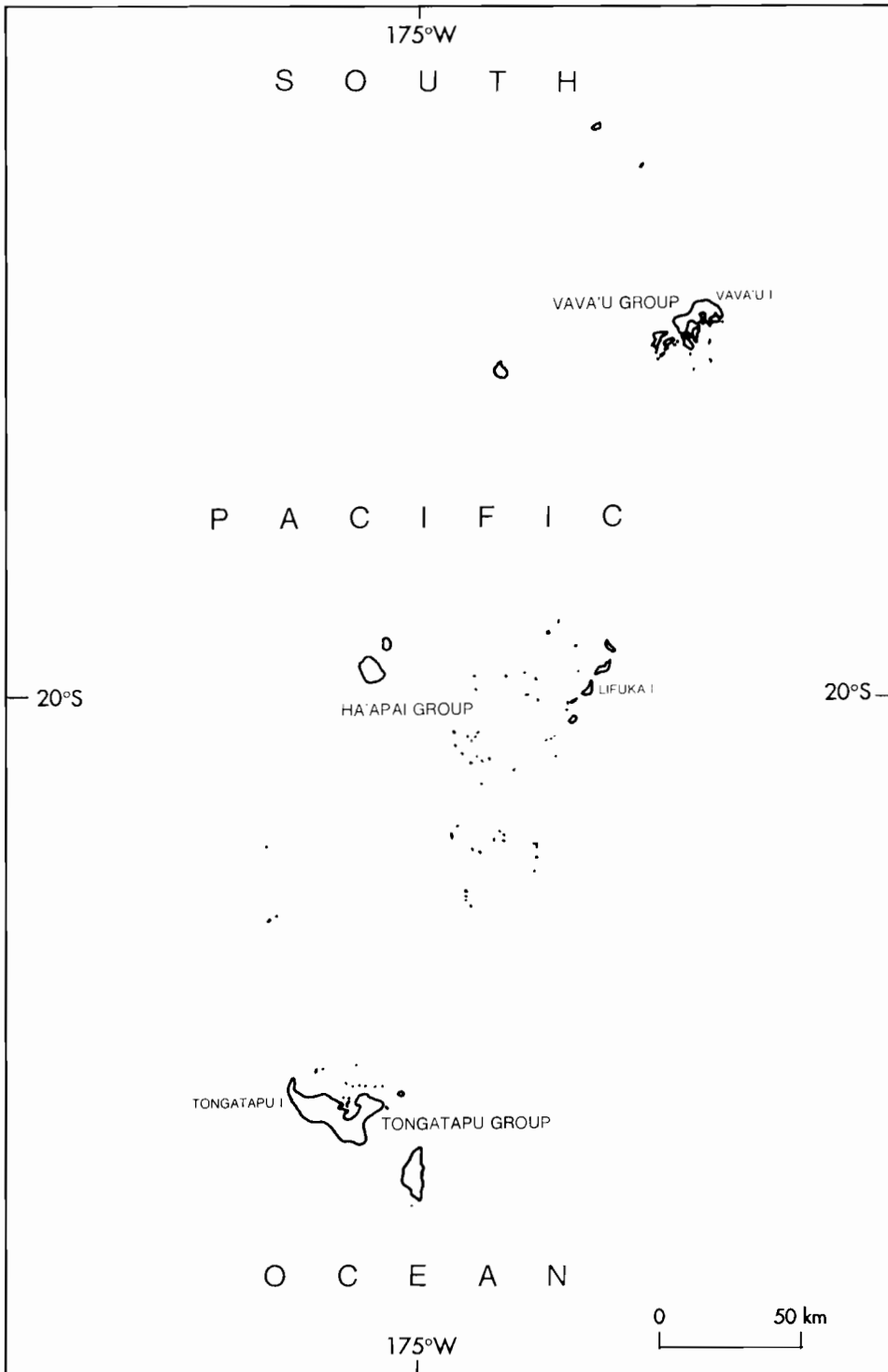
Tonga's population is currently an estimated 96 000 of which 64 000, or 66 percent, live on the main island of Tongatapu. Over recent years, Tonga's population has increased only slowly, largely because of heavy overseas migration, especially to New Zealand.

The economy is based on the production of coconut products for export (primarily coconut oil and desiccated coconut), bananas and a variety of agricultural and light industrial items. It also sustains a wide variety of products for domestic consumption, a large part of which is produced under subsistence conditions. Major prospects for development are related to a more intensive utilisation of land for agriculture, exploitation of marine resources and further development of tourism and light industries.

As is clear from Tonga's current Five Year Development Plan (Government of Tonga (1987a), fisheries is one of the leading sectors for purposes of achieving increased production and economic growth. A more intense effort to develop Tonga's mariculture potential is implied in the principal development objective for fisheries, namely:

increase production of fish and other marine products in order to maximise social and economic benefits for Tonga, having full regard for the biological constraints of maximum sustainable yield (Government of Tonga 1987a, p. 181).

The Plan goes on to identify several key measures for achieving increased fish production in both shallow waters (including reef and reef slopes) and pelagic zones. Such measures include: a more active artisanal boat-building program, an improved marketing system, an upgrading of the Fisheries Division (part of the Ministry of Agriculture, Fisheries and Forests) and greater encouragement of the private sector in further development. For its part, the Fisheries Division focuses on several areas of fisheries development, notably the development of rural fisheries,



Map 8.1 The Kingdom of Tonga.

low-technology commercial inshore fisheries, aquaculture research and other special services. Its rural fisheries work involves the development of boat building, training, technical advisory services and the establishment of ice plants and related facilities. The main areas of aquaculture work are giant clams, oysters, seaweed culture and mullet culture, but in none of these areas are present development efforts very extensive.

In so far as the Fisheries Division's artisanal fisheries development work is concerned, specific objectives are laid out as follows:

- to expand artisanal fishing by introducing new fishing craft and improving fishing techniques which together will help to improve the amount of fish supplied to local markets and for export.
- to reduce the pressure on traditional fishing grounds by diversification into unexploited species inshore and offshore areas beyond the current range of the artisanal fleet.
- to provide additional employment opportunities and to increase income from fishing activities, particularly in the outer islands groups where marine resources are concentrated.

Particular opportunities and possibilities for developing Tonga's mariculture (and aquaculture) have been the subject of several recent expert studies. In 1988, the Food and Agricultural Organization (FAO) drew up a Master Plan for mariculture/aquaculture development, including prospects relating to giant clams, fish ponding and green mussels, and a number of key proposals (e.g. training) contained in this plan are being considered for implementation. Tonga has also had the benefit of several technical studies on particular aspects of mariculture: for example, Chesher (1988) on the revitalisation of giant clams in Tonga and Braley on aspects of giant clam development (report not yet available).

In practice, mariculture in Tonga has made little headway. It is confined to fish trapping by means of fish fences erected by villagers on reef areas. (There are presently around 50 such structures in the Kingdom.) It also includes the establishing of so-called 'clam circles' (see later section) as a means of reviving interest in clam culture, although this initiative is closely linked to government efforts to foster greater public awareness of environmental issues. Current mariculture experiments (e.g. seaweed farming), being undertaken by the Fisheries Division can also be noted.

Further opportunities for mariculture would seem to be considerable, especially given Tonga's archipelagic spreads and large reef area together with other natural advantages. The realisation of such a potential calls for appropriate development measures—legal, tenurial, research etc.—in both subsistence and commercial sectors. A major recent initiative is the enactment of new legislation—the Fisheries Act 1989 and the Fisheries Regulation 1987 (Government of Tonga 1987b)—which, among other things, addresses the issue of property rights in relation to reef mariculture projects. On such projects, the legislation provides exclusive rights to the leased areas.

Reef property rights and traditional sharing arrangements

As noted earlier, ownership of Tonga's territorial waters (Tonga has not declared an Exclusive Economic Zone) both sea and inland waters, is vested in the Crown. Tongan territorial boundaries were defined by Royal Proclamation (by King George Tupou I) in 1887. According to this proclamation Tonga's territorial boundaries were declared to include all islands, rocks, reefs, foreshores and water lying between the 15°00' and 23°30' South parallels and between 173°00' and 177°00' West Meridians. The Land Act of 1927 officially conferred on the Crown all land and sea areas within the Tongan territorial limits.

Fishing in Tonga's territorial waters is open to all Tongans. Villagers have no exclusive rights, either legal or customary, to particular areas of reef and lagoons. Fishing in these inshore waters, as is the case with pelagic waters, is open slather. Also, there is no restriction governing the kind of fish species Tongans can fish for within these waters. Anything is allowed.

Open access, however, is restricted in two particular cases. The first relates to fishing activity on areas declared a natural marine park, which currently total 11.¹ These marine parks have been established primarily for environmental and fish conservation and exclude all commercial fishing but allow some subsistence activity.

The second case relates to reef areas surrounded by fish fences; here the rights of owners are recognised over a distance of 1.6 km (1 mile) around the fish trap (but boat passage is allowed). Such structures operate under a licence which has to be secured annually from the Department of Police at a cost of T\$10.²

There are other special exceptions to free access. These include fishing rights on inshore lakes and rivers/streams which belong to the King. Also, the extensive waters of Fagauta Lagoon, south east of the main township and approximately 400 ha (1000 acres) in size, is a protected area in the sense that commercial fishing is banned. This protected status was conferred upon Fagauta Lagoon by the Fisheries Act of 1976.

Territorial rights towards reef and lagoon areas that villagers apparently enjoyed in earlier times seem to have disappeared. On outer islands, however, residual notions of territorial rights towards offshore waters persist somewhat, but apparently have no practical impact. In practice of course, it is common to find villagers confining their fishing activities, especially in the case of subsistence fishing, to adjacent offshore reefs but it is not uncommon for villagers to fish in one another's

¹There are five such marine parks or reserves on Tongatapu (Hakaumama'o Reef Reserve, Pangaimotu Reef Reserve, Monuafe Island Park and Reef, Ha'atafu Beach Reserve and Malinoa Island Park and Reef Reserve), three on Vava'u; two on Ha'apai and one on Eua.

²The Tongan Pa'anga (T\$) is pegged at par to the \$A, which at the time of fieldwork was equal to US\$0.75.

backyards, so to speak. In the case of small islands owned by a noble, fishing by outsiders is rare.

All fishing carried out commercially requires a permit from government. Fishing permits for Tongans can be obtained from the Department of Police and for foreign fishing ventures, from the Department of Inland Revenue. Foreign venture proposals, which have so far been primarily for pelagic fishing, have to be licensed by the Privy Council.

Leasing of reef areas for marine development and related purposes can be negotiated with government. Granting of a lease is dependent on the perceived merits of a project and since 1984, an impact assessment study is required as part of a project submission.

Sharing arrangements

Traditional fishing methods involving village groups and sharing arrangements are rarely practised today in Tonga. Fishing is now largely a matter for individuals, immediate family members and groups working together with a boat and net. However, traditional forms of group fishing are still practised on outer islands where subsistence life remains strong, as seen on Vava'u and Ha'apai groups. Such surviving custom is seen in that of *toungaue* where villagers cooperate for purposes of fishing or carrying out other forms of work without monetary payment. Work is carried out with a view of reciprocation among members and in the case of fishing, members of the work group share in the catch.

Another form of sharing activity is the *uloa*, or fish drives, which can involve up to two villages or as many as 30–40 villagers. Here, the participating villagers form a large circle while holding a simple net made from palm fronds attached to a rope. By pulling on the rope the fish are driven into a trap at one side of the circle. The catch is divided among the villagers, usually with a larger share going to the head fisherman and local chiefs.

A related form of group fishing is *velo*, a traditional practice that can involve two or three villages. In this case, the participating villages form several concentric circles and drive the fish into a trap located at the centre of the innermost circle. Apparently, this form of sharing arrangement is rarely practised.

As noted earlier, ownership of Tonga's territorial waters including reefs and lagoons, is vested in the Crown. Apart from certain restricted areas, notably natural marine parks, such waters are effectively a common property within which all Tongans can enjoy the right to fish, both commercially and for subsistence. A notable feature of this ownership pattern is the absence of traditional-based claims by local village groups on the fishing rights of their waters. By comparison with most other Pacific island countries, Tonga's system of reef tenure and fishing rights is uncomplicated. One advantage is that it gives Tongans complete freedom to fish anywhere in these waters, unfettered by customary or other restrictions. However, uncomplicated as it is, for purposes of mariculture development, the present

system of marine tenure has two major weaknesses. The first relates to the need to establish extensive rights to reef and lagoon sites required for mariculture. Given Crown ownership, this requirement can be met by adequate leasing arrangements between government and the mariculture operators (see later).

A second aspect of the existing tenure system relates to the need for measures to protect areas under mariculture from outsiders, including poachers. For successful mariculture, it is necessary to restrict access to the site of the operation. Legal framework for the protection of mariculture areas under lease is provided for under the Fisheries Act of 1987.

A related problem is the need to ensure effective policing of mariculture operations—a requirement that, in Tonga, appears to call for cooperation between government, the mariculture venture and the local community. Additionally, it calls for cooperation (and compliance) on the part of fishermen in general. Without such cooperation formal government regulations will have little effect.

The leasing of Crown land for aquaculture is provided for by the Fisheries Act as noted above. Section 25 of the Act states that ‘government may lease areas, lagoons, the foreshores and sea-bed for the purpose of aquaculture’ (Government of Tonga 1987b, p. 26). Such leases are awarded both to Tongan ventures and foreign investors, and the Act empowers the Minister responsible for fisheries (i.e. the Minister of Agriculture, Forestry and Fisheries) with the task of prescribing the terms and conditions of the leases.

The same Minister is empowered under the Fisheries Act of 1987 (Government of Tonga 1987b) to control the licensing, regulation and management of particular areas, including aquaculture operations (see Part IV, Regulation 40 (2)(a)). Part of the Minister’s regulatory functions refers to the question of entry into the areas leased for aquaculture purposes. Under Section 40 (2) (a) of the Act, the Minister is responsible for regulating or prohibiting the entry into leased land or to any ‘water superjacent to such land’ (Government of Tonga 1987b, p. 28).

It may also be noted that the Fisheries Act Section 22(1) empowers the Minister to declare any area of fishery water to be reserved for subsistence fishing and to stipulate the kind of fishing vessel and method of fishing that can be used in each area. Although the primary purpose of this part of the Act is to protect subsistence resources from commercial exploitation, such a provision may be useful in establishing reserve areas for subsistence-oriented mariculture.

As noted above, formal measures are already in place for the leasing of reef areas for mariculture as well as the regulation and protection of mariculture operations. These legislative measures are backed up by the technical facilities of the Fisheries Division and other government agencies. This support relates particularly to such services as the demarcation of lease areas, negotiating fees for leases, project assessment and evaluation, and mediating between the mariculture venture and local communities.

Institutional aspects

Several institutions operating in the village environment are important in developing fisheries in Tonga, and can play a particularly valuable role in mariculture development. The roles of the Tongan Fishermen's Association and the Town Officer are particularly crucial.

The Fishermen's Association was established in 1988 as a voluntary organisation with assistance from the Fisheries Division. It has grown rapidly with a current membership of around 3000 and includes practically every village in the Kingdom. The purpose of the association is to provide a formal mechanism for raising and discussing issues of vital importance to fisheries development, particularly small-scale village fisheries. It also acts as a forum for assisting the Fisheries Division in the planning of fisheries development and in implementing particular development programs.

The Fishermen's Association has three branches located on Tongatapu, Vaba'u and Ha'apai, and its affairs are guided by a governing council. The Fisheries Division continues to play an active part in the association and provides the association's secretary (the head of the Fisheries Division) and treasurer.

As a forum for highlighting fisheries issues and problems and bringing them before the government, the Fishermen's Association has the potential to play a major role in the development of fisheries in Tonga. From the viewpoint of government, it can also be particularly useful in taking some of the workload off the Fisheries Division in the task of promoting artisanal village-based fisheries.

The Town Officer is a government representative in a village and acts as the formal intermediary agent between the village and the central government. He is appointed by the village (normally by local elections) and his responsibilities cover a multitude of tasks directed at promoting the social, welfare, and economic needs of the villagers.

As a village resident familiar with village affairs and development needs, the Town Officer can play a leading role in promoting development projects at the village level. This role is particularly crucial at the early stages of project development, especially in promoting the merits of a project and in negotiating terms, conditions and the nature of local participation.

Giant clam circle project

Tonga's 'giant clam circles' have created considerable interest around the South Pacific region. This initiative is of interest in that it is a novel experiment and one which highlights many of the problems associated with mariculture in the Pacific islands context. The first giant clam circle was planted in 1986 (in June during Environmental Week) on a reef area in Nuku'alofa (fronting the present Ministry of Education building) under the auspices of the Ministry of Land, Survey

and Natural Resources (also involving the Fisheries Division and an outside research foundation). Since then at least four other clam circles have been established in various locations. The underlying rationale for the project is threefold: to revitalise the dwindling stocks of clams; to increase public environmental awareness; and to foster education on marine food organisms (Chesher 1988).

Giant clams circles are a circular arrangement of around 100 clams spread evenly over an area of approximately 500 square metres (0.13 acres). The main clam species are *Tridacna derasa* and *Tridacna squamosa*. Site location has to satisfy certain conditions (depth, clear reef bottom, etc.) and preferably be close to areas of settlement to facilitate policing. A circle site is marked by a buoy and may be linked to the shore by an underwater trail (for the public to visit). Government has provided some funds for purchasing stock. The concept of planting clams in protected reef areas is apparently not new to the Pacific. As pointed out by both Chesher (1988) and Johannes (1982), the protection of clams in this fashion is known to have been practised in several other Pacific locations. According to Johannes, for example, the people of Shortland Island in the Solomon Islands collected clams and placed them in protected areas, and similar practices were found in the Tagula area of PNG and on the island of Savai'i in Western Samoa. However, it appears that the primary purpose of clam protection in these cases was to ensure emergency food stocks rather than stock revitalisation as such.

Tonga's giant clam circle experiment is based on the belief that such formations will protect and augment natural stocks. This belief is supported by considerable biological evidence and, as pointed out by Chesher (1988 p.3):

In areas where giant clams are kept in protected embayments for everyday food supplies there is an abundance of clams of all sizes in the same bays and in nearby fringing reef environment.

The placement of clams in a circle is based on the following considerations (Chesher 1988, p. 3):

- 1 The orderly and systematic placement of the clams ensures they will not be mistaken for a natural population but clearly have been placed there by someone; such an awareness will help prevent poaching.
- 2 The spacing of the clams equidistant from each other is important to maximise spawning.
- 3 Each clam can be identified by its position and this will assist in growth, spawning and mortality studies.

Other advantages of the project are that it does not depend on development assistance, costs are minimal and its importance is readily accepted by the local communities.

Apart from the giant clam circle on Nuku'alofa, other clam circles have been established at Falevai Village on Kapu Island in the Vava'u group, and on Neiafu and Pagamotu Island, part of a marine reserve park not far from Fuaa Harbour on Tongatapu.

Four possible sites for clam circles have been identified in the Vava'u group of islands (Hunga, Tuanga, Mala and Ofu) but future developments will depend partly on the availability of funds.

Regarding progress, the giant clam circle on Falevai Village, Vava'u, established in 1988, appears to be doing particularly well. This success is due at least in part to a favourable location: the clam circle is located near the police station (under construction at the time), is close to the residence of the District Officer and it is well placed to facilitate research work on the surrounding reefs. Success is also due to the way in which the project was presented to the villagers. From the very beginning, the Governor of Vava'u took the initiative—he selected the site for the project and called a meeting of all Town and District Officers to explain the purpose of the clam circles. This initiative succeeded in winning the support of the local people who agreed to act as guardians of the project and to refrain from taking the clams.

By contrast, the clam circle on Neiafu appears to have failed and future prospects are uncertain. The main reason for the lack of success was said to be a failure to control poaching. This weakness, in turn, reflects a lack of adequate policing of the project and insufficient support from the local community.

It would be premature to predict the outcome of Tonga's giant circle experiment and on the specific factors making for success or failure; but the experiment so far seems to point to the critical importance of having local communities actively involved in the project. The Falevai village experiment seems to support this conclusion: essentially, local people must be encouraged to appreciate the value of the project to their community and to feel that they have a stake in such developments. Among other things, their support is essential to control poaching.

Reef property rights and possible approaches for successful mariculture

As already noted, Tonga's system of reef and lagoon tenure is based on Crown ownership, but that for purposes of fishing (including mariculture) free access to the marine zone is available to all Tongans. Fishing—both commercial and subsistence—is carried on with few restrictions (the main restrictions applying to fishing on marine parks) in relation to territorial waters and types of fish that may be caught. Given this system of tenure—which in practice amounts to exercising common property rights—mariculture development demands that exclusive rights be acquired over the reef and lagoon areas needed for the activity. Such rights can be obtained under the framework of existing legislation governing the leasing of reef and other categories of waters for aquaculture purposes.

Reef property rights

Specific terms and conditions for the leasing of reef and lagoon (and land in general) suitable for mariculture are provided for by legislation. For aquaculture

purposes, the Fisheries Act of 1987 empowers the minister responsible for fisheries to regulate lease terms, covering such areas as project site, demarcation of boundaries, environmental safeguards, government access to project results, and leasing fees. The Act also places on the government the responsibility for protecting mariculture operations located on the leased areas.

Crown ownership of Tonga's entire territorial waters has clear advantages from the viewpoint of the prospective investor. It means that the investor needs to deal with only a single authority rather than a multiplicity of claimants exercising fishing rights over particular reef areas. It also has the advantage in that a consistent and uniform set of criteria can be applied for regulating leases.

In addition to leased areas, a certain level of mariculture activity can be undertaken on marine and related reserve parks. This kind of activity is illustrated by the giant clam circle project. Here, the right to conduct mariculture activity is based on a different set of legislation (Parks and Reserves Act 1976), and such activity is restricted to those projects with an environmental significance.

External participation

The development of Tonga's mariculture potential beyond a small subsistence base invariably calls for foreign participation, particularly in the form of outside investment. Such participation seems particularly beneficial when it involves a significant degree of collaboration with local people, through joint venture arrangements.

Foreign investment can be especially valuable in developing large commercial projects geared to export production. The benefits that the foreign investor can bring to a mariculture project are several-fold. Foremost are capital, management and technical expertise, which are all in scarce supply in Tonga. Equally important are the benefits that derive from having access to overseas market networks and research facilities as well as the capacity to pass on, through training, maricultural skills and knowledge to the local people.

Foreign participation through technological and financial assistance from bilateral and multilateral sources also has a role to play. This form of assistance has the advantage over foreign investment in that technology and finance can be obtained without surrendering control; a possible disadvantage is that such assistance may not be as effective as foreign investment in terms of marketing and management. However, such assistance can be valuable in particular cases; for example, in providing support for local groups that may wish to be involved in mariculture predominantly as a small-scale subsistence orientated activity. Groups that may benefit in this way include cooperatives and youth groups.

Tonga has succeeded in establishing the basic structure and services to facilitate foreign investment in mariculture and other sectoral areas. Leasing arrangements are straightforward and the Fisheries Division can provide basic information on technical aspects including suitable areas for mariculture, leasing arrangements

and potential local partners. Other forms of assistance, including tax concessions, are also available.

Location

For clam culture, as probably for other kinds of mariculture, Tonga offers, by virtue of its extensive reef and lagoon areas and related natural advantages, many suitable locations. This being so, the choice of actual site will depend on other factors that are likely to influence the successful operation of a project; for example, proximity to coastal communities, transportation facilities and the extent to which local groups are receptive to the project. Official views on possible sites can also be important, especially as increased decentralisation of economic activity is a major government development objective.

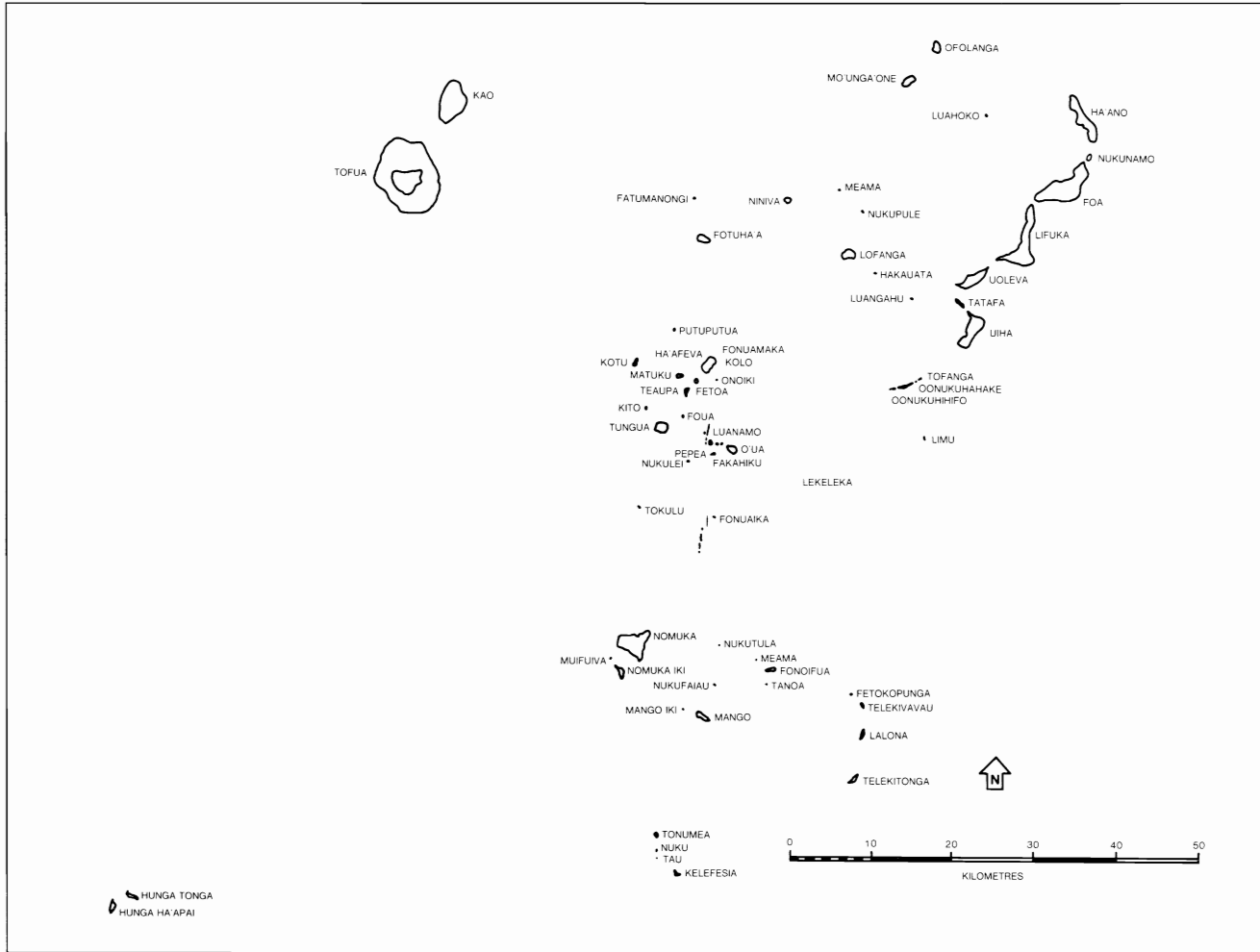
One question that has to be resolved is whether to establish clam projects close to coastal communities or to choose more distant locations. Closeness to coastal communities can be advantageous in cases where the cooperation of local people is sought, possibly in connection with the effective policing of project operations. However, for larger projects with significant foreign investment a location away from populated areas may be more attractive. Among other things, such a location may allow the project to proceed with a minimum of outside intrusion.

The results of my inquiries regarding specific sites for a major giant clam venture suggest that the Ha'apai group of islands may be the most promising and merit serious consideration.

The Ha'apai group lies halfway between the Tongatapu group in the south and the Vava'u group in the north and comprises a somewhat scattered archipelago of 51 islands, only 17 of which are inhabited (see Map 8.2). The group has extensive reefs and lagoons, some of which are rich in marine life (e.g. the islands of Nomuka, Mango, O'ua, Kout, Lofanga and 'Uiha).

Ha'apai's population totalled 8978 in 1986 (Government of Tonga 1988, p. 14), of whom just over 70 per cent are located on the Hahake sub-region, north-east of Ha'apai. The group has suffered a loss of population in recent years, both to Tongatapu and overseas, and has one of the lowest per capita incomes in the country: T\$335 in 1981-82 versus \$634 for Tongatapu and \$440 for Vava'u. Its economy is based on fishing and copra making and has a strong subsistence base.

Ha'apai's potential for clam culture is based in its extensive reef and lagoon areas, some of which presently appear to be little used. Ha'apai is also favoured as a site for a major clam project for other reasons. One relates to the fact that Ha'apai is in a state of economic stagnation and could benefit considerably from the introduction of a new project. Another reason is based on what one observer described as 'the mentality' of the Ha'apai people—their industriousness, thriftiness and commercial mindedness—qualities that are likely to ensure success in a new mariculture venture.



Map 8.2 Ha'apai region, Kingdom of Tonga.

Officially, there appears to be firm support for establishing a major clam project on Ha'apai—for one thing, such an initiative is consistent with current government policy favouring greater decentralisation. It is apparent also that such a project would interest aid donors whose assistance would be required to strengthen infrastructure and related requirements. Australia, in particular, is committed under current aid arrangements with the Government of Tonga to channel a portion of aid funds to Ha'apai's development.

Local participation

Almost all field informants in Tonga stressed that the key to successful clam cultivation in Tonga and mariculture in general, is to work with the local people. Even though Tongans themselves have no legal claims to reef areas, their cooperation is, nonetheless, vital for success. The importance of securing the cooperation of local communities has been noted throughout this chapter and is clearly illustrated by the giant clam circle project on Vava'u. Here, a major reason for success appears to stem from the fact that the project was, from the very beginning, set up with the close involvement of the community.

A vital prerequisite for success is to work out the mode of cooperation between the venture and the local community. The local community should be made to feel that it has a vested interest in the venture. The nature of community participation can take different forms, including various kinds of joint venture arrangements allowing for a degree of local ownership: here some flexibility is required to allow, for example, the deferment of equity payments. Other meaningful forms of local participation include involving villagers in decision making and creating employment opportunities.

Meaningful participation will help sustain local interest in the project and, in practical terms, make for effective policing of operations to deter poaching and unwarranted intrusion from local fishermen.

Conclusion

The tenurial and legal framework in Tonga is highly favourable for clam culture and mariculture in general. The tenure system applying to reefs and lagoons (as part of the Tonga's territorial waters) is based on Crown ownership which, however, confers on all Tongans virtually unrestricted rights to fish anywhere within these areas. Leasing of reef and lagoons for purposes of mariculture, along with associated terms and conditions, is provided for by legislation.

Beyond leasing arrangements, several other aspects need to be considered in any attempt to set up a successful clam project, including commercial ventures with significant foreign investment. These aspects include:

- working closely with local people—the cooperation of nearby coastal communities is essential; active local participation should be encouraged including participation as joint venture partners.

- effective policing arrangements of mariculture operations can be achieved only with the assistance and cooperation of local groups.
- collaboration with village-based agencies and support from the Fishermen's Association and the village Town Officer can be particularly valuable, especially at the formative stages of a project.

As for specific locations for launching a major commercial clam project, many informants pointed to the Ha'apai group of islands, with its extensive reefs and lagoons combined with the purposefulness of its people, as perhaps having the best potential.

Acknowledgments

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9

Marine Property Rights in Fiji: Implications for the Development of Giant Clam Mariculture

T'eo I.J. Fairbairn

Abstract

Marine property rights in Fiji are characterised by state (the Crown) ownership of offshore waters (including seabeds) and Fijian tribal ownership of fishing rights on customary fishing grounds. These fishing grounds are extensive, covering adjacent reefs, lagoons, estuarine and mangrove areas and some outer-reef zones (as well as rivers). Rights to fish on these customary grounds are regulated by tribal groups, as represented by a tribal lineage—the *yavusa*—or a sub-division of this lineage—the *mataqali*. The rights of each tribal group over its recognised fishing area apply to the right to carry out subsistence fishing and the power to regulate commercial exploitation of these waters.

On biogeographical and ecological grounds, Fiji has the potential to develop giant clam culture as a major productive activity, both subsistence and commercial. However, as practically the entire reef area considered suitable for clam mariculture falls under customary forms of marine tenure, a major requirement is to gain access to these areas. The most critical step in this process is to obtain the consent of the tribal group in which the fishing rights are vested. Regardless of whether a major giant clam project is initiated by a tribal group or by an outside developer, a key ingredient for success is the active support of villagers. This support is critical—to gain access to the reef area in the first instance, and to ensure local cooperation during subsequent stages of project development and operation. There are many possible avenues for fostering meaningful and close cooperation with villagers, including some form of joint venture or partnership arrangement.

Background

Fiji occupies a central position in the South Pacific and is one of the largest and most scattered archipelagic groups in the region. It lies close to the Kingdom of Tonga, Western Samoa, Vanuatu and New Caledonia. The nearest metropolitan countries are New Zealand, which lies approximately 2100 km to the south, and Australia, which is 3100 km to the south-west.

Fiji has a land area totalling 18370 km² of which 86 per cent is accounted for by the two large islands of Viti Levu (10390 km²) and Vanua Levu (5530 km²). In total, Fiji comprises over 320 islands, of which 150 are uninhabited. Many of the component islands are very small, low-lying, coral-based structures that are poor in natural resources. The area of Exclusive Economic Zone under Fiji's jurisdiction totals 1290000 km².

The population of Fiji is currently around 720 000, about 90 per cent of whom live on the two main islands of Viti Levu and Vanua Levu. This population, which is multi-racial, is dominated by Fijians and Fiji Indians (who are mostly descendants of indentured labour brought from India in the last century to work on sugar plantations). Each of these major groups accounts for around 46 per cent of the total population. The remaining population comprises primarily other Pacific islanders, Europeans, Chinese and people of mixed ethnic origin. There has been a decline in population since 1987 as a result of heavy emigration by Fiji Indians following the military coups of that year. The present rate of population growth is 1.8 per cent per year.

The economy is based on the development of Fiji's varied natural resources as well as service industries, including tourism. In agriculture, sugar—both production and processing—is dominant, in most years accounting for around 13 per cent of GDP and over 50 per cent of export earnings. The notable agricultural commodities are ginger, fruit juices, coconut products and cocoa. Tourism and related activities comprise a leading sector which has considerable potential for expansion, while processed fish, wood products (mainly lumber) and gold are also prominent. Manufacturing, which to date has been directed mainly at import-substitution, is modest (accounting for 12% of GDP) but appears to be growing rapidly especially in relation to the production of garments for export.

Exports are dominated by sugar, but several other resource-based items are significant; for example, ginger, wood products, gold and processed fish. Regarding fish products, export earnings are modest and, in 1987, they contributed a total of F\$25 million¹ of total export earnings (including re-exports) of F\$409 million (equal to Aust. \$22 million and Aust. \$360 million, respectively), or six per cent. Fish exports take the form of preserved and canned fish (tuna) supplemented by a small amount of fresh and dried fish products.

A major thrust of current government policy is to encourage fisheries development both for subsistence and commercial purposes. This emphasis is based on the need to encourage full exploitation of an abundant natural resource and to open up new employment opportunities in that sector.

As outlined in Fiji's Ninth Development Plan 1986–1990 or DP9 (Government of Fiji 1985, p. 71), the major objectives of the fisheries sector are to:

- (a) generate further employment opportunities in the exploitation and processing of marine resources;
- (b) increase production to satisfy local demand for fish and other marine fish products;
- (c) increase value added in fish production for exports; and
- (d) regulate and control the exploitation of fin and non-fin fishery products.

¹F\$1 = A\$0.88

Programs for developing the potential of the country's fisheries are laid out in DP9 by four major sub-areas: rural fisheries development; commercial artisanal fisheries; industrial fisheries; and fish farming. Considerable emphasis is given to the role of industrial fisheries in the economy, especially the exploitation of skipjack tuna and associated processing activities.

According to DP9, the main possibilities for fish farming relate to carp on fresh water rivers and ponds, prawns and mussel farms, and seaweed (*Euchema* variety) production (Government of Fiji 1985, p. 74). A range of measures is proposed to realise this potential, including the promotion of fish farming techniques and assistance with the construction of fish ponds.

The Fisheries Division's latest annual report (Government of Fiji 1989, pp. 13-14) provides a summary of progress made so far in various areas of fish farming, including pilot and experimental projects. These areas include clams, seaweed culture, freshwater fisheries, carp and tilapia culture. The report noted that as many as 27 rural aquaculture farms were in production in 1988.

The Fisheries Division's efforts to develop clam culture are presently modest. These efforts are largely confined to hatchery work on the island of Makogai which lies north-east of Viti Levu, about 50 km offshore. However, the Division has been responsible for carrying out an extensive survey on clams which found that the main clam variety, *Tridacna derasa* (*vasua dina*), has been greatly overfished. Largely based on this finding, an official ban was imposed on the export of *vasua* and will apply until stocks have recovered.

The Fisheries Division's giant clam operations on Makogai include six quarantine tanks for imported broodlings and six tanks for developing and nurturing stocks. Two more tanks are soon to be installed. The Division's plans for Makogai are to establish it as a major mariculture site designed to foster clams and other products such as béche-de-mer, trochus, pearl shells and mangrove crabs. Funds are being sought from the Food and Agriculture Organization (FAO) of the United Nations to implement these plans.

On Makogai, a *tabu* (taboo) has been imposed on the northern side of the lagoon so as to protect it from commercial fishing. (This protected area does not include the clam hatchery area whose development predated present clam project work.) Consideration is being given to converting Makogai's offshore areas into a marine reserve. However, before this step can be taken, the consent of the Tui Levuka, a high chief on Ovalau who holds the fishing rights on Makogai's coastal areas, must be obtained. Among other things, appropriate ways to compensate the Tui Levuka for fishing rights that he will have to forego (and is presently foregoing as a result of the partial *tabu*) need to be worked out should agreement be reached on the creation of a marine reserve.

Property rights

The background

In common with many other Pacific island countries, property rights on Fiji's coastal waters essentially operate under a dual system whereby property rights are shared between government (or the Crown) and indigenous Fijians. This dual system is marked by government ownership of the territorial waters, within which lie the so-called customary fishing grounds of Fijians, and tribal ownership of the fishing rights on these grounds. Government ownership extends to reefs, lagoons and other territorial waters and includes seabeds and mineral resources. Fijian rights are confined to recognised fishing grounds and include subsistence and commercial fishing as well as the right to authorise commercial fishing by those outside the particular tribal group in which the fishing rights are vested. These rights also apply to the right to control practices that may damage marine resources.

Government ownership of Fiji's reefs and lagoons (as well as of rivers and other inland waters) was established in 1874 with the advent of the Deed of Cession. The Deed of Cession, which was signed by a group of leading Fijian chiefs, gave Queen Victoria (and Her Successors) possession of and sovereignty over the Fiji Islands, specifically, 'all lands not properly alienated and not needed by the Fijians'. By this action, Crown ownership was also established over all reefs and territorial waters which contained traditional fishing grounds.

It may be noted in passing that the significance of Crown ownership of Fiji's offshore waters does not appear to have been fully understood by Fijians at the time of Cession—a feature that has persisted from the post-Cession period to the present. Apparently, the signatory chiefs fully expected—in line with their chiefly customs—that ownership over their fishing grounds, as with their lands, would, in due course, be returned to them. The question of legal ownership persists, and sections of the Fijian people have recently sought, through legislative means, to reassert ownership rights over customary fishing grounds and all associated resources, including seabeds. (At a recent meeting of the Great Council of Chiefs, a motion was presented by the Western Chiefs to have ownership of marine resources by Fijians included in the proposed Constitution.)

While as a consequence of Cession, the Fijians lost ownership rights of their fishing grounds, they retained fishing rights over these areas. Successive representatives of the British Crown in Fiji confirmed that the customary fishing rights of Fijians would be fully protected and secured. These assurances were subsequently incorporated in various official ordinances, principally, Fisheries Ordinances (1894, 1924 and 1941) and the Birds, Game and Fish Protection Ordinance (No. 20 of 1923).

According to the latter ordinance:

It shall be unlawful for any person to fish on any reef or any kai (cockle) or other shellfish bed in any water forming the ancient customary fishing ground of any mataqali unless that person was a member of such a mataqali or held a licence from the Colonial Secretary.

This basic provision protecting the customary fishing rights of Fijians has been refined and modified over time in response to changing political, social and institutional circumstances. Present legislation (e.g. Marine Space—Chapter 158A, Law of Fiji 1978), accords protection to ‘any area in which the rights of any *mataqali* or other division or sub-division of the Fijian people have been registered by the Native Fish Commission in the Register of Native Customary Fishing Rights’. In relation to access for those not belonging to the tribal group which controls the fishing grounds, a permit to fish is required from the Commissioner of the Division in which such area is located.

A major problem in relation to property rights on reef areas that has had to be faced over time has been the need to clarify the fishing rights of individual tribal groups. Traditionally, tribal groups had developed their own way of defining areas over which they had control but, even so, such a system left the way open to much dispute, often leading to violence. The problem of the lack of clarity regarding the fishing rights and how far these rights apply was addressed by the Fisheries Ordinance of 1924. This ordinance highlighted the need for a clarification of fishing rights and recommended that the limits of reefs and shellfish beds belonging to different *mataqali* be defined and properly recorded. The latter recommendation provided the basis for the establishment of a Native Fisheries Commission (incorporated under the Native Land and Fisheries Commission) whose responsibility was to investigate and examine tribal claims for customary fishing rights over reef areas and to register these claims. The work of the Commission has made considerable progress despite the many difficulties inherent in such a mandate.

Fijian reef tenure

The fishing rights of Fijians apply to customary fishing grounds that tribal groups have, over time, established on adjacent reef and other coastal areas. Traditionally, control over and usage of these fishing grounds was governed by custom. Such fishing grounds comprise rivers, estuarine areas and offshore waters, usually extending from shore (high-water mark) to the outer edges of fringing or barrier reefs. They also include lagoons and shallow coastal waters not bounded by a reef. As will be shown later, considerable variation exists in the location, size and other physical features of fishing zones controlled by the different tribal groups.

Access to the customary fishing grounds of each tribal group is open to members of that group (leaving out those from outside, fishing commercially under a fishing licence). These tribal groups are, the *vanua*—the broadest tribal and social unit that is associated with an identifiable physical territory (Ruddle 1989); the *yavusa*—tribal lineages of the *vanua*; and the *mataqali*—a sub-unit of the *yavusa* and the principal group for the purposes of land occupation. The *mataqali*, in turn, is composed of smaller family units—the *tokatoka*—which are equivalent to extended family units. The *mataqali* falls into a number of functional categories, each specialising in a particular area, for example, fishermen, farmers, builders and chiefs.

The chiefly groups who exercise effective control over customary fishing grounds vary from area to area and reflect the hierarchical and stratified nature of the Fijian social and political system. In practice, most of the customary fishing grounds that have been identified fall under the effective control or custodianship of the head of a *yavusa* (*turaga ni tokatoka*) or, in some cases, of several *yavusa* (*turaga ni yavusa*). Otherwise, this role is exercised by the *mataqali* chiefs and, in a few cases, directly by a paramount chief.

Important differences also exist regarding fishing practices used by tribal groups. As Iwakiri (1986 p. 135) has observed: 'There are no written regulations on *mataqali* fishing practices because of differences in culture and tradition at each *mataqali* level. Each *mataqali* has its own identity which has been passed from generation to generation.'

The areas claimed by Fijians as their customary fishing grounds cover practically the entire reef and other coastal zones of the country. A total of 410 separate fishing grounds has been defined so far and officially recorded for purposes of eventual registration (and surveying). Such grounds are recorded by *yavusa* tribal division in accordance with the ancestral fishing rights (*vanua*) of the group. In the not infrequent case where several *yavusa* share a common fishing zone, the rights of each participating *yavusa* are recorded for registration (i.e. in the Register of Native Customary Fishing Rights). The process of registration has been virtually completed, although only seven customary fishing grounds have so far been surveyed—all on the coastal waters of the island of Beqa—to determine absolute boundaries.

Customary fishing rights apply to reef areas directly offshore from the village or groups of villages—essentially lateral extensions of the terrestrial boundaries of a particular land-holding group. However, many tribal groups control fishing rights over coastal or territorial zones which lie far from shore and, in some cases, this is in addition to those adjacent to shore. Particularly complicated reef tenure arrangements can arise in relation to fishing rights on offshore islands or islets where the claims of both the inhabitants and those from other islands are often recognised.

Tribal groups generally had clear ideas of the extent and limit of their fishing grounds and they relied heavily on certain physical features as a means of demarcating boundaries. Iwakiri (1983 p. 135) observed that these fishing areas were usually bounded by readily identifiable marine physical features such as patch reefs, reef holes and reef passages and, at the seaward end, by the outer limit of the barrier reef which is exposed at mean low water.

The use of physical marine features to identify tribal fishing areas can be illustrated by the two extracts from the Native Lands Commission (D.W. Wilkinson) records compiled in 1899 (Hornell 1940, Appendix VII). The first extract records the evidence for the *Yavusa Vusaratu, Serua*, as follows:

We (the people of the above tribe) fish upon our line of reefs and the main reef, commencing at the passage at Somosomo then following up said reef to the

eastward to the Yarawa passage and the patches along our coastline within said main reef. The Tomasi of Serua and Manggumanggua (Maqumaqua) and Korovisilou have equal right and privileges on said reefs with ourselves.

The second extract relates to the *Yavusa Vusu Mbatiwai (Batiwai), Serua*:

The reefs along the coastline and the main reef and patches opposite Tolunga (Toluga) Bay, that is from the Rokosou Point on the west and Rukunivutu on the east point; we fish in all these reefs and patches together with the towns people of Thulanuku (Culanuku) and Wainiyambia (Wainiyabia).

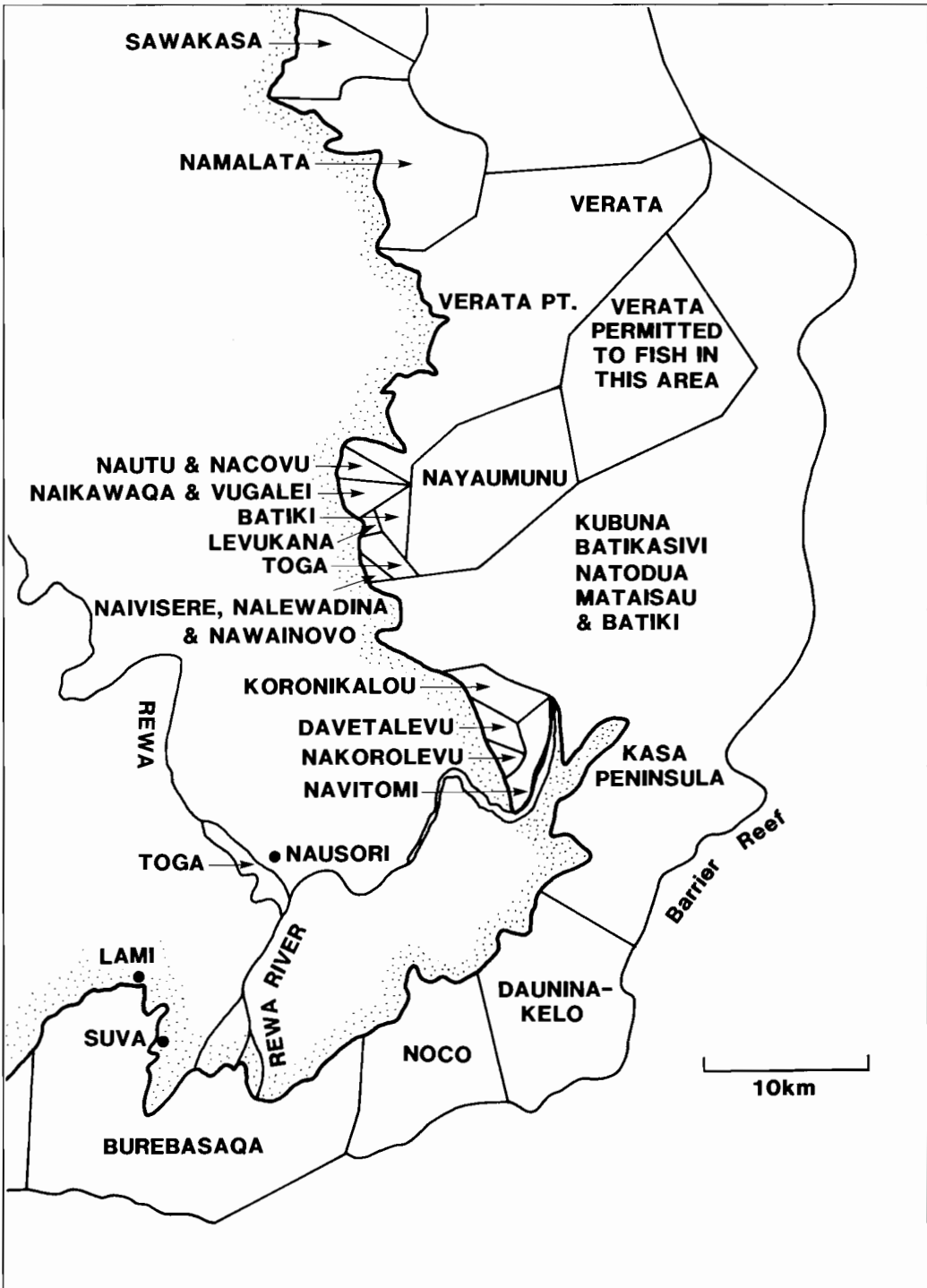
Key aspects of reef tenure can be highlighted with the aid of Maps 9.1, 9.2 and 9.3. Map 9.1 shows the pattern of tribal fishing grounds that has been established along the southeast coast of Viti Levu, Fiji's main island. It includes the area in the vicinity of the Rewa River Delta. Map 9.2 shows the corresponding division for a southern section ('Coral Coast') of Viti Levu, and the offshore island of Beqa.

Apart from confirming the dominance of reef tenure in which customary fishing grounds are essentially extensions of village or tribal boundaries, Maps 9.1 and 9.2 show other important features of reef tenure:

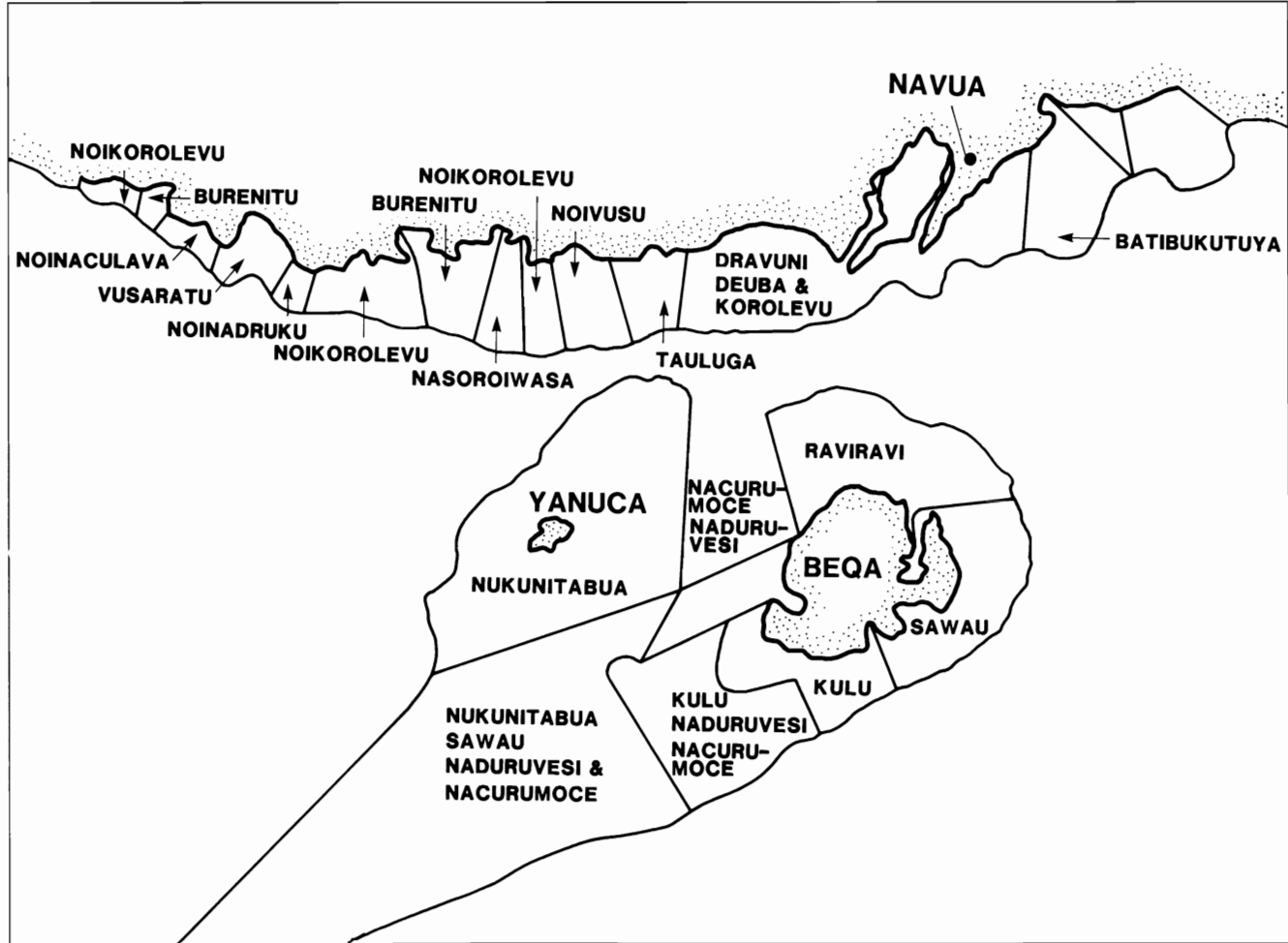
- The fishing grounds of some groups are located on outside coastal waters and cut off from shore by the fishing zones of other tribal groups. Examples are the Vanua ni Nayaumunu in Map 9.1, and Vanua ni Nukunitabua in Map 9.2. These 'outer' fishing grounds appear to lie on extensive shallow areas in which smaller islands are sometimes found.
- The sharing of customary fishing grounds between different *yavusa* is common; such sharing tends to occur on outer reefs or coastal zones, for example, that shared by Kabuna, Batikasivi, Natodua, Mataisau and Batiki in Map 9.1. In some cases, a sharing *yavusa* has exclusive fishing rights elsewhere as, for example, the case of Nukunitabua in Map 9.2.
- Significant variation exists in the size of customary fishing grounds. In Map 9.2, Nukunitabua is large as compared with Burinitu and in Map 9.1, Verata is many times larger than, say, Nakorelevu. According to estimates made by the Fisheries Division the size of these fishing grounds varies from several square kilometres to around 30 km².

Another aspect of interest relates to reef tenure on some outer islands where the entire reef and other coastal zones are open to all inhabitants of that island. This form of access is usually made possible by the existence of a single or dominant tribal group.

The present marine tenure arrangements can give rise to several kinds of disputes. Disputes often arise over fishing boundaries where there is a lack of precise demarcation. These disputes often come to a head as a result of present attempts to register customary fishing rights. Often the source of the dispute relates to poaching, fishing without a licence and disagreement over the issue of fishing permits (especially where fishing areas are shared by different tribal groups).



Map 9.1 Patterns of tribal reef tenure along the southeast coast of Viti Levu in an area encompassing the Rewa River delta.



Map 9.2 Patterns of tribal reef tenure along the southeast coast of Viti Levu, the 'Coral Coast' and for the offshore islands of Beqa and Yanuca.

Licensing requirements

Fishing activities on customary fishing grounds are dominated by subsistence fishing and some small-scale commercial fishing, mostly to supply local urban markets. Subsistence fishing does not require a fishing licence and the scale of activity is usually controlled by local chiefs. Fishing methods employed include hand collection, fishing lines and traps, and the use of small craft. In addition to reef and bottom fishing, the reef products include a wide variety of shell fish, sea slugs, octopi and other shallow water sea growths. Part of the subsistence (unlicensed) catch is sold informally in local markets but such activity normally takes place on a small scale.

Commercial fishing on customary fishing grounds is open to both members of the home tribal group and to those outside this group, but it should be noted that, under the Fisheries Regulations, commercial fishing on these areas requires a fishing licence. Such a licence is designated as an IDA (inside demarcated areas), the dividing line being the low water mark of fringing reefs. (Note that the holder of an IDA is permitted to fish outside customary fishing grounds.) However, members of the tribal group which owns the fishing rights do not require a licence if they fish with a spear or line from the shore.

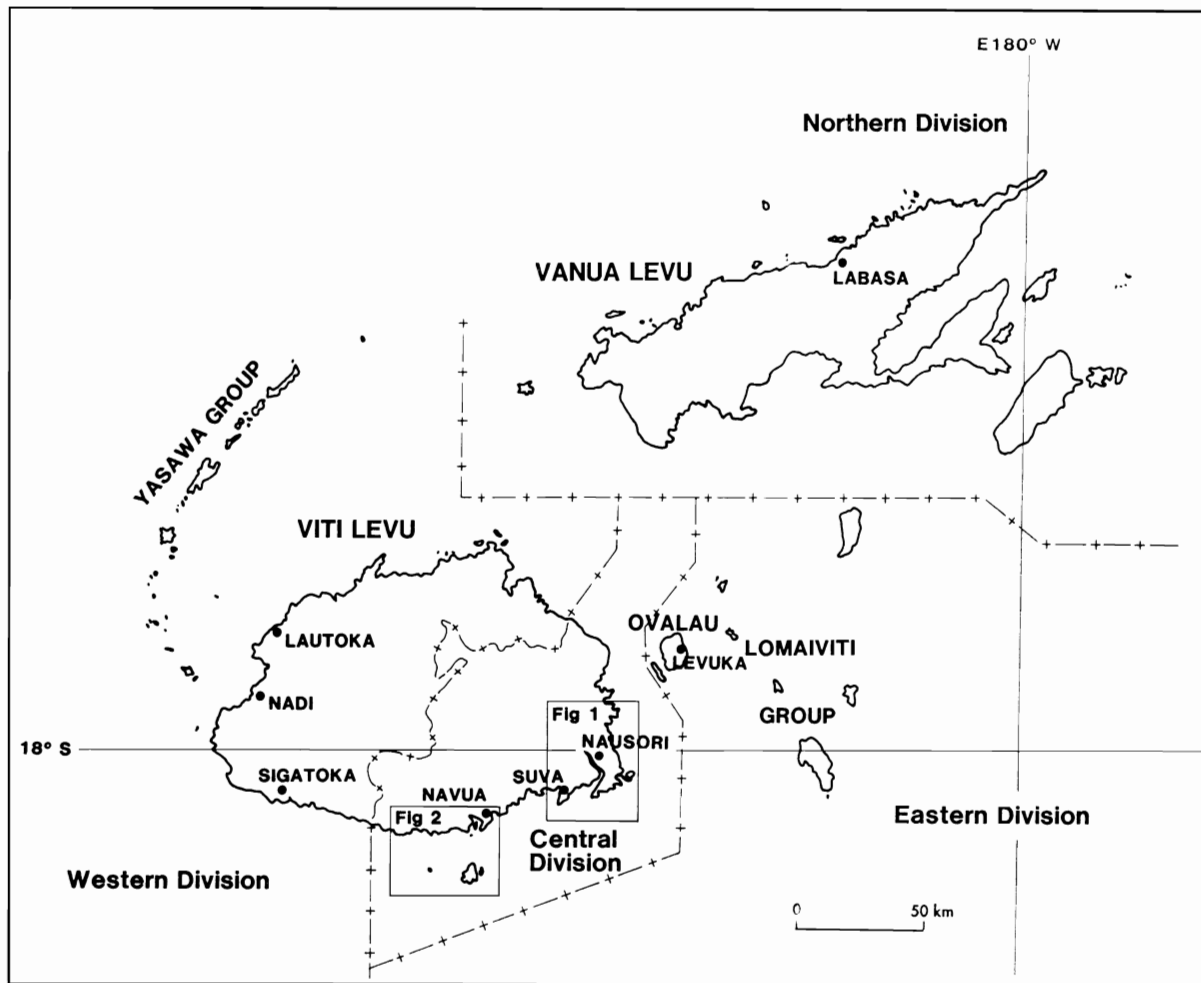
Application for a fishing licence is made through the Fisheries Division, but where fishing is to be carried out on customary fishing areas, the applicant must first secure a permit to fish from the tribal group whose fishing grounds are the object of the application. Application for such a permit must be made through the District Commissioner for the area in which the fishing ground in question is located. Approval by the Commissioner is contingent on the consent of the tribal group and the outcome of consultations with the Fisheries Division. Insofar as the fishing licence is concerned, a small fee is charged by the Fisheries Division and renewal is made on an annual basis.

The main authority determining whether or not a fishing permit is issued is the tribal group—the *yavusa* or *mataqali*. These authorities, in approving an application, can recommend that certain conditions or a combination of conditions, be met. These conditions usually relate to:

- the species of fish that may be harvested by the permit holder;
- excluded areas;
- conservation of reef resources; and
- allowable method of fishing.

Apart from being responsible for issuing fishing licences, the Fisheries Division is also charged with the task of registering the fishing vessels of holders of a licence, and for this it charges a nominal fee (\$4).

Regardless of whether a major giant clam project is initiated by a tribal group or by an outside developer, a key ingredient for success is the active support of villagers. This support is critical to gain access to the reef area in the first instance, and to



Map 9.3 General location in Fiji of the tribal reef tenures shown in maps 9.1–9.2.

ensure local cooperation during subsequent stages of project development and operation. There are many possible avenues for fostering meaningful and close cooperation with villagers, including some form of joint venture or partnership arrangement.

Under existing legal arrangements, no provision is in place to compensate Fijians for allowing commercial fishing on their grounds by outsiders. Apparently, this situation has arisen because Fijians do not have ownership of the fishing resources. However, in practice, compensation is made on an informal basis—apparently a form of ‘goodwill’ payment—and now appears to be a common practice when issuing a fishing permit. Information on the level of such compensation is not available, but it is believed that, at least for non-Fijians, these ‘fees’ vary from zero to \$500. For Fijians, such payments are low and, in many cases, made in kind.

Present access arrangements relating to the customary fishing grounds are based on the recognition of the fishing rights of individual tribal groups. These fishing grounds have been classified over time and are in the process of registration by tribal groups. Registration will do much to minimise inter-tribal disputes over fishing boundaries, as these have been common in the past. However, two problems that need to be addressed relate to the activities of commercial fishermen on these fishing grounds and the question of compensation for villagers for admitting outside commercial fishing, as noted earlier. With regard to commercial fishing, a serious problem relates to the possibilities of overfishing by individual licensees which can lead to resource depletion and the deprivation of village members. Clearly, an effective means of controlling and regulating commercial overfishing needs to be established.

Shared fishing efforts

Most coastal villages still practice traditional fishing activities involving group cooperation and sharing of the catch. Communal fish drives (*qoli kubu*) are widely found, while joint fishing activities by women on reef zones are common.

Fish drives usually involve participation by the whole village and take place under the direction of a traditional master fisherman (the *Gonedau*). The mechanics of a fish drive have been described by Iwakiri (1983, p. 139) in relation to fishing on Beqa Island. These drives entail the use of several fishing craft, a net (woven from coconut fibre), a long cord or rope (usually a liana-type vine) and sticks, as well as the active participation by up to 40 villagers. To catch the fish, the villagers, linked together by a cord, form a semicircle on the seaward end of the reef; then, moving shoreward they drive the fish toward the net which acts as a trap. The villagers work the fish toward the net by pounding the sea floor with sticks. The whole operation takes about an hour.

Communal fishing of this kind is usually carried out on special occasions and is primarily for subsistence purposes.

Fishing on reefs at low tide is dominated by women mainly relying on hand collection methods. This form of 'reef collection' is carried out both by individuals and small groups of women. The main activities are digging for mussels and other shellfish and collecting crabs, giant clams, crayfish and seaweeds.

Communal fishing by women is also carried out on shallow reef waters using nets. Nets of different sizes can be used and the number of participating women—usually organised in pairs—can vary from 12 to 60. The largest nets used measure up to 4 metres long and just over 3 metres wide and are slung between two poles, affixed at each end. To catch the fish, the women form a line at the deep end of the reef, holding their nets horizontally and somewhat below the surface of the water. The women then slowly move toward shore, forming a circle and sweeping the fish as they move in with their nets, forming a trap. The fish are caught by raising the nets and closing the sides off so as to prevent possible escape. The catch is shared among the women along traditional lines.

Fishing along basically communal lines is also undertaken by so-called rural fishing groups. These fishing groups operate in cooperatives in which members have to pay fees to join, and directors and other executive officers are appointed (Iwakiri, 1983, p. 138). The members of a fishing group are normally drawn from the same village or *mataqali* but participation by people from neighbouring villages is common. Fishing is directed mainly at supplying local markets and the value of the catch of a particular group can be substantial. Up to 30 such fishing groups are believed to be in operation.

Institutional aspects

In addition to the Fisheries Division, several other institutions and agencies are playing a key part in developing Fiji's fisheries resources, including those on customary fishing grounds. These other agencies include the Native Land and Fisheries Commission, the Divisional Commissioners and village wardens.

The Fisheries Division of the Ministry of Primary Industries is the principal official organ responsible for fisheries development—subsistence, artisanal, large-scale commercial and aquaculture. The Division's work is organised into three key units: resource assessment and development, technical services (including training and boat-building) and extension services. Part of the resource assessment task is the compilation of production data by various fisheries categories, and the Division is also responsible for the registration of fishing vessels and the issue of fishing licences. Upon request, the Division will carry out resource assessment surveys on customary fishing areas and make recommendations for the Native Land and Fisheries Commission.

The Native Land and Fisheries Commission was established soon after the passage of the Fisheries Ordinance in 1942 and operates under the Ministry of Fijian Affairs and Rural Development. The Commission is responsible for the identification and division of customary fishing boundaries of individual tribal claimants,

regulations over these areas and, in general, for protecting the interests of Fijians in relation to their ancestral rights. The commission is guided by the tribal groups in setting boundaries, which, prior to registration, need to be approved by these groups.

The Native Land and Fisheries Commission plays a key role in resolving disputes over fishing boundaries and can call on other agencies, including the Fisheries Division, for assistance. As a result of the commission's work to date, all tribal fishing grounds have been identified or are in the process of being identified before the point of registration.

The District Commissioners play a key role in the application process associated with fishing on tribal fishing grounds. The commissioners have the power to grant a fishing permit once the request has been approved by the chief or chiefs acting on behalf of the tribal group on which the fishing area is located. Under existing legislation, the commission has power to approve (or veto) such requests and, in this respect, can seek the advice of the Fisheries Division which is responsible for issuing the fishing licence once a permit has been approved.

The appointment of fish wardens is provided for under the Fisheries Act (1978). Wardens are appointed by the Minister of Primary Industries, usually following a request by the tribal group. The responsibility of wardens is to detect and prevent offences under the Act. Their duties include the patrolling and policing of the customary fishing areas of their communities, particularly to ensure compliance with licensing requirements and other conditions that may be attached to the licence. However, wardens have not been effective in carrying out their functions, a reason for this being that in many cases wardens—as honorary officials—have not been provided with funds to offset their expenses.

Clam culture—prospects and possible approaches to development

Fiji offers considerable scope for the development of clams as a major mariculture project, both subsistence and commercial. The country, which is one of the largest island groups in the South Pacific, offers a rich variety of physical features that are favourable to clam culture. Given Fiji's archipelagic spread, the country has considerable areas of reef, lagoons, shallow shelf areas and numerous islands of varying size that offer opportunities for clam mariculture. It is also apparent that the supply—and present stocks—of clams in Fiji has been reduced to extremely low levels as a result of overexploitation in recent years. For these reasons alone, the case for regeneration and expansion of supply is compelling.

It is also apparent that, properly approached, a major clam project has a good chance of being smoothly integrated into the traditional social and economic life of Fijian villagers (see Tisdell 1986, p. 93). Among the various reasons for this are prospects that the project will enhance the availability of clams for subsistence consumption, and villagers can develop a commercially viable project based on the

adaptation of their traditional skills. Prospects of integration are probably best for projects initiated and developed by tribal groups themselves, but externally initiated projects can also be approached in such a way as to minimise the disruptive effects on the village.

Efforts to develop a major clam project in Fiji—whether subsistence or commercial—can be a matter of some complexity, given the nature of existing reef tenure. Key issues that have to be faced and resolved include the formal leasing of project sites, licensing requirements, negotiations with tribal groups over the use of customary fishing grounds, and meaningful ways of involving villagers in the project. The process of development calls for close cooperation between key government organisations, including the Fisheries Division, divisional officers and tribal groups ranging from paramount chiefs to heads of *yavusa* and *mataqali* chiefs. It also calls for close collaboration with local villagers to ensure policing and to prevent encroachment into project sites.

Insofar as the legal requirements are concerned, the fact that ownership of the offshore areas and seabeds is vested in the Crown means that a lease over the site chosen for a project must be secured from government. This requirement also applies to a few small privately owned sites (e.g. Mago Island in the Lau group), since private ownership does not extend to property rights on marine space (Tisdell 1989, p. 86). Lease arrangements relating to seabeds on foreshore areas are provided for under the Crown Lands Act and require that anyone whose rights are infringed is adequately compensated (Adams 1989, p. 3). An essential step in lease negotiations is to obtain the consent of the tribal group whose fishing areas are the subject of the lease. In addition to a lease, a fishing licence and permit are needed. A licence for mariculture as such cannot be issued. Both the lease and the fishing licence (and permit) provide a basis for exercising exclusive rights over these fishing resources, and for taking safeguards against poaching.

Under present legislation, no recognition is given to the right to own organisms under mariculture. Strictly speaking, ownership of the mariculture organisms is vested in the Crown (and fishing rights with tribal owners). As such, mariculture operators are not legally entitled to the product of their efforts, which is clearly a major disincentive to investment in mariculture. There is therefore a need to revise the law to allow mariculturalists to own what they grow and to establish a new permit system covering mariculture.

For reasons noted above, Fiji offers a wide range of possibilities for the development of a major clam project. The evidence suggests that, because of differences in natural conditions within Fiji, some locations would be better suited than others. For example, particularly favourable natural conditions for clams are believed to be present on many islands of the Lau Group, which lies on the eastern side of Fiji. The Lau Group comprises many islands of varying size, with considerable areas of reef and lagoon. Another factor that will tend to influence the choice of a suitable site is whether or not fishing rights on a particular area are under dispute. Current efforts to clarify the customary fishing grounds of particular tribal and village groups have brought many disagreements to the surface, particularly

over boundaries. It may be many years before such disputes are resolved. Such disputed areas should be avoided.

Assistance on the selection of possible sites can be obtained from the Fisheries Division, which can advise on an area's natural suitability and whether it is under dispute. As regards the latter, the Native Land and Fishing Commission can also be consulted.

Few precedents exist regarding lease negotiations for mariculture. Such a process calls for the outside developer to approach the tribal owners of the fishing rights for consent. As noted, the appropriate tribal authorities, who represent the owners, are the heads of tribal groups, and for purposes of consultation and negotiation they may be approached through the Fisheries Division and the district commissioners.

The appropriate tribal authority differs from one part of the country to another, depending on the prevailing chiefly structure and distribution of power and related factors. In some cases—for example, in many of the Lau Group of islands—it is customary for negotiations with local tribal groups to be preceded by consultation with the paramount chief of those islands (presently the Prime Minister, Ratu Sir Kamisese K.T. Mara). However, in most cases, the relevant authority is the head of the *yavusa* or the chief of the *mataqali*. In these negotiations, it is common to mark the occasion with a traditional ceremony such as the drinking of *yagona* and the presentation of symbolic gifts (notably the *tabua* or whale's tooth).

Apart from the formal requirements associated with gaining access to the use of reef areas for mariculture, it is also essential to secure the support of the local villagers. The support and cooperation of local villagers is vital for the successful implementation and operation of the project. Among other things, local people can be most effective in policing the project site and they can be expected to refrain from disturbing clam beds. Their knowledge and expertise about traditional forms of clam culture and conservation, as well as of the local marine environment can also make a significant contribution to the project.

Meaningful participation by local villagers can take a variety of forms and can include some kind of joint venture, the appointment of local leaders as supervisors and advisers as well as other informal arrangements. Specific forms of participation can be worked out with villagers and tribal leaders, but the main requirement is to gain the support of the villagers so that they will feel that the project is in their interest and will bring them tangible benefits.

A possibly useful precedent for Fijian involvement in mariculture projects is provided by a seaweed farm that was recently established in Kasavu Village, Vanua Levu. This farm is a commercial venture involving Australia, New Zealand and Fijian ownership. Active local participation is represented by the appointment of the village chief to the board of directors and the fact that up to 30 villagers are employed on the farm, part-time. (It may be of interest to note that, unlike giant clams, no fishing licence is required to harvest seaweed—seaweed does not exist in a legal sense as this product is not covered by the Fisheries Act.)

The protection of clam project sites against poachers can be largely achieved by securing the cooperation of villagers, as noted earlier. Failing that, or by way of complementing and reinforcing such cooperation, a traditional form of sanction—the so called *tabu*—can be used as a form of control. Under *tabu*, tribal chiefs can prohibit villagers from intruding or interfering in project activity. In its application the *tabu* can be directed at prohibiting different kinds of activity on and around the project site, for example, the taking of clams, fishing of any kind, and entry by villagers. *Tabu* is normally applied to meet short-term needs but can be imposed serially where a project such as clam mariculture calls for a longer period of protection.

Tabu has recently been used on a number of occasions to protect offshore fisheries resources. In 1975, it was used to prohibit commercial fishing on Suva Harbour which had been depleted by overfishing. Similarly, in 1987, a *tabu* was applied under government instigation to the northern area of Makogai Island, as a step toward converting the area into a marine life park. In both cases, *tabu* proved to be a valuable initial step in the protection of resources, that was followed-up by supporting legislative measures (for example, under Regulation II of the Fisheries Regulations applying to the classification of restricted areas).

It appears that the *tabu* can still play a valuable role in the development of clam culture, as with other mariculture projects. This role is thought to be particularly useful in rural and outer island communities, where Fijian custom and traditions are still powerful forces. It is likely to be highly respected by Fijians where proper regard for traditional ceremony has been observed, including the serving of *yagona*. The value of *tabu* lies in the fact that it can be applied quickly, is still respected by Fijians and can be imposed for specific purposes and for specific periods (normally up to a year). It has so far proved a useful means of controlling fishing activities pending the preparation of more complex legislation.

Conclusion

Fiji's extensive reef and lagoon areas offer considerable scope for clam culture and other forms of mariculture. However, efforts to establish a major clam project, especially on a commercial basis, can be complicated and need to be handled carefully. The main source of complication relates to the system of property rights on offshore waters, which is characterised by Crown ownership of these waters (including seabeds) alongside tribal ownership of fishing rights on so-called customary fishing grounds. These fishing grounds, which cover nearly all reef and lagoon areas, are highly fragmented, with fishing rights divided among different tribal groups. It is essential for the establishment of a clam project to secure the consent of tribal and village groups for mariculture activity on their fishing grounds.

Assistance in identifying a suitable project site and in negotiating with tribal groups can be obtained from the Fisheries Division, the District Commissioners and the Native Land and Fisheries Commission. Regarding possible project sites, the smaller outer islands, such as those in the Lau Group, appear to have many

attractive features for clam development including small (human) populations. A factor to be considered is whether or not a particular area is under dispute.

A key requirement for a successful clam project is to secure the support of local tribal and village groups both to gain initial access and to ensure successful project implementation and operation. Local villagers can be particularly useful in policing project sites, while local leaders can contribute meaningfully to the project through constructive involvement, possibly at supervisory and managerial levels.

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10 Reef and Lagoon Tenure in the Republic of Vanuatu and Prospects for Mariculture Development

T'eo I.J. Fairbairn

Abstract

Property rights to the Republic of Vanuatu's extensive reef and lagoon areas are held by traditional land owners. Current legislation confers on indigenous customary owners of land, ownership and usage rights of areas extending out to the ocean side of offshore reefs, although in practice, many villages claim rights over sea areas that extend beyond the legal limit. In effect, therefore, reef areas are seaward extensions of land over which landowners—usually those adjoining the reef—can claim ownership. Notwithstanding individual ownership rights, reefs and lagoons remain predominantly common property where all members of a given village are free to carry out fishing and related activities. However, overall control of village reef and lagoon areas is usually the responsibility of the village council, comprising village chiefs and elders and, in some cases, an area council composed of leaders from several villages.

Vanuatu is endowed with many reef and lagoon sites that appear suitable for the development of clam and other forms of mariculture. In effect, to develop a major mariculture project, whether commercial or predominantly village subsistence, a developer would need to approach the appropriate village authorities to seek approval of a project. In the case of individual villages, these authorities are normally the village council and chiefs and the individual reef owners. The approval by these authorities will ensure acceptance of the project by the village as a whole, as well as its cooperation during project implementation. Adopting the right approach in explaining the nature of the project to villagers and proof of the project's viability are vital prerequisites for success in winning local support. Equally important, as emphasised by many village leaders interviewed, is the need to draw up an agreement between the host village and the developer, laying out specific project objectives, mode of operation and terms and conditions of the project.

Background

The Republic of Vanuatu is situated in the western Pacific Ocean, between 12° and 21°S latitude, and 166° and 171°E longitude (Map 1.1). It is a Y-shaped archipelago

comprising 80 islands, extending about 800 km, north to south (Map 10.1). The land area of the group totals 12000 km² and its closest island neighbours are New Caledonia to the south, Fiji to the east, and Solomon Islands to the northwest. From Efate island, Vanuatu's main island and administrative centre (Map 10.2), the distance to Sydney (to the southwest) is around 2250 km.

Population is currently an estimated 143000 and is expanding at an average rate of 2.9 per cent annually. Indigenous Melanesians — Ni-Vanuatu — comprise 94 per cent of the total, the remainder being European, Chinese and other Pacific islanders. Over half of Vanuatu's population is located on three islands: Efate with around 30000, Espiritu Santo with 28000 and Malakula with 20000.

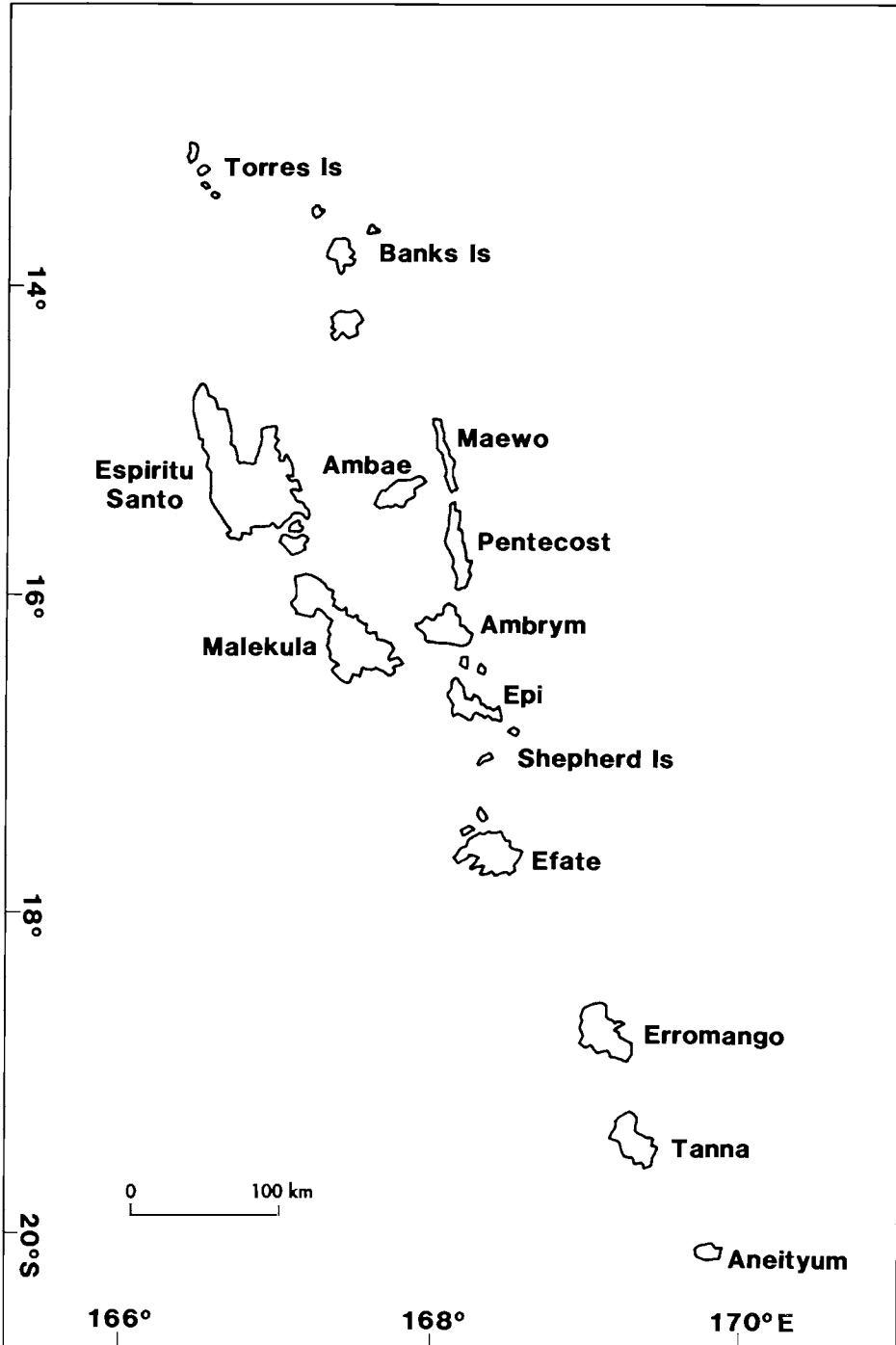
Vanuatu has a dual economic structure with a substantial subsistence sector co-existing with the modern cash economy.

The proportion of the population that depends, to some degree, on the traditional subsistence economy is estimated at 80 per cent. The cash economy is dominated by primary activities, notably copra and beef, and by services such as government and tourism. Gross national product is estimated at US\$850 per capita.

Copra is the leading export product and, in 1988, the value of this product totalled US\$9.0 million, equal to 45 per cent of total export earnings. Most of the remaining export earnings are accounted for by beef, cocoa and forest products. Like most other Pacific island countries, Vanuatu has, in recent years, recorded considerable trade deficits in its balance of payments, with the cost of imports far exceeding export earnings. These deficits have been largely offset by development assistance receipts. Beef and copra, with coffee and cocoa, hold the greatest potential for expanding exports.

National development planning was inaugurated in 1982 and the country's second national plan, covering the period 1987-1991, was published recently (Government of Vanuatu 1990). This latest plan lays out a set of development objectives, strategies and programs for implementation during the plan period, as well as the leading constraints that have to be overcome. The plan's major objectives are to:

- achieve an increased degree of economic self-reliance based on natural resource development;
- accelerate human resource development for increased Ni-Vanuatu participation in, and control of the economy;
- increase productive utilisation of the country's natural resource base as a means of generating viable and sustained economic growth;
- achieve more even patterns of regional and rural development (Government of Vanuatu 1990, p. 7).



Map 10.1 The Vanuatu archipelago.

Fisheries, both coastal and oceanic, are viewed as a major area for development. According to the development plan, government policies in fisheries are:

- to maximise fisheries' contribution to the economy;
- to stimulate increased production for both domestic and overseas markets;
- to lessen the dependence on imported canned fish (Government of Vanuatu 1990, p. 246).

These objectives are to be realised primarily by tapping the fisheries potential of outer reef slopes and ocean as well as that of reefs, lagoons and rivers.

Responsibility for implementing government policy in fisheries lies with the Fisheries Department, established in 1978, which is part of the Ministry of Agriculture, Forestry and Fisheries. The department's work (Government of Vanuatu 1989) to date has largely focused on efforts to:

- establish coastal fisheries as a commercially viable activity;
- determine resource availability;
- promote technical training;
- improve fishing techniques; and
- investigate certain aquaculture possibilities.

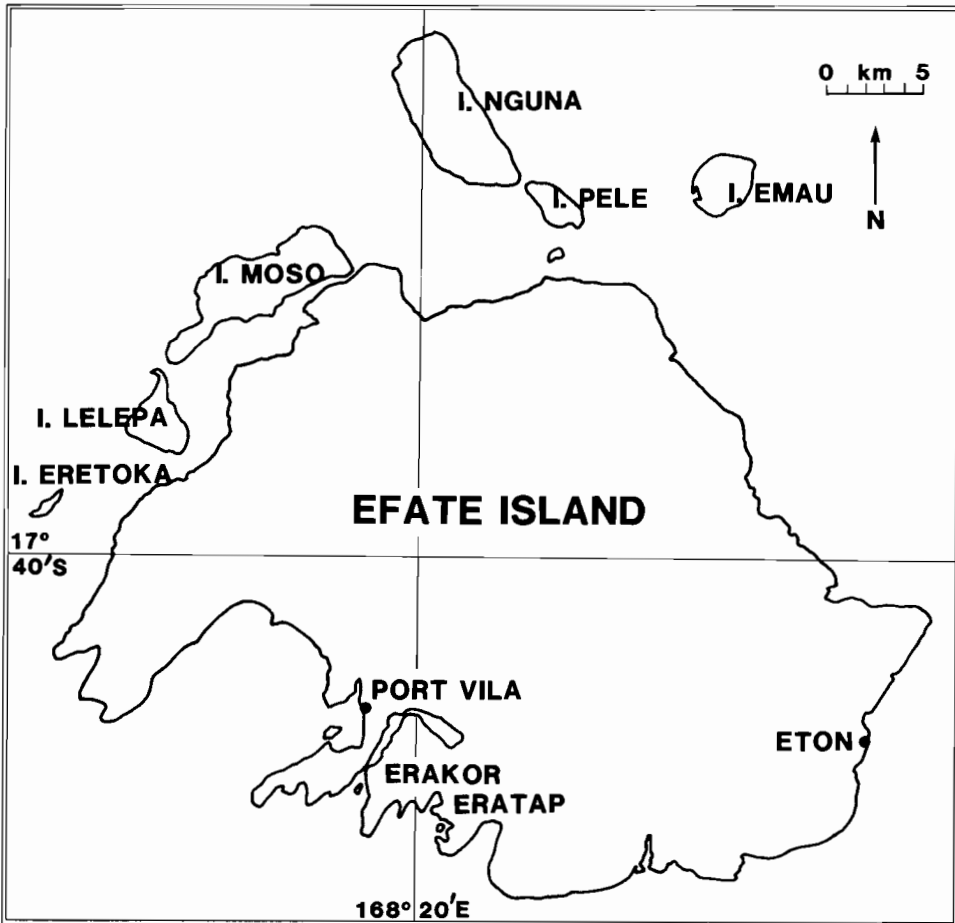
Prominent in the Department's work to date have been efforts to promote a Village Fisheries Development Programme (VFDP) in an attempt to foster commercial fishing among rural communities. Insofar as aquaculture is concerned, in practice, efforts to realise its potential have been limited. The current development plan (Government of Vanuatu 1990, Vol. 1, p. 252), draws attention to past failures in attempts to culture oysters and to develop a small-scale shrimp farm on Efate under private initiative. Present involvement in aquaculture on the part of the Fisheries Department is restricted to the maintenance of a small trochus hatchery at its headquarters in Port Vila, although the Department has recently recruited an aquaculture officer. Serious efforts to promote other forms of aquaculture, including giant clams, have yet to be made.

The trochus hatchery has only recently been established under a small grant from FAO. It is essentially a pilot project undertaken as part of a region-wide program to foster trochus. The aim of the project is to establish a regional hatchery from which trochus seedlings can be made available to interested island countries. Present facilities are limited to two breeding tanks.

Useful information on Vanuatu's marine resources has recently come to light which may provide a basis for a more active effort to promote aquaculture in the country, including giant clam culture. The information is contained in a recent publication entitled, 'The Marine Resources Survey of Vanuatu' (Done and Navin 1989) and represents the results of surveys on selected reef sites by a team working under the auspices of the Australian Institute of Marine Science, Townsville. The survey results relate to a variety of reef aspects, including coral reef and seagrass

beds, benthic communities on coral reefs, availability of bêche-de-mer, extent of crown-of-thorns starfish infestation, and the status of giant clams.

In relation to giant clams, the survey found that only *Tridacna maxima* was common to all island sites surveyed (13 in all) but that the stock of other giant clam varieties was patchy or absent (Zann and Ayling 1990, p. 95). The survey recommended that measures be taken to reintroduce *T. gigas*, which was found to be virtually extinct, and to protect stocks of *Hippopus hippopus*, which had apparently been heavily exploited.



Map 10.2 Efate island, Vanuatu's main island and site of its administrative centre, with offshore islands. This map indicates the general location of Eratap, Erakor and Eton.

The purpose of this chapter is to describe reef and lagoon tenure in Vanuatu and associated traditional forms of sharing arrangements. I have relied heavily on the results of field visits in May 1990 to three villages—Eratap, Eton and Erakor—on Efate to collect basic information. In each village discussions were held with local chiefs and elders.

Eratap village is located about 20 km southwest of Port Vila. The village has a population of 300, divided into four clans with a head chief and four 'assistant' chiefs. Eratap's economy is based on copra and cocoa and the sale of fish and trochus to the Port Vila area.

Eton lies on the southeast coast of Efate about 45 km from Port Vila. With a population of 250, the village has a single clan and one chief. Copra is the main crop, supplemented by the sale of fish, trochus, green snail and lobsters.

Erakor has a population of around 1250 and is one of the largest villages of Efate. The village lies a short distance south of Port Vila and is within the Port Vila urban boundary. There are four clans, but only one chief, and the village economy depends heavily on wage earnings derived from Port Vila, and on fishing and the collection of crabs and lobsters.

The legal framework

Ownership of reef areas in Vanuatu resides with the customary owners of land. This pattern of ownership is formally enshrined in the country's Constitution adopted in 1980 (with the advent of independence). According to the Constitution (Government of Vanuatu 1980a), all land in Vanuatu belongs to customary land owners, and this ownership carries with it the right to own adjacent reef and other near-shore areas (see Sections 71 and 72 of the Constitution). According to the Land Reform Regulation (No. 31) of 1980 (subsequently embodied in the Land Reform Act, see Government of Vanuatu 1988(a)), 'land' is defined to include: 'improvements therein or affixed thereto and land under water including land extending to the sea side of any offshore reef but no further' (Government of Vanuatu 1980b, p. 4). This means that customary ownership of land legally extends to the outer edges of fringing reefs.

Fishing rights on reef and lagoon areas are governed by custom. However, in practice, although ownership resides with customary land owners, reef and lagoon areas of a village are open to all members of that village for fishing and related purposes.

Ownership of mineral (including oil and gases) and other inorganic materials is not clear, but they can be presumed to belong to the state. This presumption follows from the interpretation of land under the Land Leases Act of 1983 (No. 4) which defines 'land' as: 'land above mean high water mark but does not include minerals and other workable and removable substances' (Government of Vanuatu 1983, p. 2).

Matters pertaining to fisheries development in Vanuatu fall under the Fisheries Act (No. 37 of 1982). This Act provides for national 'control, development and management of fisheries in waters over which Vanuatu has established fisheries jurisdiction' (Government of Vanuatu 1982, p. 1). These waters apply to the various territorial zones lying within the country's exclusive economic zone. The Act is primarily concerned with the control and development of commercial fisheries, both local and foreign, and with licensing requirements. It makes no specific provisions for mariculture or other forms of aquaculture development.

However, the Act provides for the Minister of Agriculture, Forestry and Fisheries to regulate activities on reef and other near-shore areas. This is contained in Part 4 (General) of the Act conferring upon the Minister power to make regulations in various areas of fisheries not inconsistent with the Act (Government of Vanuatu 1982, p. 13). Section (m) of Part 4 of the Act refers to aquaculture development as well as the taking of coral, the setting of fishery fences, and the taking of aquarium fish. Insofar as actual regulations relating to aquaculture development are concerned, it appears that, to date, no such regulations have been promulgated.

Reef tenure and property rights

As previously noted, all coastal areas extending to the outer edge of fringing reefs belong to indigenous customary owners of land. This ownership pattern derives from ancient custom and has more recently been formalised in the country's Constitution and in a variety of land legislation. Such ownership implies recognition of the rights of individual landowners on reefs and lagoons, and village-wide ownership of the right to fish and to undertake related activities on these reef areas. On the latter aspect, this right amounts to the exercise of common property rights by all members of a village on customary reef areas and lagoons of his or her village.

While the ownership rights of customary owners in a village are formally recognised, the precise reef areas over which these rights apply are not always clear. Ownership rights are most clear-cut in cases where authority over village land is held by a single person, who is often the head chief. In this case, the entire reef area falls under the control of a single owner. Reef ownership is also unambiguous in isolated coastal locations where a single landowner controls the adjoining reef. Such an owner need not necessarily be a chief. Ownership of reef and lagoons is least straightforward in areas characterised by multiple reef ownership reflecting possibly complex land ownership patterns. Particular difficulties can arise in villages where land and reef ownership is under dispute.

Formally, reef and lagoon areas over which customary ownership prevails extend from the shoreline to the outer edge of fringing reefs. However, many villages lay claims to sea areas that lie beyond these boundaries—out to the 'horizon'. Such claims are often associated with sea areas that lie between the reefs of a particular village and those of a nearby offshore island.

Several instances of villages claiming additional sea areas toward the horizon came to my notice during fieldwork. At Eton village, for example, respondents informed me that the village's seaward boundary was taken as the outer edge of the fringing reef plus an additional 50 metres. At Eratap village, the villagers claimed the reef areas up to the reef edge (a distance of around 200 metres) plus an additional 100 metres beyond, an area which contained four small offshore islands (Eratap, Emal, Ekadum Lep and Ekadum Rik) belonged to the village. On Uripiv island, lying offshore on the northeast side of Malakula island, the six villages on the island owned land on the nearby island of Uriv and therefore were able to claim sea rights beyond the reefs of the home island. The establishment of village claims beyond the reef dates back to antiquity and, no doubt, was influenced by the particular circumstances of each village. Such factors can only be guessed at but may include: the pressure of population on existing reef areas, narrow reef zones and a capacity to exploit deep sea resources.

Insofar as the lateral boundaries of village reef and lagoon areas are concerned, in most cases it appears that such boundaries are fairly well established and have been determined over time through customary means (including warfare). Essentially, such boundaries are normally set where the land owned by one village gives way to land owned by another. However, the legal standing of these customary reef boundaries is not clear and, in some cases, these boundaries have come under dispute, possibly because of a lack of precision of customary means of demarcation.

As most villages in Vanuatu lie some distance away from neighbouring villages, these lateral boundaries often extend well beyond the immediate vicinity of the main village settlement. For example, at Eton village, the lateral boundaries of its customary reef area extends over an estimated distance of 35–40 km on both sides. For Eratap, the lateral extension of reef area is 20 km in one direction and 5 km in the other.

In Vanuatu, as is common with many other South Pacific countries, readily identifiable natural objects are used to demarcate land and reef boundaries. In the case of reef areas, the kind of natural objects commonly used have been pointed out by Iwakiri (1983) and Fairbairn (1990), among others. An example that emerged during my field visit to Vanuatu was that of Eton village, whose land and reef boundaries were represented by large rivers on either side of the village.

The reef and lagoon areas of some of Vanuatu's small offshore islands are characterised by an absence of designated reef zones under the control of individual villages. In such cases, the entire reef areas surrounding the island are common property in which all island residents can fish regardless of which village they come from. An example is the small island of Uripiv noted earlier; here the residents of the five villages on Uripiv can fish anywhere on the surrounding reefs.

The customary authority (or authorities) in each village that can exercise overall control over reefs and lagoons and associated resources is not always apparent, and there appear to be significant differences throughout the country in the manner

in which reefs are controlled and managed at a village level. However, in general, the exercise of this function involves several entities and groups, notably the village council, the local chief (or chiefs), and the landowners. In some cases, an area council—a body of village leaders representing several villages—also plays an important role. Apparently, it is not always easy to determine how much power over reef matters is exercised by each of these groups and some overlapping and blurring of authority is evidently quite common. In general, however, the paramount authority is the village council.

As the traditional head of a village, the chief still plays a significant role in village life. He, along with lesser chiefs (commonly referred to as 'assistant chiefs'), is still the leading figure and authority in the village council, which is a group composed of chiefs and other village elders who act as a kind of local government body at the village level. On matters relating to reef and lagoon usage, the principal chief can still exert considerable influence, either as an individual or through the village and area councils and, in practice, he is often the dominant influence. The authority of the chief (or chiefs) can be particularly strong where he himself is a substantial landowner and with similarly substantial claims to reef areas. For example, the principal (and sole) chief of Atavoa village on Ambae island owns all land on that village and, consequently, claimed ownership of the entire reef area of that village.

In almost all cases, the village council is the principal custodian of reef and lagoon areas among village communities. In general, the village council exercises authority over the overall use of reefs and lagoons, including any major commercial development that may be envisaged. The authority of the village council, in some cases, also extends to 'customary' sea areas that the village may have claimed beyond reef and lagoon zones, as noted previously. Aspects of reef usage and development that normally fall under the jurisdiction of a village council include: the imposition of fishing bans (*tabu*) on village fishing grounds (perhaps, for conservation or restocking purposes); settling disputes with neighbouring villages over poaching and related matters; enforcement of fishing regulations imposed by government; and control over the exploitation of reef materials and beach sands. As discussed later in this chapter, the village council is also the key group for handling matters relating to the granting of fishing rights to outsiders and for negotiating leasing arrangements for the use of village reefs.

Area councils can also play an important part in determining reef usage and development, especially where the interests of several villages are involved. According to respondents, the support of an area council is crucial in certain areas of reef developments. Thus, at Erakor village, respondents pointed out that village support for a major mariculture development on its reef and lagoons would depend on the reaction of its area council. In this case, the supremacy of the area council was somewhat unusual but arises from the fact that, because of its size, Erakor village was large enough to justify the formation of its own area council.

The special rights of customary landowners whose land adjoins the reef have been noted, rights that are recognised by both custom and legislation (although many such customary areas are currently under dispute by rival claimants). These

include the right to lease reef sites belonging to them, normally subject to approval by the village council (and possibly the area council) and chiefs. In many cases, they may also include an exclusive right to use sea areas close to land for special purposes including the mooring of fishing crafts, the erection of fish traps and the establishment of breeding areas for clams and other shellfish. They may also lay claim to the ownership of sand and other useful materials that may be found on their reef area.

Fishing on reef areas of each village is restricted to the people of that village who, in general, enjoy equal rights in these waters. Fishing by neighbouring coastal villagers is disallowed, although, there is apparently some flexibility on this matter. Should people from neighbouring villages wish to fish on the customary reef areas of another village, they must first inform the reef-owning village and, in most cases, must secure the permission of the village council. It also appears that reciprocal arrangements are sometimes made between adjacent villages allowing inter-village fishing, but these arrangements now appear to be rare.

Permission authorising outside fishing is normally a matter for the village council. Whether or not the council decides to grant permission depends on many factors, which may include: a wish to assert and reinforce a village's authority over its reef resources; the need to enforce any village regulations that may have been made to control fishing activity; and the need to promote the conservation of reef resources. A council may also be influenced by commercial considerations, for example, the wish to extract some financial benefit from outside exploitation of its reef resources.

Villagers are becoming increasingly aware of the commercial worth of their reef resources. At Erakor village, for example, I was told that outsiders are not allowed to fish unless permission has been granted and a fee paid. This applies not only to fishermen from neighbouring villages but to outsiders in general. Thus, at the time of my visit, Erakor was hosting two outside fishermen: one from the island of Malakula, who was fishing for *bêche-de-mer*, and another from Pentecost, who was collecting trochus. The former was being charged a fee of 12 000 vatu per year and the latter 2000 vatu per year.¹

The enforcement of village bans on fishing by neighbouring villages is not without difficulties owing to the often extensive spread of a village's customary reef waters. Villagers now employ a variety of means to discourage poaching on their reef areas. Thus, both Eton and Erakor villages regularly use the radio as a means of warning others against fishing on their reef areas. Public notices are also installed, usually on adjacent land borders, for the same purpose.

Where encroachment does occur, the offender is told to leave. However, where infringement is considered serious, it is likely to be brought up before the village council and, possibly, the area council, for resolution. A final resolution may call for compensation by one village to another, possibly based on traditional means such as the presentation of pigs and kava.

¹In 1990, \$A1 = ca. 90 vatu

Many villages on Vanuatu are located inland without direct access to reefs, and this situation and its implications for reef tenure and fishing rights is not without interest. In general, such villages have no claims to fishing rights on coastal areas but, in practice, many have gained access by coming to an understanding with the people of the coastal village or by some other means.

In some cases, access to coastal waters derives from kinship connections which are sometimes associated with the fact that the inland village was originally settled by people from the coast. Here, traditional rights to fish on customary reef areas have been maintained despite the change of location. In most cases, however, the right to fish on coastal waters is one that has been developed from traditional times and perpetuated by the ability of these villages to stay on good terms with one another.

Maintaining such a relationship calls for the observance of various customs, usually involving a payment for the right to fish. This payment normally takes the form of a presentation of traditional gifts such as pigs, kava, taro and other valued items.

A variety of other reciprocal arrangements is also found. One such arrangement that came to my notice was in Tanna where some of the coastal villages permit fishing by people from inland villages in exchange for the right to hunt on land belonging to the inland villages.

Sharing arrangements

Fishing in Vanuatu is largely undertaken on an individual basis. It appears that group or communal fishing was never a strong tradition in Vanuatu as compared with many other Pacific island countries such as Western Samoa and Fiji. Such group fishing as did occur in the past has probably been weakened over time as a result of increasing contact with the monetary economy. However, several instances of group fishing came to light during fieldwork. Such fishing usually involved small groups of from two to five people, and is frequently undertaken on special occasions.

As practised at Eton village, fish trapping takes place in rock pools found on reef platforms, and involves from two to five men. The fish trap is formed by pieces of old cloth held together by tree branches and implanted with poles on the reef floor. Fish are trapped as the tide recedes and then stunned for catching by applying a poison made from a local vine. The catch is shared among the participants.

Institutional aspects

Fisheries department

The Fisheries Department plays a key role in the development of commercial projects in fisheries and fish licensing. The department is responsible for servicing

fisheries projects for purposes of obtaining a fishing licence and for advising the minister in charge of fisheries on the merit of proposals. These projects may relate to fishing activities, processing and marketing. In carrying out this task, the department normally liaises with other ministries, including that concerned with business development. Where a proposal involves the use of land and reef areas, the Fisheries Department must also liaise with the Department of Land.

Under the Fisheries Act (Government of Vanuatu 1989), the Fisheries Department is responsible for issuing fish licences. The Act provides for the issue of two kinds of licences: a local licence and a foreign licence. A local licence applies to fishing boats over 10 metres in size and a fee of 5000 vatu is charged. In the case of a foreign fishing licence, government approval for the project is essential. The Government's decision is based on a recommendation from the minister in charge of fisheries. A fishing licence, whether local or foreign, has to be renewed annually.

The Fisheries Department is the key organisation for servicing enquiries on fishing prospects in Vanuatu and for providing basic assistance in the development of such projects. The particular functions involved are outlined later in this chapter.

Cooperatives

Cooperatives play an important role in the economy of Vanuatu and have the potential to play a useful role in promoting productive projects at the village level, including the development of clam mariculture. There are presently 180 cooperatives involved in retailing and in produce purchasing and marketing (e.g. copra and trochus). These cooperatives, typically having 20–50 members, appear to be particularly strong in remote areas, including outer islands. Turnover per cooperative is as high as 120 million vatu and most have been able to grant rebates to members on a regular basis. Some also have accumulated substantial cash reserves.

Four regional cooperative associations have been established (the first in 1987) to which individual cooperatives can belong. These associations are: Tanna, Ambrym, Malakula and Ambae. A national cooperative federation was founded in the 1970s but is not presently very active. Advisory services to individual cooperatives can be secured from the Co-operative and Rural Business Development office in Port Vila.

According to informants, cooperatives can play a useful role in the development of mariculture projects, including giant clams. This role stems from the fact that cooperatives are well organised and well run in many villages, and several have been able to accumulate substantial funds which could be invested in mariculture projects. Some of these cooperatives, for example in Santo and Malakula, are apparently looking for new areas in which to invest funds and diversify away from their core trading activities.

The Development Bank of Vanuatu

The Development Bank of Vanuatu provides a development loan facility which could be tapped for purposes of developing a major mariculture project. Any loan submission for such a project could be considered on its merit, and Development Bank support would be expected if the project were shown to be potentially viable. Bank finance can be made available to villages for purposes of acquiring an equity in the venture, given that villages usually lack other means for mobilising capital funds.

Giant clam mariculture: prospects and approaches

As with many other archipelagic countries, Vanuatu is endowed with reef and lagoon areas suitable for giant clam cultivation and related forms of mariculture. According to field respondents, the best reef sites for purposes of clam development are selected reefs on Espiritu Santo, the northern reefs of Efate (and also the eastern side of Port Vila), and several locations on Malakula. The reef areas of several small islands were said to provide an excellent natural environment for clams. These small islands include Banks Islands, north of Vanuatu, and the Shepherd Group on the east-central side of the country.

A suitable site for a major giant clam project, however, requires more than favourable reef or lagoon conditions. Other requirements include access to local population centres, reasonably good physical infrastructure (roads, airstrips, port) and the availability of basic services such as electricity and fresh water. For Vanuatu, the availability of a reef or lagoon area that is free of dispute among rival land owners is also important.

Several of the favoured natural locations noted above can be ruled out as possible major giant clam sites because of their extreme isolation and undeveloped infrastructure. This applies to Banks Islands and other remote locations which are disadvantaged by the absence of basic facilities. Difficulties can also arise in reef and lagoon areas close to Port Vila because of the heavy concentration of population and attendant pressure on these reefs.

Selected sites on Santo, northern Efate and Malakula perhaps offer the most attractive locations for mariculture development. All these areas have access to village populations as well as to transport and related services. On Malakula, two locations are said to be particularly attractive for clam development—Uripiv island on the north-east coast and the Maskelynes Islands on the south-east coast. As noted earlier, Uripiv is an offshore island with extensive bays and reefs between it and another adjacent offshore island (Uriv). The Maskelynes Islands consists of 10 offshore islands surrounded by large reef and lagoon areas. These islands lie only a short distance away from the main island of Malakula where port and air facilities are available (at Lamap).

The choice of a suitable project site can also be influenced by the pattern of land and reef ownership. From the viewpoint of negotiating a site, and even of managing the project at a later stage, there is some advantage in choosing a somewhat isolated bay area under the control of a single landowner. A further advantage can also accrue where only a single family, or at most a few families, live on the adjoining land. This situation can facilitate the policing of the mariculture project.

The development of a major giant clam, or other mariculture project for that matter, on the customary owned reef and lagoon areas of Vanuatu calls for a careful selection of project site and fulfilment of certain licensing requirements (Government of Vanuatu n.d). It also requires the developer to ensure that he approaches the village authorities in the proper way to obtain access to reef sites and to secure the cooperation of the village.

Assistance in choosing a suitable reef or lagoon site for a clam farm or other forms of mariculture can be obtained from the Fisheries Department. This department can assist in liaising with the village chiefs and village councils for purposes of discussing various aspects of a proposed project, including technical and financial aspects, the extent of village interest, and areas of possible participation by villagers. The Fisheries Department can also assist a developer in matters relating to land and reefs (e.g. seeking clarification from the Ministry of Land whether the reef area is under dispute), and in negotiating with village authorities over a lease (Government of Vanuatu 1989). In the case of commercial projects, the department can also facilitate the securing of a business licence from the ministry in charge of industries should it be decided to proceed with the project.

In setting the stage for a major mariculture project, a critical step is to have discussions with the village chief (or chiefs) and the village council (and, in some cases, the area council). It is essential to win the support of these village groups which are the owners and custodians of the reefs and lagoons belonging to a village. Winning this support calls for a developer to fully explain the purposes, rationale and operational features of a proposal, and to spell out how such a project could bring tangible benefits to the village.

The support of the particular landowner in whose reef area the project site is to be located is also essential. However, such support is likely to be forthcoming once the village council has approved a project.

Village leaders interviewed seemed to think that it would be necessary to draw up an agreement between the village and the developer setting out specific terms and conditions of a project. Such an agreement would specify project objectives, mode of operation, the extent of local participation, project duration and ways of compensating the village for the use of reef facilities. The leaders saw such an agreement as essential in order to minimise possible misunderstanding between the participating groups.

Any such agreement would need to give specific recognition to the claims of the village as a whole (as represented by the village council) and those of the owner of the project site. In practical terms, this might mean that fees paid for the use of reef

sites be paid to both the village council and to the individual owner. The respective claims to other possible benefits likely to flow from the project (e.g. employment) would also need to be covered.

It may be necessary to draw up a separate agreement with the reef owner: this will depend on the circumstances of each village. Such an agreement is probably necessary where a reef owner controls isolated reef areas and where he is expected to play a particularly active part in running and operating the project.

My discussions with villagers suggest that there was considerable interest in the possibility of establishing a major clam project in their villages. The indications were that local support would be given, provided that the viability of such a project could be demonstrated and that the expected benefits to the village appear as being both tangible and positive. On the kind of practical benefits they expected from a project, the villagers emphasised such aspects as the creation of employment opportunities, money incomes (including fees from leases) and the chance to restock and regenerate their reefs and lagoons.

It would appear, therefore, that if the right approach were adopted to promote the project among the villagers and if the project could be shown to be viable, the support and cooperation of the villagers could be expected. Adequate discussions with village leaders—through the village councils—to explain the nature and purpose of a project is particularly important. Apart from paving the way for project development, such cooperation is vital for the effective policing of project sites to protect them against encroachment from other villagers. As pointed out by one villager, once an agreement was reached with the village council, 'the village people will look after the project in the right way'.

Conclusion

In Vanuatu, the ownership of reefs and lagoons resides with indigenous customary land owners, as do the fishing rights on these coastal areas. The ownership and usage of these reefs and lagoons are governed by custom. Unfortunately, detailed information on customary forms of reef tenure and usage is not readily available but it does appear that reef tenure is characterised by considerable variation from one village to the next. However, in practice, it appears that while ownership rights on reefs reside with land owners (normally owners of adjoining land), the principal authority over village reef and lagoon areas is exercised by the chiefs and village councils and, in some cases, the area councils. For fishing and related purposes, the reef area of a village is effectively common property, in the sense that normally all members of that village can enjoy equal rights.

A vital requirement in efforts to establish a giant clam project, or any other form of mariculture for that matter, is to gain the support of the village council and chiefs, as well as that of the particular landowner who controls ownership rights over the reef area in question. Provided the proposed project is presented and developed in the right way, and is shown to be viable, the support of the village leaders and that of the village as a whole is likely to be forthcoming. From discus-

sions with village leaders on the possibility of developing a major clam project, much interest was shown in drawing up an agreement that would clearly set out terms and conditions, and what was expected from each party to ensure a successful outcome.

Acknowledgments

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11

Traditional Reef and Lagoon Tenure in Western Samoa and Its Implications for Giant Clam Mariculture

T'eo I.J. Fairbairn

Abstract

In Western Samoa, as with many other Pacific island countries (e.g. Fiji), the system of property rights on reef and lagoon areas is characterised by legal ownership by the state combined with customary ownership of fishing rights by indigenous village groups. These groups hold customary fishing and related rights over adjacent reef and lagoon areas to which all members of the group can enjoy relatively unrestricted access. Overall control of the customary fishing ground of a particular group is exercised by a village council or *fono*, composed of those who hold chiefly status.

Western Samoa is generously endowed with reef and lagoon habitats suitable for clam and related forms of mariculture. However, to gain access to such areas for mariculture purposes, it is necessary to obtain the consent of the villagers through their village council. Whether or not such consent is obtained appears to depend on the villagers' assessment of the nature and extent of the benefits that are likely to result from a mariculture project. Village support is essential not only to gain access to a project site but also to ensure continuing cooperation on the part of villages during the implementation and production stage. Particularly important is village support to prevent fishing and other forms of intrusion on the project site.

Introduction

Western Samoa is unusually well endowed with reef and lagoon areas suitable for giant clam and other forms of mariculture. These reef and lagoon areas are owned by the state but customary ownership of fishing rights is recognised and remains firmly entrenched. Samoan fishing rights over reefs and lagoons are based on customary usage of village fishing grounds and apply on an individual village basis. The responsibility for regulating fishing and related activities in these areas lies with the village council or *fono*, comprising the chiefly group of *ali'i* and *faipule*. Fishing rights can be exercised by all members of a particular village, subject to any restrictions that may have been imposed by the village chiefs (and central government).

Official efforts have been made over the years to promote giant clam cultivation, largely through the nurturing and distribution of breeding stocks to villagers. Attempts by a private sector group to cultivate giant clams on an offshore island—Namu'a Island lying off the east coast of Upolu—is currently attracting considerable interest, and is worthy of official support. Western Samoa has the potential for major giant clam development: it has ample reef and lagoon areas (most of them depleted due to overfishing in the past) suitable for such activity, while there is clear evidence of strong unsatisfied demand in the local market.

To gain access to reef and lagoon habitats for purposes of giant clam cultivation, it is necessary to obtain the consent of the village. This consent can be sought through the village *fono*, with possible assistance from the Fisheries Division, Ministry of Agriculture, Forests and Fisheries, and the resident village government agent—the *pulenu'u*. Support for a project can be expected to be forthcoming if the village leaders are convinced that it will bring about tangible and practical benefits to the village, although not necessarily in the form of direct financial benefits. Once village support is assured, customary forms of controls and sanctions are available and can be applied to ensure that villagers do not intrude on the project site and facilities.

Glossary of Samoan term

aiga	family, relative
aku	tuna (skipjack)
alia	twin-hulled fishing craft
ali'i	chief
atule	big-eyed scad
aumaga	group of untitled males
fa'amo'a	group fishing by women
faipule	district representative
fono	council, assembly for deliberation
lama	night fishing on canoes
malie	shark
mata	group fishing by men
Pulenu'u	government agent in a village
sa	a village edict or prohibition
talo	taro
tapu	sacred
tautai	master fisherman
to'ana'i	Sunday meal following church service
tuiga	group fishing practice

Background

Western Samoa is located in the Central Pacific region, between 13° and 15°S latitude and 168° and 173°W (Map 1.1). It is composed of two main islands—Upolu and Savai'i—and a number of small offshore islands or islets, some of them uninhabited (see Map 11.1). Land area totals 2935 km² of which Upolu accounts for 1113 km² and Savai'i 1726 km². The group lies approximately 2900 km northeast of Auckland and 4000 km northeast of Sydney. Western Samoa's closest island neighbours are American Samoa, the Kingdom of Tonga, Wallis, and Tokelau.

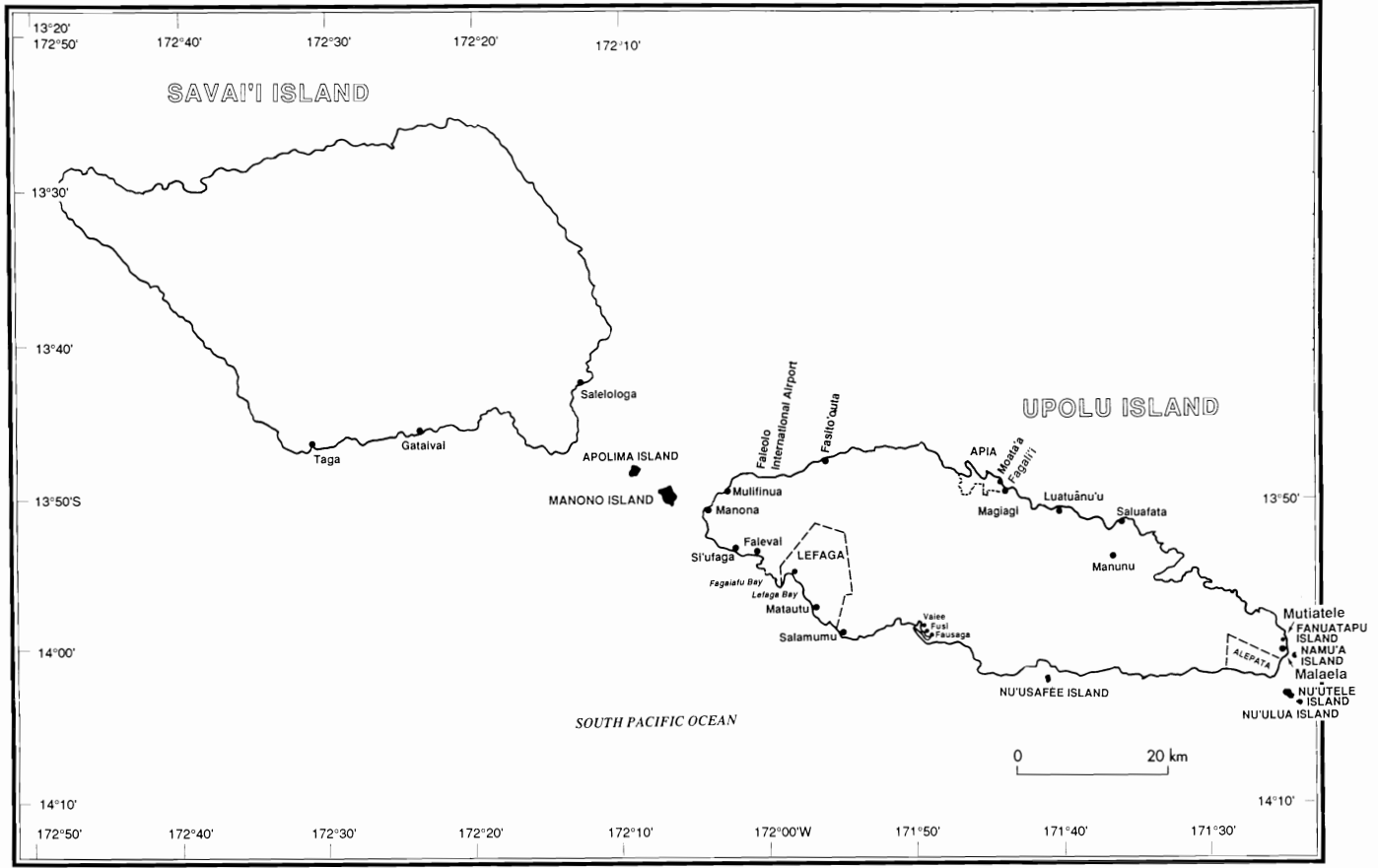
Western Samoa's total population is currently around 166000, of whom 76 per cent are found on Upolu and 24 per cent on Savai. Apia, the nation's capital and administrative centre, accounts for around 24 per cent of the total population, and the periurban coastal villages of northwest Upolu for another 24 per cent. The population is homogeneous, almost wholly of Samoan extraction. The natural rate of population growth is high (around 2.5% p.a.) but, due to heavy emigration, the actual annual growth rate is low at about 0.6 per cent. New Zealand and the United States are the primary destinations for Samoan migrants.

GDP is approximately WS\$200 million (1988) which is equivalent to WS\$700 per capita.¹ Economic structure is dominated by the primary sector—agriculture, forestry and fisheries—which accounts for half of both employment and GDP, and around 90 per cent of export earnings. The village subsistence component of the primary sector remains substantial. The services sector is large and dominated by government and tourism, while manufacturing is small, accounting for only 6 per cent of GDP.

Exports are dominated by coconut products in the form of oil, cream, meal and copra, and in 1988 these products accounted for WS\$18.3 million out of total export earnings of WS\$29.7 million, or 61 per cent. The only other significant export items are cocoa and taro. In common with many other Pacific island countries, Western Samoa's export earnings are usually substantially below the value of imports, giving rise to large trade deficits in the balance of payments. In 1988, while export earnings totalled WS\$31.4 million, imports were recorded at WS\$155.1 million, a shortfall of WS\$124.1 million. Such deficits have been possible only because of heavy inflows of private transfers from overseas kinsmen and external aid grants which, when combined, are usually large enough to offset the trade deficit.

Present development objectives, as outlined in the current development plan (Government of Western Samoa 1987, p.25), emphasise the need to achieve sustained economic growth as a means of realising improvements in the quality of life of all Samoans. Other objectives include: the attainment of greater national self-reliance; the widening of economic opportunities; and the protection of the natural environment. Growth strategy is based on the capacity to achieve increased agri-

¹In 1988 (Dec.) one Western Samoan tala was worth Australian \$0.54; at the time of my (Oct 1990) fieldwork the Australian equivalent was \$0.56.



Map 11.1 Western Samoa.

cultural production through improved productivity and product diversification, and also relies on realising the development potential of fisheries, tourism and light manufacturing.

Fisheries is a major component of the Western Samoa economy, particularly at the rural village level, and the potential for future development appears to be considerable. A major potential lies in a more intensive exploitation of the outer reef waters of the country's Exclusive Economic Zone (EEZ). Although the EEZ is comparatively small (approximately 120000 km²), it is apparently relatively well stocked with tuna, mostly skipjack. There is also a significant potential for exploiting bottom fish resources (mainly snapper) at several locations (notably sea banks and seamounts). However, the nearshore reef and lagoon waters presently offer little scope for substantial increases in yield because of heavy overexploitation in the past.

According to the current development plan (Government of Western Samoa 1987, p. 56), the overriding objective in fisheries is to develop the country's marine resources as a means of promoting economic growth and national self-reliance. Increased production for local consumption is a major priority in the immediate term, but the establishment of large-scale export-oriented ventures will also be an important goal. The expansion of local production is emphasised because of the perceived need to improve nutrition, reduce the heavy dependence on imports, and expand employment and income-earning opportunities in the rural village sector.

Developing Western Samoa's fisheries resources is the responsibility of the Fisheries Division which is part of the Ministry of Agriculture, Forestry and Fisheries. In recent years, the Fisheries Division has been involved in several major programs to strengthen the country's fisheries. These have included a project to build fishing boats (*alia*) suitable for village-based artisanal fishing, the provision of fish aggregating devices (FADs) to facilitate tuna fishing in deep waters, and a strengthening of the Division's extension and advisory services. Efforts are also being made to assess offshore bottom fishing resources and investigate possibilities for a major export industry based on deep-sea fishing.

In recent years, the Fisheries Division has been active in promoting aquaculture/mariculture, although much of the effort has been essentially experimental in nature (Government of Western Samoa 1988). Past efforts to propagate giant clams for distribution as breeding stock for villages have been particularly notable. In some degree, this effort has been prompted by the fact that the natural stock of giant clams in the country has declined sharply as a result of overexploitation.

The Fisheries Division has also attempted to foster the cultivation of green mussel (*Perna viridis*) and giant Malaysian freshwater prawns (*Macrobrachium rosenbergii*) but with limited success in both cases. Areas of current interest include the propagation of giant clams, the Pacific oyster and trochus. For purposes of breeding, the Fisheries Division maintains several tanks at its Apia headquarters for clams, trochus and several other species.

The development and regulatory role of the Fisheries Division is guided by several pieces of legislation including: the Fisheries Protection Act 1972; the Fish Dynamiting Act 1972; and Fisheries Act 1988. However, except for the Fish Dynamiting Act, such legislation mainly focuses on commercial fishing ventures as opposed to fishing on Samoan villagers' customary fishing grounds.

Official policy towards the exploitation and management of Samoan fishing activity on nearshore waters can be described as one of minimum intervention. This policy stems from the fact that, in practice, the primacy of Samoan villager rights over their customary fishing grounds is recognised, and these rights are fiercely guarded by these villagers. Combined with this reality is a belief that the traditional methods that Samoans have employed over time to manage and control their marine resources can still work effectively. Continued reliance on customary methods of control makes sense for the added reason that the Fisheries Division simply does not have the resources to monitor village-based fisheries activities and to enforce fisheries regulations throughout the country's many coastal villages.

The capacity of village chiefs to exercise their traditional authority at the village level has been strengthened by the recent passing of the Village Fono Bill (1990). Essentially an amendment to the Constitution, this legislation provides for the *ali'i* and *faipule*, i.e. the group of village chiefs and orators, to exercise their chiefly authority in accordance with Samoan custom and usage. In the fisheries area, the new legislation enhances the power of *ali'i* and *faipule* in relation to controlling fishing and related activities on customary reef and lagoon areas. Under the provision of the Fisheries Act 1988, any regulation promulgated by the chiefs, through the village *fono*, can become a national by-law. However, for it to become a by-law, the proposed regulation must first be submitted to the Fisheries Division for consideration, signed by the Director of the Department of Agriculture, Forests and Fisheries, and then gazetted. (These village regulations are now also commonly announced over radio.)

The purpose of the study

This chapter examines the system of property rights on nearshore marine areas—reefs, lagoons and mangrove areas—that prevail in Western Samoa. It is part of a study of marine property rights in the South Pacific involving the following tasks:

- 1 A general review of reef and marine property rights in the South Pacific as far as these may affect the development of giant clam mariculture, with more in-depth overview for selected countries.
- 2 Consideration of customary reef tenure and sharing arrangements in relation to reef resources and in relation to productive activities.
- 3 Consideration will be given to the institutional type of mariculture development that may be successful.

For the purpose of collecting information, the author visited Western Samoa during October 1990. Discussions on marine tenure in Western Samoa were carried

out with senior staff of the Ministry of Agriculture, Forests and Fisheries, officers of the Fisheries Division and other sources including those from the private sector. Also, visits were made to three rural locations to inspect mariculture projects and to seek the views of village leaders on the subject of customary marine tenure. Specifically, the areas visited were: Fusi village, Manono village and Namu'a Island.

The village of Fusi is situated on the south coast of Upolu and is part of the Safata District (see Map 11.2). The village has access to one of the largest and best-sheltered bay areas in the country and is also well endowed with agricultural land. Fusi has a population of approximately 550, six family groups (*aiga*), and 53 resident *matai* (around 12 other *matai* reside outside the village). The neighbouring villages are Vaie'e to the west and Fausaga to the east. The cultivation of taro, coconut and copra and the trapping of crabs are the main economic activities.

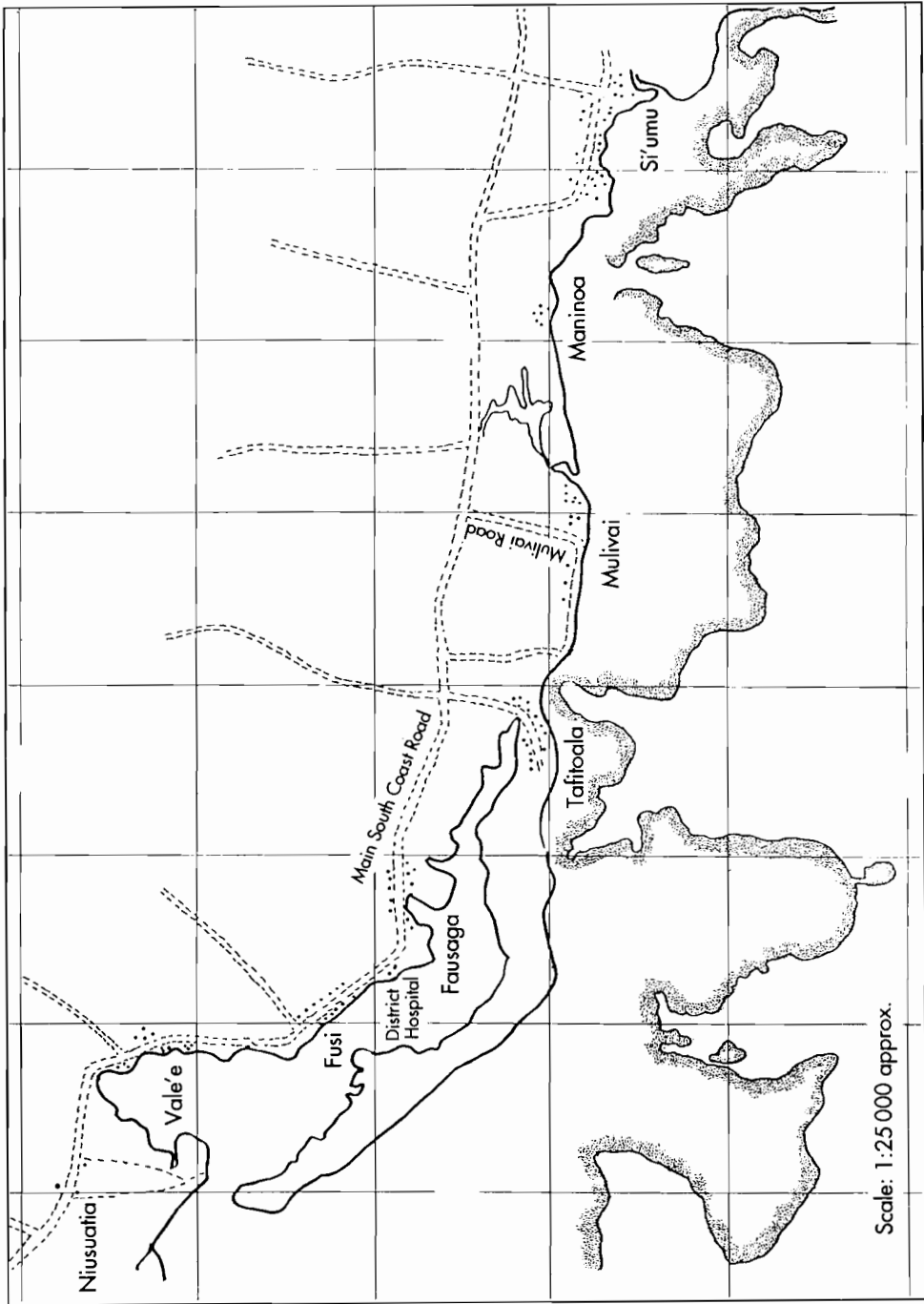
Manono village, commonly referred to as Manono Uta, is located on the extreme northwest tip of Upolu and is part of the community of Manono Island which lies several kilometres offshore (see Map 11.1). The lagoon area under the control of Manono community is extensive and mainly comprises the waters lying between the village and the island. Population is an estimated 1200 and there are around 100 *matai* (excluding those not residing in the village). Lacking access to good agricultural land, the village is forced to rely heavily on fishing for the Apia market. The main subsistence crops are taro and coconut.

Namu'a Island is one of several islands lying a short distance from the coast of the Aleipata District on the southeast coast of Upolu (see Map 11.3). The island has a classic volcanic structure but has been heavily eroded on the seaward (outer) end by wave action. Owned by the government, the island is approximately 15 ha in size and its only residents are a chief and his wife from the village of Malaela on Upolu, who work as caretakers for a giant clam project on Namu'a (see following section). The entire area between Namu'a Island and the Upolu coast comprises lagoon waters.

Mariculture: the recent experience

As previously noted, the Fisheries Division has played an active part in promoting mariculture, its efforts being particularly notable for green mussels, Pacific oysters and giant clams.

Attempts to promote the farming of green mussels began in the early 1980s. The lead was taken by the Fisheries Division which established rafts and related facilities for green mussel growing on three lagoon sites, including those at Asau village in Savai'i and Fusi village in Upolu. Green mussel spats were imported from French Polynesia and placed on rafts at the three sites. These projects progressed well at the development stages and appeared set to become firmly established as a promising new rural industry. Convinced that the villagers could manage the projects themselves, the Fisheries Division withdrew, leaving them fully responsible. Unfortunately, this optimism was not borne out: the villagers could not sustain development



Map 11.2 Western Samoa, Fusi village and surrounds.

and it was not long before each project lost momentum and collapsed. Poor management and supervision by the villagers, in some cases combined with lack of cooperation among village groups (e.g. among women's groups), were said to be largely responsible for the failure.

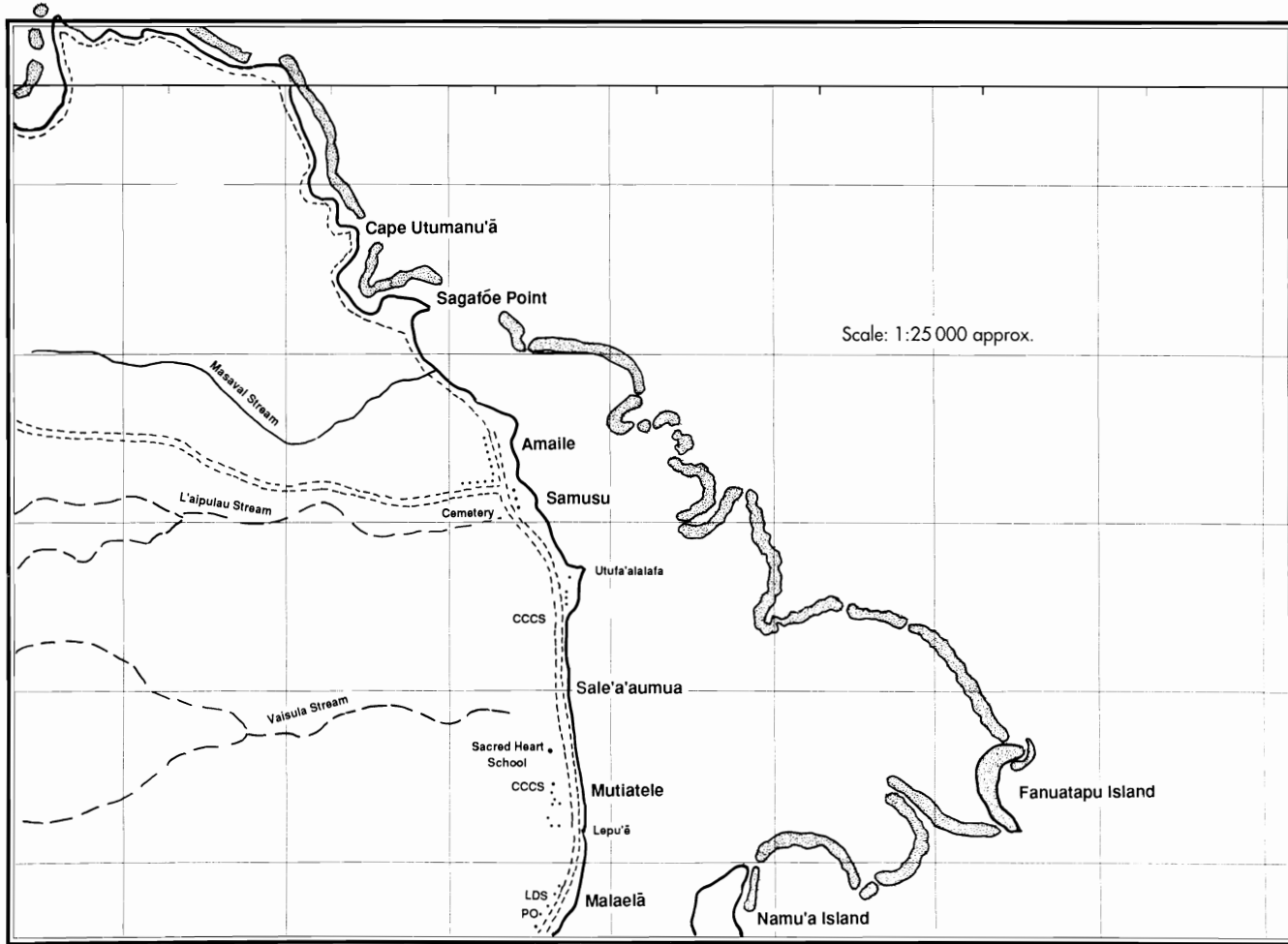
The farming of green mussels remains technically and ecologically feasible but a more effective approach to development seems essential for success. A project to cultivate Pacific oysters was established in mid-1990 at Fusi village. It was initiated by an officer of the Fisheries Division whose father held a *matai* title in the village. Fusi itself seemed an excellent site for this kind of venture as it has extensive bay areas with sheltered and shallow waters. Largely an experimental project closely monitored by the Fisheries Division (which does regular checks), the project occupies an area of around 50 by 25 metres. Facilities include a series of shelves or ramps supported by poles driven into the bay floor. A local villager acts as a caretaker using a small boat provided by the Fisheries Division.

The project is strongly supported by the village which has imposed a set of penalties or fines for anyone who enters or takes oysters from the project. The first crop of oysters was to be harvested in December (1990) and it was hoped that a large proportion would be sold locally.

The country's first major attempt at giant clam mariculture began in 1989 on Namu'a Island. The project was established by a private company, Namu'a Aquaculture, which has five local shareholders, assisted by the Fisheries Division. It is largely the inspiration of a young Apia entrepreneur, Peter Meredith, the country's leading diver, who saw the potential for giant clam farming on the large and relatively protected lagoon waters of Namu'a Island. The securing of the project site was facilitated by the fact that Peter Meredith had family links with Malaela village which is opposite Namu'a on Upolu, and the fact that his father held a *matai* title in that village.

Present operations are confined to a small lagoon area measuring around 20 × 15 m in size, extending from Namu'a's main beachfront. From government the company has leased a total lagoon area of 15 ha plus a few acres of land, under a 20-year lease with right to renew for a further 20 years. Project facilities include several metal ramps suspended above the lagoon floor by steel or wooden poles, and around 80 trays for the clams. The clam stock numbers around 1800 and is of varying age up to 2.5 years with the main species being *Tridacna derasa*, *Tridacna gigas* and *Tridacna squamosa*. (Restocking was necessary, mainly using broodstock from the Fisheries Division, after heavy destruction by Cyclone Ofa in early 1990.)

The project relies heavily on the Fisheries Division for technical assistance, especially in relation to marine biology. A local villager has been appointed as caretaker for the project, and so far support from the mainland village has been excellent. The immediate aim of the project is to consolidate what has already been achieved and improve facilities to ensure future viability. Among the top priorities are the installation of hatcheries (breeding tanks), a laboratory and processing



Map 11.3 Western Samoa, Namu'a island and surrounds.

equipment. Major aims are to develop the capacity to supply clams to the local market, to provide breeding stock to interested villagers and to develop an export capacity.

This enterprise has considerable potential for development, especially because of Peter Meredith's strong commitment to it and the availability of suitable lagoon areas under long-term lease. However, its ultimate success will depend on the capacity of the enterprise to upgrade facilities and the availability of finance to do this. The project is deserving of official support, including government assistance to secure overseas technical and financial resources.

Marine tenure

Up till now, Western Samoa's system of reef and lagoon tenure has not been the subject of detailed study, but it has been commented upon by a number of observers. One of the earliest observers was W. von Bülow, a German national and longtime resident of Apia around the turn of the century. In 1902, he published a short account of Samoan native fishing rights (see Appendix A), and drew attention to the elaborate system of ownership rights on customary fishing grounds, which encompassed the area lying approximately between the beach and the outer edge of the reef (von Bülow 1902). As reported by von Bülow, ownership rights were held by village communities, extended families or individual title-holders and the coastal areas over which these rights applied were clearly defined. Owners exercised fishing and other rights (e.g. to take marine sediments) over their fishing grounds, but were subject to certain 'duties' imposed by the village authorities. These duties included the obligation to turn over certain fish species (e.g. turtles) to the village assembly (*fono*) or a particular chief, and the obligation to obey village decrees (*sa*) forbidding fishing on reefs and lagoons for a defined period of time.

More recently, Johannes (1982) reported on Western Samoa's reef and lagoon resource management situation for the Government of Western Samoa and the South Pacific Commission, Noumea. In his report, Johannes offered a few observations on traditional Samoan fishing rights and how these evolved and had been modified over time. Johannes pointed to the lack of basic information on Samoan fishing rights—information which he thought could play a vital part in the management and utilisation of the country's coastal resources—and urged that a comprehensive study be undertaken into the marine environment including reef and marine tenure.

The most fundamental change that has occurred in marine tenure in Western Samoa, certainly since von Bülow's time, has been the transfer of ownership of customary fishing areas from families and related groups to the state. As in many other Pacific island countries, this change took place during the period of colonial rule and the system of ownership that was then introduced has persisted to the present day. The notable exception was Vanuatu where, through the Constitution, all land and customary fishing grounds that had been alienated reverted to customary owners.

In contemporary Samoa, the system of property rights on reef and lagoon areas is characterised by state ownership (as part of the country's territorial and EEZ areas) and customary ownership of fishing rights on these waters. These fishing rights apply to customary fishing areas that villages have claimed since time immemorial and are well defined and demarcated. (By legislation these fishing rights can extend out to a limit of 8 km (5 miles) from the mean high water mark.)

As is common in the South Pacific region, fishing rights over customary fishing grounds belong to individual villages. As a general rule, each village, as a largely autonomous functioning unit, can claim exclusive rights over its designated customary fishing grounds. These fishing grounds normally comprise reef, lagoon and mangrove areas extending seaward from the land boundaries of the village to the edge of fringing reefs. The size of these fishing grounds varies enormously depending on the extent of the coastal land boundary of a village and its reef and lagoon configuration. However, in the majority of cases, the lagoon waters out to the edge of the reef measure well over a kilometre, and are therefore extensive.

On several locations on the main island of Upolu, the fishing rights of villages extend to the lagoon areas surrounding offshore islands. Examples are a number of villages in Aleipata, such as Malaela and Mutiatele, which traditionally fished on the lagoons of the offshore islands of Namu'a and Nuutele. The villagers of Manono, both on Manono Island and Manono village on Upolu, traditionally fish on the lagoon areas that lie between Upolu and Manono Island, covering a distance of 3–4 km. In general, the presence of offshore islands greatly increases the size of the lagoon waters available to the main villages for fishing and related activities.

Rights to fish on the customary fishing grounds of a neighbouring village (or villages) are still found and exercised. Where such 'outside' fishing occurs, it usually takes place on the outer edge of the lagoon, as far away as possible from the host village. I came across several instances of such fishing, for example, in Fusi village where people of the neighbouring villages were permitted to fish on lagoon waters beyond the main bay area; and two sub-villages of Savaia and Tafagamanu at Lefaga which share the same reef and lagoon areas. Fishing by outsiders can be carried out only with the approval, tacit or overt, of the host village and such arrangements are normally made on a reciprocal basis.

Until recent times, the exercising of fishing rights on the customary fishing grounds of other villages was apparently fairly widespread. I was told, for example, that the villagers of Manono formerly used the fishing grounds of villages at least 10 km away (e.g. Leulumoega, Fasito'outa and Mulifanua) but that this had ceased when these villages forbade such fishing. However, Manono fishermen can still fish on lagoon waters extending out from the airport—a distance of about 10 km to the east—as villagers who used to live in this area have been relocated. Nevertheless, cases where outside fishing is allowed are no longer common. The reason for the decline largely relates to increasing demands on reef resources as a result of population pressure and fishing for commercial purposes. In recent times these pressures have forced many villages to ban outside fishing and to reserve reef and lagoon resources for the exclusive use of home villagers.

Many coastal villages permit fishing by people from inland villages who lack direct access to the coast. These rights are usually exercised by those inland villages that are not far from the coast, and were acquired through historical and family ties. (Many inland villages were originally settled by coastal villagers as a result of population pressure.) I came across several examples of fishing by inland villagers including fishing by Manunu village on the fishing grounds of Saluafata and Luatuanu'u, and by Magiagi village on the coastal zones of Fagali'i and Moata'a.

The customary fishing grounds of a particular village are effectively common property in the sense that all villagers are free to exercise fishing rights as members of that village, subject to any restrictions that may have been imposed by the village *fono* or by the central government. However, in practice, certain other customary restraints may affect the freedom of individual fishermen to fish in these waters. Thus, in most villages, households located on the water's edge can claim a form of occupant's rights over adjacent lagoon areas, normally around 5–10 metres from the land at high tide. Other villages will tend to respect this right and do so by keeping a respectable distance from the area concerned. Fishing rights may be further curtailed in cases where a village permits outside fishing; such a sharing arrangement effectively deprives host villagers of the opportunity to exercise sole access to lagoon resources.

Certain customary practices regarding the catching of particular species of fish persist in some villages; in most cases, such practices affect the fishing rights of outside villagers. Thus, in 1960, van Pel (Johannes 1982, p. 12) noted that around Manono Island, only the inhabitants may catch mullet and *atule*; and Johannes (1982, p. 12) reported that in Savai'i fishing for 'whitebait' during the annual run is the exclusive right of the villagers of Gataivai. In Fusi, the trapping of crabs was restricted to local villagers. In relation to turtles, a common custom is to present the catch to the village chiefs for customary distribution. No doubt, many other forms of customary arrangements could be found in contemporary Samoa.

The rights of Samoan villagers to exercise their customary fishing rights in reef and lagoon areas are fully recognised. In practice, however, these rights go beyond fishing and related activities: they also confer custodial rights to manage and carry out related activities in these waters as was true in pre-colonial days. Their role as custodians of the reef and lagoons is clear from my discussions with village leaders. A common expression used by these leaders is: '*Matou te vaa'iga le gataifale*'—we are responsible for looking after and overseeing our reefs and lagoons. This statement implies a right, or obligation, to manage and regulate fishing activities on these waters. The recent passing of the Village Fono Bill, as noted earlier, has served to reinforce the role of individual villages as custodians of reefs and lagoons.

While ownership of customary fishing rights belongs to the village as a whole, the control and regulation of village activity on reef and lagoon areas is exercised by the village council or *fono*. Each village has its own *fono* comprising all those holding chiefly status i.e. chiefs and orators who are collectively known as *ali'i* and *faipule*. The *fono*, which usually meets weekly (normally on a Monday), is a form

of local government at the village level, responsible for managing and regulating village affairs based on Samoan tradition. The authority of the *ali'i* and *faipule* extends to the management and control of reef and lagoon areas.

The powers of the *ali'i* and *faipule*, as exercised through the village *fono*, are considerable, and are expressed through customary methods. This group can impose traditional sanctions, the *sa* or *tapu*, upon the village and can support them with penalties of various kinds and degree of severity. These penalties are commonly imposed in the form of fines in cash or goods (such as pigs, canned food, bread etc.), and in extreme cases, banishment from the village. The application of customary sanctions may involve the banning of fishing altogether for a specific period, the catching of a particular species or the use of a particular fishing practice.

Village *sa* have been imposed to ban fishing based on the use of dynamite and *ava niugini* (*Derris elliptica*)—a mixture made from a noxious plant originally brought from New Guinea. It was also apparent that many villages have placed bans on night fishing (*lama*) and the use of gill nets. The main reasons for these latter restrictions arise from the difficulties of controlling the activity of night fishermen and, in the case of net fishing, to prevent resource depletion.

Disputes between villages over fishing rights are rare and, if they break out, are settled through customary channels, i.e. through discussion between the respective village *fono*. During fieldwork, the only dispute that came to my notice concerned Nu'utele Island, a small offshore island lying off Aleipata District. Ownership is being contested by the three leading chiefs of the district (Sagapolutele, Fuataga and Tofua) and, in this case, the dispute has been brought before the Land and Titles Court, Apia, for resolution. The dispute began in 1986 and may take some time yet to resolve.

Sharing activity

Fishing by village groups is still common and applies to both fishing nearshore and beyond the reef. However, such fishing now takes place less frequently than in earlier times and involves mostly untitled males and women.

The most common form of group fishing arrangement is the *mata*. The *mata* involves fishing from canoes in nearshore waters using spears, slings and, sometimes, gill nets. The fishermen are usually young untitled males led by a master fisherman, the *tautai*, and the fishing group may vary from several canoes (and fishermen) to as many as 20 craft. Sharing arrangements in relation to the catch vary depending on whether fishing is carried out for the purpose of meeting village needs on one hand or of satisfying family needs.

The organising of a *mata* to satisfy the needs of the village normally takes place in response to a special occasion that would call for a meeting of village chiefs. Here, the specific purpose of the *mata* is to provide fish to help feed the village

leaders and, consequently, the catch is pooled and individual fishermen do not share in the catch. For most rural villages in Samoa, this fishing for communal needs occurs periodically, depending on how often the *matai* assemble for special meetings.

The carrying out of *mata* to meet the needs of individual families in the village takes place on a more regular basis. It normally takes place on Saturdays so as to provide fresh fish for the Sunday meal (*to'ona'i*). Here, each member of the group is free to keep his catch—to feed his family or dispose of as he sees fit. A method of group fishing by women that used to be widely practised but is now much less common is the *fa'amo'a*. This fishing method involves a group of women forming a circle and driving the fish into a basket strategically placed in the coral community and disguised as a natural shelter for the fish. To force the fish out of the coral, the women would beat the coral with a long stick shaped like a golf club. A basket made from coconut material is used to trap the fish. The catch was usually shared equally among the participants.

A variant of the *fa'amo'a* is the *tuiga*, which was also a popular form of group fishing during earlier times. A long stick was used to scare the fish out of their coral shelter and a net was used as a trap.

In earlier times, group fishing on outer reefs, usually for tuna (*aku*) and shark (*malie*), was carried out regularly, but now appears to have given way to more individual efforts, especially with the growing use of motorised crafts. Other group fishing activity includes that carried out by women in shallow lagoon waters (usually at low tide). Normally, two or three women would take part and it usually entails foraging for and collecting a variety of shell fish and other marine growths. An element of sharing is usually involved in these efforts.

Development approaches

The potential for clam mariculture in Western Samoa is considerable, possibly one of the best in the South Pacific region. The country is generously endowed with good natural habitats for giant clams: there are numerous coastal locations that are reasonably protected from winds and with extensive areas of clear sheltered lagoon waters. The extent of reef and lagoon areas with water less than 50 m deep is estimated at 23 000 ha (Johannes 1982, p.2). This potential has to be considered alongside the fact that a large part of the country's reef and lagoon waters is impoverished and the rejuvenation of such areas through giant clam mariculture would represent a major social benefit. It is also apparent that there exists a large unsatisfied demand for giant clams in the domestic market.

Practically the entire coast of Upolu is encircled by fringing reefs that usually extend out from shore by around a kilometre. Upolu is therefore well endowed with lagoon waters that could be the basis for clam mariculture. Reef and lagoon areas in Savai'i are less extensive than in Upolu (a large part of the coast of Savai'i is covered by lava) but, nonetheless, Savai'i has large coastal areas that are suitable for the cultivation of giant clams.

While Western Samoa offers an abundance of possible locations suitable on ecological grounds for the cultivation of giant clams, a further factor that has to be considered is the population density of nearby villages. There are clear advantages in selecting a project site on an area of low population density so as to minimise the danger of human intervention, especially village fishing. In this regard, reef and lagoon waters that lie some distance away from the main village centres can be attractive. On this criterion, most of the villages located in the northwest of Upolu—stretching from the Apia township as far west as the international airport area—would rank poorly as possible sites.

According to senior officers of the Fisheries Division, some of the best reef and lagoon areas for purposes of giant clam mariculture can be found on the south-western and southern coast of Upolu. Those areas that were considered particularly attractive—in part, because of low population densities—include Fagalei and other areas near Lefaga such as Fagaiofu Bay and Falevai village. The villages of Matautu and Salamumu were also favoured. There is also scope for giant clam mariculture in several islands offshore from Upolu, including Nu'utele and Nu'usafe'e.

It is apparent that the extensive southern coast of Upolu, particularly lagoon areas that are not subject to heavy fishing by nearby villages, offer considerable scope for giant clams. Selected areas in Savai'i as well as the other two inhabited islands of Manono and Upolima—both lying between the northwest side of Upolu and the southeastern section of Savai'i—are also potentially attractive.

Given the nature of customary marine tenure in Western Samoa, a key requirement for the establishment of a giant clam mariculture project on reef and lagoon waters is the consent of the village holding fishing rights over such areas. Consent must come from the *ali'i* and *faipule* group who act on behalf of the village. The decision of the *ali'i* and *faipule* is, by custom, binding on all villagers.

An essential step is to submit the project proposal to the *ali'i* and *faipule* for consideration. This submission can be done through the village *pulenu'u* who, as the local representative of the central government, can request the village chiefs to meet to discuss the merits of the project. The Fisheries Division will need to be represented at these discussions to assist in explaining the project to the chiefs, to provide technical information if needed, and generally to facilitate the process of discussion and negotiation. The Fisheries Division, as the official agency in this area, can fill a vital role as an intermediary between the developer and the village.

Establishing a commercial giant clam project on the reef and lagoon areas of a village requires close collaboration between the developer and the village authorities i.e. the *ali'i* and *faipule*. As in the case of Namu'a Acquaculture, this collaboration may take place on an informal basis with local villagers not involved as equity partners in the venture. However, various forms of joint venture arrangements may also be considered to allow villagers to play a more direct role (e.g. as directors) in the venture.

Cooperative arrangements with village groups such as Women's Committees and the group of untitled males— the *aumaga*— do not appear to offer real possibilities for collaboration. Non-traditional groups such as cooperatives show limited possibilities as partners since they are not generally active in Samoan villages. The reasons for collaborating with the *ali'i* and *failpule* is that they are the highest authority in the village and can speak on behalf of all villagers.

An important requirement is to ensure that the project is carefully explained to the villagers so they have a clear understanding of the nature and purpose of it. It is particularly important that the villagers understand the aims of the project, possible benefits for the village, the implications for their fishing rights and need to observe any regulations or decrees issued by the village in order to protect the project from intrusion by villagers.

The response by villagers toward a giant clam undertaking will depend on what villagers perceive as the likely benefits to them. It was clear from my discussions with village leaders that these benefits need not come only in the form of money payments. Some informants stressed the value of such a project for the future well-being of the village and family groups, and the possibility of sharing in some way in the harvest when the project had become a going concern. Others highlighted the possible benefits of such an enterprise in terms of improved nutrition for the village people, while yet others conceived of possible benefits realised in the form of improvements to local roads, water and power facilities. Informants at Manono village saw the chance to sell clams to a nearby holiday resort (under construction) as a potential major benefit.

A formal agreement between the village and the developer, which would spell out project aims and conditions as well as the responsibilities of the respective parties, may be preferable, but is not essential. However, it is imperative that each party has a clear understanding of its responsibilities and obligations. Important features that need to be understood include: the exact area of the lagoon waters that will be developed as a project site; specific measures that need to be taken to protect the project; and what penalties the village is willing to use to discourage poaching and interfering with project equipment and general facilities. An indication of how villages are to benefit from a successful project should also be considered.

Those responsible for the project should have a firm understanding of the nature of customary obligations and how these obligations can be handled. Villagers will tend to expect those involved in the project to show that they are willing to act as though they were part of the village community and show this by making an occasional contribution— in cash or kind— to the village, especially on special occasions. These contributions, which perhaps can be looked upon as the 'price' that has to be paid for the use of reef and lagoon areas, can be made in the form of cash or food— including imported foodstuffs such as canned fish and meat, bread, sugar, tea and the like. Gifts in the form of building materials are also appropriate. Such contributions can be made during a major village event such as the official opening of a church, school or other infrastructure or a special meeting of

the village *fono*. During my visit to the giant clam project at Namu'a Island, I learned that the project coordinator was contemplating providing gifts of food (bread, biscuits and canned fish) to an upcoming meeting of the village *matai* of Malaela village as a gesture of goodwill to the village for its cooperation to date. This meeting was planned to discuss the local agricultural situation, and the value of the proposed gift from the project was expected to amount to around WS\$400.

Once consent is obtained, a village— through the *ali'i* and *faipule*— is in a position to provide considerable practical support for a project. Agreement by the chiefs implies acceptance by the village as a whole. Sanctions, in the form of the traditional *sa*, can be levied as a means of protecting the project from intrusion and interference by both local and outside villagers. Village chiefs also have the power to impose penalties in support of sanctions. Support through the appointment of a local villager to act as a caretaker for the project can also be secured.

The power of village chiefs to apply customary sanctions is widespread among the village community. In relation to the existing mariculture projects in both Fusi and Malaela villages, I learned that the village chiefs were prepared to make these sanctions even more severe to ensure effective compliance.

The willingness of Fusi and Malaela villagers to impose severe sanctions to protect their mariculture projects (oysters and giant clams respectively) represents a clear commitment to their projects. In Fusi, the penalty for breaking the *sa* was a fine of WS\$100 plus a contribution of 100 *talo* and one pig. Of the cash fine, an amount of WS\$50 was to be paid to any villager who had informed the village chiefs of the infringement (the other WS\$50 would accrue to the village). The customary fines imposed by Malaela village to protect the giant clam project at Namu'a Island were a cash fine (to be determined by the chiefs), 100 *talo* and one pig, but these penalties would double or triple for more serious offences.

From the foregoing, it is clear that Samoan villages, through their traditional village *fono*, have at their disposal an arsenal of potentially powerful mechanisms for supporting giant clam and other forms of mariculture. The development of a giant clam project can be facilitated by having to deal with a single authority, i.e. the *ali'i* and *faipule* (through the village *fono*), and once consent has been given, the developer can negotiate with the village chiefs over the question of imposing village sanctions and what forms these sanctions should take. It is vital, however, for the developer to continue to enjoy acceptance by the village community and this can be done by ensuring that the village stands to gain some tangible benefit from the project, including that received in the form of customary gifts.

Conclusion

The system of marine property rights found in Western Samoa is similar to that operating in many other Pacific island countries including, for example, Fiji. This system is characterised by state ownership of reef and lagoon areas (as part of the country's territorial waters) and customary ownership of fishing and related rights

on these waters. These customary fishing rights are held by individual villages and apply to village fishing grounds that have been established and defined over time. The power to regulate and enforce fishing activity on the fishing grounds is held by the village *fono*, comprising the group of *ali'i* and *faipule*. Subject to any regulation made by the *fono* and/or the central government, all villagers are free to exercise fishing rights on reef and lagoon areas belonging to the village.

Western Samoa is generously endowed with extensive reef and lagoon areas that could provide suitable natural habitats for giant clams, the south and southwest coasts of Upolu being particularly attractive. To gain access to a village reef and lagoon site for giant clam mariculture, the consent of the village *fono* is required, and in this regard the Fisheries Division and the village *pulenu'u* can play a valuable part in negotiating for village support. Support for a project will depend on how the villagers perceive project benefits but, once permission is given, the village chief can apply customary sanctions as a means of protecting the project activity from intrusion by villagers.

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Appendix

Fishing Rights of the Natives of German Samoa

W. von Bülow (*Globus* LXX XII, p.40–41, 1902)

Translated from German by Christa Johannes

Fishing rights are a peculiarity of Samoan customary rights. The regulations relating to fishing rights are as many and various as the regulations relating to customary rights concerning the possession, acquisition and disposal of land. The natives' subsistence comes mainly from agriculture and fishing.

It is not surprising, therefore, that these two sources of livelihood are specially protected by customary rights. According to customary law the boundary between land and sea is the line which marks the waves crashing against the coast at the time of mean high water mark, namely the 'high water mark'. The space between this high water mark and the respective water's edge at any particular time is considered a traffic route.

The space between the traffic route and the outer edge of the reef, that is, the 'lagoon', is considered the fishing ground.

Just as all land in Samoa has its owner—even if in the time it has become more and more difficult in some cases to determine the rightful owner—so all Samoan fishing grounds have their owners.

These owners are either communities, chiefs' families, or else ownership rights or certain parts of ownership rights with the possession of particular areas of a fishing ground. (Translator's note—the meaning of the second half of the sentence seems unclear.)

These rights are old and have remained valid into most recent times.

Offences against these laws were punished by the local assembly up to the most recent times.

Fishing outside the reefs, 'to the ends

of the world', to Tutuila and Manua in the East, to Toelau in the North, the Uea and Viti in the West and the Foga mamao in the South is free. But there are valid rules even for fishing outside the reef (particularly in relation to shark fishing — *lepa malie*— and bonito fishing— *alo atu*), rules that are determined by the guild of fishermen, the *tautai*, and which are enforced by the latter. These are outside the framework of this work.

Fishing rights are generally considered as non-saleable in Samoa. Nevertheless in the 1870s it happened that native fishing grounds were surrendered to strangers; this, however, in part without obtaining the assent of the state. Thus it happened, for example, with the so-called 'little harbour' of the harbour of Apia.

On the island of Upolu, where the natives are no longer so singularly dependent on the yields from their fishing grounds as formerly when the number of foreigners was smaller and the opportunity of making a living (working for wages?) was less, interest in the former fishing grounds seems to have already greatly declined.

On the island of Savai'i, on the other hand, the old customs still continue in their purest form, the boundaries of fishing rights are still least obliterated, and the effort and joy in fishing are still most pronounced.

Therefore, it is on this island that infringements into fishing rights are felt most acutely. The worst infringement of this kind is dynamiting within the reef. It is without doubt that in a circumference of many meters all sea animals die where a single 1/4 cartridge of this material explodes. As fish mostly spawn within the reefs, it is quite conceivable that a well-stocked fishing ground can be ruined—depopulated—within a very short time.

These fishing grounds, which carry with them ownership rights or parts of ownership rights which favour village communities, extended families, or individual titleholders, are known. Known both according to their general position as well as according to their boundaries in relation each other.

These fishing grounds make up part of the wealth of the owner and therefore should be protected by law today just as much as any other possession—something which until this day has actually been the case in the villages.

Fishing rights entitle the owner to every kind of fishing on his fishing ground, so the piling up of coral and stone heaps as hiding places for fish, and to setting up any number of fish and crab traps.

The duties of an owner of a fishing ground are in general the following:

1 If he catches certain large species of fish (the turtle, *laumei*, is also considered as 'fish'—*ia*) he has to turn them over to the village assembly or in some villages to particular chiefs or to particular speakers (translator's note—talking chiefs?).

2 In addition he has to follow the orders of the village assembly if for certain periods it forbids the catching of *atule* (South Sea Herring) in order for the assembly to gain time to prepare to catch this fish in the *lauoa* (a large drag-net), or

3 If the assembly declares the ocean 'forbidden'—*sa*—because a high chief died, or because during a transfer of the remains of a long-deceased person from the present grave to a new grave his bones were 'bathed' by the sea.

4 The owner has to allow his own village or neighbouring localities to cast their large drag-net, but to do so without searching through the stone heaps he has set up himself,

5 As well as to allow everyone to cross his fishing ground while dragging a fishing lure, *pa*, any time of day or night.

In civilised countries fishing with explosives is heavily punished.

It is hoped that studying the customary rights of the Samoans concerning fishing will continue to their fair treatment by foreigners and to the maintenance of our fishing supply.

12 Institutional Factors, Giant Clam Culture and Conservation in Fiji, Tonga and Western Samoa

Luca Tacconi

Clem Tisdell

Abstract

This contribution analyses the role of institutional factors in giant clam farming and conservation in the South Pacific. Institutions can be characterised as *organisations* and *rules of the game*. This distinction is adopted in the present report. The development of a giant clam farming industry can be speeded up by Fisheries Divisions through collaborating with the private sector and by providing it with information, for example, on giant clam farming methods. Fisheries Divisions can promote clam conservation, not only by restocking reefs and introducing regulations on clam export and collection, but also by stimulating the establishment of community resource management schemes based on the rich tradition of customary marine tenure found in the countries considered in this chapter. This can result in cheaper methods of clam conservation than restocking and may also help in maintaining traditional knowledge of the marine environments.

Introduction

The implications of institutional factors for giant clam culture in the South Pacific have been partly analysed by Fairbairn (1991a). His analysis was limited to the relevance of customary marine tenure for the development of commercial large-scale giant clam farming. However, there is a broader range of institutions that have implications for (large and small-scale) giant clam farming and conservation.

The term 'institution' is used in economic analysis with different meanings. Thus, it is appropriate to define its meaning as used in the present context. An institution has been defined as 'a social organisation which, through operation of tradition, custom or legal constraint, tends to create durable and routinised patterns of behaviour' (Hodgson 1988 p. 10). This definition encompasses Van Arkadie's (1990) distinction between institutions as *organisations* and institutions as *rules of the game* which is useful in the present analysis. An *organisation* may be a government body (e.g. a Fisheries Division), or a producer's cooperative and so on. To this category also belong traditional organisations such as village councils. The *rules of the game* regulate the functioning of a society (e.g. its written and unwritten laws) or the functioning of organisations. These rules are important

because they 'channel the behaviour of people with respect to each other and their belongings, possessions and property' (Runge 1984, p. 807). Agents follow certain forms of action that conform to accepted social behaviour because they agree with it or because they fear the penalties they would face violating the rules (cf. Rawl 1972; Schotter 1981).

This chapter will consider the role of organisations in clam farming and conservation, paying particular attention to the implications of the rules of the game for farming and conservation of giant clams.

Institutional factors and giant clam culture

The major emphasis of research into giant clam culture has been on the biology of clams, cultivation methods and assessment of the profitability of giant clam farming. However, other factors will also influence the successful adoption of giant clam farming. The perception of the issues involved in giant clam culture and the actions of institutions such as government fisheries divisions and private firms are two of these factors and are considered in the following section.

Organisations and clam farming

The importance of institutional arrangements for clam farming is exemplified by the case of Western Samoa. A commercial giant clam farm was established by a private entrepreneur on Namu'a island. This was the only commercial farm existing in the three countries visited (Western Samoa, Fiji and Tonga). Its development was partly due to collaboration between the private entrepreneur and the Samoan Fisheries Division. This collaboration started when the businessman (an experienced diver) collected some giant clams for the Fisheries Division to use as broodstock. In return, the Fisheries Division provided him with clam seed spawned by the division itself. More seed from overseas research stations were also introduced to the farm at different times. Collaboration also continued in the form of periodical visits to the farm by Fisheries Division staff and by overseas researchers.

Such collaboration could enable Western Samoa (which does not receive direct development assistance for research on giant clams) to be the first of the three South Pacific countries visited to produce giant clams on a commercial basis and with good prospects for export. In fact, as mentioned by Tacconi and Tisdell (1992b; see also Ch. 14), the Samoan commercial farm has received inquiries from a New Zealand company interested in importing giant clams.

It seems from the above case that collaboration between fisheries divisions and the private sector, as well as provision of information about production methods, are important factors in encouraging the development of the giant clam industry.

In this regard, a contrasting picture emerged from interviews in Fiji and Tonga. In these countries, private entrepreneurs do not seem to have much information about giant clam farming. Nevertheless, it was found that in both countries private companies could be interested in clam farming. In Tonga, one entrepreneur (a fish

exporter) showed particular interest and noted that he was actively looking for an appropriate site. He pointed out that his business relations with local people (the customary owners of the reefs) could facilitate an agreement about the conditions for the establishment of an eventual venture (e.g. rent of reef or profit-sharing).

Rules of the game and clam farming

In the South Pacific, tenure rights (*rules of the game*) to land and marine areas are often vested in the traditional (customary) owners. Present-day tenure systems have not only evolved through adaptation of old, traditional systems, but have also been shaped by the colonial influence and by the post-colonial independent states. The complexity of these systems has been increased by creating an overlay of 'modern' and 'traditional' rules. This has at times increased the frequency of land disputes because of uncertainty about the ownership of land returned to local communities after a long period of colonial rule. Most importantly, the colonial era has left the people suspicious about state intervention in land matters. These issues have particular importance in relation to how the development of a clam farming or conservation project should be approached.

Multiple ownership, land disputes and fragmentation of land parcels are often cited as major obstacles to economic development. However, to understand the issues at stake it is helpful to take a look at the concept of development and at two different approaches to tenure issues. Development can be interpreted as qualitative, *social development* of individuals, groups and societies. In its quantitative aspect; development is usually considered by economists as meaning an increase in income and/or wealth (*economic development*). However, economic development is only one aspect of the broader concept of development.

While economists have analysed the implications of tenure systems for economic development, social scientists from other disciplines have considered tenure rights from a broader perspective (Crocombe 1987a). Tenure systems are not just a component of the economic structure of a society but are also an integral part of the social system of the specific society. In the Pacific, 'Rights to land are the focus of social identity, the hallmark of citizenship in the local community... An islander with land has confidence, status and security' (Crocombe 1987b, p. 374). It has also been noted, perhaps too optimistically, that 'Independent Pacific Island governments *accept* [author's emphasis] that these systems, being an expression of social structure itself, are basic to the continued welfare of their societies' (Baines 1989, p. 273). However, economic development initiatives undertaken by these governments often tend to disrupt traditional resource-management systems. Baines describes these as a 'development dilemma which is crucial for the future of the people of the South Pacific Islands...' and asks '...Will serious efforts be made to adjust approaches to economic development so as to ease those disruptions... which are eroding Pacific island societies themselves?' (ibid). This approach contrasts startlingly with the orthodox economic approach that sees economic development as the only objective to be achieved, and customary tenury rights as constraints on economic development. When the point of view that tenure systems are an integral part of the local value-system is adopted, the issue becomes one of

pursuing forms of economic development consonant with those values, thus pursuing development in its broader sense.

While much work has been done in relation to land tenure systems and their implications for development, limited attention has been paid to these aspects of marine tenure systems. However, recent research is extending the social importance of land tenure rights to marine tenure rights. Concluding a study on the Solomon Islands, Hviding (1989, p. 27) states that 'The sea is the people's source of much of what they need in terms of food and money, but it is also a source of history and identity.'

Research on the implications of marine tenure systems for giant clam mariculture in Fiji, Tonga, Vanuatu and Western Samoa found that 'customary marine tenure can be a significant constraint to the development of a major giant clam mariculture project' (Fairbairn 1991a, p. i). It appears that this is due to uncertainty over reef ownership rights. However Fairbairn also recognised that, if villagers can benefit from the project, then an agreement between the 'project developer' and the customary owners of the reef may be reached.

Thus, the obstacle to the development of a project is not the customary marine tenure system in itself but the *entitlements* to the benefits from such a project. It is not surprising that local people do not want to give away their use-rights to the reef without receiving benefits in return. Uncertainty over rights to use a particular reef area can sometimes be a problem, but decision-making mechanisms are mostly in place to resolve such disputes and resolution can normally be achieved if proper benefits are forthcoming.

The role of institutions in giant clam conservation

Farmed giant clams may be used for commercial purposes or to restock depleted reefs for conservation purposes. There is, however, the need to study the role that institutions might have in the conservation of giant clams. This is so for two reasons.

First, a conservationist measure such as the restocking of a reef may prove successful in a protected area or marine park, such as the Australian Great Barrier Reef, where poaching is quite unlikely. However, in the South Pacific countries where giant clam meat is an appreciated seafood, restocking of reefs without strengthening existing institutional arrangements, or creating new ones where these are lacking, is at best a dubious exercise, as overfishing might deplete the clam stocks once more. In this case, institutional arrangements have a *complementary* role to play in reef restocking.

The second reason for giving attention to institutional arrangements has more far-reaching implications. Reef restocking obviously involves a cost that has to be supported by the organisation undertaking the project. This cost should be

compared to that of a program designed to conserve giant clams through the adoption of resource-management rules. In this case, institutional arrangements would be a *substitute* for reef restocking.

The case for closer attention to institutional arrangements is reinforced by the following considerations. The viability of a restocking program will depend on whether giant clam farming is economically viable and is actually undertaken in the country proposing to implement reef restocking. This is because:

- (a) there are economies of scale in the hatchery phase of clam farming (Tisdell et al. 1990); thus the cost of clam seed will be higher if they are produced only for restocking purposes; and
- (b) in developing countries where development needs may appear to be more important than conservation needs, maintaining clam farming purely for conservation purposes may not be politically viable. If clam farming is also a commercial activity, clam conservation could be accepted as a spin-off of commercial farming.

Another consideration is that, if commercial farming is not viable on a small-scale (because it is not profitable or because it does not integrate well with villagers' livelihood strategies), an institutional program for resource management might not only protect giant clams from local extinction, but could also eventually increase giant clams available for consumption and sale.

Government regulations on giant clams

A 10-year ban on giant clam exports was introduced in Fiji in December 1988 in order to protect dwindling clam stocks. There has been no attempt, however, to regulate domestic consumption. This might be due to the fact that domestic consumption is not perceived as a threat to the natural clam stock and/or because it is felt that such regulation could not be enforced.

The Government of Tonga has not introduced a ban on clam exports (there appears to be limited export taking place), but it is introducing a regulation on the minimum size for harvesting giant clams. These sizes are as follows:

<i>T. maxima</i>	155 mm
<i>T. squamosa</i>	180 mm
<i>T. derasa</i>	260 mm.

Enforcing this regulation will prove to be extremely difficult without the full cooperation of fisherfolk and of retailers. Although spot checks could be done at the local markets and clams in shells measured, it would be difficult to cover all markets, e.g. village ones. Also, the size of clams cannot be directly measured when they are sold frozen in plastic bags. Furthermore, fisherfolk have the option of consuming undersized clams at home while selling only legal-sized ones. The practice of consuming small-sized clams at home, in order to maximise economic returns from clam collection, is already adopted in Tonga (Tacconi and Tisdell 1992a; see also Ch. 15).

No regulations on the harvesting of giant clams have been introduced in Western Samoa. Nevertheless, due to the apparent heavy exploitation of clam stocks, the current FAO/UNDP marine resource management project may recommend a total ban on giant clam collection, even though it might be disregarded by the people concerned (Zann, pers. comm.).

From the foregoing observations, it is evident that conservation measures would have a better chance of success if they involved local communities. The importance of the involvement of traditional institutions in conservation has been stressed by several authors with specific reference to the South Pacific (e.g. Carew-Reid 1990).

Community resource management and giant clam conservation

While tribal societies appear never to have reached the rates of exploitation of natural environments typical of modern societies, whether tribal societies had a deliberate conservationist spirit reflected in their traditional resource-management systems has been (and remains) an object of discussion. In fact, it has been argued that these systems embody a spirit of conservation¹ but recent research tends to show that this is not always the case. Traditional management systems may be successful in avoiding resources exploitation in some instances, but this is not due to an intrinsic conservationist spirit according to Hviding (1989).

Thus, there will be instances where external intervention might be needed in order to initiate conservation measures. These initiatives should *whenever possible* build on already existing resource-management institutions. As already noted, this would increase the success rate of these interventions by decreasing the 'dissonance' (Bromley 1986) between external goals and action, and local values, beliefs and goals. Furthermore, building on existing resource-management systems can also be a low-cost and flexible approach (Cramb and Wills 1990; Runge 1986).

To understand how a community-based conservation program for giant clams can be established, and the difficulties that will be faced, we will consider the status of giant clams as a resource, the property rights regime under which they can be managed and the complexities of a resource management system with reference to Western Samoa as a specific case.

'In contemporary Samoa, the system of property rights on reef and lagoon areas is characterised by state ownership (as part of the country's territorial and EEZ areas) and customary ownership of fishing rights on those waters. These fishing rights apply to customary fishing areas that villages have claimed since time immemorial and are well defined and demarcated.' (Fairbairn 1991b p. 15; see also Ch. 11). Fairbairn also reports that individual villages may claim exclusive

¹See Johannes (1978) and Polunin (1984) for opposing views on this topic in relation to marine environments.

rights over the customary fishing grounds. Because of increased pressure on marine resources due to population growth and commercial fishing, the practice of allowing neighbouring villages to fish in the customary grounds is declining.

The system of marine tenure rights found in Western Samoa approximates the system defined as a common property regime (CPR) but some qualifications are needed. A CPR 'will consist of a well-defined group of authorised users, a well defined resource that the group will manage and use, and a set of institutional arrangements that define each of the above, as well as the rules of use of the resource in question. In addition to the rules of use there will be rules for changing the rules of use' (Bromley 1989 p. 871). This definition is inclusive of the two characteristics attributed by Feeny et al. (1990) to what they call communal property. These characteristics are '(a) the exclusion of other potential users, and (b) the regulation of use and users to ameliorate the problems associated with subtractability' (ibid. p. 5). The same authors also define 'common property resources as a class of resources for which exclusion is difficult and joint use involves subtractability.'² Defining a 'common property resource' in its physical connotation does not however make the analysis clearer and may instead lead to some confusion. In fact, Bromley (1989) stresses common-property resources do not exist as such, but only resources managed under a specific property regime, i.e. a resource managed under private property will be in that specific condition a private property resource.

In Western Samoa, the customary system allows each village to exclude other users from customary reef areas. Restrictions on resource use and users may be imposed by the *fono* (village council) or by the central government (Fairbairn, 1991b; see also Ch. 11). If restrictions are imposed, this satisfies the characteristic of 'regulation of use and users'. Here, the qualification to be made is that while Bromley (1989) specifies that the *group* will manage the resource, Fairbairn (1991b; see also Ch. 11.) contemplates the intervention of the central government. The extent of government intervention and possible conflict of the goals of participants in resource management could weaken common property management. In Samoa, however, local communities appear to be firmly in control of their resources (e.g. most villages with direct access to beaches charge an entrance fee to be paid by tourists and also by locals coming from other villages) and the government respects local community management.

The marine tenure systems commonly found in Western Samoa differ from the CPR captured in Bromley's (1989) definition, for one of the characteristics of the latter system is that a 'well defined resource' is the object of management. A customary reef area cannot be defined as a resource because a reef area hosts several different fish resources with specific biological characteristics. Thus, specific rules for the management of the different resources are required. The customary marine tenure systems commonly found in Western Samoa have therefore the essential elements to become CPRs, but to actually establish a CPR,

²Originally stated by Berkes *et al.* (1989, p. 11)

each single village council has to deliberate on the rules for the management of the specific resources.

Giant clams are found in customary areas and have been overexploited. Although stock assessment of giant clams has not been undertaken in Western Samoa, an indication of the overexploitation of giant clams is the sharp drop registered in the quantity of clams marketed at the daily Apia fish market. In 1986, the weight of in-shell clams marketed reached 10 tonnes, but in 1990 it had dropped to 0.1 tonnes (FAO 1990).

To get a better understanding, although only from a qualitative point of view, of the available stocks of clams and their status (e.g. institutional features), a rapid assessment was organised during fieldwork in Western Samoa. The areas and villages visited were the coastal villages of Upolu island shown on Map 11.1. These were selected on the basis of the list of villages whose inhabitants, according to market surveys conducted by the Fisheries Division, had sold clams in the Apia market in 1986.

The general picture that emerged from semi-structured interviews with fisherfolk in the villages, was one of generalised depletion of clam stocks. Only in one village, Manonouta, did a group of villagers declare that they were still sporadically selling clams at the market. Collection of clams by villagers for their own consumption had also markedly diminished due to a decline in the stock of clams. If the present trend continues, the two species of clams left in Western Samoa (*T. sqamosa* and *T. maxima*) may soon follow *Hippopus hippopus* on the path to local extinction.

An example of how to proceed with clam conservation in Western Samoa, (and also in other Pacific countries after the due adjustments for local conditions) is set by Salamumu village. The village, on the southern coast of Upolu island, has scattered houses along the road leading to the beach and reef area. Other private houses and meeting places stretch along the beach.

In 1988, the village council, formed by matais³ (chiefs), passed a regulation (proposed by a matai who resides in New Zealand) establishing rules for the management of giant clams, thus changing their status from one of an open-access resource to one of common (communal) property resource. This regulation stated that for three years:

- villagers could not collect giant clams in order to sell them;
- villagers were allowed to collect clams for their own consumption; and
- a fine of tala 50 was to be paid by those breaking this regulation.⁴

After the third year, collection for sale was allowed again because the number of giant clams on the reef appeared to have increased and also because people were

³In Western Samoa the chieftainship system is still quite strong. The matais are however fairly representative of the general community needs, given that each family has a matai. In Western Samoa, approximately one person in ten is a matai.

⁴At the time of the fieldwork the exchange rate was Tala/A\$= 0.6.

in need of money to pay contributions to the church. A visit to the reef at low tide (water depth 40–50 cm), with an experienced fisherman did not, however, result in the sighting of clams. According to the fisherman 'it is easier to find the clams when the tide is lower'. A quantitative stock assessment would be needed to better determine the effectiveness of a community management scheme such as that of Salamumu. Nevertheless, the important point to be made here is that this community set in place a management plan that protected clams and this was done for a resource that is quite marginal for the local economy. We do not have quantitative data on the contribution of giant clams to the local diet or to local incomes. However, data at the national level show that giant clams constitute only a small portion of total seafood consumption (Tacconi and Tisdell 1992c; see also Ch. 13).

It has been hypothesised that the 'tragedy of the commons' better describes the exploitation dynamics of unimportant resources than vital ones (Kimber, 1983). In fact, when 'survival is at stake, the rational individual will exercise restraint at some point.' (Wade 1987, p. 101). This proposition seems to apply to Western Samoa in general, where clam stocks have been depleted. However the relevant fact is that in Salamumu collective action was taken to protect a marginal resource. This might be explained as follows. Firstly, there is the 'stewardship' factor. In Western Samoa, villagers see themselves as custodians of the reef and have the right and the obligation to manage their marine resources (Fairbairn 1991b; see also Ch. 11.). This leads to the 'economic implementation' of the management rules. By definition a marginal resource carries limited economic benefits. The imposition of a relatively high penalty greatly reduces incentives to break the rules. Also, in a cohesive community, the moral incentive to behave according to the rules is high. These two elements tend to reduce enforcement costs and thus facilitate the establishment of a resource management scheme.

Conservation plans similar to that of Salamumu could be promoted in other villages in Western Samoa as a cheap method to protect giant clam stocks. Because of the expected marginal importance of clam resources to the village economy, it would pay to promote conservation awareness within a global program of environmental protection and not just address giant clam conservation. To be successful, management plans have to be adopted by the local communities as their own. Western Samoa is in an excellent position to promote these schemes because of the presence of fundamental characteristics needed for the success of these plans (see Wade 1987).

One factor that could slow down the process of community discussion and adoption of management plans is the impact of migration on the effectiveness of village councils in decision-making. In the village of Vailea, during a group interview with three matais, it was pointed out that to deliberate on a management scheme, the village council had to call for a meeting of all the matais from the village. Because some matais were living overseas, the council had to defer the meeting until all of those matais could be present. Given that migration is a common feature of Samoan villages, the impact of migration on local decision-making institutions should be considered as well as the implications of this phenomenon for resource management.

Conclusion

Institutional features of economic and social systems tend to receive too little attention in considerations of development and conservation projects. Nevertheless, they play an important role in determining the success of such initiatives. It has been argued that accounting for the social significance of institutions such as customary tenure rights will enhance the consonance of development and conservation projects with the local values, beliefs and goals.

Taking this approach need not hamper the economic viability of projects. According to the specific economic conditions, institutional arrangements can be seen as either complementary to, or a substitute for the project approach. In actual fact, proper institutional arrangements can reduce the cost of giant clam farming or conservation.

Pacific countries have a rich tradition of community management of natural resources. Viewing this tradition as a resource to tap could both improve policy decisions and help to preserve local knowledge of the local natural environments. Conservation initiatives should be not only about preserving natural environments, but also about preserving our knowledge of these.

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Western Samoa

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Part IV

Markets and Economics of Production in the Pacific Islands

13 Domestic Markets and Demand for Giant Clam Meat in the South Pacific Islands: Fiji, Tonga and Western Samoa

Luca Tacconi

Clem Tisdell

Abstract

This chapter analyses the domestic markets and demand for giant clams in Fiji, Tonga and Western Samoa. For the three countries, historical trends in giant clam marketing are presented. The potential domestic markets for giant clam meat are then considered. The demand by the tourist sector (e.g. hotels and restaurants) is found to be very limited in Fiji and almost non-existent in Tonga and Western Samoa. Demand by private consumers (households) may be sufficient to support a small clam maricultural industry. Characteristics of the preferences of Fijian consumers for giant clam meat are also considered.

Introduction

The objective of this chapter is to assess the demand and markets for giant clam meat in Fiji, Tonga and Western Samoa. After several years of research, introduction and extension of giant clam farming is being promoted by the fisheries divisions of several Pacific countries. An assessment of the economic potential of domestic markets, export markets and production conditions is therefore needed. This chapter addresses the first issue; the other two topics will be dealt with in Chapters 14 and 15.

The structure of the fish markets and the amount of information available about these varies across the three countries under consideration. In order to give a clearer picture of the specific conditions of each country, the results for each are presented separately.

This report is based on information and data collected in Fiji, Tonga and Western Samoa during the period 26 August–3 October 1991. Exchange rates at the time of the survey were as set out below.¹

¹Fiji: F\$=\$A0.90; Tonga: Pa'anga (\$T)= \$A1.00; Western Samoa: Tala (W\$S)= \$A0.60.

The Fijian market for giant clams

The species of giant clams still naturally found in Fijian waters are *Tridacna derasa*, *T. maxima*, *T. squamosa* and *T. tevoroa*. However, only the first two species, according to the (Fiji) Fisheries Division's annual reports, are found in the marketplace. Figure 13.1 presents data on quantities and prices for giant clams marketed in Fiji during the period 1980–90. Some comments about these data are needed. It appears that over the 11 years considered the total quantity of clams marketed has not varied greatly. However, some changes have occurred. Since 1986 marketed quantities of *T. maxima* have increased several-fold, whereas the opposite trend is clear for *T. derasa*. The latter species was the basis of an intensive export trade between 1984 and 1988, and this exploitation was partly responsible for a considerable reduction in the natural stock of *T. derasa*. The large quantities of *T. derasa* marketed in 1987 (and to some extent in 1986 and 1988) were mainly by the National Marketing Authority (the commercial arm of the Fijian Army). It mainly exported the adductor muscle, selling the frozen mantle on the local market.

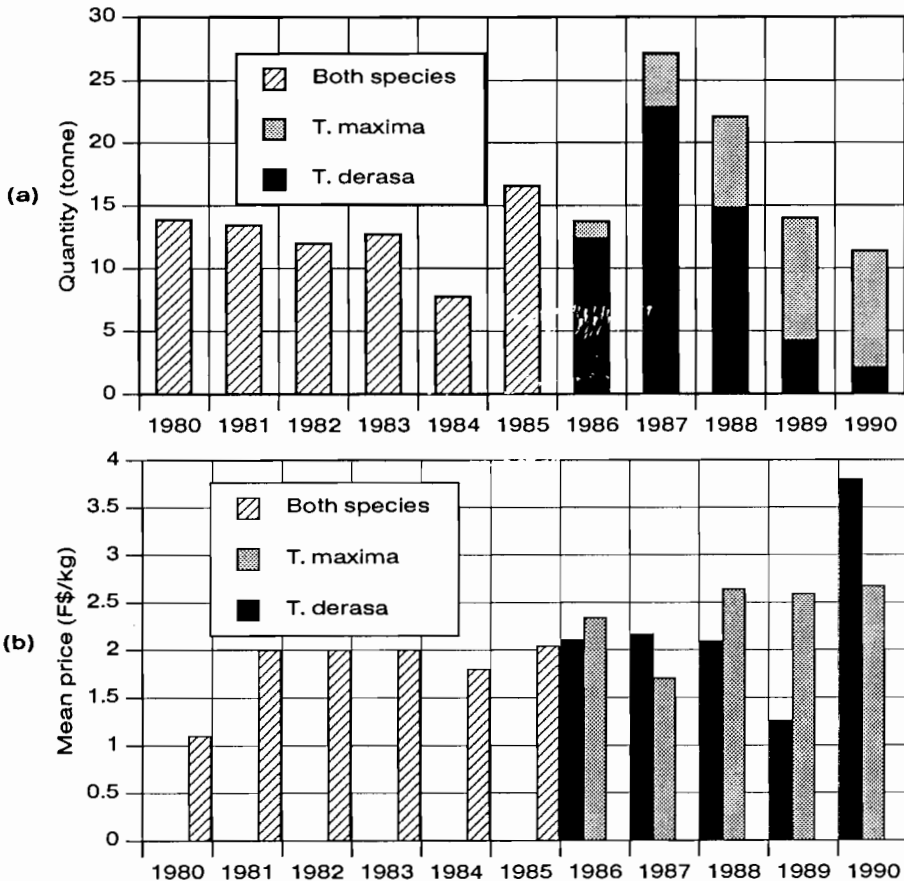


Figure 13.1 Quantities (a) and prices (b) of giant clam marketed in Fiji.

Note that the supply of clam meat almost doubled between 1986 and 1987 without any impact on its price. This might indicate that the demand for clam meat is fairly elastic and that a sizeable increase in supply does not greatly affect the price.

A word of caution is necessary about the estimation of the mean prices presented in Figure 13.1. Giant clams are sold on the market both in their shell and without their shell. This makes estimation of the mean price fairly difficult and subject to approximation. The prices reported in the Figure 13.1 should be considered as the prices of in-shell clams (Sogovale pers. comm.). In fact, in the Fisheries Division's annual reports the prices per kilogram given for other shellfish include the shell, as for example for *Batissa violacea*, locally known as Kai (a freshwater shellfish). If the price per kilogram reported in Figure 13.1 is taken as that for the total weight inclusive of shell and adopting a ratio of 0.16 for meat weight/total weight, the net price of *T. derasa* meat for the year 1990 would be approximately F\$24. This appears to be a high price, but is not very different from the one recorded by the Marketing Authority in Tonga for live clams.² According to a former employee, the Fijian National Marketing Authority (NMA) was selling frozen clam mantle in 1986-87 for prices ranging between F\$0.5 and 1.5. The interviewee also remarked that the NMA 'had a hard time selling the totality of clam meat'. Whether that was due to an oversupply of clam meat or to marketing problems is an open question.

In relation to Figure 13.1, it should also be noted that data for the year 1984 were extracted from Fijian Fisheries Division's files and not from annual reports as was the remainder of the data. This may be partly responsible for the sizeable difference in the recorded quantity of clam meat marketed in 1984 compared with 1983 and 1985.

The quantities marketed, as reported in Figure 13.1, refer to commercial sales at municipal markets, roadside markets, hotels and restaurants, and other shops such as supermarkets and butcher shops. Local trade (e.g. at village level) and subsistence consumption are not measured. Fisheries Division (1986) 'guess-estimated' subsistence consumption to be about 40 tonnes a year.

The potential domestic market

The potential of the domestic Fijian market to absorb clam meat cannot at present be estimated in precise quantitative terms. Nevertheless, this section presents information collected during fieldwork, in order to provide a picture of the 'possible' market potential. It raises issues that should be taken into account in developing the giant clam mariculture industry.

²During field work conducted for this report, at the Saturday fish market in Suva only one large clam of approximately 30-35cm was sold for F\$13. Taking a meat weight of 500-700gm, the price for clam meat would be in the range of F\$18-26/kg.

A giant clam producer in Fiji, the export market aside, can market his/her produce to domestic consumers, and to the hotels and restaurants, which mainly cater for overseas tourists but also to a limited extent for domestic tourists.

The 'hotel and restaurant' trade

In research on aspects of giant clam marketing, some testing of the possible acceptability of clam products in restaurants and hotels has been undertaken (e.g. Cowan 1988) and it has been suggested that the potential size of this market is worth examining, because tourists might show considerable interest in exotic food (Hambrey 1991). Several hotels and restaurants were surveyed in Fiji, to determine their use of giant clam meat. However, before presenting the details of this survey it is helpful to consider some characteristics of the structure of the fish market in Fiji.

The structure of fish marketing in Fiji has changed considerably over the past decade. According to the Fiji Fisheries Division (1990), in 1978 about 50 per cent of total fish produce (i.e. fish, shellfish, etc.) was marketed through municipal markets and the other 50 per cent through other outlets such as shops, restaurants, hotels, butchers, supermarkets and cafés. In 1990, municipal markets accounted for only 16 per cent of the total fish market. The composition of the marketed fishery produce had also changed. While in 1978 non-fish products (e.g. crabs, bivalves) accounted for only 3 per cent of the market, this figure had risen to 19 per cent in 1990. Within the category of non-fish sales, hotels and restaurants have increased their share over recent years, as indicated in Table 13.1.

Table 13.1 Volumes of non-fish sales (metric tonnes) in Fiji.

Year	Municipal markets	Other outlets	Total	Hotels and Restaurants	%
1987	1336.89	590.31	1927.20	33.94	1.8
1990	1298.05	536.70	1834.75	101.81	5.5

Source: Data from Fiji Fisheries annual reports 1990 and 1987.

Non-finned seafood purchased by the hotel and restaurant trade consists almost exclusively of crustaceans. Crustaceans are the most expensive non-finned fish produce and accounted for about 70 per cent of the value of non-finned fish marketed in 1990. Given that the share of restaurants and hotels in this produce was about 45 per cent, their (approximate) total share of the non-finned fish market was around 31 per cent in 1990 for a total value of about F\$1 073 300.

If the giant clam mariculture industry could access this market, it would have good prospects for expansion. From Table 13.1 the fast growth in demand for seafood from the hotels and restaurants is clear. However, from the data and information collected it seems that the likely share of giant clam products in this market could be quite small. Giant clams have been available on the Fijian market over the last few years, but few have been sold through hotels and restaurants. According to

Fiji Fisheries Division annual reports, in 1987 and 1990 the weight of giant clams (*T. derasa*) sold by hotels and restaurants was only 80 kg, or less than 1 per cent of the total marketed quantity. This is in sharp contrast, for example, to the situation for lobster. In fact, demand by tourists for this product is very high and the share (by value) of hotels and restaurants in lobster sales was 46 per cent in 1987 and 61 per cent in 1990. These data indicate little interest by this sector in giant clams as seafood. This deduction is supported by the interviews conducted with managers of hotels and restaurants.

There are just over 80 hotels in Fiji. They range in size from large international hotels with more than 400 beds to small isolated resorts which accommodate only a few guests. Nine hotels, representing about 10 per cent of the total number of hotels in Fiji, were contacted. Given that six hotels in the sample are amongst the largest in Fiji, two are medium-sized ones and only one is of small size, they account for a market-share much in excess of 10 per cent. It should also be noted that many small hotels do not provide restaurant facilities. Of the nine hotels contacted, only three were presently serving giant clams. Only one had giant clams on the menu on a regular basis and this was served as 'seafood salad' at F\$4 per portion. Of the other two hotels, one served giant clams at its Saturday night banquets while the other one served clams only every two to four months at special receptions. The hotel serving clams on a regular basis is located at Sigotaka (southwest coast of Viti Levu) and buys directly from fishermen at a price in the range of F\$3-4.50/kg. They use about 40-50 kg giant clam meat 'almost' every week and have been serving clam meat for the last 8 years. Supplies of clam meat are said to be sufficient to their needs and they could not increase sales.

Of the other two hotels, the one located in Naoli found supplies of clam meat to be sufficient to satisfy its needs, and was buying clams directly from fishermen at a price of F\$5/kg. The manager of the second hotel in Suva found clam meat difficult to find on the Suva market. However, when clam meat is available the hotel uses only 2-3 kg per week. Clam meat is served raw in coconut milk and appears to be popular with Japanese tourists. The clientele of this hotel consists of Japanese (50 per cent) and European tourists (50 per cent).

Of the other six hotels contacted, only one, based on the southwest coast of Viti Levu, had tried giant clam meat in the past. The local fishermen were not providing a regular supply of clam meat to it, and clam meat was said not to be very popular with European tourists, who make up 99 per cent of the guests of that hotel. The remaining five hotels were not using giant clam meat and as far as the staff knew, they had not used it in recent years. One of the reasons given was that the chefs, of Indian and European origin, do not like or do not know giant clam meat.

Of the 36 major restaurants in Fiji, 13 were contacted. None of them had giant clam meat on the menu. Only one of three restaurants specialising in seafood had used clam meat in the past but was now finding it difficult to buy fresh clam meat of good quality. This restaurant, located in Suva, used to use about 10 kg of clams a week, buying this quantity at F\$3-4/kg. The adductor muscle was the only part served, marinated in lemon juice. The mantle was found to be difficult to prepare

for European tourists. The muscle was sold at F\$3.50 per portion and six portions could be prepared with one kg of muscle.

Four Indian restaurants contacted did not serve clam meat because it was claimed not to be a traditional Indian dish and customers would therefore not ask for it. The same applied to three 'Continental' restaurants. Of 25 Chinese restaurants, 6 were contacted. Again, some owners or managers answered that clams are not part of their traditional diet. Some knew giant clams but said that there was no demand for giant clam meat.

Giant clams were known to the manager of an Italian resort but he said that there was insufficient supply of them and that they 'are banned'. However, his answer probably arose from lack of knowledge of the clam market (little interest in it?) as most of the clams presently sold in Fiji are marketed at the Lautoka market reasonably close to this Italian resort.

From the above evidence, a giant clam mariculture industry could expect only to sell a small share of its produce to the hotel and restaurant sector, at least given this sector's present knowledge of clam products. However, the development of new clam products might attract more interest from this sector.

The Fijian household consumer market

As already noted, the Fisheries Division estimates that subsistence consumption of giant clams could be around 40 tonnes a year, and the quantity of marketed clams is of the order of 10 tonnes a year.

Indian people appear not to like giant clam meat. Even if there are occasional exceptions, it can be safely assumed that, on the whole, only native Fijians consume clam meat.

At the 1986 census, the Fijian population was estimated to be 329305. Approximately 60 per cent of Fijians live in rural areas, i.e. about 197000. If we assume that Fisheries Division's estimates of subsistence consumption of clam meat of 40 tonnes per year consumed in rural areas, this gives an annual average rural per capita consumption of clam meat of 203 g. In urban areas, taking the 1986 figure of marketed clam meat, per capita consumption of clam meat would be 13.74 tonnes as indicated in Table 13.1, and, given an urban Fijian population of 132305, per capita consumption of clam meat would be 104 g. These are only very rough estimates but certainly support the conclusion that the contribution of clam meat to the local diet is small. While this may not be so in some villages, particularly some coastal villages, we are concerned here with the aggregate picture. Jansen (1990) reported that in 1984 the average per capita consumption of fish was 41.5 kg per Fijian but the contribution to food consumption of shellfish was small. The Fijian household consumed on average 0.5 baskets of shellfish a week. If a basket has an average weight of 2 kg of shellfish (as was found during fieldwork at the fish market in Suva) its net meat weight is about 320 g. Using Jansen's (1990) estimate that a Fijian household has, on average, 6.4 members, per capita annual consumption of shellfish in urban areas is 1.3 kg.

Given that giant clams constitute only a minor proportion of the shellfish marketed,³ the average per capita consumption of giant clams, estimated above, is in line with the results of Jansen (1990). The question to be addressed is whether this consumption would rise as a result of an increased supply of clam meat and what would be the level of price paid per unit of this increased supply. To find a tentative answer to these questions, retailers and consumers were interviewed.

The structure of the clam meat market is relatively simple. Women and men collect clams on the reefs close to their villages. Then it is usually the women who sell the clams and other products at the fish market (weekly in Suva). Clam meat was also sold through supermarkets and butcher shops. Two supermarkets were contacted in Suva. Only one used to sell giant clam meat, but it had stopped as 'There is no supply'. It received pre-cooked mantle (the muscle was apparently sold to someone else, possibly for export) from individual fishermen in the Lau group. The quantity bought (at F\$3.20/kg) was about 50 kg every fortnight. The retail price was F\$4.50/kg. The manager of the fish section of the supermarket thought that the maximum retail price could be about F\$4.75/kg and that they could not increase their sales to much more than 50 kg fortnightly. However, if 'the quality was good some increase in sales could be achieved'.

Five butcher shops were also contacted. Two of them did not deal in fish. The other three were selling fish (fresh and frozen fish, crustaceans) but not clam meat. According to them there is no market (or only a slight one) for clam meat. Unfortunately, during the two weeks of fieldwork in Fiji, only one woman sold clams (one) at the market, so that it was impossible to interview a sample of retailers at the market. She stressed the fact that the clam she was selling was so expensive (F\$6 for a 30–35cm clam) because 'they are very difficult to find and that the clams left in the water are all very small'.

Fijian consumers were also interviewed to ascertain their preferences, frequency of consumption of clam meat and sources of supply. Seventy-seven consumers were interviewed, but only 68 questionnaires will be considered here due to the dubious nature of the results for nine of them (one batch). It should be stressed that the objective of this survey, given the limited number of consumers interviewed and the manner in which they were chosen (people encountered at the fish market), is not to draw conclusions that can be extended at the national level but simply to gather some ideas, in a limited amount of time and with limited resources about some factors that can affect the clam meat market.

To ascertain consumer preferences a pairwise ranking matrix was used.⁴ Giant clam meat is not considered a substitute for finned fish therefore, in the ranking exercise, clam meat was compared with Kai (*B. violacea*), bêche-de-mer and

³1 Ranking by quantity of shellfish sold in Fiji in 1990:

- 1 *B. violacea* mt 1175.63;
- 2 *A. cornea* mt 88.06; and
- 3 Tridacnidae mt 11.36

⁴For information on this methodology, see the International Institute for Environment and Development (1989).

octopus, species which, like giant clams, have a marginal role in the local diet. Figure 13.2 shows an example of pairwise matrix ranking. Each species listed is compared with the others and a ranking of preferences can be established. The interviewee is asked to state if he/she 'prefers eating' giant clams or Kai, giant clams or bêche-de-mer and so on. The answers are marked down in each box at the intersection of the row and column representing the two species considered. The dotted boxes arise because of the impossibility of comparing a species with itself. For example, the hypothetical consumer, whose answers are reported in Figure 13.2, would prefer giant clams (3 preferences) to kai (2 preferences), octopus (1 preference) and bêche-de-mer (zero preferences). This procedure allows the determination of the 'preferred' species by each respondent. Thus, the adoption of this methodology enables ascertainment of consumers' preferences independently of the influence of relative prices.

	GC			
Giant clam		K		
Kai	GC		BM	
Bêche-de-mer	GC	K		O
Octopus	GC	K	O	

Figure 13.2 Pairwise matrix ranking.

Of 68 consumers, 8 (11.8 per cent) did not like clam meat, therefore they were not tested for preferences. The remaining 60 consumers expressed their preferences in the way reported in Table 13.2.

Table 13.2 Preference ranking for four species of non-finned fish.

Number of respondents	First preference	Percentage
30	Giant clams	50.0
22	Octopus	36.7
5	Bêche-de-mer	9.3
3	<i>Batissa violacea</i>	5.0
60		100.0

Note that, of the four species tested, Fijian consumers prefer the giant clam the most. *Batissa violacea*, the most common bivalve, comes last with only 5 per cent of respondents ranking it as their first preference.

The frequency of consumption of giant clams was also considered in the survey and is reported in Table 13.3. Thirty per cent of the respondents consumed clams at least once a week and more than 50 percent (56.66 per cent) of them consumed clam meat at least monthly.

Table 13.3 Frequency of consumption of giant clams.

Frequency	Frequency of consumers' preferences as expressed in pairwise ranking		
	Preferred species	Non-preferred species	Total
At least weekly	6	12	18
At least monthly	9	7	16
Less than monthly	5	9	14
When available on market	10	2	12
	30	30	60

The relationship between the preferences expressed by respondents for giant clam meat in relation to other non-finned fish was considered. These showed no significant association using a Chi-square test.

To perform the Chi-square test, the categories 'Less than monthly' and 'When available on market' were grouped. This was done for three reasons. Firstly, only one of four investigators collected six answers 'When available on market'. His personal judgment of the interviewee's answer, or the way in which the question was posed, could influence the outcome of the survey. Second, in carrying out Chi-square tests the use of very small sample groups (fewer than five individuals) should be avoided and groups should be clustered together. Third, complementary to the previous one, 'When available on market' is interpreted as occasional consumption and can be grouped with 'Less than monthly'. The Chi-square statistic was 3.24 and is not significant at the 10 per cent confidence level. The frequency of consumption may be influenced by other variables such as income, island of origin (i.e. where giant clams are consumed on a regular basis) and general preference for seafood compared with other food items.

The interviewees were also asked about the source of the clam meat consumed. The results are presented in Table 13.4.

Less than 50 percent of the respondents relied solely on the market as a source of clam meat. Of these, the majority—about 60 per cent—consumed clam meat at least monthly. Again, of the respondents that collected giant clams, the majority consumed giant clams at least monthly. A more uneven consumption pattern is evident for the groups that rely on composite or gift sources. Gifts of giant clams are usually sent from the village of origin of recipients and among the respondents it appeared that gifts from the Lau group were quite frequent. One consumer received clams by plane almost every week from Lakeba. Consumers whose village of origin is in the Lau Group also appeared to be the keenest clam consumers, whereas people from inland villages, because of their geographical location, do not eat clam meat very often and sometimes they do not know how to prepare it.

Table 13.4 Source of clam meat consumed and frequency of consumption.

Frequency	Source of clam meat							
	Buy		Collect		Gift		Composite	
	PS	NP	PS	NP	PS	NP	PS	NP
At least weekly	3	6	2	3	0	0	1	3
At least monthly	5	3	3	0	0	2	1	2
Less than monthly	2	1	2	3	1	1	0	4
When available on market	5	2	0	0	0	0	5	0
Subtotal	15	12	7	6	1	3	7	9
Total	27		13		4		16	

Legend:PS: Preferred species as from pairwise ranking

NP: Non-preferred species as from pairwise ranking

Composite: Combination of sources: e.g. buy and gift.

Respondents were asked if their present supply of clam meat was sufficient for their needs. The distribution of their answers is presented in Tables 13.5 and 13.6. In Table 13.5 the answers from all respondents are included, whereas Table 13.6 shows the answers of the respondents whose exclusive source of clam meat is the market. As already remarked at the beginning of this section, the present results are purely exploratory given the limited size of the sample. In the pooled group presented in Table 13.5 it is interesting to note that 50 per cent of those interviewees who rated giant clams as their preferred species stated that available supplies are sufficient for their needs.

Of this 50 per cent, the majority is concentrated in the consumption categories 'At least once a week' and 'At least once a month'. This suggests that when consumers are genuinely interested in clam meat, they can usually find sufficient supply. In the category of 'Not preferred species', the majority of consumers did not find the supply of clam meat to be sufficient. The percentage of those unable to find

Table 13.5 Distribution of answers to the question: 'Can you find as much clam meat as you would like?'. (All respondents included).

	Preferred species		Not preferred species	
	Yes	No	Yes	No
At least once a week	5	1	5	7
At least once a month	5	4	2	5
Less than monthly	4	1	2	7
When available on market	1	9	0	2
Total	15	15	9	21

as much clam meat as they like increases for those who consume clam meat only occasionally ('Less than monthly' and 'When available on market'). The influence of preferences seems to arise also in Table 13.6, where buyers in the category 'At least once a week' declared that they could find sufficient clam meat, and all consumers grouped under 'When available on the market' said the supply was insufficient.

From Tables 13.5 and 13.6 scarcity of supply of clam meat seems dominant. Sixty per cent of the respondents (Table 13.5) declared that supplies of clam meat are insufficient. As expected, this percentage is slightly higher (63 per cent) in Table 13.6, where only 'buyers' of clam meat are considered.

Table 13.6 Distribution of answers to the question: 'Can you find as much clam meat as you would like?'. (Only clam buyers included).

	Preferred species		Not preferred species	
	Yes	No	Yes	No
At least once a week	3	0	3	3
At least once a month	2	3	1	2
Less than monthly	1	1	0	1
When available on market	0	5	0	2
Total	6	9	4	8

Several respondents pointed out that giant clam meat is currently expensive. It has already been noted that clams in the shell can reach a price of over F\$20/kg. Even if clams are regarded by some consumers as a delicacy, it cannot be assumed that maricultured giant clams sold on the market in sizeable quantities would attract a price much higher than that of fish or substitutes such as *B. violacae* (kai). The weighted mean price of fish in 1990 was F\$3.28/kg. Taking the edible percentage of whole weight fish to be 80 per cent, the price for net weight of meat would be F\$3.94/kg. The maximum fish price reported for 1990 was F\$5.14/kg. That yields a net meat price of F\$6.17/kg. As was remarked by one respondent, 'two dollars worth of kai (one 'heap') provides a meal for a family of four and this is much cheaper than giant clams'. The net weight price of kai reported during fieldwork was F\$2.50/kg net of shell. This price should be kept as a reference point when planning the local marketing of clam meat in substantial quantities, since it might constitute a floor-price for giant clam meat.

The Tongan market for giant clams

Five species of giant clams used to be found in Tonga: *T. derasa*, *T. squamosa*, *T. tevoro*, *T. maxima* and *H. hippopus*. However, the last appears to have become extinct in Tongan waters (Manu et al. 1989).

Statistics on fish landings have been collected in Tonga for only a few months (starting date: 1 July 1991). It was therefore not possible, unlike Fiji, to consider the statistical trend in marketing of clam meat over recent years. McKoy (1980) reported the following estimated landings of clam meat in the Tongatapu group (whole weight):

1974	24090 kg	1977	88096 kg
1975	41344 kg	1978	153293 kg
1976	83450 kg		

Taking the landings for 1976 and assuming a ratio of meat/whole weight in the range 0.07 to 0.17 the annual per capita clam meat consumption in Tongatapu (population 57000 in 1976) would be 102–235 g. This figure is similar to that for Fiji. However, the twofold increase in landings between 1976 and 1978 would bring per capita consumption up to 182–417 g.

The only other data available are those from the survey of fish landings started by the Ministry of Fisheries in July 1991. During the first 10-week period of the survey, giant clams appeared on the market quite regularly.

Some respondents (fishermen and market retailers) reported that there is less diving for clams in winter compared with summer, when the water is warmer. Thus, the quantities reported in Table 13.7 are for a winter period and may underestimate annual landings of giant clams in Tongatapu if they are scaled up to cover a year. Also, the survey of fish landings had just begun and, with experience, some improvements and refinements in data collection could be expected.

Taking the average weight of a basket of giant clams worth T\$10 to be 8 kg (as found from fieldwork) and that of a T\$5 basket to be 4 kg, the total weight of giant clams marketed over the 10-week period is estimated with their shells to be 1508 kg. Clams sold in baskets fall within a limited size range. The net (meat) weight of an 8 kg basket was found to be 560 g. This gives a ratio of meat/whole weight of 0.07. The weight of clam meat (net of shells adopting a ratio in the range 0.07–0.16) would be approximately 105–241 kg over the 10-week period. Including clams sold on 'strings' (clams sold on a string have an approximate meat weight per string of 2 kg) the total net weight of sales of clam meat would be 123–259 kg. The annual landings would therefore be in the range of 639–1346.8 kg. This amounts to only 5 per cent of the size of the landings estimated by McKoy (1980) and would give only an annual per capita consumption of clam meat for Tonga of 19 g. The extent to which this is an underestimation of actual landings and the extent of the decreased landings due to overexploitation since McKoy's estimates were made can be assessed only when further data becomes available from the Ministry of Fisheries.

Unfortunately McKoy (1980) did not report the market price for clam meat at the time of his survey. This would have allowed a comparison with current prices. During fieldwork a wide range of prices was found to exist for giant clams. Live

Table 13.7 Frequency, quantities and prices of giant clams marketed in Nuku'alofa, commencing 1 July 1991.

Survey week No.	No. of market days in the week	No. of days on which clams were sold	Quantity ^a (No. of baskets or strings)	Price ^b per unit (T\$)
1	6	5	B 5	5
			B 17	10
			S 9	10
2	6	3	B 20	5
3	5	3	B 5	5
			B 5	10
4	6	5	B 2	4
			B 33	5
			B 20	10
5	6	5	B 22	5
			B 18	10
6	5	2	B 13	10
7	6	2	B 15	10
8	3	2	B 1	5
			B 19	10
9	1	0	-	-
10	5	2	B 13	5
			B 31	10

Source: Ministry of Fisheries Files

Legend: B = basket

S = string

^aTotal quantity is slightly underestimated as landings for 3 days were not clearly reported in Fisheries files and were therefore excluded.^bPrice is whole weight for baskets, kg/net weight for strings.

clams sold in a 'basket' recorded a price of T\$17.8/kg for their meat. Large clams (e.g. *T. derasa* over 30 cm) attracted a price ranging from T\$10 to T\$14 each. A clam bought at the market by Tacconi for T\$10 yielded 750 g of meat, thus implying a price for its meat of T\$13.3 or F\$17.7/kg. Fisheries data show that clams sold on a string sell for around T\$10/kg. The abovementioned prices are for fresh clam meat. During a market day, frozen meat of giant clams (33 bags of 1 kg each) were being sold for T\$5/kg. They had been fished in Ha'pai and sent by boat to the Nuku'alofa market. This discrepancy in prices could be due to the fact that the latter clams were not as fresh as the former ones, their colour being 'yellowish'. They had been fished several days before their actual marketing.

By observing the marketing of giant clams at the shellfish market in Nuku'alofa (where the most commonly traded clams were *T. squamosa* and *T. maxima*) the impression may be obtained that clams are not scarce. For instance, on 12 September 1991, 25 'baskets' (T\$5 each), 10 large clams and 15 medium-sized clams were counted. The market started at 8.00 am and by 1.00 pm about half of the produce had been sold. Later in the afternoon some of the clams were still unsold. An interview undertaken with one of the market retailers revealed that it happens often that there are unsold clams at the end of the day. This apparently limited demand for clam meat is due partly to the fact that they are expensive in comparison to other fish products. At the time of the fieldwork, the average price of fish was T\$2-3/kg.

The relatively high price for clam meat may be due to at least two factors. The first is the economic scarcity of giant clams. It is important to differentiate between physical and economic scarcity (e.g. Dewes 1989). Physical scarcity refers to the natural availability of a resource. The natural availability of giant clams is currently lower than in the past (Manu et al. 1989). Economic scarcity refers to the availability of a resource in order to satisfy the needs of customers. Physical scarcity does not imply economic scarcity as the resource may have a close substitute. Thus the price of a resource is not determined by physical scarcity but by economic scarcity. The high relative price of giant clams in Tonga may therefore indicate local economic scarcity.

However, another factor may be having a relatively important influence on the price of clam meat. According to market retailers and fishermen, a substantial share (some hypothesised up to 50 per cent) of the clams fished in Tonga are sent to Tongans who have migrated to countries such as New Zealand, Australia and the USA. The purchasing power of these expatriates is much higher than that of the Tongans living at home, who often find the price of clams too high.

Note that even without taking into account the influence of expatriate Tongans, the price of clam meat as measured in Nuku'alofa is largely urban determined. It does not reflect economic scarcity in rural villages. Wage income is concentrated in Nuku'alofa, the capital of the Kingdom, and it attracts migration from the rest of the archipelago. Giant clams fished in the Tongatapu and Ha'apai archipelagos appear to be marketed in Nuku'alofa where according to fishermen and retailers interviewed 'people pay higher prices for giant clams'.

According to a fisherman from Tongatapu, most of the clams are sold in Nuku'alofa and rarely in the village. When giant clams are sold in the village the price asked for them is normally lower than Nuku'alofa 'because of social obligations'. The Nuku'alofa market is also supplied from the Ha'apai group. At least three operators (middlemen) were identified as supplying this market. One operator, based in Pangai (administrative centre of Ha'apai) buys the clams from 15-20 fishermen, mainly from the island of Uiha and neighbouring islands. The clams taken out of the shell are kept in a freezer until a sufficient quantity (50-100 kg.) is accumulated to be sent by ship to Nuku'alofa. This happens on average once a week. This retailer also sells locally for T\$5.5/kg. However, he affirmed that

local people buy for relatives in Nuku'alofa. The latter send the money to Ha'apai thinking that clam meat is cheaper there. In his opinion, local people cannot afford to buy clams at that price.

Two more operators, one based in Ha'apai and the other in Nuku'alofa, use their own fishing boats to trade in clam meat. The operator based in Ha'apai, whose main activity is deep-sea fishing, collects clams and also buys them from fishermen living on the islands between Pangai and Tongatapu. Clams are collected mainly in summer when he can sell up to 100–200 kg of frozen clam meat per week. The purchase price is approximately T\$2.50/kg and the retail price is T\$5/kg. The other operator based in Nuku'alofa, collects clams in the Ha'apai group in Summer (October–February) and sells about 100–200 kg clam meat per week at the Nuku'alofa market.

The Vava'u archipelago was also surveyed and it was found that only one shop, owned by a local fish exporter, was retailing small but undisclosed quantities of clam meat (mantle) for T\$7/kg. The adductor muscle is exported. This business has an agreement with several fishermen to buy 'all' their catch, and this includes giant clams. An informal local market for clam meat might exist but because of the limited time available it could not be assessed.

The retailers contacted in Tonga could not assess whether they were able to increase clam meat sales, but the prevalent feeling was that the demand for giant clam meat was being satisfied. The few restaurants and hotels catering for the small number of overseas visitors to Tonga (39350 in 1987) do not deal in clam meat. Therefore they would be unable to absorb a substantial quantity of clam meat produced by a domestic clam industry.

The Western Samoa market for giant clams

Two species of giant clam are found in Western Samoa: *T. squamosa* and *T. maxima*. *Hippopus hippopus* has, it seems, become extinct. Statistics on fish landings are scanty but those available for recent years reveal a worrying decline in inshore landings of fish, including those of giant clams. The period 1986–90, for which consistent data are available (except for 1988, yet to become available), shows a sharp decline in the total weight of inshore finned fish marketed in Apia, from 246 tonnes in 1986 to 49 tonnes in 1991 (FAO 1990). According to FAO, factors such as change in the marketing structure, increase in domestic consumption in villages and a decrease in the artisanal fishing effort might have contributed to this dramatic decline. However, these factors alone are considered to be insufficient to explain the decline, and stock depletion is thought to be an important factor.

A sharp decline in quantities marketed has also been recorded for giant clams: from 10 tonnes (whole weight) in 1986 to 0.1 tonnes in 1990. In 1990, a further 0.3 tonnes appear to have been sold through hotels, restaurants and other shops. Estimates of giant clam use for subsistence are not available. From preliminary results

of the survey being conducted as part of the current FAO resource assessment project, giant clam catches seem to be very sporadic (Zann, pers comm).

From estimates of consumption provided by Zann et al. (1984), daily per capita consumption of invertebrates by Western Samoans was approximately 43 g (net weight) in rural areas and 26 g in urban areas. Per capita finned fish consumption was estimated to be 203 g/day in rural areas and 80 g/day in urban areas. If it is assumed that the edible weight of finned fish is 80 per cent of their whole weight (Jansen 1990), consumption of invertebrates would account for about 20 per cent of total fish consumption in rural areas and 29 per cent in urban areas. Zann et al. (1984) estimated that fish (finned and invertebrates) provided about 82 per cent of the minimum daily protein requirements of Western Samoans in rural areas and 35 per cent of that in urban areas. However, it should be noted that, if an 80 per cent recoverable meat weight for finned fish is applied, these estimates would be reduced to 65 per cent in rural areas and 30 per cent for urban areas. These earlier estimates would overestimate present consumption of fish, as preliminary estimates for 1991 of annual per capita fish consumption are in the range of 25–35 kg for rural areas and 15–20 kg for urban areas (Zann, pers comm). These levels are approximately 28–38 per cent of previous figures for rural areas and 39–52 per cent of previous estimates for urban areas. To what extent has statistical assessment improved and/or consumption of fish changed? A survey detailing consumption of all items in the diet (and not just fish) is needed to give more reliable estimates of consumption patterns and trends.

Zann et al. (1984) also provided estimates of the shares of different invertebrates in consumption of seafood by Western Samoans. Miscellaneous bivalves (which include giant clams) accounted for 9 per cent of consumption of invertebrates, followed in importance by gonads of sea cucumbers (49 per cent), gonads of sea urchin (14 per cent) and sea-cucumber bodies (11 per cent). Adopting consumption estimates provided by Zann et al. (1984), bivalves would have contributed approximately 1.2 per cent by weight to food-intake in rural areas and about 0.8 per cent in urban areas. The contribution of giant clams to food intake is very small, as they represent a fraction of invertebrates consumed. In 1986, they accounted for about 27 per cent of the invertebrates marketed at the Apia fish market. Their share had declined to 1.8 per cent in 1990. This decrease happened amid a general reduction in the quantity of marketed invertebrates through the Apia fish market: from a total of 37.1 tonnes in 1986 to 5.6 tonnes in 1990.

If the decline in marketed giant clams is due to stock depletion, as postulated by FAO (1990) and as appears to be so from further details reported in Tacconi and Tisdell (1992; see also Ch. 12), and not to a change in demand or structure, a clam farming project could look to filling an apparent gap in supply of about 10 tonnes (gross weight) a year (i.e. the difference between the quantity of giant clams marketed in 1986 and that marketed in 1990). In terms of net meat weight, this amounts to 1–2 tonnes depending on the factor (0.1–0.2) adopted to calculate net meat weight from clams in the shell. This market could be most likely satisfied by a single farm.

If clams (*T. derasa*) are harvested at 6 years of age, the supply of 10 tonnes (whole weight) would require approximately 2300 clams (weighing an average of about 4.3 kg; see Munro 1988). This could be supplied on a continuous basis by establishing approximately 15300 (maximum) to 7600 (minimum) clams each year on the farm. The higher figure applies if the cumulative mortality rate at the end of the year is 85 per cent and the lower figure if it is 70 per cent.⁵

The likely retail price for farmed clams is difficult to determine. In interviews with fishermen, current prices were reported to be about WS\$30 and higher for large clams, WS\$10.30 for medium clams and WS\$5 for small clams. However, these price-levels may not hold if substantial quantities of giant clams are reintroduced to the market. Details of prices from Fisheries' Department files are scanty and difficult to interpret. In 1986, the price appeared to be in the range of WS\$6–15/kg. This should refer to whole weight of clams but as prices on the survey forms often appeared to be 'per clam' it is difficult to use these data.

Ten 'other retail outlets' (i.e. hotels, restaurants and shops) that were reported to have sold about 0.3 tonnes of giant clams in 1990, were contacted. None of them had any supply of clams recently (one retailer noted that supply had stopped at the time of cyclone Ofa in February 1990). They expressed the view that interest in clams is very limited and that even if supply was continuous, they could not indicate approximate sales.

A commercial farm is already operating in Western Samoa and the size of the internal market does not seem to justify, at this stage, a further expansion of clam farming in Western Samoa.

The above analysis, combined with the fact that giant clams are only a minor item in the local diet, seems to support Zann's view that the Fisheries Division should probably prioritise its commitments and reduce its resources devoted to giant clam farming (Zann, pers. comm.). This need not imply a complete withdrawal of government support for giant clam farming. For example, a joint-venture with the already existing commercial farm in Western Samoa could be considered. The Fisheries Division, for example, could provide the expertise for the hatchery phase of operations.

Conclusion

The main finding of this study is that local markets and demand do not appear to be sufficient in themselves to justify a large giant clam farming industry in the South Pacific countries visited. There appears to be limited unsatisfied local demand for giant clams, but the extent of this is difficult to quantify. The contribution of giant clams to the local diet is relatively minor. A large local market for giant clam meat at prices sufficient to cover the costs of farming giant clams does not seem to exist in the South Pacific countries visited. The main prospects for a

⁵This is an approximation of data reported by Munro (1988).

giant clam mariculture industry would be for export markets. The economic prospects for such exports need careful examination before it is decided to allocate a considerable amount of resources to the industry.

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14 Exports and Export Markets for Giant Clam Meat from the South Pacific: Fiji, Tonga and Western Samoa

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Clem Tisdell

Abstract

This chapter explores the giant clam meat export experience of Fiji, Tonga and Western Samoa. This is done by reporting on interviews conducted during fieldwork in these countries and by presenting secondary data. For Fiji, the introduction of an export ban for giant clam products meant the interruption of an (unsustainable) export of more than 30 tonnes of clam meat per year. A future clam mariculture industry could therefore look towards at least recapturing this share of the export market. Western Samoa and, to a lesser extent, Tonga have limited experience in clam export due to limited natural availability of clam stocks. In Tonga, there is however some commercial export taking place in the Vava'u group. For export purposes, the Vava'u group appears to be in a better position than the Ha'apai group because of favourable air links to overseas markets.

Introduction

As discussed by Tacconi and Tisdell in Chapter 13, there is only limited demand for giant clam meat in Fiji, Tonga and Western Samoa. The identification of export markets for clam products and likely levels of demand therefore becomes important, if giant clam culture is to bring significant economic benefits to the people of the South Pacific states.

Several studies have reviewed and assessed export markets for giant clam products (e.g. Shang et al. 1991; Chapter 17 this volume; Stanton 1990; Dawson 1986). The objective of this chapter is to assemble information on the export experience of Fiji, Tonga and Western Samoa and draw implications from it for potential export of cultured clams from these countries. Instead of directly surveying overseas markets, this chapter relies on the knowledge of overseas markets available to local seafood exporters and uses statistical information available on giant clam exports from the countries considered. It makes use of the results of interviews with local exporters, secondary data collected during fieldwork in the period of 28 August–3 October 1991 and other secondary sources. The position for Fiji, Tonga and Western Samoa is considered in separate Sections.

Giant clam exports by Fiji

Of the three countries considered, Fiji has had the largest level of commercial exports of giant clams. However, commercial exploitation of tridacnids for export has been discontinued in Fiji because the Fisheries Division found it to be the most serious cause of clam stock depletion. A 10-year export ban on clam meat was imposed by the Fijian Government in December 1988. However, there has been no attempt to regulate exploitation for the domestic market and for subsistence consumption.

Detailed data on quantities of clam meat exports are available since only 1984, when export licensing was first introduced, and are presented in Table 14.1.

Table 14.1 Quantities exported of giant clam meat from Fiji, 1984-88.

Year	Weight (kg)
1984	7276.5
1985	20794.7
1986	16806.0
1987	5490.0 ^a
1988	38493.0

^aData available only for the period September–December
Sources: Fiji Fisheries Division (1986a); Fiji Fisheries Division (1987); and Fiji Fisheries Division Files

In 1984, licensed exports for giant clam meat (mantle and muscle) amounted to 7276.5 kg. The countries of destination were New Zealand ('meat'), Australia ('mantle' and 'muscle') and Taiwan ('muscle'). It is thought that the produce shipped to Australia was being re-exported to Asia. A sample shipment was also sent to Japan (15 kg). In 1985, a large increase in exports was registered. Export for the year were 20794 kg and were distributed as reported in Table 14.2. Also small quantities of clam mantle were sent as test marketing samples to Canada, Australia, Hong Kong, Singapore, New Zealand and Japan in the period 1985-1988. Unfortunately, the outcomes of these tests are not known.

In the first seven months of 1986, total exports amounted to 11316 kg. In the same year, from the end of August to December a further 5490 kg were exported. A sharp increase in exports occurred in 1988, the last year of exports of clam meat. From the files of the Fisheries Division, total licensed exports amounted to 38493 kg, an average of just over 3 tonnes per month.

Exporters were not required to disclose the price received by them for their exports of clam meat when applying for export permits. However, the Fiji Fisheries

Division suggested that these prices ranged between F\$20/kg and F\$40/kg for the muscle, as a commercial operator was reported to purchase the muscle in Suva for F\$7-10.5/kg during the period 1985-86 (Fiji Fisheries Division 1986b).

Three major commercial operators who had been active in the export of clam products were interviewed. They reported FOB (free on board) export prices for the muscle ranging from between F\$12 kg (1986-87) to F\$26 kg in 1988. These operators used their boats to collect clams and also bought from local fishermen. The common practice was to export the adductor muscle and to sell the mantle locally for F\$0.5-2/kg. Limited exports of mantle, as samples and for commercial purposes (at an FOB price of F\$1.5/kg), were reported by these operators.

The above-mentioned exporters (and a fish exporter) thought they could export sizeable quantities of clam adductor muscle (according to one operator up to 3 tonnes per week) to countries such as Taiwan, Japan, Korea and USA. The extent to which the export price of clam muscle (F\$20-40/kg depending on quality of the muscle) is sensitive to variation in the quantities exported is not known, but one operator believed that he could export up to 20 tonnes a year without affecting this price.

The above price level appears to be consistent with the prices for giant clam muscle reported by Shang et al. (1991) for Taiwan. Shang et al. estimated that the price for adductor muscle in Taiwan ranged from between US\$7.69/kg for muscle of less than 100 g in weight, to US\$30.77/kg for muscle of more than 400 g. However, muscles of the largest size can be expected only in clams which are many years old.

It is generally agreed that size and weight of the muscle of the giant clam increase with the clam's age. *T. gigas* and *T. derasa*, the largest species of clams, have the largest muscles and, apart possibly from *T. squamosa*, are likely to be the only species worth farming commercially if the main purpose of the mariculture is to market the muscle, which is currently the only giant clam product having a ready market in Taiwan (Shang et al. 1990).

Shang et al. (1990, p. 11) report that a 5-year-old *Tridacna gigas* (the fastest-growing giant clam) could yield an adductor muscle of 290 g (470 g for a 7-year-old). This may be an overestimate of the actual weight/age ratio for adductor muscle, according to data derived from research at the Orpheus Island Research Station, James Cook University. The average wet weight for the muscles of ten 5-year-old *Tridacna gigas* was found to be 54.81 g (standard error 13.88). The mean dry weight was 12.99 g (standard error 2.99) (P. Lee, pers comm. with L. Tacconi). Moreover, the data of Watson and Heslinga (1988, p.222) indicate that *T. derasa* would have to be at least 7 years in age before its adductor muscle could exceed 100 g.

If farmed *T. gigas* or *T. derasa* are not kept longer than 10 years before marketing, top prices per kilogram for clam adductor muscle are unlikely to be obtained. There are always strong economic pressures not to hold such resources for a very long period of time even if their price per unit tends to rise with age. This is because, after a point, the growth rate of giant clams as a function of age tapers off, mortality continues (even if at a somewhat reduced rate in older clams) and the rate of interest (or returns from alternative investment opportunities) places pressure on commercial operators to turn over their investment periodically. Furthermore, especially in newly established farms, liquidity and cash-flow considerations may dictate that clam stocks be sold at as early an age as gives a satisfactory return rather than waiting for higher returns. Nevertheless, though it may not pay to hold clams in mariculture long enough to obtain the top price for the adductor muscle, it can be profitable to hold them long enough to obtain an intermediate price, a price which of course will be considerably less at the farm-gate than the wholesale or retail price at the place where the end-use of the adductor muscle is to occur.

Preliminary Australian evidence indicates that giant clams (*T. gigas*) can be profitably produced for meat at farm-gate prices which in practice seem achievable in existing or potential markets (Tisdell et al., unpublished data). Such sales are assumed to be based solely on the meat of older clams which can be divided, if so desired for separate sale, into adductor muscle and mantle, a practice previously followed by Fijian exporters. These estimates of profitability are not based upon the supply of giant clams for the Japanese sashimi or sushi market. In Japan, current interest in using giant clams for these purposes is mostly confined to the Ryukyus in the far south of the country. This demand is best satisfied by the supply of *T. crocea* rather than the species currently being favoured for mariculture in Fiji, namely *T. derasa* and *T. gigas*, which are best suited to supply giant clam adductor muscle.

Fiji has had no experience in exporting *T. crocea* which does not occur naturally in Fijian waters. *T. crocea* clams need to be air-freighted to serve the Japanese market and this might be best done in the shell. It would be difficult for Fiji to compete in the market, even though clams to serve this market can be harvested at a relatively young age. If this export market is viable for exporters, strong competition can be expected from the Philippines which has primarily exported *T. crocea* to Japan and which is located within the natural distribution of the species.

In addition to the above, farmed supplies from the Ryukyus are likely to come on stream in Japan. Land-based, or virtually land-based farming operations for *T. crocea* are a possibility there. 'Reefarm', at Cairns in northern Australia, has used land-based tanks to produce all of its *T. crocea* to a stage where they have been sold for sashimi to the Japanese, or to supply the aquarium trade. While this can be done for *T. gigas* and *T. derasa*, the Japanese do not find these species to be very suitable for sashimi.

For mariculture, *T. gigas* has some advantages over *T. derasa* considering the type of export markets which Fiji has supplied in the past. It has the largest adductor muscle and is the most rapidly growing of all clams. Another advantage is that it can be grown in intertidal culture, which is preferred over subtidal culture by

most Fijians (see Chapters 2 and 3). Subtidal culture is the only form of ocean culture to which *T. derasa* is suited. However, it may be that *T. gigas* is not as hardy as *T. derasa* and seems to have become extinct in Fiji—whether due to natural causes or overexploitation by humans is unknown. It has now been reintroduced using stock from the James Cook University Research Station, near Townsville, Australia, with a view to its eventual use for commercial and subsistence purposes and for restocking of reefs.

Whether giant clam adductor muscle might be a close substitute for other seafood products, and therefore the extent of market competition that it might face, is another question worth while considering. A previous exporter of giant clam meat suggested that adductor muscles in the size range of 20–200 g would be in competition with scallops but that muscles over 200 g would have their own separate market and would attract higher prices. However, another exporter thought that clam muscle would be in competition with abalone rather than scallops. The extent to which giant clam meat can substitute other seafood products remains uncertain (see Stanton 1990).

Table 14.2 indicates that the weight of mantle of giant clams exported from Fiji in 1985 approached that of muscle. The categories 'meat' and 'mantle and muscle' do not differentiate between the two components so it is difficult to be precise about the exact composition of the exports. The use made of the exported mantle is unclear but much of it seems to have been consumed by Pacific Islands immigrants in New Zealand, Australia, USA and Canada. This is known to be the case in New Zealand as discussed, *inter alia*, in Chapters 16 and 17. Some mantle may have also been used in manufacturing, e.g. for flavouring manufactured soups (Tisdell 1989).

While Pacific Island immigrants to more developed countries may represent the main existing market for giant clam meat, the potential Taiwanese and Hong Kong markets should not be neglected. Nevertheless, previous studies may have tended to overstress these markets to the detriment of the immigrant markets (Dawson and Philipson 1989).

Direct exports of giant clam meat to Japan by Fiji in 1985 were insignificant. This is not surprising given the unsuitability of Fijian clam products to the Japanese market. Unless Japanese requirements change, Fiji and other South Pacific nations do not appear well placed to achieve export sales of clam products in Japan.

Giant clam exports from Tonga

Detailed statistical information on export of giant clams from Tonga is not available. McKoy (1980) reports that a private operator was engaged in clam meat exports in the mid 1970s, but this business ceased in 1977 because of insufficient natural stocks. From anecdotal evidence, it seems that another exporter was involved in heavy short-term exploitation of clam stocks in the Ha'apai group.

Table 14.2 Distribution of giant clam exports from Fiji by products and by country of destination (1985).

By product	Weight (kg)
Mantle	6355
Muscle	7180
Meat	3341
Mantle/muscle	3823

By country	Weight (kg) product
New Zealand	7970 (mainly mantle)
Australia	5291 (mainly muscle for re-export)
Taiwan	1824 (muscle)
Hong Kong	1280 (muscle)
USA	421 (muscle)
Canada	100 (mantle)

Source: Fiji Fisheries Division (1986a).

The Government of Tonga has not introduced a ban on the export of clam products. However, because of limited natural stock, there is little export of giant clam meat and this activity is not perceived as threat to clam stocks.

Currently, there appears to be no commercial exporter in Tongatapu. Friendly Island Marketing Co-operative Ltd, based in Nuku'alofa, exported small quantities of frozen muscle and mantle to Hawaii during the period 1986-87. They discontinued exporting 'because there was not enough supply'. Records of export prices and quantities were not available.

A returned migrant from the USA reported that, in two successive trips in 1986 and 1987, he sold two tonnes of frozen clam meat to the Tongan community in California. The clams were sold in less than a month at a price of US\$10/kg on the first occasion US\$11/kg on the second trip. This might indicate the price-level that could be obtained for commercial exports to the Pacific community on the West Coast of the USA. The size of this market needs to be determined.

Limited exports were also reported to have taken place from the Ha'apai group to PagoPago (American Samoa). This export activity was interrupted in 1982 when the air service between Ha'apai and PagoPago was suspended. The export price for mantle was T\$6/kg (T\$/A\$1) but records are not available for the price of the muscle and for the quantities exported, which were defined by the exporter as being 'limited'. Sporadic export of whole clam meat to PagoPago was also reported

from the northern archipelago of Vava'u. Export of about 50 kg per week took place for about two years until March 1991, when it was discontinued 'because of non-profitable prices in PagoPago'. The purchasing price in Vava'u was T\$/5kg and CIF export price received was US\$6/kg (approximately T\$11/kg).

A commercial operator is currently exporting giant clam meat from Vava'u. This middleman has a special agreement with a number of fishermen. They sell all their catch to the operator who exports the best quality fish once a week with a chartered plane, and sells locally the catch that cannot be marketed overseas. Undisclosed quantities of adductor muscle are exported 'via PagoPago to Japan, London and Frankfurt'. Sales are arranged through fish-brokers and not directly to customers. The export price was not disclosed.

As noted by Tacconi and Tisdell (Chapter 13), a large share of the clam meat, sold at local markets in Tonga is probably sent by relatives to Tongans living overseas. This may well account for the largest share of clam meat exported by Tonga, as some interviewees hypothesised that up to 50 percent of the clams marketed in Nuku'alofa might be sent overseas. These exports are not likely to be officially recorded.

The impact of this unofficial export activity on the Tongan natural stock of giant clams cannot be assessed. In fact, given its 'underground' character, it is extremely difficult to gauge the size of this 'market'. Also, it is doubtful that an export ban imposed to protect the natural stock of clam would work. At present, the Tongan Ministry of Fisheries is not contemplating introducing a ban on exports, though other conservation measures are to be implemented (Fairbairn Chapter 8, Tacconi and Tisdell Chapter 12).

Giant clam exports from Western Samoa

There is little evidence to suggest that commercial exports of clams on a sizeable scale have ever taken place from Western Samoa. However, the commercial clam farm based in Namu'a island has received enquiries from a New Zealand chain of food stores on the availability of supplies of giant clam meat, suggesting some New Zealand interest in importing clam products (see also Chapter 17).

Further discussion and conclusion

In Fiji, an industry farming giant clams might at least hope to fill the gap in supply of clam meat for export created by the ban imposed in 1988 on exports of wild clams. This gap could be around 38 tonnes a year since exports in 1988 were 38.5 tonnes. The composition of these exports in terms of mantle and muscle is not known precisely but the figures for 1985 (see Table 14.2) indicate that exports consist of about half muscle and half mantle. Assuming that Fijian exporters received F\$20/kg for muscle (a conservative figure) the value of muscle exports annually would be F\$380000. If they receive F\$5/kg for mantle, the value of

exports on this account would be F\$95000. Thus, the total value of Fijian exports of clam meat would be F\$475 000. It seems, therefore, that annual export markets valued at least a half million Fijian dollars could be re-acquired as a result of clam culture. However, growers could expect to receive only about half of this sum, given the type of mark-up which has prevailed in the past.

To supply the level of exports of clam meat which were achieved by Fiji in 1988, a large number of clams would need to be grown in Fiji. The number required to supply the market would depend on the species and their age at harvest. Main exports were previously dependent on *T. derasa* and current plans of the Fisheries Division are to foster its use for farming or culture, although introduction of *T. gigas* is a longer term possibility. Let us therefore base our estimates on the cultivation of *T. derasa* and assume that it is held for 6 years, a period which maximises biomass production both for adductor muscle and soft tissues according to the estimates of Watson and Heslinga (1988).

On average, a 6-year-old *T. derasa* has an adductor muscle weight of 81.7 g according to the estimates of Heslinga and Watson (1988, p. 222). Therefore, to supply 19 tonnes of muscle (the estimated quantity of Fijian exports of clam muscle in 1988), 232558 6-year-old giant clams would be required. These clams would more than meet the requirements for mantle from export since for 6-year-old clams the ratio of soft tissue to muscle is approximately 0.5. Thus, a considerable amount of mantle in excess of export requirements would need to be absorbed by the local market unless the export market for mantle could be expanded.

The above estimate of the number of 6-year-old clams required to meet the annual export market does not allow for drip loss. For muscle this is probably of the order of 5–10 per cent. If it is 10 per cent, then around 250000 6-year-old clams would need to be harvested annually to satisfy export requirements.

The number of seed clams that would have to be grown out each year to satisfy this end requirement will depend on mortality rates. It seems that mortality rates for *T. derasa* are lower than those for *T. gigas* when both are grown under suitable ecological conditions (see Munro 1988, p. 219). For 2-year-old seed clams about 95 per cent can be expected to survive to 6 years of age when they are used for ocean stocking. The survival rate of 1-year-old seed clams will be lower than that of 2-year-old clams. Suppose it is 90 per cent. Then, over 275000 1-year old *T. derasa* would need to be committed to ocean culture commercially to meet Fiji's export needs, assuming that previous export levels of demand can be re-established. This would call for about three large farms handling 100000 clams annually or around 28 smaller farms handling around 10000 clams annually but even small sized units could conceivably be economic in the Fijian situation in semi-subsistence communities.¹ It is clear that if Fiji can re-establish its previous export market that this, in

¹If the plan of the Fisheries Division to supply households with 600 seed clams was followed, more than 400 households would need to engage in clam culture to meet 1989 export levels of clam meat.

conjunction with its domestic market, could provide an economically sound basis for the establishment of an industry based on the mariculture of giant clams.

With respect to Tonga, the Vava'u group seems to be favoured for the eventual establishment of commercial giant clam farming. An existing exporter of giant clam meat may provide needed market knowledge and local contacts and knowledge. Also, compared with the Ha'apai group, Vava'u has easy access to cheaper international transport through the American Samoa airport of PagoPago. Tonga has good prospects for expanding its exports of giant clam meat as a result of giant clam mariculture.

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15 Economics of Giant Clam Production in the South Pacific—Fiji as a Case Study

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Abstract

This contribution examines the economics of giant clam mariculture in the South Pacific, with special attention to Fiji. Economic and biological data are used in order to determine the internal rate of return from a small clam-farming enterprise. (Under certain conditions, it is found that clam mariculture could be commercially profitable. Important factors affecting profitability are found to be 1) postharvest drip loss, 2) prices of seed clams, 3) prices of output and 4) mortality rates of clams. It is unlikely that villagers will undertake clam farming as a subsistence activity. The main interest of villagers lies in finding new commercial activities to supplement their existing subsistence production.

Introduction

The economic viability of giant clam farming has been considered for Australia by Tisdell et al. (1991a,b; unpublished data). A comparable analysis for Pacific countries has not been undertaken, with the exception of some work by Hambrey (1991). This chapter tries to fill this gap.

Because of the experimental stage of giant clam farming and lack of experience with commercial clam farming in Fiji, only limited data are available to analyse its profitability. The analysis of returns from *Tridacna derasa* farming reported in this chapter is based on data provided by the Fiji Fisheries Division. At the present stage the Fiji Fisheries Division is planning to supply *T. derasa* seeds to interested farmers, as these seeds are already available from the Division's nursery.

Although *T. gigas* have been imported by the Division's nursery from Australia, there are as yet insufficient seed of this species to distribute it to farmers. However, it is likely to be distributed once stocks of seed have been built up and the Fisheries Division has had more opportunity to assess its ecological potential for farming under Fijian conditions. Because of its faster growth rate, *T. gigas* might yield a higher meat volume than *T. derasa*. On the other hand, *T. gigas* appears to have a higher mortality rate than *T. derasa* and this would reduce its relative productivity. Nevertheless, economic returns will be influenced by factors other than meat productivity. The fact that *T. gigas* is an intertidal species, whereas *T. derasa* is

subtidal, means that the costs of handling and farming the former are likely to be less than for the latter. Furthermore, it seems that, in most of the South Pacific, an intertidal species would be more suitable for present work patterns and the existing gender division of labour (see Chapters 2 and 3).

Fieldwork on which much of this chapter is based was conducted during the period 26 August–3 October 1991 and we acknowledge the extremely helpful assistance of the people listed at the end of Chapter 12, and their organisations.

Before looking at the likely returns from commercial farming of giant clams in Fiji, it is worth while considering the economics of subsistence cultivation of clams and reviewing other factors that may influence decisions by islanders about whether to grow giant clams for subsistence purposes.

Economic prospects for giant clam farming by villagers for subsistence purposes

One of the advantages sometimes claimed for giant clam cultivation is that coastal people, especially those in tropical Indo-Pacific atoll countries, may be very interested in adopting it to provide food for subsistence purposes, especially to meet their protein 'needs' (e.g. Baker 1988; Watson and Heslinga 1988). However, as discussed in this section, even if giant clam meat were readily available, it is doubtful that it would form a large part of the diet of Pacific Islanders.

Tacconi and Tisdell (Chapter 13) found that, at the aggregate level, in Fiji and Western Samoa the relative contribution of giant clam meat to the local diet is very small. This could be ascribed to either lack of supply of clams or to lack of demand for greater consumption. In practice, it is possibly explained partly by both factors. Nevertheless, from village surveys it seems that even when giant clams are readily available that they do not constitute a major part of diets, and are certainly not a staple food item. From qualitative information obtained during fieldwork, it appears that traditionally clam meat has been either a 'ritual' food consumed on special occasions such as village festivities, or a delicacy consumed at most once or twice a week in limited quantities. Traditional societies in the Pacific also used giant clam stocks as a standby source of food, often storing them in 'clam gardens' for use during food shortages. In a sense, they constituted a living larder. The small part which giant clams play in local diets has also been observed in Wallis Island by Pollock (Chapter 5).

Vuki et al. (Chapters 2 and 3) reported that in the Lau group, Fiji, villagers appeared to be particularly interested in giant clam farming as a source of income. It was found that growing giant clam for food could involve a relatively high opportunity cost in terms of other subsistence opportunities foregone, e.g. fishing or vegetable gardening. Not only must this opportunity cost be considered but it must be realised that clam farming could involve a considerable cash outlay for a village household because clam seed are expected to cost between F0.50 and F\$1.00 each.¹ Households are especially short of cash in semisubsistence traditional villages in Fiji and

¹The exchange rate at the time of fieldwork was F\$/A\$=0.90

have a strong desire for cash and presumably a high current time-preference for it. This may make them reluctant to invest in projects other than those giving a very quick return of cost.

If a household buys 600 clam seeds (*T. derasa*) for F\$300–600 to produce food, the capital outlay involved would represent a major investment. The average capitalisation of a Fijian household as measured by Veitayaki (1990) in the village of Qoma (Qoma Island) is as follows: House F\$945, houseware F\$421, boat F\$448, outboard engine F\$660, fishing gear F\$130, farm tools F\$44. Obviously, these measures of household capitalisation are only indicative and cannot be extended unquestionably to the rest of Fiji. However, they point to the fact that investing even in a small giant clam project might be a relatively major expenditure for a household, and would be a major decision.

While risk in household decision-making is often underestimated, it plays an important role (e.g. Eder 1991; Byerlee 1991). It is arguable whether a household, with low capitalisation, would be willing to make a substantial capital investment in a still risky enterprise such as clam farming, not to earn cash but to 'grow' food. Note that even if the investment in giant clam farming did not involve a major capital outlay for a family, the risk involved in giant clam farming (e.g. due to diseases, predators, theft) should be always accounted for and compared with that involved in obtaining food from alternative sources. As a general rule, new enterprises involving innovative activities usually entail a greater degree of risk and uncertainty than already established enterprises centred on traditional activities such as fishing by normal methods.

Note also that risk will influence the rate of adoption by villagers, of clam farming as a commercial activity. Even if villagers are interested in clam farming in order to increase their future income (Vuki et al. Chapters 2 and 3), the uncertainty about market prospects for sale of giant clam products will influence their (rate of) adoption of clam farming.

A lower bound for the cost of producing clam meat for subsistence purposes (for consumption by producers or households themselves) can be calculated as follows, assuming an interest rate of 10 per cent as a measure of the opportunity cost of capital and ignoring all costs (for example, labour and other operating costs²) except the cost of seed.

If a household purchases 600 1-year-old seed clams at F0.50 and holds them for 5 years, this will involve an initial outlay of F\$300 and should result in the production of 198.2 kg of clam meat, assuming a mortality rate of 25 per cent in the first year and 5 per cent thereafter. The meat weight is based on estimates by Watson and Heslinga (1988). The opportunity cost per kilogram of clam meat produced is therefore:

$$300 (1 + 0.1)^5 / 198.2 = \text{F}\$2.44/\text{kg}$$

This assumes a 5 per cent drip weight loss. Drip weight loss refers to loss of fluid from meat as a result of standing.

²See next section for discussion of these costs.

If the mortality rate of the clams is 25 per cent in the first year but 10 per cent thereafter the cost will be higher but not as much as might be imagined. The cost per kilogram in this case is just over F\$3 (\$3.04). These price levels seem comparable to those for fish and shellfish at municipal markets in Fiji. However, if labour and other costs are added they would in all probability be higher. Labour costs will primarily depend on the opportunity cost of labour. If the price of clam seed were F\$1, then this would double the capital cost estimates given above and would certainly result in clam meat being considerably more expensive to produce than the costs (prices) of fish and shellfish available in the municipal Fijian markets. These prices should reflect the opportunity costs of supplying these species.

Data on prices of fish and shellfish at the *village* level were not available and so a direct comparison of these prices with the costs derived for clam meat production is not possible. However, the price of fish in municipal markets in Fiji varied in 1990 between a maximum of F\$4.09/kg in Nausori and a minimum of F\$2.52/kg in Labasa (Fiji Fisheries Division 1990). These prices of course include transport costs and margins retained by traders. The flesh of kai (*Batissa violacea*), a freshwater shellfish, at the municipal market in Suva was calculated by Tacconi and Tisdell (see Chapter 13) to sell for F\$2.50/kg. It may be reasonably expected that the prices for fish and shellfish at the village level would be lower than those at the municipal markets because of the absence of transport costs and dealers' margins. Thus the cost of giant clam meat production by a household may be higher than other available alternative types of seafood. In any case, the cost will not be low in comparison to the alternatives.

It would be erroneous to consider villages as homogeneous communities. Inequality in income distribution is the norm (Hill 1986). Income affects expenditures on food. With regard to the Pacific, Shaw (1983) subdivided rural people into two groups: those with 'low cash incomes' and those with 'moderate cash incomes'. Those in the low income groups depend on subsistence food whereas those in the moderate income group purchase part of their food. Given the amount of capital and initial outlay required for household production of clams, poor households are likely to be particularly reluctant to invest in it.

A further look at the economic strategies of householders is instructive. Veitayaki (1990) reports that fisherfolk consume unsold fish or fish of lower commercial value in order to maximise their cash returns from fishing activities. Similar strategies were observed in the course of fieldwork in Tonga and Western Samoa in relation to sales of giant clams (Tacconi and Tisdell, Chapter 3). Women and men interviewed stated that they prefer to sell their clam catch rather than using it at home 'because it is a good source of cash'. They occasionally keep some clams for home consumption, but only a small proportion of the total catch and consisting usually of the less saleable clams. This tendency to maximise cash receipts from clam collection was evident from the fact that in Tongan fisherfolk tend to use only the smaller clams for home consumption as the larger clams can be sold on the market for a higher price per unit of weight.

The Fisheries Division in Fiji is planning to provide 1-year-old *T. derasa* seeds to interested farmers (Ledua, pers. comm). In respect of subtidal farming of *Tridacna*

derasa, Vuki et al. (Chapter 3) found that, in the villages surveyed in the Ono-I-Lau group, 16 out of 48 villagers interviewed thought that subtidal farming would be a hindrance to village activities. The species chosen, and therefore the method of cultivation—i.e. subtidal or intertidal—is also likely to affect the gender division of labour. Because of their traditional activities, men are more likely to be involved in subtidal farming and women in intertidal farming (Chapter 2). However, this division of labour may not be maintained. It has been observed in different parts of the world that, when a new income generating activity is introduced, it is often the men that take over that activity irrespective of the traditional division of labour within the family (e.g. Henshall Momsen 1991).

If the above economic considerations and livelihood strategies of villagers are taken into account, clam farming may more likely be economically viable as a commercial activity than as a subsistence one. Let us consider the potential economic returns from commercial farming in Fiji.

Economic returns from clam farming

Potential economic returns from commercial clam farming by villagers are calculated on a similar costing basis to that employed previously for subsistence cultivation. This assumes that the cost of clam seed is the overriding cost component. In the commercial case the cost of cages for protecting young clams is added, but labour and other operating costs are again ignored, partly because their likely levels are so imperfectly known.

It seems not unreasonable at the village level to ignore operating costs, other than labour costs, because these are likely to be very small. In the case of *T. derasa*, while use of a boat is required for cultivation purposes, most coastal village households already have a boat and there would be no or little extra cost involved in occasionally using it in the husbandry of clams. Also, because a boat can reasonably be expected to be already available to villages, it is not allowed for as a capital cost of farming *T. derasa*.

While labour costs in the village for the ocean growout of giant clams are unlikely to be high in Fiji, the fact that these are ignored is more problematic. The opportunity cost of households using labour in clam production must be zero or near zero if this assumption is to be reasonable. Evidence at the village level indicates that labour cost is unlikely to be zero (Chapter 3). It could be low, however, because giant clams grown out in the ocean may not need to be tended as regularly as in the case of many annual crops. This would mean that labour can be used for tending clams when it is not so much needed for other tasks; that is, when it has a low opportunity cost. Nevertheless the returns estimated below should be considered as upper bounds for the alternative circumstances considered. These circumstances involve a range of prices for clam meat and different levels of drip weight loss prior to the marketing of the meat. While drip weight losses of 5 per cent and 40 per cent are considered, a 40 per cent drip loss may be unlikely if the meat is marketed at the farm-gate.

Returns are calculated on the basis that farming follows the pattern that is expected to be recommended by the Fiji Fisheries Division. According to this pattern, villagers keep their newly acquired 1-year-old seed clams in protective cages in the ocean for one year and then grow them out on location in the ocean. The Fisheries Division suggests that farmers harvest their clams when they are 6-years-old, that is 5 years after the farmer purchases them. It expects to make about 600 seed clams (*T. derasa*) available to each village farmer allocated clams. Thus, the capital cost likely to be incurred by a village farmer purchasing 600 seed clams can be estimated in the following way.

From the experience at the Fiji Fisheries Division's nursery, one roll of chicken fencing wire makes six cages at a cost of F\$69. Each cage contains 200 clams and is expected to last for 2 years. If the farmer buys 600 clam seeds, the cost of 3 cages for 1 year is \$17.25. Because 3 cages hold 600 seed clams, only half a roll of wire is needed, and these cages can be used for two batches of clams. Hence the previous estimate. However, chicken wire may not offer sufficient protection against all predators of clams e.g. large fish can break the wire and heavier gauge wire may be needed. The non-subsidised price for clam seeds is expected to be between 50 cents and F\$1 each. Thus, the total cost for the seeds would range between F\$300 and F\$600. Total capital cost is as indicated in Table 15.1.

Table 15.1 Estimated capital costs for establishment of 600 *T. derasa* clams in ocean growout, Fiji.

Seeds (at F\$1 each)	600.00	Seeds (at F\$0.5 each)	300.00
Cages (3) ^a	17.25	Cages (3)	17.25
Total	\$617.25	Total	\$317.25

^aBased on wire cost only, assuming that clams remain in cages for one year only.

Now consider the expected production of clam meat. The average volume of commercially valuable meat (muscle, mantle and gonad) that could be expected from a 6-year-old *T. derasa* cultured in Fiji is not yet certain, due to the limited number of observations available on cultured clams in Fiji. Fiji Fisheries Division (1986a) reports a ratio of adductor muscle to total flesh weight in the range of 15 per cent to 20 per cent. Hambrey (1991) considers that ratio to be in the order of 14 per cent. Watson and Heslinga (1988) report a ratio of muscle to 'all other soft parts' of 15.3 per cent for a six-year old *T. derasa*. For the following analysis we shall employ the data from Watson and Heslinga (1988) since that is the only study available which documents exactly the data for 6-year-old *Tridacna derasa*. The use of these data could result in an overestimate of growth rates in Fiji, due to the fact that Palau, where Watson and Heslinga conducted their research, may have more favourable environmental conditions for *Tridacna derasa* farming than Fiji.

Watson and Heslinga (1988) found that, on average, a 6-year-old *T. derasa* yielded 81 g of muscle and an additional 535 g of tissues. Of the latter tissues, the

kidney is not useable commercially. The Fiji Fisheries Division estimates it to weigh about 50 g. Deducting this, saleable tissues (other than muscle) weigh 485 g. Alternative postharvest drip-weight losses from soft tissues of five per cent and 40 per cent are considered. Hambrey (1991) suggests a postharvest drip loss of up to 50 per cent and this appears to be confirmed by practical experience at 'Reefarm', a commercial mariculture farm on Fitzroy Island, North Queensland, Australia (Barker, pers. comm.). The mortality rate is taken to be 25 per cent during the first year and the alternatives of 5 per cent and 10 per cent are considered for the following years (Ledua, pers. comm.).

In the following calculation, labour costs or other operating costs are not considered. This is not because it is believed that there is freely available surplus labour, but because the amount of labour requirements and other costs are considered (by the Fijian Fisheries Division) to be extremely limited. If this assumption is proved to be incorrect or an inadequate approximation, a revised analysis accounting for the exact costs should be carried out. Notice, however, that an allowance for such costs will reduce returns.

The farm-gate prices adopted for the analysis are based on the prices which have been reported for the Fijian giant clam market (see Chapters 13 and 14). For adductor muscle, the prices adopted are F\$10/kg, F\$7/kg and F\$5/kg. The price of other edible tissue is assumed to be either F\$2/kg or F\$3/kg, prices which have prevailed in the Fijian market. Given the above, anticipated gross revenue or income from clam-farming can be estimated for the alternatives. The calculations and results are set out in Table 15.2.

On the basis of the above costs and anticipated levels of gross income or revenue, the internal rates of return (profitability) of a clam farm based on 600 clams can be estimated. If a linear relationship exists between clam numbers and cost, then these results can be scaled up or down for a farm of a different size. Variables having a considerable impact on the profitability of clam farming are: 1) the price of clam seeds, 2) the price of the output, 3) the postharvest weight drip loss, and 4) the mortality rate of clams. Table 15.3 sets out rates of return for alternative values of these variables as specified in Table 15.2.

At a price for clam seed of F\$1 each, a 5 per cent drip-weight loss and for the highest farm-gate price considered in Table 15.2, the maximum internal rate of return (IRR) from clam farming is only 5.4 per cent. In another case the IRR is 0.9 per cent and it is negative for all other cases considered in Tables 15.2 and 15.3.

The picture is much more promising if the Fisheries Division can keep the cost of seed clams to F\$0.50 each. With a drip-weight loss of 5 per cent, in three cases out of six the IRR would exceed 10 per cent and in one case it would be close to 9 per cent. In the most optimistic case, the IRR exceeds 20 per cent, about four times the IRR when the seed price is F\$1. A decrease in the price of clam meat from F\$10/kg for the muscle and F\$3/kg for the 'other tissues' to F\$7/kg and F\$2/kg, respectively, results in a decrease in the IRR from 20.4 per cent to 11.5 per cent. A further drop in the price of the muscle (to F\$5/kg) causes a decrease in IRR by over

Table 15.2 Estimated gross income from sale of meat from 6-year-old *T. derasa* in Fiji.

	Weight (kg)	Gross income (F\$)		
		High price: muscle F\$10/kg; other tissues F\$3/kg	Medium price: muscle F\$7/kg; other tissues F\$2/kg	Low price: muscle F\$5/kg; other tissues F\$2/kg
Case 1—Low mortality rate				
Mortality rate 25% year 1: 5% subsequent years.				
Surviving clams (end of 5 years) No. 366 (61%)				
Muscle	29.6	296.00	207.20	148.00
Other tissues	168.6	319.50	213.00	213.00
Total	192.8	615.30	420.20	361.00
Case 2—High mortality rate				
Mortality rate 25% year 1: 10% subsequent years.				
Surviving clams (end of 5 years) No. 294 (49%)				
Muscle	23.8	238.00	166.60	119.00
Other tissues	85.6	256.80	171.20	171.20
Total	109.4	494.80	337.80	290.20

Table 15.3 Estimated internal rates of return (%) from clam farming in Fiji: based on costs and gross income levels indicated in Tables 15.1 and 15.2.

	Price per unit of output		
	High	Medium	Low
Drip loss 5%			
Low mortality			
Seed F\$1 each	5.4	Negative	Negative
Seed F\$0.5 each	20.4	11.5	8.9
High mortality			
Seed F\$1 each	0.9	Negative	Negative
Seed F\$0.5 each	15.3	6.7	4.2
Drip loss 40%			
Low mortality			
Seed F\$1 each	Negative	Negative	Negative
Seed F\$0.5 each	14.2	5.85	2.6
High mortality			
Seed F\$1 each	Negative	Negative	Negative
Seed F\$0.5 each	9.3	1.3	Negative

two percentage points. Notice that when the adductor muscle is priced at F\$5 and 'other tissues' at F\$2, the IRR is consistently below 10 per cent. Shang et al. (1991) observed that the wholesale price for adductor muscle smaller than 100 g could be expected to be about US\$7.7/kg (approximately F\$12/kg). If that is correct, and handling, packaging and transport costs are accounted for, it could imply a farm-gate price close to F\$5/kg. Nevertheless, IRR could be as high as 8.9 per cent. Note that with a drip loss of 5 per cent a positive rate of return exists for all cases shown in Table 15.3 when the clam seed costs F\$0.5 each. This is an encouraging result.

In the case of a drip loss of 5 per cent, a reduction in the mortality rate from 10 to 5 per cent results in a five point percentage increase in IRR.

When a postharvest drip loss of 40 per cent occurs, the IRR exceeds 10 per cent only when mortality rates are at the low level and for the most optimistic output price (muscle F\$10/kg and other tissues F\$3/kg) considered. It is obvious that if a postharvest drip loss of 40 per cent occurs, this would drastically reduce the profitability of clam farming. Reduction in this drip-loss can add significantly to the economic success of clam farming.

From this analysis, it appears that a priority should be to keep the cost of clam seeds to growers low (e.g. F\$0.50 each or lower). The extent to which the cost of seeds and on-farm mortality rates are correlated, will determine whether both variables can be substantially improved at the same time.

The price of the adductor muscle can be expected to be largely determined on international markets, unless a country can achieve a certain degree of monopoly in its supply. If export taxes exist in exporting countries and they substantially reduce farm-gate prices, a relief from these taxes could be considered in order to promote the industry. To improve the marketing power of producers, cooperatives could be formed or the produce could be sold through already existing marketing co-operatives.

Conclusion

The assumption, adopted by some researchers working on the development of giant clam farming, that villagers in the Pacific might be eager on economic grounds to farm giant clams for their own consumption, does not appear to be supported by present evidence. It may not be rational for villagers to invest their limited resources in a risky activity such as giant clam farming in order to produce food, because fish is generally available at lower cost and with less financial risk.

It has been claimed that clam farming could reduce protein deficiency in the South Pacific. Empirical evidence on nutrition in the South Pacific suggests that a certain degree of malnutrition (especially among children) is found in Melanesia. Nutritional disorders are mainly related to changes in the diet and not to lack of protein (Thaman 1983; Manderson 1987). This is also confirmed by Bloom (1986), who reports that changes in the diet arising from 'modernisation' are the most

important factors at the roots of low nutritional status in Fiji, Solomon Islands, Tonga, Vanuatu and Western Samoa. Unfortunately, most of the empirical evidence refers to urban areas. More village-level studies and, for the present purpose, coastal village studies, would be useful. However, even if we assume that malnutrition exists in coastal villages, it cannot be asserted that giant clam farming would reduce the problem. First, if malnutrition is due to an insufficient food production, the cost of protein provided by clams in relation to effort should be compared with the cost of alternative sources of protein. It is usually the poor who face protein deficiency and the cost of producing protein is therefore relevant. The second point to be made in respect of malnutrition is that often it is not a 'production problem' but an 'entitlement problem' (Sen 1981). In other words, food is available but the poor cannot afford it. The solution is to increase their income. In the present case, the economic benefits from giant clam farming should be compared with alternative income-generating activities appropriate to those in need.

In this respect, it has been noted that villagers themselves appear to be more interested in engaging in cash income-generating activities than in increasing supplies of food. It is important for project sustainability that both needs and objectives of the beneficiaries are taken into account (Tacconi and Tisdell 1992).

The possibility of eventually providing subsidised clam seeds to villagers should be considered. If clam seed were made available by fisheries divisions in the Pacific, free of charge to all interested farmers, this could lead to a lack of care of seed by farmers and would be costly to the fisheries divisions. However, some subsidy, especially if it were met by development assistance, might be economically justified. Nevertheless, consideration should also be given to whether these funds could be used to generate more profitable activities for the villagers. In other words, the opportunity costs of those funds should be considered. Fisheries divisions could, for example, provide clam seeds at a subsidised price (e.g. 50 per cent of the actual cost). One implication of this approach, apart from the issues raised above, is that it could accentuate inequalities at the village level if only better off villagers can afford to pay the subsidised price.

This analysis indicates that giant clam farming can be commercially profitable in Fiji under conditions that could be reasonably approximated in practice given Fiji's past experience in marketing clam meat. That is not to say it is likely to be a highly profitable industry. Furthermore, circumstances are also possible in which it will be an uneconomic industry. However, in a country such as Fiji where few profitable investment opportunities exist, especially in some of its atoll areas such as the Lau Group, these results provide qualified economic support for the further development of the industry.

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16

Possible Demand for Giant Clam Meat by Tongans and Their Descendants in Australia

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Abstract

The giant clam has been traditionally a food of Pacific islanders. Thus, migrants from these nations living in Australia and their descendants may seek to maintain giant clam meat as part of their diet. Members of the Tongan community in Brisbane were interviewed in December 1989 and January 1990 in order to test this hypothesis. Information was collected in order to determine the size of the Tongan community in Australia, what quantities of clam meat they might be prepared to buy, at what prices, and the type of product they might seek. Although the Tongan community is relatively small in Australia (about 10000–15000 persons) it could represent a substantial market because of the quantities of clam meat Tongan families plan to purchase (1–4 kg/week per family) even at relatively high prices (A\$5–12/kg). More importantly, however, Tongans are prepared to buy the meat of the whole clam, not just the adductor muscle. In the past the adductor muscle has been the focus for clam meat marketing. But the value of the meat of a whole clam may be greater than for the adductor muscle alone, even though its price is moderate compared to that of the adductor muscle. Tongans, along with other Pacific islander communities (if the latter have similar consumption patterns as appears likely), could provide a very profitable market for the giant clam industry in Australia, and may provide scope for imports from the Pacific islands themselves.

Introduction

Government support for research and development of techniques for giant clam farming has been based to a large extent on the belief that this will eventually result in an economically viable industry. In Australia and, judging from the observations in the previous chapters, also in the Pacific islands, this will require the establishment of economically viable, commercial farms. The prospects for development of clam mariculture for subsistence purposes seem to be very limited. Apart from this, clam mariculture may also be used to a limited extent to restock reefs and supplement natural stocks of clams if such activities are subsidised by governments or local communities.

If giant clam farms are to be economically viable, they must find adequate markets for their products. Previous market studies conducted at the University of Queensland (Tisdell 1989a,b) indicate that the Australian market for clam shells and aquarium specimens will be insufficient to support a significant industry. This leaves clam meat as perhaps a more promising outlet for supplies, with shells and aquarium specimens providing subsidiary markets. This of course does not mean that markets for other clam products (e.g. for medicinal use) could not become more prominent in the future. Apart from the Australian domestic market, there are possible export markets, e.g. in Taiwan and Japan.

Those Australian enterprises which have started giant clam ventures have done so without having clear forecasts of the demand for their product. Initially, farmers believed that there were good prospects for exports of clam meat to Taiwan. Studies by Dawson and Philipson (1989), however, indicated that the demand in Taiwan is for adductor muscle only and the market is not large. Shang et al. (1991) reached a similar conclusion. Despite the cautious conclusions by Dawson and Philipson (1989) about the size of the Japanese market for meat from young giant clams (cf. Shang et al. 1991), prospects in this market continue to attract farming ventures. Nevertheless, the size of the Japanese market remains uncertain, and it may very well be that, at present, it would be unable at realistic prices to absorb all potential giant clam production.

Given the above circumstances, it is important to explore geographical markets other than those in northeast Asia, and perhaps especially those in the south-western Pacific. Australia and New Zealand, for instance, are potential markets for giant clam meat. In New Zealand, the United States and Australia there are significant numbers of migrants, and their descendants, from the Pacific islands. Since giant clams are a significant food item (in some cases a delicacy) in the Pacific islands where they occur naturally, the overseas 'migrant' population of islanders might constitute an important market for farmed giant clam meat. While the Australian market may be satisfied by Australian supplies, there may still be room for imports from the Pacific. The New Zealand market would need to rely completely on imports since giant clams cannot be grown there. As a step to assessing the market in Australia, interviews were conducted with Tongan residents in Brisbane, Queensland.

Background of the respondents

Three Tongans who had been living in Brisbane for 2–17 years were interviewed individually. Another 30–40 Tongans were consulted at the annual meeting of the Tongan Ethnic Association in Brisbane. Three major points were discussed:

- 1 Does a demand for clam meat exist in Australia among Tongans and Tongan descendants? The answer was definitely yes.
- 2 What is the size of the 'Tongan' ethnic group in Australia? General consensus about the size of the population of Tongan descent in Australia was that it lies somewhere between 10000 and 15000.

- 3 What prices would Tongans be prepared to pay for clam meat and what quantities would they be prepared to purchase? Responses varied but, overall, responses from the three individual respondents appeared to be representative of the views expressed by the rest of the Tongans present at the meeting.

The first respondent was Mrs Pilimilose Mafi, secretary of the Tongan Ethnic Association of Queensland. She migrated to Australia with her family in 1973 and has only recently been back to Tonga. While there she consumed a lot of clam meat. She has not eaten giant clam meat in Australia because it is unavailable but she has frequently eaten giant clams in Tonga where their meat forms an important part of the local diet.

The second respondent was the Reverend Kalapoli Paongo who had resided in Brisbane for the last 4 years. During that time he has been studying in the Education Department at the University of Queensland.

The last respondent was Mr Pita Taufatofua who worked for the Department of Agriculture and Fisheries in Tonga and came to Australia with his family to complete a doctorate (in agriculture) at the University of Queensland. While living in Tonga he was well aware of Tridacnidae through his work at the Fisheries Department and also consumed giant clam meat regularly. This made him an ideal respondent.

Giant clam species present in Tonga

The Tongan name for giant clam is 'Vasuva' or 'Vasua' and according to Mrs Mafi, two types of giant clams are consumed in Tonga: a smaller clam referred to as 'Kukukuku', which may be *T. maxima*,¹ and a larger clam 'Tokanoa'. Translated from Tongan the latter means 'they don't stick to the rocks'. These larger clams are probably *T. derasa*, which are also found in Tonga (Heslinga 1989, p. 305).

Besides the two types of clams mentioned above Mr Taufatofua said there was another type of giant clam consumed in Tonga, namely the 'Matahele'. From Mr Taufatofua's description, this would appear to be *T. squamosa*. This is his favourite eating clam and he prefers the largest sizes available. As only fossils of *H. hippopus* have been found in Tonga (Dawson and Philipson 1989, p. 97), all species found in Tonga have been accounted for by the three Tongan names; 'Kukukuku', *T. maxima*, 'Tokanoa', *T. derasa*, and 'Matahele', *T. squamosa*. McKoy (1980, p.8) interprets the Tongan names differently: 'Tokanoa', large tridacnids, 'Matahele', medium-sized giant clam, and 'Kukukuku', small giant clams.

Mr Paongo pointed out that, in Tonga, coastal dwellers collect giant clams and store them near the sea shore in the shallow water until they are required. This is

¹Mrs Mafi showed us some shells of this smaller clam, which she had eaten in Tonga and they appear to be *T. maxima*.

quite common practice in the Pacific islands. The continuing interest of Tongans in preserving giant clam stocks is discussed by Fairbairn in Chapter 6.

Use of giant clams in Tongan cooking

Apart from the kidney and, in the case of *T. maxima*, the byssal attachment, all of the meat of both small and large clams are consumed, either raw or cooked, by Tongans. Mrs Mafi's personal preference is to eat small giant clams raw and larger ones cooked. This is mainly because the smaller clams are tender compared with larger ones. The mantles of the bigger clams can be quite 'rubbery' and rough as well as blackish-blue in colour. Mrs Mafi rates the meat of giant clams as excellent on a scale of 'below average' to 'excellent' (disregarding 'do not know'; see Q. 14 of the survey form in the Appendix for this Chapter).

For culinary purposes Mrs Mafi distinguishes three parts of the giant clam:

- i) the mantle (black and blue in colour), which she likes least of the three parts;
- ii) a harder part which appears to be the adductor muscle—Mrs Mafi likens it in taste to scallop or abalone and it is her second most favourite part of the clam; and
- iii) a softer white part that Mrs Mafi describes as similar in taste to octopus and which is her favourite part. This appears to be the gonad, which comprises 35–40 per cent of the body mass when it peaks in size shortly before the spawning activity takes place (Shelley and Southgate 1988, p. 86).

Mr Paongo focused his discussion mainly on the larger variety of clam, which he says he likes best. He also categorised the meat of the giant clam into three edible parts, the two white parts (one of which is harder than the other) and the mantle.

Mr Taufatofua says that in preparing the giant clam its byssal attachment and its kidney are removed and the remaining part chopped into small pieces and then cooked in a variety of ways.

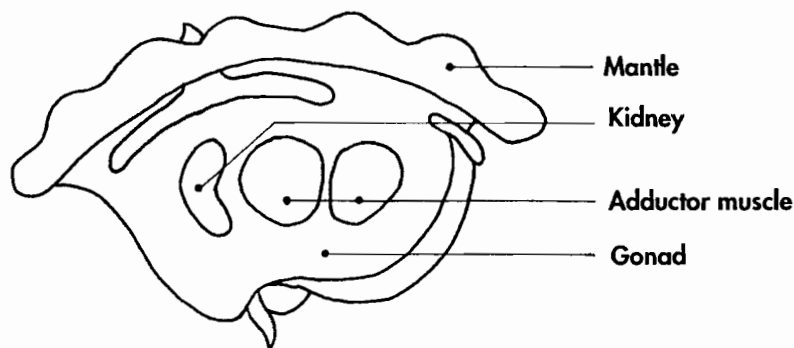


Figure 16.1 Three edible parts of the giant clam and inedible kidney as described by Tongan respondents.

Mr Taufatofua, like the other respondents, described three edible parts of the clam. From his description and from scientific information about tridacnid physiology, the four major parts of the giant clam can be illustrated as in Figure 16.1. These parts are indicated below and their corresponding Tongan names are shown in italics.

1. the mantle—*lau*
2. the adductor muscle—*hoko*
3. the gonad or the white soft tissue—*fua*
4. the kidney—*'ahu*

The white soft part of the giant clam is the gonad. It is referred to in Tongan as '*fua*' which means the egg. The '*fua*', according to Mr Taufatofua, can vary in colour from white to brownish.

Tongan recipes for preparing giant clam meat

According to Mrs Mafi, Tongans cook clams in coconut cream, in water, or bake them and add coconut cream afterwards. Mr Paongo described three different ways of preparing the giant clam, all of which involve the use of coconut milk. The three ways are:

1. The clam meat can be baked in banana leaves to soften it and then cooked in coconut milk.
2. It can be eaten raw by just adding coconut milk to it. This dish is called '*ota*' in Tongan.
3. It can simply be boiled in coconut milk.

Mr Taufatofua likes to eat the meat of the giant clam in raw form as a main dish or after it is first marinated in lemon juice and then cooked in coconut milk. All Tongan recipes for preparing giant clam meat appear to make use of coconut milk. However, Mr Taufatofua said that he had seen edible giant clam in dried form in Tonga about 20–30 years ago.

Availability of giant clam meat in Australia

There are no clams for sale in Brisbane or nearby as far as Mrs Mafi knows. Mr Paongo has been unable to obtain giant clam meat in Australia. Mr Taufatofua has never seen giant clam meat for sale in Australia. Also natural stocks of giant clams are not present near Brisbane in the areas where Tongans go to collect shellfish (e.g. at Wynnum or at Sandgate).

Because of stringent restrictions on the collection of giant clams in Australia (Great Barrier Reef Marine Park Act 1975; Fisheries Act 1976–1984; Fishing Industry Organisation and Marketing Act 1982–1984) and on their importation (CITES Agreement and Wildlife Protection (Regulation of Exports and Imports Act 1982), giant clam meat from natural sources is unavailable. Because of this situation, all

respondents indicated that the Tongan community as a whole would welcome the supply of giant clam meat from farms.

According to newspaper reports, a number of Pacific islanders have collected giant clams illegally from northern Australian waters for consumption. This further indicates the existence of a demand for giant clam meat among Pacific islanders.

Sales of giant clams in Tonga

Mr Paongo reported that, in Tonga in 1988, a big clam of approximately 40 cm in size would cost about Tongan² \$5, while smaller clams were sold in bunches of 10 for about T\$6–8.

Small clams are sold by the basket while large clams of around 30–40 cm are sold individually (cf. Chapter 13). Early in 1989, according to Mr Taufatofua, baskets which contained 12 small clams sold for about T\$4–5 while the large clams were sold for about T\$4–10 each. The price of the large clams in Tonga varies according to the availability of their supply. Natural stocks in Tonga have been seriously depleted as a result of overfishing by locals³ and, in the past, by poaching by foreign vessels.

Type of clam meat required by Tongans

If clam meat were commercially available in Australia through clam farms, Mrs Mafi would be interested in purchasing it. She claims that other Tongans and even Samoans would be similarly inclined.

She would prefer to purchase fresh giant clam meat, as that is how it is usually consumed in Tonga. However, if it were supplied in frozen form only she would still purchase it. She would even be inclined to buy dried clam meat. Although she has never tried it, she believes it might be similar in flavour to dried fish or dried octopus, which she has eaten in Tonga.

Mr Paongo says clams, like fish, form an integral part of the diet of Tongans. As they have developed a taste and a liking for the giant clams, they would definitely buy some giant clam meat even if a wide range of other types of meat were available. However, as Mr Paongo is not accustomed to dried clam meat, he would prefer to purchase fresh or even frozen meat. He would be inclined to buy clam meat regularly, the frequency of his purchase depending on the price of the clam meat. If the price were comparatively high, he would purchase the clam meat less frequently. If the price of giant clam meat were extremely high, he might refrain from using it at all in his diet, even though he personally prefers clam meat to any

²The Tongan dollar was pegged against the Australian at 1:1 in 1988.

³The landings of giant clams in Tongatapu increased by more than six-fold from 1974 (24 090 kg) to 1978 (153 293 kg) (McKoy, 1980, p. 37).

other kind of meat. Mr Taufatofua would welcome the opportunity to purchase giant clam meat supplied by clam farmers. However, whether or not he would purchase it and in what quantities would be determined by its price and to some extent by the quality of the product. 'There are too many other products available for your dollar, if the clam should be too expensive', according to Mr Taufatofua. He had no preference for fresh or frozen clam meat, but if dried clam meat were also available, it would be on the bottom of his list (ranked by him as inferior).

Quantities of giant clam meat likely to be purchased by respondents and prices

As Mrs Mafi and her husband like the taste of giant clam meat very much, she would buy it on a regular basis taking about 1 kg/week. However, this would depend on its price. Mrs Mafi was not very specific about the price she would be willing to pay for giant clam meat, except that she would pay a bit more for it than the price for mussels. To a Tongan, she says, clam meat is rated as superior to the mussel meat. Thus she would be willing to pay a premium for clam meat. As she could not provide us with a price for the mussels, a seafood outlet which was contacted quoted a price between A\$4.99–6.99/kg for mussel meat. It would therefore seem that Mrs Mafi would be prepared to pay around A\$6–8/kg for clam meat.

Because clam meat is rare in Australia and Mr Paongo has developed a taste for it, he would be willing to pay about A\$5–6/kg for it. Mr Paongo would be prepared to spend about A\$15–20/week to obtain 3–4 kg of clam meat per week for his family of 6 people. Not surprisingly, Mr Paongo rates giant clam meat as an excellent product.

Mr Taufatofua, who rates giant clam meat as an above average product, would be willing to buy 1–2 kg/week of it for his family of six people, and he would be prepared to pay A\$10–12/kg for it. He considers this price to be reasonable, because the meat content of a 30 cm clam in Tonga would be about 1 kg and clams there would cost up to T\$10 each. Munro (1989, p.555) states that the flesh weight of the giant clam is about 16.5% of the total weight. Also, he earlier calculated (Munro 1985, p.219) the average total weight of *Tridacna gigas* at size 31.95 cm (5 years) to be 7.02 kg and at size 41.05 cm (7 years) to be 15.46 kg. Thus at size 31.95 cm, the meat content of this species of clam would be 1.16 kg ($7.02 \times 0.165 = 1.16$ kg), while at size 41.05 cm, it would be 2.55 kg ($15.46 \times 0.165 = 2.55$ kg). Mr Taufatofua's justification of price would be correct for a 30 cm clam, but not for a 40 cm clam of this species. Notwithstanding that, it seems that Mr Taufatofua would be prepared to pay between A\$10 and A\$12/kg for giant clam meat.

Tongan population in Australia

In order to estimate the likely demand by Tongans and their descendants in Australia for giant clam meat, it is necessary to estimate the size of the Tongan

ethnic community in Australia. While this is difficult to achieve accurately, respondents provided us with some useful information which has been supplemented by data from the Australian Bureau of Statistics.

Mrs Mafi estimates that there could be up to 700 Tongans living in Brisbane but there are few on the Gold Coast, Sunshine Coast, and in north Queensland.

According to Mr Paongo, some 900 Tongans live in Brisbane and this population is increasing, as more and more Tongans are sponsored by their Australian relatives. Mr Paongo states that there are only very few Tongans living in north Queensland (maybe fewer than 100). Tongans appear to be mainly concentrated in large Australian urban centres. Mr Paongo estimates for:

- (a) Sydney: more than 6000 (possibly up to 10000)
- (b) Melbourne: 1500 to 2000
- (c) Newcastle: 900
- (d) Perth: 600

Mr Taufatofua's estimates of the size of the Tongan population in Australia are similar to those of Mr Paongo:

- (a) Sydney: 8000
- (b) Melbourne: 3000-4000
- (c) Perth: 400
- (d) Brisbane: 700
- (e) North Qld: Few

He says Tongans feel secure in groups. Because initially they concentrated in a few centres they are less likely to move from their established communities. This would account for the lack of Tongans in north Queensland.

The Australian Bureau of Statistics Census of 1986 (ABS 1986) states the Australian Tongan-born population to be 4473. If one accounts for an increase in the Tongan population due to immigration to Australia, children born to Tongan parents in Australia and that ancestry was not recorded in this Census, and the possibility that some illegal immigrants were not included, a figure of 10000-15000 for the Tongan ethnic community in Australia seems to be justified. This estimate is similar to that suggested by Mr Paongo and Mr Taufatofua.

Potential sales of giant clam meat to the Tongan community in Australia

If other Tongans living in Australia were just as eager to buy giant clam meat as Mr Paongo (3-4 kg/week for a family), the Tongan community alone could be a substantial market for giant clam meat. Even at lower levels of consumption, the market would remain substantial.

Estimates are given below for consumption of 1.25 kg or 2.50 kg of clam meat per Tongan family in Australia assuming six Tongans per family (an approximate figure suggested by respondents) and taking two alternative population estimates. The size of a Tongan family is assumed to be greater than the Australian average. This assumption actually makes for more conservative estimates of sales than if families were supposed to be smaller.

(a) Given 10000 Tongans Australia-wide the quantity of sales can be calculated as follows:

6 Tongans per family (assumed on average)= 1650 Tongan families.

(i) Lower level of clam meat consumption

1650 × 1.25 kg of clam meat per week per family= 2062.5 kg/week
or 2.062.5 × 52 = 107.25 tonnes/year.

(ii) Higher level of clam meat consumption

1650 × 2.50 kg of clam meat per week per family = 4125 kg/week
or 4125 × 52 = 214.5 tonnes/year

(b) Given 15000 Tongans Australia wide, the quantity of sales is estimated as follows:

6 Tongans per family (assumed on average)= 2500 Tongan families

(i) Lower level of clam meat consumption

2500 × 1.25 kg of clam meat per week per family= 3125 kg/week
or 3125 × 52 = 162.5 tonnes/year

(ii) Higher level of clam meat consumption

2500 × 2.50 kg of clam meat per week per family= 6250 kg/week
or 6250 × 52 = 325 tonnes/year

Table 16.1 indicates the potential quantities of annual sales of clam meat to Tongans in Australia and their value for alternative prices and quantities of consumption per family. It suggests an annual value of sales ranging from \$0.5 m to almost \$4 m depending upon the assumptions used. Sales of a value within the range of approximately \$1 m to over more than \$2.5 m seem to be a realistically possible. The number of clams required to supply this market would be greater than that needed to supply shells for the whole Australian market (Tisdell 1989a) if

Table 16.1 Total potential value of annual sales (A\$m) of giant clam meat and quantities in tonnes (t) to Tongans in Australia at alternative assumed prices and quantities of consumption per 'family'.

	10000 Tongans		15000 Tongans	
	1.25 kg/ family	2.50 kg/ family	1.25 kg/ family	2.50 kg/ family
Total quantity	107.25 t	214.5 t	162.5 t	325.0 t
\$5.00/kg	\$0.54m	\$1.07m	\$0.81m	\$1.63m
\$8.50/kg	\$0.91m	\$1.82m	\$1.38m	\$2.76m
\$12.00/kg	\$1.29m	\$2.57m	\$1.95m	\$3.90m

clams of 7-years of age or younger are used to supply meat. Table 16.2 relates the meat weight of a clam to its age and provides information on the value of a clam for its meat alone at various ages. Table 16.3 indicates the total numbers of clams needed at various ages to supply total quantities of clam meat.

Estimates in Tables 16.2 and 16.3 have been made both on the basis of no drip loss from the meat and a 40 per cent drip loss. ICLARM South Pacific research indicates that a 40 per cent loss in meat weight due to drip loss is possible between harvest and retailing of the meat, if clams are not sold live (Hambrey 1991). However, from Table 16.3 it is clear that whether or not one allows for drip weight loss, the potential demand of Tongans in Australia for clam meat is substantial and would appear to be sufficient in volume to support at least one or more commercial farms.

Table 16.2 Value of a single clam at varying weights (ages) and varying prices/kg for clam meat alone (whole clam) with and without drip loss^a. Weight based on estimates by Munro (1988) for *T. gigas*.

A\$ price/kg	Wet weight of meat and age of clam					
	1.16 kg (5yrs)		2.55 kg (7yrs)		4.29 kg (9yrs)	
\$5.00	\$5.80	(3.48)	\$12.75	(7.65)	\$21.45	(12.87)
\$8.50	\$9.86	(5.92)	\$21.68	(13.00)	\$36.47	(21.88)
\$12.00	\$13.92	(8.35)	\$30.60	(18.36)	\$51.48	(30.89)

^aValue with 40 per cent drip loss indicated in parentheses.

Table 16.3 Number of clams required to supply the varying total quantities of clam meat with and without drip loss.^a

Retailled tonnes/year	Weight of meat and age of clam		
	1.16 kg (5 yrs)	2.55 kg (7 yrs)	4.29 kg (9 yrs)
107.25	92457 (154095)	42059 (70098)	25000 (41667)
162.50	140086 (233477)	63725 (106208)	37839 (63132)
214.50	184914 (308190)	84118 (140197)	50000 (83333)
325.00	280172 (4469953)	127451 (212418)	75758 (126263)

^aNumber of clams required allowing for 40 per cent drip loss is shown in parentheses.

From an economic point of view it would seem important to sell all of the edible meat of the clam not just the adductor muscle. The adductor muscle makes up 10–15% of the total weight of the meat (Dawson and Philipson 1989, p. 94).

Assuming that the muscle is 15 per cent of the total weight of the flesh (all of which is edible except the kidney which constitutes a very small portion and which is ignored for the purpose of the following calculations) the price of the muscle needs to be 6.66 times that of the whole meat, to be worth as much as the latter. Thus, at a price of \$5.00/kg the whole meat of the clam is equivalent to \$33.33/kg for the adductor muscle alone. However, this makes no allowance for drip loss from the meat. This is much less for the muscle than for the whole meat. If it is 40 per cent for the whole meat and 5 per cent for the muscle, the price of muscle needs to be 4.21 times that of the whole meat for the value of the muscle to be equivalent to that of the whole meat on the basis of wet (newly harvested) weights. If the whole meat sells for \$5.00/kg, the price of the muscle must be \$21.05/kg if, after allowing for drip-weight loss, the muscle alone is to yield the same level of revenue as the sale of the whole meat.

Of course with larger clams it may be economic to separate the adductor muscle from the soft tissue and sell these independently. Clearly, however, there are likely to be economic advantages in selling all the meat.

Concluding comments

In Table 16.1 the quantity of giant clam meat purchased per family has not been allowed to vary with its price, although it would do so in practice. We have insufficient information to judge the extent of the likely variation. Our statistics should not be regarded as precise, but as indicative estimates only. We have also used rather conservative consumption levels, given the responses from those interviewed. In addition, it might be observed that the sample is small – three respondents interviewed in depth plus 30–40 members of the Tongan Ethnic Association commenting on in-depth responses. Nevertheless there is no reason to expect the results to be unrepresentative.

While our results support the hypothesis that a substantial market for giant clam meat is likely to exist amongst Pacific islanders in Australia, specific evidence from Islander groups other than Tongans would be worth while having. This chapter also suggests that, in terms of size of market, the market for meat rather than shells and aquarium specimens is likely to be the mainstay of any substantial commercial industry concentrating on the Australian market. Worldwide, and in the long-term, the meat is likely to be the principal product market for the giant clam industry (Tisdell 1990).

In Australia, apart from Pacific islander communities, communities from Asia might provide further market outlets for meat of giant clams. However, most Asians in Australia seem to have little existing demand for clam meat because of their unfamiliarity with it. A recent survey of Asian restaurants in Australia found that their owners and managers had little knowledge of giant clams as a food item, even though they are interested in trying it (Tisdell, unpublished data).

Acknowledgments

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Appendix

Questionnaire for Pacific islanders, regarding giant clam meat consumption, January 1990.

- | | |
|--|---|
| <p>1 Name, address and telephone number of respondent</p> <p>2 From which country do you originate or are you a descendant of?</p> <p>3 How long have you been residing in Australia?</p> <p>4 Have you ever consumed clam meat?</p> <p>5 a) Do you know the names of the giant clams, which you have eaten? (e.g. <i>Hippo</i> clam or <i>Tridacna gigas</i>).
b) Are there any varieties which you like best?</p> <p>6 What is the preferred size of the clam you eat?</p> <p>7 a) How do you prepare the giant clam meat?
b) Do you know of any other recipe for giant clams?</p> <p>8 What parts fo the giant clam do you use for eating? (e.g. mantle, adductor muscle, whole clam).</p> <p>9 Have you been able to obtain giant clam meat in Australia? Yes No
a) If yes, where do you get it from?
b) If no, do you know where it might be sold?
*Please circle correct answer</p> <p>10 As you may know, it is now possible to farm giant clams. If there was someone farming giant clams in Australia, would you be interested in buying giant clam meat from them?</p> <p>11 Would you be interested in purchasing fresh clam meat, frozen clam meat or dried clam meat? Please elaborate.</p> | <p>12 a)Would you buy the clam meat on a regular basis or just occasionally? (e.g. how many times per year? Please elaborate)
b)What quantities of giant clam meat would you buy?</p> <p>13 What would you regard as a reasonable price to pay for giant clam meat per kilo? (please specify:
a) whole clam, mantle or adductor muscle.
b) fresh, frozen or dried.</p> <p>14 How highly do you rate clam meat as a food item?
a) Excellent product()
b) Above average product()
c) Average product()
d) Below average product()
c) Do no know()</p> <p>15 In what other areas of Australia do you think there might be Pacific Islanders who are interested in purchasing giant clam meat and how many Pacific Islanders live there?</p> <p>16 Do you have any contact address of Pacific Islander clubs or associations in those areas? Please list</p> <p>17 Would you like a complementary copy of the report on this survey? YesNo
Thank you very much for your co-operation.</p> <p>Clem Tisdell
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17 **The Market for Giant Clam Meat in New Zealand: Results of Interviews with Pacific Island Immigrants**

Clem Tisdell

René Wittenberg

Abstract

As part of an examination of the potential market for giant clam meat, the Pacific islander community in New Zealand was considered. Pacific islander descendants were interviewed in July 1990 in both Auckland and Wellington, the two New Zealand cities having the highest concentration of these immigrants.

As a result of these interviews the size of the potential market for giant clam meat amongst New Zealand Pacific Islanders was estimated at up to 3120 tonnes annually with a potential retail value of NZ\$31.2 m. This would make this potential New Zealand market four times as large as that of Australia, and much larger than estimated market sizes for both Japan and Taiwan in terms of meat weight. It supports our hypothesis that the Pacific islander migrant population is likely at present to constitute a larger market for clam meat than the Asian one.

Introduction

Studies of the potential market for the meat of farmed giant clams have in the past concentrated on East Asian countries, especially the more developed or newly industrialising countries in this region: Japan, Taiwan, Hong Kong, and to some extent, Singapore and Malaysia (Dawson and Philipson 1989; Center for Tropical and Subtropical Aquaculture 1990; Shang et al. 1991). By comparison the potential of other Pacific Basin countries to absorb exports of giant clam meat has been virtually ignored. While some marketing studies have been done in Hawaii, this is the exception rather than the rule. Considerable numbers of Pacific islanders have migrated to New Zealand, the USA (especially California) and, to a lesser extent, to Australia and Canada. We speculated in the previous chapter that these migrants and their offspring could provide a sizeable and ready market in the Pacific Basin for exports of giant clam meat. Our survey of Pacific islanders in Australia lent support to our hypothesis that this was a promising market. Pacific islanders on the whole rate giant clam meat highly as a product, eat all the meat (except the kidneys), and Pacific island migrants appear to be prepared to pay a price for the product at least similar if not higher than that paid for high quality fish. The clam is so highly regarded by some of these migrant groups that it is especially sought after for inclusion in feasts for special occasions.

New Zealand has the largest population of migrant Polynesians in the world and possibly also the largest overall Pacific islander migrant population. However, the migrant population of Pacific islanders in the USA, especially of Micronesians, is high. The purpose of this chapter is to report the results of a market survey of Pacific islanders in New Zealand concerning their demand for giant clam meat. Given its ethnic composition, location and close Pacific island links, it seemed likely that New Zealand could be a major market for exports of giant clam meat from the Pacific islands. Giant Clams do not occur in New Zealand waters, principally, it seems, because of the natural environmental conditions, e.g. water temperature and number of sunlight hours in winter, are unfavourable to them.

The survey, the results of which are reported here, was undertaken in July 1990. The questionnaire reproduced in Appendix A formed the basis of interviews conducted by René Wittenberg. In all, 36 Pacific islander residents of New Zealand were interviewed in depth: 10 Samoans, 10 Tongans, 4 Cook Islanders, 3 Niueans, 4 Tokelauans and 3 Fijians, representing each of the major islander migrant groups. It was impossible to draw the sample in a random manner because of the time and cost which this would have entailed, so, in effect, selective sampling occurred.

The Pacific islanders who were interviewed were all selected because of their close and constant association with the Pacific islander community at large. In particular, Pacific islanders from Pacific Islander Educational Resource centres, Pacific Islander Employment Training centres, a Samoan Newspaper, the Ministry of Pacific Islander Affairs, various Pacific Islander clubs and associations, the Tongan King's residence and a number of Pacific Islander consulates were approached by telephone and suitable arrangements made for further interviews. The respondents were knowledgeable not only on the subject of the giant clam, but also, through their links with Pacific islanders in New Zealand, were able to provide valuable information about the possible demand for giant clam meat by the Pacific islander community generally.

Population statistics of Pacific islanders in New Zealand

The population of Pacific islanders in New Zealand (excluding Maoris) has increased steadily since 1951 when they numbered 3600 in the census (Beaumont 1988; New Zealand Department of Statistics 1988). In the census taken in 1986, Pacific islanders numbered 127735 and formed 3.9% of the total New Zealand population of 3263283. The projected number of Pacific islanders for the 1991 census is 167700.

The Pacific islander populations mentioned include both individuals of a single Pacific island ethnic origin and those of partial Pacific island origin. The latter includes persons of Pacific island Polynesian origin and of some other ethnic origin, whilst the former includes only persons of Pacific island Polynesian origin.

Pacific islanders in New Zealand consist mainly of people of Polynesian background drawn from six Pacific nations. The main groups and their populations as a percentage of the total population of Pacific islanders in New Zealand are Samoans (51.3%), Cook Islanders (25.5%), Tongans (10.3%), Niueans (9.5%), Tokelauans (1.9%) and Fijians (1.5%).

Most Pacific islanders have settled in the two urban centres of Auckland and Wellington. Approximately 64.1% reside in Auckland, a further 16.1% live in Wellington, while the remainder are scattered around the North and South Islands. Auckland, as was mentioned repeatedly by both Pacific islanders and New Zealanders, is the largest Pacific islander city in the world, with a Pacific islander population of more than 100 000. While the Fijian capital, Suva, has a population of 118 000, which exceeds Auckland's Pacific islander population, a very large percentage of Fijians in Suva are of Indian descent and not of Pacific islander origin. Therefore, Auckland may still be considered to have the largest Pacific islander urban community in the world.

Three of New Zealand's major Pacific islander groups (the Cook Islanders, Niueans and Tokelauans) have populations in New Zealand far in excess of those in their native countries (cf. McKee and Tisdell 1990, Ch. 7). Only 36.3% of the Cook Island population, 17.7% of the Niuean population and 40.4% of the Tokelauan population still live in their native countries.

In the context of a possible market for giant clam meat amongst Pacific islanders in New Zealand, the age distribution of the island immigrant population warrants careful consideration. Generations of Pacific islanders, either born or raised in New Zealand have, in many instances, adapted to the New Zealand style of food and lost the taste for, or interest in, their traditional foods. However, the type of upbringing young Pacific islanders experience may influence their possible interest in foods such as the giant clam. If the upbringing of Pacific islanders in New Zealand has followed island traditions, chances are that they would readily eat traditional foods and so would be likely to eat giant clams. Conversely, New Zealand born Pacific islanders not brought up in the traditional manner would be less likely to buy or to eat giant clam meat. The age distribution of Pacific islanders in New Zealand is shown in Table 17.1.

Table 17.1 Age distribution (%) of Pacific islanders in New Zealand.

Age group	0-9	10-19	20-29	30-39	40-49	50-59	60+
%	22.2	21.1	20.5	17.7	9.8	6.1	3.4

As shown in Table 17.1, 43.3% of Pacific islanders are under the age of twenty. Members of this age group (0-19) might be expected to be more reluctant to include giant clam meat in their diet than older groups. However, traditional

upbringing and regular family activities such as feasts, will ensure that at least a sizeable proportion (possibly 50% or more) of this younger age group would be inclined to eat giant clam meat.

Samoans

The Samoan community, with 62553 members, accounts for more than 51% of the total Pacific islander population in New Zealand. The largest number of Pacific islanders interviewed in New Zealand were Samoans. All of the Samoans interviewed originated from Western Samoa, although some American Samoans have migrated to New Zealand. Most American Samoan emigrants have gone either to Hawaii or the West Coast of the United States of America. Both these locations could represent further significant markets for giant clam meat.

In total, detailed interviews were held with 10 Western Samoans. They had been living in New Zealand for between 2 and 41 years and all had consumed giant clam meat.

The Samoan name for the giant clam is 'Fascia' with no distinction of different species. Only two species of giant clam are found naturally in Samoa, namely *T. maxima* and *T. squamosa* (Munro 1989, p. 546). None of the respondents was able to differentiate between the giant clam species consumed in Samoa. This lack of ability to distinguish between the various giant clam species was apparent among all six Pacific islander groups interviewed. If this lack of preference for the meat of particular giant clam species holds true, the New Zealand market will not restrict the species of giant clam grown.

Samoan respondents on the whole preferred to eat smaller-sized clams, because these are more tender. Nevertheless, they readily consume giant clams of all sizes.

There is a strong preference for eating raw giant clam meat. Samoans suggested the following recipes for the preparation of giant clam meat:

1. Chopped into small pieces, then soaked in lime juice and a little bit of vinegar, with onions and soya sauce.
2. Raw with coconut milk, lemon juice and some salt.
3. Raw with salt and vinegar.

When the giant clam is cooked before eating, the meat can be:

1. Chopped into small pieces and cooked in a casserole with salt, pepper, onions and coconut cream.
2. Steamed or fried in butter with seasoning and then eaten with caviar, salted crackers and port.

This last recipe might be of interest to speciality gourmet restaurants, who might be interested in giant clams as an 'exotic' food. This 'delicacy' or 'exotic

shellfish' prospect could make the meat attractive in the lucrative speciality European market or the East Asian market. As might have been noted, the above recipes are not all traditional recipes but have been developed and modified to take advantage of ingredients made available as a result of European contact.

None of the Samoans interviewed had eaten dried clam meat. The Samoans, like all of the Pacific islanders who were interviewed, consumed the whole clam, minus the kidney which has a very bitter taste.

Three of the 10 Samoans interviewed had eaten giant clam meat in New Zealand, but that had been a few years previously. One Samoan explained that a relative had obtained giant clam meat at a communal market—a market where a lot of Pacific islanders in New Zealand go to buy their food (e.g. taro and other vegetables, seafood, etc.). The other two Samoans had obtained the clam meat through visits to relatives, or had brought it back when returning from visits to Samoa.

No one spoken to had recently been able to obtain giant clam meat. Even when they had done so earlier, it occurred very rarely and infrequently. The 10 Samoan respondents welcomed the possibility of being able to buy giant clam meat in New Zealand.

All of the Samoans interviewed have active and constant contact with the Samoan community in New Zealand. The respondents included individuals from the Samoan Consulate, the Pacific Islander Educational Resource Centre, the Samoan Star Newspaper and members of Samoan clubs. They were asked whether they thought that other Samoans in the community would be willing to buy giant clam meat if it were available in New Zealand. All believed that this would be so and pointed out that there would be a considerable demand for the giant clam meat amongst Pacific islanders in general. The product is known to them, is considered a delicacy and thus would form an important part of their traditional family feasts which occur on weekends, usually Sundays. Seven of the 10 respondents said they would like to purchase giant clam meat at least once a week and the most enthusiastic prospective purchaser wanted to buy it as often as three times a week. The other three Samoans said that they would wish to buy giant clam meat on a regular basis ranging from at least six times a year to at least once a month.

Quantities which they would intend to purchase on each occasion ranged from 1 kg up to 5 kg for a family of about five people. Generally, however, quantities of around 2 kg per family would appear to be the normal size of each purchase.

The prices given in this chapter are all in New Zealand dollars, unless otherwise stated. The exchange rate was \$A1:\$NZ1.3 at the time of the survey. Samoans said they would be willing to pay between NZ\$2.50/kg and NZ\$10.00/kg for giant clam meat. The average price suggested was in the range NZ\$5.00/kg to NZ\$7.50/kg. This price was somewhat less, on average, than that which other Pacific islanders would be prepared to pay.

Samoans indicated that they preferred to purchase fresh giant clam meat rather than meat in frozen or other forms. This is because clam meat traditionally is eaten very fresh in Samoa. All Samoan respondents did, indicate however, that they would buy frozen giant clam meat if fresh clam meat were unavailable. All of the Samoans said that they would not be interested in purchasing dried clam meat. Considering the willingness of Samoans to purchase giant clam meat if it were available, it is not surprising that 6 of the 10 Samoans interviewed considered giant clam meat to be excellent, 3 of the 10 rated it as an above average product and only a single person regarded giant clam meat as an average product.

Tongans

The Tongan community, with 12534 members, is the third largest of the Pacific islander groups in New Zealand. Altogether 10 Tongans were interviewed. Like Samoans they were most enthusiastic about the prospect of being able to buy giant clam meat in New Zealand. The Tongan respondents had been resident in New Zealand for between 4 and 27 years and all had consumed giant clam meat at some time.

The general Tongan name for the giant clam is 'Vasua'. Unlike other Pacific islanders interviewed, the Tongans were able to identify different species or types of giant clams by different names. Three species of Tridacnidae can be found in the Kingdom of Tonga, *T. maxima*, *T. derasa* and *T. squamosa* (Munro 1989, p. 546). 'Tokanoa', 'Matahele' and 'Kukukuku' are the most common names given to different types of the giant clams (see Chapter 16). However, an elderly lady, who was living at the Tongan King's residence in Auckland, also suggested some other names. She mentioned that giant clams were referred to as 'Kelea', 'Topulangi', 'Elili', 'Mehungo', 'Too' and 'Ohule'. What these names stand for, or if they actually refer to giant clams, is not known to us, but they could possibly refer to different recipes or preparations of giant clam meat. The preferred giant clam for consumption is the smaller clam (Kukukuku), whose tenderness makes it more appealing for eating. Nevertheless, larger sized clams (Tokanoa) are still eaten.

The Tongans in New Zealand have a diverse range of recipes for giant clam meat. Favourite recipes, including those for raw giant clam meat, were reported to be:

- 1 Raw, sliced giant clam with onions, tomatoes and coconut cream.
- 2 Marinated with lemon juice and coconut cream.
- 3 Cooked in coconut milk and water together with onions and then curry.
- 4 Baked in an earth oven with taro leaves and a coconut cream mixture.

In general, smaller clams tend to be consumed raw, whereas larger giant clams, which are considered to be tougher (especially their mantle), are cooked or baked to tenderise them. Again, like all other Pacific islanders, Tongans consume all of the meat of the giant clam except the kidney.

Some of the Tongans interviewed had actually obtained giant clam meat in New Zealand, but none had done so recently. Two main sources of past supply were mentioned. One source was from relatives who brought it with them when they came over from Tonga on a visit (see also Chapter 14). Another was from the sale of giant clam meat in Auckland in the past. To our knowledge, no one was actually selling giant clam meat in New Zealand during the time of our survey. It was impossible to identify persons who had previously sold giant clam meat. However, from our discussion with the Pacific islanders, it appears that the giant clam meat sold in New Zealand originated in Fiji. It did not include the adductor muscle. The giant clams were sold frozen in plastic blister packs (possibly weighing about 0.5 kg) for NZ\$8 per packet. This appears to have taken place in 1987 and 1988. It is consistent with information about exports of giant clam meat from Fiji (see Chapter 14).

The giant clam meat which was sold appears to have been quite popular and sold out relatively quickly despite the estimated retail price of NZ\$16/kg and the fact that it was reputed to be of only average quality and did not include the adductor muscle. The meat was sold out completely, according to one Pacific islander, as soon as this source became known to the Pacific islanders. This case is another indicator of the popularity of giant clam meat amongst Pacific islanders. Many migrants from Pacific islands tend to base the prices which they say they are willing to pay for giant clam meat on the prices they would pay in their country of origin. We were informed that prices for giant clam meat have been increasing steadily in Tonga as giant clams have become scarcer. Increasing scarcity of giant clams in the Pacific islands has resulted in giant clam becoming dearer than fish, even in the islands.

Tongans interviewed were willing to pay prices for giant clam meat ranging from NZ\$3.50 up to NZ\$20.00/kg. The person who quoted NZ\$20.00/kg would only be prepared to pay this much for fresh clam meat, while he would be prepared to pay NZ\$15.00 for frozen meat. Generally NZ\$10.00/kg appears to be an acceptable price for giant clam meat amongst the Tongans interviewed. As might be expected, all Tongans interviewed responded favourably when asked if they would be interested in purchasing giant clam meat in New Zealand. Nine of 10 Tongans interviewed would prefer to buy fresh clam meat, but would buy frozen clam meat if fresh clam meat were not available. Only one Tongan wanted to buy dried clam meat.

Both the price of clam meat and the income of Pacific islanders in New Zealand will limit quantities of giant clam meat purchased. In New Zealand, Pacific islanders by and large are part of the unskilled workforce, thus receiving a much lower wage than the average New Zealander. An economic downturn in New Zealand has particularly affected the employment of unskilled workers and thus the proportion of unemployed Pacific islanders is much higher than average. Even though diminished levels of income restrict the purchasing power of Pacific islanders in New Zealand, they have a strong preference for fish and traditional food products especially for the family feasts held on weekends. The giant clam is considered to be a

delicacy and would take pride of place at such feasts and purchases by Pacific islanders could thus be expected even when their incomes are low. Thus, one elderly Tongan lady stated that she would buy the giant clam every day if she had the financial means, but as she does not have the means, she would restrict her purchases to between 2–3 kg/week.

A Tongan lady from the Tongan King's residence stated that the 17–20 people living there would consume roughly 30 kg/week for which they would be prepared to pay up to NZ\$10.00/kg. The 10 Tongan respondents said they would buy giant clam meat on a weekly to fortnightly basis in quantities ranging from 1–5 kg. Typically, a Tongan family could be expected to consume about 2.5 kg/week of giant clam meat, judging from the responses obtained. Tongans in general rated giant clam meat very highly as a food item. Seven of 10 respondents rated it an excellent product, 2 of the 10 considered it to be an above average product, while only one person considered it an average product.

Cook Islanders

The Cook Island community in New Zealand numbers 31092, which makes it the second largest Pacific islander group in New Zealand. Four Cook Islanders were interviewed but none of them appeared to share the enthusiasm of other Pacific islanders for giant clams. The four Cook Island respondents had been in New Zealand between 10 and 34 years and have returned to the Cook Islands on numerous occasions. Three out of the four Cook Islanders rated the giant clam as an average product and one considered it to be below average as a food item. Nevertheless, all of the four Cook Islanders would buy giant clam meat if it were available in New Zealand.

Two Cook Islanders have eaten giant clams in New Zealand and they still have them sent over by plane from relatives in the Cook Islands. The three giant clam species that can be found in the Cook Islands, which are located in the southeast extremity of the natural range of the Tridacnidae family, are *T. derasa* (introduced from Palau recently), *T. maxima* and *T. squamosa* (Munro 1989, p. 546).

The Cook Islanders refer to the giant clam as 'Paua'. This is of extra interest since the Maoris apply the same name to the same type of shellfish. The Maori 'Paua' is a species of abalone found in New Zealand. According to one Pacific islander, a Samoan, the New Zealand Paua, which is a very popular food among the Maoris, is very similar in taste to the giant clam and it is his belief that the giant clam could thus become quite popular with Maoris. Because of the ancestral links that the Maoris have with the Pacific islanders and the high proportion of fish in their diet, there is some basis for speculating that giant clam meat would be accepted into the Maori community. If such happened, the potential market for giant clam in New Zealand would increase dramatically, as the Maoris form 12.4% of the total population.

While the Cook Islander respondents overwhelmingly preferred smaller-sized giant clams they will eat larger ones as well. One Cook Islander said that, back in the Cook Islands the meat of the large clams was actually fed to the pigs.

The clams are eaten in many different ways. While the giant clam is salted or dried in the Cook Islands, the usual way of eating it is unprocessed or cooked. When eaten raw, it is normally diced and lemon juice is added—when cooked, it is prepared with taro leaves and coconut cream. The entire clam, excluding the kidney, is consumed.

The kidney, according to one Cook Islander woman, is used in the Cook Islands for medicinal purposes. It is used for treating leukaemia because of claimed iron-enriching properties. If therapeutic values can be attributed to any parts of the clam, this would greatly enhance its market-ability and commercial value.

Fresh or frozen clams would be preferred by the Cook Islanders, but dried, salted and tinned clams would also be readily accepted.

The Cook Islanders interviewed would buy the giant clam meat occasionally, maybe once a month. However, two of them still appear to have ready access to giant clams in New Zealand (sent by relatives) and unless that source disappeared they would not be considering purchasing clam meat. Generally the quantities which would be purchased were up to 2 kg a time.

The price the Cook Islanders would be prepared to pay for the giant clam meat was in the range NZ\$5–10/kg.

Nuieans

There are 11625 Nuieans living in New Zealand. They therefore form the fourth largest Pacific-islander group in New Zealand. Three Nuieans, with a period of residence in New Zealand ranging between 5 months and 25 years, were interviewed. They have all consumed giant clam meat and two of them have eaten giant clam meat in New Zealand. This was imported privately from Rarotonga in the Cook Islands. Although not specifically mentioned by Munro (1989) or Heslinga (1989), Nuie, which lies between Tonga and the Cook Islands, may have the three species of giant clam present in Tonga and the Cook Islands: *T. maxima*, *T. derasa* and *T. squamosa*.

The Nuiean name for giant clam is 'Gege' (pronounced Nge-Nge) and is used for all giant clams irrespective of their size, colour or shape. All three Nuieans interviewed prefer small-to medium-sized clams rather than the tougher larger-sized clams. However, their opinions varied when it came to rating the giant clam as a food item. One Nuiean rated giant clam meat as an average food item, one above average and one excellent. All Polynesian Pacific islander recipes for preparing giant clam meat are very similar. Nuieans usually eat clams raw having marinated

them in lime juice and coconut cream, but they are also cooked. The meat is first steamed and then cooked in lemon juice and coconut cream in an earthen oven.

All the flesh of the clam except the kidney is used. The Cook Islanders preserve some of their clams in salt, but, although it is an effective preservative, the Nuieans feel that the salt absorbs the natural juices of the giant clam and thus spoils its flavour.

All three Nuieans would be interested in buying giant clam meat if it were exported to New Zealand. They would be interested in buying mainly fresh or frozen giant clam meat but they would be willing to try smoked, salted or tinned giant clam meat if it were available.

Giant clam meat would, it was said, be purchased mainly for feasting on festive occasions, e.g. special holiday celebrations, weddings and similar events. The quantity of giant clam meat consumed would depend on the occasion and the number of people attending and thus could vary between one and several kilos. For normal family consumption, Nuieans could be expected to buy about 1 kg of giant clam meat monthly. The price they would find 'reasonable' for clam meat varied between NZ\$5–20/kg but all three of Nuieans were prepared to pay as much as \$10/kg.

Tokelauans

Tokelauans form the fifth largest Pacific islander group in New Zealand and with 2316 people make up 1.9% of the total Pacific islander community of New Zealand. The four Tokelauans who were interviewed had lived in New Zealand for between 11 and 20 years.

Giant clam meat appears to be a favourite food item of Tokelauans in New Zealand. Three out of four respondents rated it as an excellent product while the remaining respondent considered it average. The Tokelauan name for the giant clam is 'fasua' or 'fahua' and is the only name given to the clam. Only one species of giant clam is found in Tokelauan waters, namely *T. maxima* (Munro 1989, p. 547).

Generally small- to medium-sized clams (10–20 cm) are preferred to larger-sized clams. However, if bigger clams are still tender and delicate, they are also eaten. Generally the clam meat is eaten raw or chopped into small pieces and cooked in coconut cream. It is also cooked as a curry and all of the edible parts of the clam (minus the kidney) are used.

Tokelauans would prefer to purchase frozen or fresh giant clam meat. All four respondents indicated that they would buy giant clam meat if it were exported to New Zealand.

Their suggested frequency of purchase of clam meat ranged from twice a week to once a month plus purchases on special social occasions. Quantities which they said they were likely to purchase on each occasion varied between 2 kg and 5 kg, while the prices which they said they were willing to pay ranged from \$4/kg to \$10/kg. One Tokelauan indicated that he was so keen to buy the giant clam meat that price, within reason, was not very important.

Interestingly, the number of Tokelauans that the three respondents believed to be living in New Zealand exceeded official figures quite significantly. While officially there are 2316 Tokelauans in New Zealand according to the 1986 Census, the respondents quoted figures ranging from 3000 to 5000. The New Zealand census might not include all 'illegal' immigrants and thus may underestimate the actual number of Pacific islanders in the New Zealand population.

Fijians

The Fijian community is the smallest Pacific islander community in New Zealand, the 1875 Fijians making up roughly 1.5% of the Pacific islander community. Because these figures are based on the 1986 Census, it is possible that, after the coup in Fiji in 1987, the numbers of Fijians in New Zealand has increased significantly. Three Fijians were interviewed and they had lived in New Zealand for between 15 months and 11 years.

In the Fijian language, larger giant clams are referred to a 'Vasua' while smaller giant clams are called 'Katavatu'. Fiji still has stocks of *T. derasa*, *T. maxima* and *T. squamosa*. However, *H. hippopus* and *T. gigas*, which used to occur there, are thought to be extinct because of over-exploitation.

The three Fijian respondents all classed the giant clam as an excellent food item. Amongst this group of respondents there was no dominantly preferred size of clams for eating. Two of them indicated that they prefer larger-sized giant clams while the other respondent enjoyed smaller-sized clams. Nevertheless, all said that they would be content to eat clams of any size. Fijians eat giant clam meat raw after marinating it in lemon juice and mixing it with spring onions, chilli and coconut cream. Also, it is eaten cooked with coconut cream and vegetables. According to one Fijian, consumption habits differ between rural and urban areas in Fiji. In rural areas where no refrigeration is available, giant clam meat is quite often smoked to preserve it. In urban areas it is usually bought fresh at the local market and then eaten raw or cooked.

None of the three Fijians had been able to obtain giant clam meat in New Zealand. They were all keen to buy imported giant clam meat either in fresh or frozen form if it became available in New Zealand. All three Fijians said they would like to buy giant clam meat about once a week, in quantities varying from 1 to 4 kg a week. The interviewees said that they would expect to pay between NZ\$5-12/kg for giant clam meat if it were available in New Zealand.

Market potential for giant clam meat among Pacific islanders in New Zealand

All 34 Pacific islanders interviewed replied that they would be interested in buying imported giant clam meat in New Zealand. Twenty Pacific islanders considered it an excellent product, 6 considered it above average, 7 average, and only 1 person rated it below average.

Over three-quarters of Pacific islanders interviewed considered giant clam meat to be an above average to excellent product. This indicates a strong taste preference of Pacific islanders for giant clam meat. The fact that giant clam meat is unavailable in New Zealand may, of course, make Pacific island migrants more eager for it. Also, as pointed out by many Pacific islanders, second generation Pacific islanders are likely to lose their taste for traditional foods such as giant clam meat as they adapt to New Zealand foods. Thus, any campaign to market giant clam meat in New Zealand is likely to be more successful if it is launched in the near future. Otherwise, with successive generations the number of descendants of Pacific islanders still familiar with the giant clams will decrease.

At the moment, the majority of Pacific islanders are very keen to see giant clam meat imported into New Zealand. According to the New Zealand 1986 Census the number of Pacific islanders living in New Zealand is 167 700. Allowing for the possibility that a number of second and third generation Pacific islanders will not eat giant clam meat, and that some Pacific islanders may have little inclination to eat it, the following two population figures of consumers will be used to estimate market size:

- (a) 90000 Pacific islanders
- (b) 120000 Pacific islanders

We can group these estimates of potential consumers into family units. A reasonable estimate for the size of a Pacific islander family in New Zealand is five people. This coincides with the number suggested by the Pacific islander respondents to this survey.

Therefore, the estimated number of family units of Pacific islanders in New Zealand to consume giant clams is:

- (a) $90000/5 = 18000$ or
- (b) $120000/5 = 24000$

Most Pacific islanders interviewed indicated that they would like to buy giant clams regularly (once a week) and in reasonable quantities: 1-3 kg/week. Therefore, two alternative possible levels of giant clam consumption per family per week will be considered:

- (1) 1.25 kg/week per family and
- (2) 2.50 kg/week per family.

Thus, given these possibilities the annual quantity of sales of giant clam meat would be the four alternatives:

- (a) (I) 18000 families \times 1.25 kg/week \times 52 weeks/yr = 1170 tonnes/yr
 (II) 18000 families \times 2.50 kg/week \times 52 weeks/yr = 2340 tonnes/yr
 (b) (I) 24000 families \times 1.25 kg/week \times 52 weeks/yr = 1560 tonnes/yr
 (II) 24000 families \times 2.50 kg/week \times 52 weeks/yr = 3120 tonnes/yr

This would imply for the entire Pacific islander population of New Zealand of 167 700 an average annual level of consumption of clam meat ranging from 7.0 kg/ to 18.7 kg/person.

To calculate the likely value of giant clam sales at the retail level, the three following prices per kg were used: NZ\$5.00/kg, NZ\$7.50/kg, and NZ\$10.00/kg. The prices are within the ranges suggested by the Pacific islanders interviewed. In considering their responses about prices Pacific islanders quite often based their figures on prices they would have to pay in their native countries. According to respondents, prices have increased significantly in the Pacific islands due to dwindling natural stocks of giant clams. Respondents, because of their knowledge of these prices, had a reasonable idea of what price levels might prevail. Table 17.2 indicates the value of the giant clam sales at the alternative prices assumed and quantities of sales estimated. It suggests a gross value of retail sales annually ranging from NZ\$5.85m to NZ\$31.20m. The most favourable assumed scenario, namely 120000 Pacific islanders (willing to buy giant clam meat), at the rate of 2.5kg/week/family and paying a price of \$10.00/kg is certainly not an unrealistic possibility. This would mean the market in New Zealand could be worth up to and above NZ\$30.0 m annually, in terms of retail sales. The New Zealand market would be even larger if Maoris and New Zealanders of European descent were to purchase tridacnid meat, which they may do.

Table 17.2 The potential retail value (NZ\$) of sales of giant clam meat to Pacific island families (Pif) for alternative quantities and prices.

Consumption per year per family	Number of Pacific island families			
	18000		24000	
	1.25 kg/ family	2.50 kg/ family	1.25 kg/ family	2.50 kg/ family
Annual gross quantity sold to Pif in New Zealand	1170 t	2340 t	1560 t	3120 t
NZ\$ 5.00/kg	5.85 m	11.70 m	7.80 m	15.60 m
NZ\$ 7.50/kg	8.775 m	17.55 m	11.70 m	23.40 m
NZ\$ 10.00/kg	1.170 m	23.40 m	15.60 m	31.20 m

From this information we can establish the number of giant clams of various ages required to satisfy the estimated New Zealand demand. To do this, we have selected three different ages for the harvested clams. The wet meat weights used are those suggested by Munro (1988) for *T. gigas* and are given in Table 17.3 together with the number of harvested clams required to satisfy the market. The number of clams required to satisfy demand is shown both without drip loss and with 40 per cent drip loss. The number of clams required will, of course, vary with the estimated market size and the age of the clams, as well as with the size of drip loss assumed. However, it is clear that several hundred thousand would need to be harvested annually to satisfy the New Zealand potential market. Possibly around 30 sizeable clam farms putting down 100000 or so clams per year would be needed. This amount of grow-out is needed to compensate for mortality of clams when they are grown-out in the ocean. For example, although 100000 clams may be grown-out, because of natural mortalities only half of this number may survive if they are grown-out for several years before harvesting.

Table 17.3 Total number of harvested clams of alternative ages and weights^a required (with and without drip loss) to supply the four alternative levels of potential market demand in New Zealand^b.

Retail market demand (tonnes/year)	Weight of meat of individual clams at various ages		
	1.16 kg (5 yrs)	2.55 kg (7 yrs)	4.29 kg (9 yrs)
1170 t	1 008 621 (1 681 035)	458 824 (764 707)	272 727 (454 545)
1560 t	1 344 828 (2 241 380)	611 765 (1 019 608)	363 636 (606 060)
2340 t	2 017 441 (3 362 401)	917 649 (1 529 415)	545 455 (909 092)
3120 t	2 689 655 (4 482 758)	1 223 529 (2 039 215)	727 273 (1 212 132)

Notes:^aWeights are for *T. gigas* as estimated by Munro (1988). Meat estimated wet without drip loss.

^bNumber of clams in parenthesis allows for a 40 per cent drip loss, and is 1.66 the number not allowing for drip loss.

Import restrictions

Since the only way in which giant clams are likely to be supplied to the New Zealand market is by importation, we thought it important to consider restrictions which may prevent or impede clam imports.

Three New Zealand Government bodies—the Department of Health, the Fishing Industry Board and the Ministry of Agriculture and Fisheries—were approached and questioned about any restrictions that could affect the import of giant clams to New Zealand.

Currently there are no specific import restrictions for shellfish designed to protect the New Zealand shellfish industry. However, there are qualitative restrictions placed upon any shellfish imports, similar to those imposed by the U.S. Food and Drug Administration. These qualitative measures are administered by the New Zealand Department of Health. Its responsibility is to ensure that the quality of imported products meets acceptable New Zealand guidelines. These guidelines vary according to the form in which the shellfish is imported, i.e., frozen, chilled or tinned. Only when a shellfish has met all requirements can it be imported. To safeguard the quality and to ensure that imported mollusc flesh meets health standards, regular checks are made by the Department of Health. Aside from health standards, the only other barrier to the import of giant clams to New Zealand is the CITES (Convention on International Trade in Endangered Species) agreement, to which New Zealand is a signatory. The Import and Export of Animals section of the Ministry of Agriculture and Fisheries is responsible for the implementation of the Trade in Endangered Species Act 1989, which has been passed to enable New Zealand to fulfil its obligations under the CITES agreement.

According to this Act, no person shall trade in any specimen of an endangered, threatened, or exploited species into and from New Zealand, except via the appropriate permits or certificates which are laid down in this Act. Under section 18 of this Act, species threatened by trade—under which category the giant clam falls—do not require a permit to be imported where ‘an importer has been granted a permit to export or a certificate to re-export a specimen of the threatened species from the relevant authority of the country of export’.

In the case where ‘a permit to export or a certificate to re-export a specimen of a threatened species is not required by the relevant authority of the country of export, the Director-General may grant a permit to import that specimen subject to such conditions as the Director-General thinks fit to impose’. Thus, in theory and practice, it should be possible to import giant clams into New Zealand provided that they have been farmed and the necessary certificates have been issued.

Concluding observations

The results of this survey indicate that the potential market for giant clam meat in New Zealand is substantial. The size of the market in New Zealand amongst Pacific islanders seems to be much larger than in Australia.

In another survey that evaluated the possible demand for giant clam meat among Tongans resident in Australia, (Chapter 16), the most optimistic estimate of the market size was 325 tonnes/yr. The market size for the entire Pacific islander population in Australia could be about two and a half times that amount, about 800 tonnes/yr. The largest estimate of potential market size for giant clam meat in New Zealand was 3120 tonnes/yr. This makes the market potential for giant clam meat sales amongst Pacific islanders in New Zealand four times that of Australia. The New Zealand potential market is also much larger than that estimated for Okinawa (virtually the whole Japanese market at present) by Professor Yung C. Shang,

namely 578 tonnes annually and for Taiwan 240 tonnes (Center for Tropical and Subtropical Aquaculture 1990, pp. 1–4).

It seems that the New Zealand market could easily absorb the output of 30–40 large clam farms or, of course, the output of many more small farms or supplies from a large number of semi-subsistence enterprises in the Pacific.

As far as shipping and airline links are concerned, New Zealand is well placed in relation to Polynesia, but much so in relation to Melanesia and Micronesia. Thus the most suitable source of New Zealand supplies of giant clam meat from the Pacific islands would, it seems, be Polynesia, which has close links with New Zealand via transport and existing trade and cultural links. But environmental conditions for growing giant clams *may* on the whole be somewhat less favourable in Polynesia than in Melanesia, e.g. the Solomon islands, and parts of Micronesia. Nevertheless, farming does seem biologically and economically possible in Polynesia, e.g. in Tonga, Cook Islands, Fiji and Samoa. Experiments and trials by governments in these countries designed to spearhead giant clam mariculture are already well advanced. The fact that Fiji has in the past had substantial exports of clam meat to New Zealand (see Chapter 13) indicates that clam farms established there should be able to regain a significant share of the New Zealand market for this meat.

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Appendix

Questionnaire for New Zealand Pacific islanders, regarding giant clam meat consumption (confidential, July 1990).

<p>1. Name, address and telephone number of respondent</p> <p>2. From which country do you originate or are you a descendant of?</p> <p>3. How long have you been residing in New Zealand?</p> <p>4. Have you ever consumed giant clam meat?</p> <p>5 a) Do you know the names of the giant clams, which you have eaten? (e.g. <i>Hippo</i> clam or <i>Tridacna gigas</i>).</p> <p>b) Are there any varieties which you like best?</p> <p>6. What is the preferred size of the clam you eat?</p> <p>7 a) How do you prepare the giant clam meat? b) Do you know of any other recipe for giant clams?</p> <p>8. What parts of the giant clam do you use for eating? (e.g. mantle, adductor muscle, whole clam).</p> <p>9. Have you been able to obtain giant clam meat in New Zealand? Yes No a) If yes, where do you get it from? b) If no, do you know where it might be sold? * Please circle correct answer</p> <p>10. As you may know, it is now possible to farm giant clams. If there was someone farming giant clams in Australia, would you be interested in buying giant clam meat from them, if it was exported to New Zealand?</p> <p>11. Would you be interested in purchasing</p>	<p>fresh clam meat, frozen clam meat or dried clam meat? Please elaborate.</p> <p>12 a) Would you buy the clam meat on a regular basis or just occasionally? (e.g. how many times per year?) Please elaborate b) What quantities of giant clam meat would you buy?</p> <p>13. What would you regard as a reasonable price to pay for giant clam meat per kilo?. Please specify: a) whole clam, mantle or adductor muscle. b) fresh, frozen or dried</p> <p>14. How highly do you rate clam meat as a food item? a) Excellent product () b) Above average product () c) Average product () d) Below average product () c) Do no know ()</p> <p>15. In what other areas of New Zealand do you think there might be Pacific Islanders who are interested in purchasing giant clam meat and how many Pacific Islanders live there?</p> <p>16. Do you have any contact address of Pacific Islander clubs or associations in those areas? Please list</p> <p>17. Would you like a complementary copy of the report on this survey? Yes/No</p> <p>Thank you very much for your cooperation.</p> <p>Clem Tisdell Department of Economics University of Queensland St. Lucia 4067 Telephone (07) 377-2049</p>
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