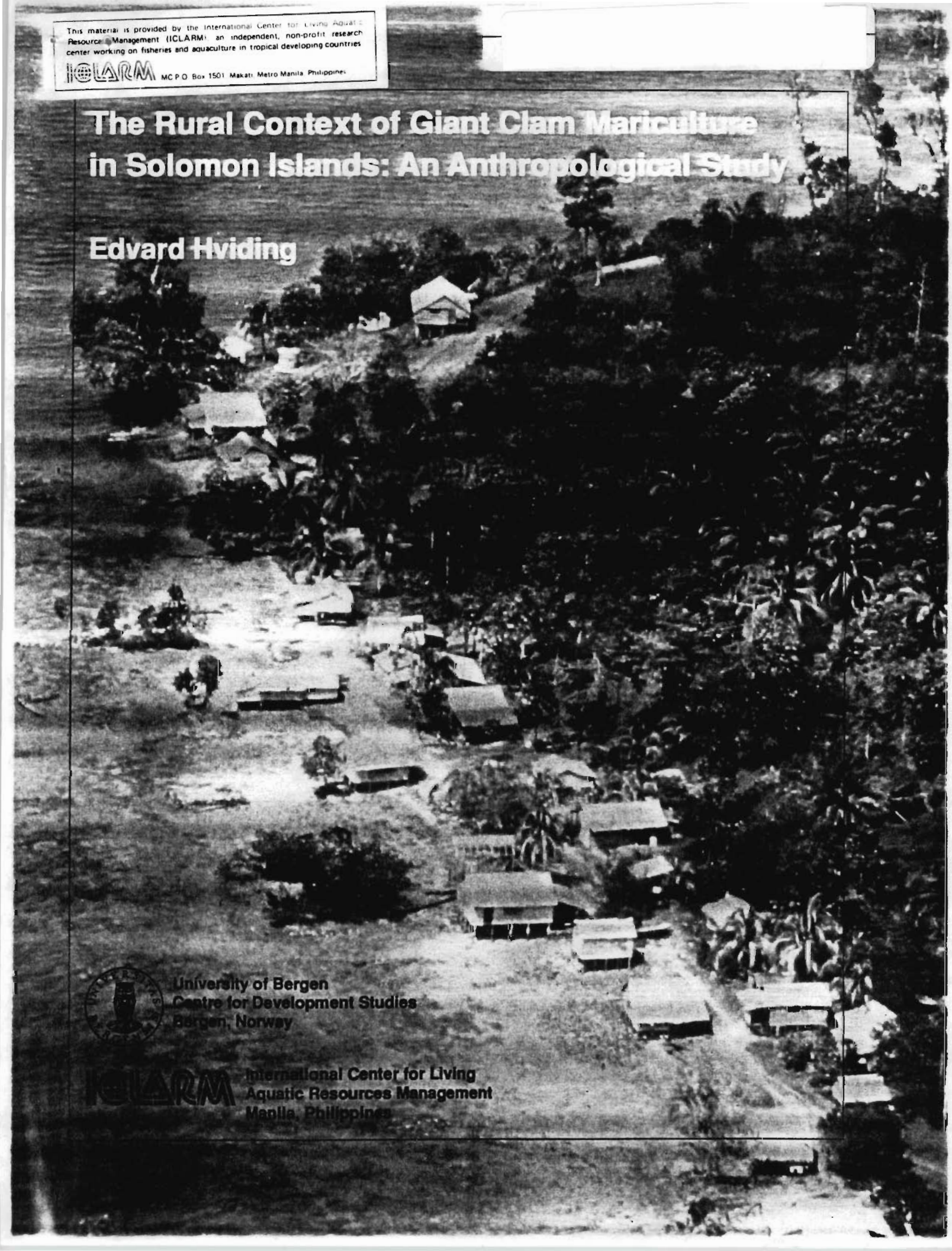
The Rural Context of Giant Clam Mariculture in Solomon Islands: An Anthropological Study

Edvard Hviding



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Cover: A typical coastal village in Solomon Islands: Chubikopi, Marovo Lagoon, Western Province. Several "clam gardens" are located on the fringing reef close to the house sites. Photo by E. Hviding.

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PREFACE

BACKGROUND AND CONTEXT OF STUDY

The research on which this study is directly based was carried out in Solomon Islands during the period November 1991 - March 1992. My previous long-term research in Solomon Islands[1] (based on 22 months of anthropological fieldwork in the Western Province; 1986-1987, 1989-1990), together with institutional links, provided the background for a joint proposal in 1990 by me (in my capacity as Research Fellow, Centre for Development Studies [CDS], University of Bergen) and John L. Munro (Director, ICLARM [South Pacific]) to investigate social, economic and legal parameters in giant clam mariculture (Hviding and Munro 1990). Through a Memorandum of Understanding signed in Bergen on 3 March 1990 between ICLARM and CDS, collaboration was arranged whereby the CDS would cover my international travel and salary,[2] and ICLARM would provide domestic travel and infrastructural support in Solomon Islands, through my appointment as Affiliate Research Scientist at the Coastal Aquaculture Centre (CAC).

A note on the place and role of the present study within ICLARM's Giant Clam Mariculture Project (GCMP) is in order: The study is simultaneously a general review of the rural context for giant clam mariculture in Solomon Islands, *and* a specific analysis of how the current activities of the ICLARM CAC interact with that context. Consequently, although being a component of the GCMP, this study also examines aspects of that project itself, with a focus on the dynamics generated in the variety of social fora where the activities of the GCMP are involved.

Methodology and Primary Sources of Information

Throughout the November 1991 - March 1992 period, rural travel alternated with periods based at the CAC during which documents were reviewed, field data processed and discussions held with CAC staff and a number of people in and around Honiara. Shorter and longer field visits were made to village locations in Western, Malaita and Central provinces, and to the corresponding provincial capitals of Gizo, Auki and Tulagi. Considering the limited time available, as well as the logistical problems characteristic of a far-flung archipelago, a balance had to be found between the wish for a broad coverage of localities where village-based giant clam farming trials are situated, and the need for deep insights into the complexities of the rural context. The latter can be reached mainly through detailed studies of particular localities. Therefore, in order to maximize the utility of existing data and to obtain in-depth baseline studies of the context for rural mariculture, emphasis was given to the Western Province, where certain infrastructural and ecological conditions seem particularly promising for mariculture development, and where I have previously carried out extensive field research on coastal resource use and management in the Marovo Lagoon area. This emphasis also re-

[1] See Hviding (1988, 1989, 1990, 1991; Johannes and Hviding 1987).

[2] My international travel was generously funded by the Norwegian Research Council for Science and the Humanities (NAVF), under a grant to the CDS-based project "Studying Customary Marine Tenure Systems for Designing the Management of Tropical Inshore Fisheries". This support is gratefully acknowledged.

flects the organization of the GCMP, which runs a field station near the provincial capital of Gizo and an expanding number of village trials throughout the province.

Techniques employed during field research were dominated by nonformal interviews with village trial participants and other village residents, including community leaders and representatives of women's organizations. A number of interviews were also made with trial applicants, to ascertain their ideas about mariculture and its prospects. Participant observation during routine visits to village trials accompanying ICLARM CAC staff gave insights into the process of participatory, collaborative research. During interviews and more formal meetings, a number of initiatives and concerns were expressed by villagers and their leaders, and these ideas were conveyed to relevant CAC staff for further consideration. My fluency in Solomon Islands Pijin and in the Western Solomons *lingua franca* of Marovo facilitated such two-way flows of information and allowed close examination of ethnobiological topics and vernacular taxonomy. Thus, an inventory of more than 100 vernacular mollusc taxa, together with detailed information on their occurrence, lives and local uses, was compiled for the Marovo area of Western Province (Hviding and Leivestad 1992). In discussions with villagers, particular emphasis was given to the rich ethnobiology and folklore surrounding giant clams. Linguistic analysis also provided insights into certain indigenous categorizations of key importance for mariculture activities, such as "husbandry" concepts.

In addition to villagers and community leaders, persons interviewed during field visits in rural and provincial locations included politicians (elected members of provincial assemblies and area councils), provincial fisheries officers, rural extension officers in fisheries and agriculture, and a variety of indigenous entrepreneurs such as managers of hotels and resorts, plantation owners and cash-crop farmers. In Honiara, persons met include representatives of relevant government ministries, regional agencies, nongovernmental organizations and aid donors, as well as business people involved in marine products, handicrafts and fish marketing.

During the November-March stay in Solomon Islands, I was accompanied by my wife Karen Leivestad.[3] A trained anthropologist with long experience from practical work with women in cross-cultural contexts, she was appointed Affiliate Scientific Assistant at the CAC and assigned tasks mainly in relation to women's roles in rural systems of food production, women's organizations and their role in mariculture development, and postharvest treatment of giant clams. Her work has made important contributions to many insights presented here, particularly in chapters 3, 5 and 7. The field component of her work involved, among other things, intensive participation in shellfish gathering in mangroves and on reefs, and participation in the activities of rural household kitchens, including the processing of five species of giant clams. Some of these findings have been reported separately, while others will be analyzed in detail in a later report (but see Appendix 2, and Hviding and Leivestad 1992).[4]

Sources of Information Within the Giant Clam Mariculture Project

The present study has drawn on previous and concurrent work carried out under the research program of the ICLARM CAC, as acknowledged throughout the report and listed in the bibliography. Numerous papers and reports on giant clams and their mariculture by Dr. John L. Munro (CAC Director) have been invaluable in providing a social scientist with the necessary

[3]Accordingly, the use of the pronoun "we" in the text of this study refers to Edvard Hviding and Karen Leivestad.

[4]Leivestad (1992), a preliminary report on rural postharvest practices and some of their implications for further research on the processing of tridacnid meat, is reprinted (with minor revisions) as Appendix 2 of this study.

technical background (Munro 1988b, 1989, 1990a, 1990b, 1991; Munro and Heslinga 1983). Numerous reports (mostly unpublished) by Mr. Hugh Govan (Assistant Research Scientist, CAC), who played the leading role in the inception and implementation of the village trial program, have been instrumental in the attempt to piece together a comprehensive picture of these activities and their local context (cf., in particular, Govan 1987a, 1988, 1989b, 1989c; Govan and Tafea n.d.). Recent working papers on the economics of village-based giant clam mariculture by ICLARM's CFTC-funded Affiliate Research Scientist, Dr. John Hambrey, have provided important insights into the dynamics of the production and marketing processes and potentials (Hambrey 1991, 1992). Finally, a mass of unpublished field reports, information leaflets, internal memoranda and policy documents produced by various authors under the GCMP and contained in the ICLARM CAC files was generously made available by J.L. Munro. The usual caveat applies where any errors made during interpretation of these documents are my own responsibility.

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Bergen, April 1993

ABSTRACT

This study, based on field research in a number of locations throughout Solomon Islands and supplemented by reviews of published and unpublished literature and other documentary sources, examines important elements of the context of village-based giant clam mariculture in the Pacific Islands region. With the increased feasibility of and interest in the development of mariculture in the South Pacific, particularly of giant clams, but also of algae and other marine products, important social, economic and legal challenges arise. This study of Solomon Islands examines social and cultural parameters typically relevant for mariculture development throughout the Pacific Islands region.

Chapter 1 summarizes key issues relating to the past, present and future importance of giant clams for Pacific Islanders, and gives an overview of the giant clam mariculture activities carried out in Solomon Islands by ICLARM. Chapter 2 provides an ethnographic sketch of culture, society and economy in Solomon Islands, with an emphasis on rural systems of production and their implications for mariculture. Chapter 3 examines the high traditional importance of giant clams in a historical and comparative perspective which includes harvesting patterns, local preferences of different tridacnid species for food, traditional postharvest methods, the roles of giant clam shell in material culture and the religious significance of giant clams. It is shown that rural people prefer to eat the smaller tridacnid species so far not favored by mariculture researchers. The largest species, *Tridacna gigas*, is typically held in reverence as ceremonial food. Chapter 4 describes traditional knowledge and beliefs about giant clams and lists taxonomies for tridacnids in 19 Solomon Islands languages. It is shown that villagers view giant clams as focal and benevolent organisms in coral reef ecology, and certain traditional management measures relating to giant clams are described. Indigenous forms of mariculture are also examined, with particular attention given to the widespread domestication of tridacnids in "clam gardens" at village shores, as well as to indigenous concepts of "husbandry". Chapter 5 is a study of ICLARM's village-level ocean nursery trials, with particular reference to mutual communication between participating villagers and mariculture researchers. Motives for village trial participation range from conservationist concerns to commercial interest, and most participants are male rural entrepreneurs. It is suggested that a present all-male bias should be reversed by actively inviting women's groups to become involved, and that better two-way dialogue be established on husbandry routines and mutual benefits. Through its emphasis on "participatory research," the village trial program is a valuable focus for farming systems analysis. Chapter 6 examines customary law as it applies to potential mariculture sites in Solomon Islands. Systems of customary marine tenure, more or less implicitly backed by state law, regulate access to and uses of virtually every reef in the country. Although limiting overall access to mariculture sites, the framework of customary marine tenure provides a wide range of possible management units in mariculture, and gives long-term security of established sites. Chapter 7 examines some important organizational circumstances for rural mariculture with reference to the flexible nature of subsistence-based household economy. Occupational multiplicity and other risk-minimizing strategies of rural households limit the prospects for full-time mariculture involvement by individual "farmers". A more likely scenario is the increased involvement of organized groups, including women's associations. The varied potential for developing and expanding domestic markets for giant clams is briefly discussed.

Appendices provide more detailed information on the traditional postharvest utilization of giant clams and on the overall importance of marine molluscs as sources of food and cash in rural Solomon Islands.

ACKNOWLEDGEMENTS

This study has benefited greatly from numerous and varied discussions during 1991-1992 with the staff of the ICLARM CAC: John L. Munro, Hugh Govan, John Hambrey, Hugo Tafea, Mark Gervis, Pat Munro, Tom Shearer, Cletus Oengpepa, Andrew Peli, Idris Lane, Lucy Gilkes, Cathreena Gervis and Toata Molea all deserve thanks for showing such interest in the study. Felistus Leung efficiently handled financial and logistic matters in Solomon Islands. Thanks are also due to staff at ICLARM's Manila headquarters who have at various stages of the study provided much help and stimulating discussion, particularly Bob Pomeroy, Kenneth T. Mackay, Jay Maclean and, not least, Daniel Pauly whose initial encouragement in 1989 led to the inception of this study. The staff of the Ian R. Smith Memorial Library have provided invaluable assistance on several visits to Manila.

Many people in Solomon Islands shared their ideas on topics examined here. Particular thanks are due to the following for providing important detailed information and kind hospitality. In Marovo Lagoon: Harold Jimuru, Vincent Vaguni, Amina Kada, Erik and Vivian Andersen, chief Kata R. Ragoso at Chea, and chief Jonathan Evu at Tamaneke. In Munda: Peter Paulsen and Angeline Yahata. For discussion, special thanks also to Rev. T. Boso (Madou), Hon. Jerry Buare, Hon. Alex Lokopio and Charlie Panakera (Gizo), a number of village trial participants (and applicants) in Central, Malaita and Western provinces, and officers of the Solomon Islands Fisheries Division in Honiara and at the Provincial Fisheries Centres in Tulagi, Auki and Gizo.

My wife and co-researcher, Karen Leivestad, has given invaluable assistance and inspiration during all stages of this study. The Centre for Development Studies, University of Bergen, has generously provided time and facilities required for completing the report in its initial and final versions. For detailed comments on and constructive criticism of a draft report (August 1992) as well as for updated information on developments during 1992, I am grateful to the scientific staff members of the CAC. Finally, very special thanks are due to CAC Director John L. Munro, without whose inspiring enthusiasm and interest in the wider issues of mariculture and its contexts this study could not have been carried out.

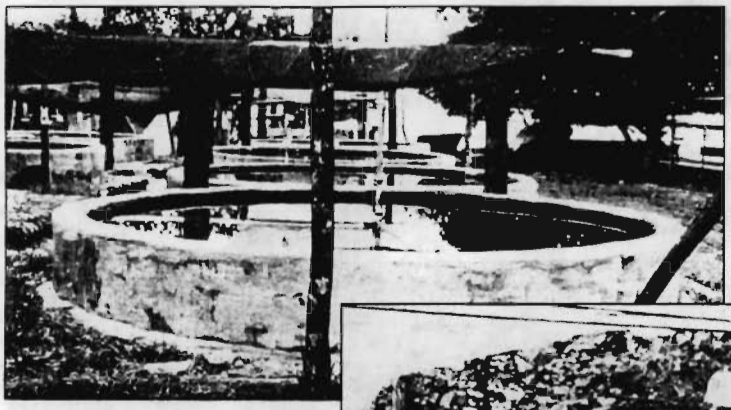
ASPECTS OF THE RURAL CONTEXT OF GIANT CLAM MARICULTURE IN SOLOMON ISLANDS
(All photos by E. Hviding)

⇩ Coastal village scene, with a residential house and a smaller attached kitchen building, both made from sagopalm thatch, on stilts over the tidal mark. A second residential building and a canoe landing complete this extended-family hamlet, one of several spread out along two kilometers of coastline and comprising a village. Small "clam gardens" (cf. chapter 4) are commonly situated right off such hamlet sites. Chea, Marovo Lagoon, Western Province.

⇧ Giant clams, mainly *Tridacna gigas* and *Hippopus hippopus*, are often collected from outer reefs and placed close to villages in family-owned "clam gardens". Here, a 50 cm *T. gigas* is harvested from a clam garden for consumption during Christmas celebrations. Vahole, North New Georgia, Western Province.

⇦ Tridacnid clams are preferably brought live to the village where they are killed and cleaned in or near the family kitchen. Here, a *Tridacna gigas* is butchered in the course of preparing a catch of bivalves, consisting of *T. gigas*, *Hippopus hippopus*, *Polymesoda* spp., *Anadara granosa* and *Gafrarium tumidum*, and collected by two women on a brief trip to nearby reefs and mangroves. The two tridacnids were taken from a "clam garden". Tamaneke, Marovo Lagoon, Western Province.

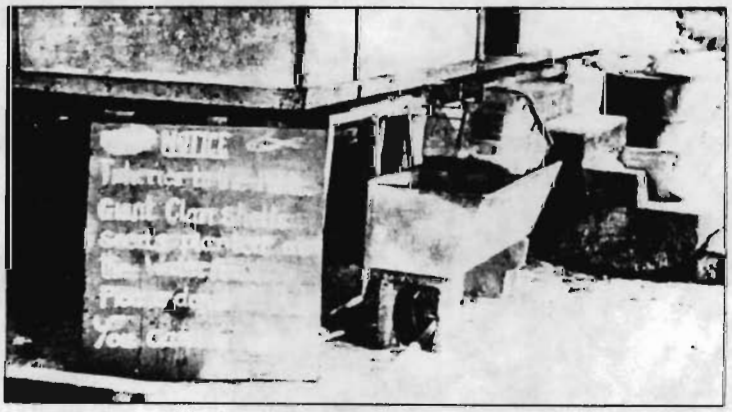
⇧ Many reminders of the important traditional roles of tridacnid shell are to be seen around and near villages today. The photo shows a large (>80 cm), old but nonfossilized *Tridacna gigas* valve used as a cache for ancestors' shell valuables, at a 19th-century sacred site in uphill coastal forest close to present-day food gardens. Near Chea, Marovo Lagoon, Western Province.



⇦ A view of the nursery tank system at the ICLARM CAC, Aruligo, Guadalcanal Province. By late 1992 the system covered 53 of these tanks totaling 364 m^2.

⇨ CAC employee Dick Tavake shows *T. gigas* broodstock to three visiting Solomon Islanders. Many visitors, both tourists and Solomon Islanders, find their way to the ICLARM CAC. Through the steady stream of nontourist visitors from around the country, public awareness of the Giant Clam Mariculture Project grows and enthusiasm for giant clam farming spreads.

⇦ During a routine visit to an ocean nursery "village trial," CAC technical aide Andrew Peli discusses tridacnid biology and mariculture with an interested Gela Islands elder who just passed by. Many rural Solomon Islanders take a strong personal interest in the life and fate of giant clams and in the possibilities offered by mariculture, and routine visits by CAC staff to village trials provide many opportunities for informal two-way dialogue about a range of technical questions and other important issues in "Farming Systems" research. Tulagi, Central Province.



⇨ Throughout Solomon Islands, reefs suitable for giant clam mariculture are considered the exclusive customary property of local groups. This sign is posted at the Provincial Fisheries Centre, Tulagi, Central Province, where a "village trial" involving the resident fisheries extension officers is located. It invokes a number of common reef tenure principles, in this case a modern combination of limited privilege granted to the Fisheries Division by local groups who retain customary control over the reef area in general, although the adjacent land is government-held.

CHAPTER 1

PROLOGUE AND OVERVIEW

This study, a component of the Giant Clam Mariculture Project (GCMP) of the International Center for Living Aquatic Resources Management (ICLARM), provides an overview of some important opportunities and constraints for the development of giant clam mariculture in Solomon Islands. The overall theme of the study is the rural context for such development, as exemplified by the GCMP carried out in the country by the ICLARM Coastal Aquaculture Centre (CAC).

Introduction

Giant clams (*Tridacna* and *Hippopus* spp. and related species) have been and remain fascinating objects for people in a wide range of societies and historical periods. In particular, this applies to the "true giant clam," *Tridacna gigas*, which grows peacefully in the luxuriant world of the coral reef to a size of more than a meter (shell length) and a weight of 250-300 kg. This remarkable animal has a wealth of culturally and materially important associations to it.

Among Pacific Islanders, who harvest the range of tridacnid clams for food, *T. gigas* is of importance not just as a highly valued, nutritious (and often ceremonial) protein food, but also as a source of shell material for key elements of material culture (valuables, tools) and for sacred ritual objects like repositories for ancestral skulls, and even as a crucial element of tribal folklore underpinning ethnic identity. In the Philippines and Indonesia, rural fishing populations also harvest rapidly dwindling numbers of tridacnids for the meat, whereas important industries of shellcraft and tile production rely on the shells of the clams (in the latter case, large fossilized valves of *T. gigas* are mined from coastal reefs). Further afield in Southeast Asia, the adductor muscle of giant clams is a delicacy for which very high prices are paid and much poaching in distant waters has been pursued by Taiwanese.

Far beyond its tropical Indo-Pacific homelands *T. gigas* evokes powerful images in Europe too, being the "killer clam" (or German "Mörder-muschel") that in innumerable South Seas tales and films traps luckless divers between its massive jaws - or, having a far more benign association not with death but rather with the opposite, being the French "benitiér" (holy water font) used for baptisms in European churches for centuries (cf. Pauly 1988).

Add to this recent realizations that giant clams are "the only phototrophic, and thus self-feeding, potential farm animal known to humankind" (Munro 1989) with a potential for feeding growing island populations (or alternatively, satisfying high-spending Taiwanese consumers), plus the listing of *T. gigas* and other tridacnids as threatened species under the Convention on International Trade in Endangered Species (CITES), and it becomes clear why giant clams are now enthusiastically embraced by a large and diverse "audience". Tridacnids are firmly on the agenda of an increasing number of people working within fields such as mariculture research, rural development, coral reef conservation and commercial entrepreneurship and are regularly subject to some level of "fetishism" - not unlike the traditional "totemism" widespread in the Pacific. Giant clams also remain important in the pragmatic and ceremonial lives of Pacific Islanders, who have had reason to worry about the future of stocks as human populations increase and as Taiwanese poachers strip ever more reefs of these vulnerable sedentary creatures. Here is fertile ground for linking local people's interests and needs and those of

mariculturists, as evidenced by the number of facilities for hatching and growing giant clams that have been set up throughout the Indo-Pacific region since the late 1970s.

Elements of the Solomon Islands Context for Giant Clam Mariculture

With many small and large lagoons, sheltered bays and extensive fringing reefs, the coastal zones around the Solomon Islands group provide eminently suitable ecological circumstances for mariculture. The GCMP is notable among mariculture projects of its kind in aiming at the early and active involvement by Solomon Islands villagers throughout the archipelago in a form of "participatory research," through a network of village-based ocean nursery trials where various parameters of giant clam mariculture are investigated.

In addition, a number of other factors characteristic of the Solomons combine to make a study of the rural context for giant clam mariculture appear particularly significant:

- most species of giant clams remain important in village subsistence, and giant clam stocks are still in a fairly good condition in most parts of the archipelago;
- giant clams have a special place in local customs and are often imbued with deep respect;
- there are a number of widespread traditional precedents of giant clam mariculture;
- localized depletion by Asian poachers has produced strong village-level interest in giant clam conservation and a consequent enthusiasm for mariculture and reef enhancement;
- throughout Solomon Islands, reefs suitable for mariculture are held by local groups through customary law with *de facto* government recognition;
- a large variety of community-based organizations exist, many of which contain potential frameworks for village-level mariculture.

Analyzing the Rural Context

Having its roots in long-term anthropological field research in one part of Solomon Islands, supplemented by brief visits to a number of other locations, this study should be viewed as an attempt at holistic analysis of the present and potential roles of giant clams and their mariculture throughout rural Solomon Islands. This approach embraces many dimensions not derived from mariculture research and development, such as aspects of folklore, of community organization, and of rural economy and food production. The analysis includes appraisals of what giant clams mean to rural Solomon Islanders, how mariculture as represented by ICLARM's research efforts in Solomon Islands is perceived by villagers and urbanites alike, and how all this is expressed by people. In an attempt to illuminate this multitude of dimensions, the following chapters contain a number of case examples. These cases also serve to convey a variety of enthusiastic local-level initiatives regarding giant clam mariculture. During the field research for this study, many requests were received from villagers for "passing on important messages" to those responsible. A number of such messages, notably relating to the potential role of mariculture in furthering coastal zone conservation and to rural preferences regarding target species, have been incorporated in the text.

Wider Relevance of this Study

Although the findings and suggestions presented here are based on and reflect conditions in Solomon Islands, many are representative of wider patterns found throughout the South

Pacific, and to some degree beyond that region. Of particular interest is the fact that giant clam mariculture operations are presently in various stages of development at many locations in the Indo-Pacific (see Copland and Lucas 1988). Further, although the study has giant clams as its focus, many of the findings apply also to the mariculture of other organisms, and to recent issues like restocking and reef fish ranching. With the proper reservations and accommodations of divergent parameters added, the information contained here should have relevance for a range of mariculture developments in the tropical coastal zone.

Approach and Overview of the Study

Examining Internal and External Parameters

So far, data on nonbiological parameters relating to the social and economic aspects of village-level clam husbandry have not been collected on a systematic basis in connection with ICLARM's village trials. However, the overall objective of these trials is broadly stated as being "to test the viability of village-based giant clam farming". As a key focus of ICLARM's research, village trials gain their own momentum in defining mariculture (and its potentials) in the eyes of Solomon Islands villagers, government officials and politicians. Indeed, few if any of the multitude of externally funded "research-and-development" projects that have been launched in Solomon Islands since independence in 1978 have reached such a level of fame throughout the country as the GCMP.[1] Virtually every adult Solomon Islander of coastal residence knows about the activities of the ICLARM CAC, and many have developed more or less well-defined expectations as to the end results of ICLARM's giant clam research. Therefore, the "viability of giant clam farming" is determined not just by the biological results documented partly through village trials, but also by important external parameters of social, cultural, economic and political nature. For this reason the study takes a broad approach to examining the context for, and potential of, village-based giant clam mariculture, and is not confined to dealing only with communities already involved in mariculture trials.

Structure of the Study

Chapter 2 describes the overall setting through an ethnographic sketch of village life in contemporary Solomon Islands. In chapters 3 and 4, the traditional importance and indigenous perceptions of giant clams are examined in detail, and traditional precedents of relevance to mariculture are described. The relevance of traditional concepts for "Farming Systems" research is examined. Chapter 5 addresses the village trials, by examining in detail their role in and relations to village life and the wider society. Chapter 6 reviews the traditional Solomon Islands patterns of reef ownership and their roles as opportunities and constraints for mariculture. a topic of key importance for such development virtually anywhere in the Pacific Islands. In chapter 7, the highly diverse and flexible nature of household-based rural economies is examined with reference to implications for mariculture development, and market scenarios are briefly discussed.

Suggestions for future directions of ICLARM's research on giant clam mariculture are given throughout the chapters. Key findings and suggestions are also summarized in the abstract

[1]This assessment of the remarkable awareness of the GCMP among Solomon Islanders is based on the author's own subjective impressions as an independent observer (unattached to ICLARM) through 1986-1990, and on follow-up investigations in Honiara and four provinces during the 1991-1992 assignment. Undoubtedly, the fact that by 1991 "virtually everyone" had heard about the project reflects the importance attached by the Solomon Islands public to giant clams and their future, as well as the novelty of the GCMP.

and in this initial chapter. Two appendices provide added detail on traditional food preparation involving giant clam meat, and on the role of marine molluscs in general in rural subsistence and cash economies.[2] The comprehensive bibliography includes references to a large quantity of published and unpublished material relating directly or indirectly to the GCMP and utilized as sources of information for this study.

Giant Clams in the Contemporary Pacific

Depletion of Stocks and the Local Value of Giant Clams

Giant clams (Tridacnidae:Bivalvia) have a wide distribution in the Indo-Pacific. In a review of information on the distribution and utilization of tridacnids and the potential for mariculture and stock enhancement, Munro (1989) concludes that stocks have been seriously depleted in many parts of the region. Several species, notably *Tridacna gigas*, the world's largest bivalve, are extinct in certain areas. Increased population pressure with resultant environmental degradation and overexploitation of reef resources is the cause of some localized depletion of tridacnids. More significant, however, is the large-scale fishery for giant clams carried out for decades on remote and not-so-remote reefs in the South Pacific by specialized Asian vessels (mainly from Taiwan, cf. Dawson and Philipson 1989). This fishery supplies Asian markets, where the large adductor muscles of giant clams are a highly priced delicacy. In many instances, the activities of Asian vessels have had the character of illegal incursions, and a number of vessels have been apprehended for poaching in the waters of Pacific Island nations.

In the South Pacific, the harvesting methods practised by Asian vessels are viewed as highly wasteful. The vessels employ divers who cut the clams open on the reef and remove the adductor muscle while discarding the voluminous meat of the clam mantle, which is ironically the preferred food of Pacific Islanders. In countries like Papua New Guinea and Solomon Islands, which have had more than their share of poaching and where increasing coastal populations put pressures on reef resources, villagers have increasingly expressed worries over the depletion of giant clams.

From the vantage point of Solomon Islands, chapters 3 and 4 of this study indicate how giant clams occupy a very special place in many Pacific Islands cultures, with an importance far beyond their role as food. Indeed, tridacnids in many ways seem to be specially cherished animals whose depletion or extinction is viewed with great sorrow by villagers. These concerns, coupled with the nearly universal existence in the Pacific Islands of social institutions that effectively create limited entry to reefs and the resources there, have accelerated the establishment of small reef plots where giant clams, collected from outer reefs, are kept by village families in the vicinity of the house. Traditionally, such simple forms of mariculture are found widely in the South Pacific, and the collection of clams for nearshore "clam gardens" from which they can be readily harvested in times of rough weather or for special ceremonial occasions is reported from archipelagoes as widely scattered as Kiribati, Tonga, Papua New Guinea and Palau.[3]

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[2]See also Hviding and Leivestad (1992), which is a baseline study of local knowledge and utilization of more than 100 molluscs species in a particularly resource-rich part of Solomon Islands, namely, the large reef-enclosed lagoon of Marovo, Western Province.

[3]See Moir (1989) for a review of the scarce documentation available for "clam gardens" in the Pacific. See also Maclean (1978) (quoted here in chapter 4) for a brief sketch of the traditional and contemporary roles of clam gardens in Manus, Papua New Guinea.

Potential Contributions of Giant Clam Mariculture

The traditional importance of giant clams, and the existing institutional arrangements that facilitate simple forms of mariculture, are some of the factors that make village-based giant clam mariculture seem a particularly promising contribution to rural development in the South Pacific. Since the diminishing wild stocks of tridacnids in the Indo-Pacific are now protected under the CITES regulations, there is presently no adductor muscle available to Asian markets through legitimate channels. Illegal supplies from the South Pacific to Southeast Asia through poaching and smuggling have also been dwindling, though still estimated at more than 300,000 clams per year in 1989 (Dawson and Philipson 1989). On this background, and assuming that the Asian markets remain willing to pay premium prices, the commercial potential of giant clam mariculture is often highlighted.[4]

The potential offered by mariculture for restoring depleted or extinct tridacnid stocks also merits attention, and appears to have been a significant motivating factor for many of the Indo-Pacific countries now participating in mariculture projects (Copland and Lucas 1988).

Nutritional Value of Giant Clams: The Case of Vitamin A in the Pacific Islands

One important potential benefit of increasing the availability of giant clam meat to Pacific Islanders through local-level mariculture and stock enhancement relates to mounting nutritional problems. Increasing protein scarcity is now well-documented among rural and urban populations in the Pacific (see, e.g., Thaman 1982). Another severe aspect of Pacific Islands malnutrition is the lack of vitamin A, which among other things is a cause of blindness among children. Increases in such blindness, as well as other serious effects of vitamin A deficiency, are reported from several island nations as presently highlighted in the media.

The role of giant clam meat in providing high-quality protein is obvious. A less obvious but not less significant nutritional contribution of tridacnid meat in light of the above is its high content of vitamin A, probably located in the zooxanthellae of the clam mantle. An analysis of the nutritional content of various seafoods from Chuuk in Micronesia shows that raw tridacnid meat (*Hippopus hippopus* and *Tridacna crocea*) contains 800-1,000 I.U. vitamin A per 100 g (Murai et al. 1958).[5] In contrast, vitamin A is shown to be absent from the meat of all other molluscs and all fish species analyzed.[6] Giant clams thus hold the potential for being a major future source of vitamin A for Pacific Islanders.

Giant Clam Mariculture in Solomon Islands

Mariculture Facilities in the Pacific

The cultivation of all species of giant clams is now regarded as technically feasible, as a result of research carried out since the 1970s at a number of locations throughout the Indo-Pacific. Hatcheries and/or nurseries for giant clams currently operate in Australia, Solomon

[4]The major Asian markets for giant clam adductor muscle have been reviewed recently by, e.g., Dawson and Philipson (1989) and Hambrey (1991). The latter also analyzes a variety of other actual and potential markets for a variety of giant clam products.

[5]I am grateful to Karen Leivestad for bringing this information to my attention, to Bob Johannes for further discussion, and to P. Munro and J.L. Munro for corroborating the suggestion that the vitamin A in question is in fact located in the symbiotic zooxanthellae of the clam mantle. The investigation quoted is of value in that it is the only one so far located by us (Hviding and Leivestad) that examines the nutritional value of tridacnid clams separately, rather than listing all molluscs or "shellfish" under one common rubric.

[6]However, vitamin A is known to occur in fish intestines, and the decline of this part of the fish in Pacific Islands diets has been pointed out as a possible major cause of vitamin A deficiency, especially in atolls with few alternative traditional sources such as fruit (R.E. Johannes, pers. comm.). John Munro (pers. comm.) has suggested that vitamin A content in fish intestines is a characteristic mainly of reef species that feed on algae.

Islands, Palau, Federated States of Micronesia (Kosrae), Marshall Islands, Fiji, Tonga, Cook Islands, Western Samoa and American Samoa.[7] Among these, major operations are those of ICLARM's CAC near Honiara, Solomon Islands, James Cook University (JCU) in Townsville, Australia (closed in December 1991), and the Micronesian Mariculture Demonstration Center (MMDC) in Koror, Palau.

Villagers Emphasize Other Giant Clam Species than those Favored by Scientists

Research and mariculture carried out so far has mostly concentrated on the two largest species, *Tridacna gigas* and *T. derasa*, generally known as faster-growing than the smaller species. However, it is the latter, mainly *Hippopus hippopus*, *T. crocea* and *T. maxima*, that are the most important species in traditional subsistence diets around the Pacific (cf. Munro 1989 and chapter 3 of this study). These species have greater natural abundance and wild stocks appear capable of withstanding continuous, though low, exploitation rates (J.L. Munro, pers. comm.). The discrepancy between species favored by mariculture researchers and in rural subsistence may have several potential implications for the relationship between mariculture development and rural communities, and possibly also for the adoption of mariculture on a wider scale. A diversification of mariculture research and practical trials to include the smaller species, despite their slower growth, may appear advisable (see chapters 3 and 4 and Case 8 of this study). However, from the point of view of mariculture research, the question of (controllable) survival rates of different cultured species is an additional important consideration in the general development of efficient cultivation systems. This, as well as (fairly invariable) growth rates, and other biological parameters, is increasingly being investigated at the ICLARM CAC particularly with regard to *H. hippopus*, now that efficient large-scale production of *T. gigas* has been attained.

ICLARM's Giant Clam Mariculture Project

The GCMP of ICLARM's CAC, located at Aruligo near the Solomon Islands capital of Honiara, aims at developing economically viable systems for the cultivation of various species of giant clams.[8] To this end, a number of ocean nursery trials have been established in villages throughout Solomon Islands to supplement the main ocean nursery facility of the CAC at Nusa Tupe, near Gizo in the Western Province. The GCMP also has as one of its specified objectives to "investigate economic, social and legal factors which affect giant clam culture in the South Pacific Region". Further, the objectives of the GCMP emphasize the restoration of stocks and a reversal of the trend toward extinction. In contrast to, for example, the activities of the MMDC in Palau, ICLARM's GCMP does not aim at "corporate" profit-oriented ventures, but rather at providing income-earning, "cash crop"-type opportunities to coastal villagers in the Indo-Pacific region. This small-scale rural orientation is evidenced by the emphasis on having villagers participate in the relatively early stages of research, through the village trials.

A primary objective for establishing the ICLARM CAC was "to create a purpose-built giant clam hatchery in a representative Pacific equatorial environment at which giant clam farming systems could be tested for their practicality, productivity and economic viability" (Maclean and Dizon 1991). Whereas the technical feasibility of giant clam mariculture has been the major focus of CAC operations since the beginning, studies relating to economic and social feasibility have been only carried out more recently as technical feasibility has become established.

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[7] J.L. Munro (pers. comm.).

[8] See Maclean and Dizon (1991, p. 116-135) for a recent summary of the GCMP and related activities at ICLARM's South Pacific Office.

Consequently the process of compiling, analyzing and integrating a broad range of biological, economic and sociocultural data along the lines of a "Farming Systems" approach, such as pioneered by ICLARM elsewhere,[9] is in its early stages of development. It is important that a range of social and cultural parameters constituting the rural context for mariculture development should now be closely integrated into the GCMP, and the village trial operations provide a most fruitful context for the systematic gathering of such a variety of data. In addition, suggestions provided by village trial participants themselves open up a two-way dialogue that allows for a further fine-tuning of mariculture research and development to the realities of rural life in Solomon Islands and elsewhere in the South Pacific.

Options for the Mariculture Process

The various stages in the mariculture of giant clams are explained in detail in, for example, Crawford et al. (1987), Copland and Lucas (1988) and Munro (1989). Briefly, the mariculture process falls into three main stages: (1) hatchery and land-based nursery, (2) ocean nursery and (3) grow-out. For an overview of the entire mariculture process, a simplified description of the approach currently followed at the ICLARM CAC for *Tridacna gigas* is summarized in Table 1.1.

Table 1.1. A simplified description of stages in the mariculture of *Tridacna gigas* at the ICLARM CAC.

Stage	Duration	Growth stage (SL)	Technology/ location	Comments
Hatchery and settlement tanks	0-20 days	0.1-1 mm	High-intensity rearing in tanks/CAC	Larvae are given artificial feeds
Land nursery	20 days - 5 months	1-8 mm	Intensive rearing in running-water tanks/CAC	May be transferred to ocean nursery from 3-4 mm SL
Ocean nursery (floating)	5-9 months	8-30 mm	Floating cages, close monitoring by ICLARM staff/CAC or Nusa Tupe field station	Provides more protection against predators than bottom or trestle cages, but technology probably too vulnerable for village use
Village ocean nursery	9 months - 2 years	30-100 mm	Covered cages, on bottom or on trestles, inspected by grower 2-3 times a week/on shallow reefs at village locations	Clams vulnerable to predators (gastropods, crustaceans, etc.)
Exclosures	2-3 years	100-200 mm	Encircling net held up by floats, inspected by grower weekly/on shallow reefs at village locations	Protected against predators (fish, octopus)
Grow-out	3-6 years	200-500 mm	Unprotected, monitored by grower/suitable reef	Proposed harvest size at ≥ 450 mm

A number of options exist for the organization of the mariculture process, relating to the transitions from land-based hatchery and nursery tanks, to ocean nurseries and finally to the unprotected grow-out stage. At the ICLARM CAC, an approach has been chosen where juveniles or "spat" are moved out into ocean nurseries at an early stage. The technology associ-

[9]See Edwards et al. (1988) for an introduction to this approach.

floating pontoon arrangement which is in turn anchored to the reef. The main "take-off stage" of interest for the present study is when juveniles of around 3.5 cm shell length (SL) are transferred from the protected environment of intensive nurseries at the CAC (or at the Nusa Tupe field station) to village trials.

Successful applicants for village trials are expected to inspect and clean the cages of clams regularly and to remove any predators found. In return for this, they have ownership of all clams eventually reared. During routine visits to the village trials, data on a number of key biological parameters such as growth, mortality and predation are collected by ICLARM staff. Villagers participate as volunteers in the research efforts of the ICLARM CAC from this stage, and through the trials giant clam mariculture is introduced into village society and perceived as a novel form of "animal husbandry," "cash cropping," "gardening" or "development project" (see chapters 4 and 5 for discussion of indigenous perceptions of mariculture).

CHAPTER 2

THE RURAL BACKGROUND FOR GIANT CLAM MARICULTURE

Introduction

This chapter provides a brief generalized overview of village life in contemporary Solomon Islands. Its aim is to provide a background on which to view the topics addressed in subsequent chapters; in other words, to "set the scene" for potential developments in giant clam mariculture in terms of opportunities and constraints posed by the sociocultural and economic fabric of rural communities. The overview draws on my own field research and on information contained in official statistics and in published material by a number of authors.[1]

A Note on Culture, Society and Sociocultural System

In this study, the concepts "society" and "culture" (and "social"/"cultural") are used as in normal anthropological analysis: "Society" refers to a human population marked by relative separateness from other populations and by a distinctive culture (Keesing 1981), and "culture" to the system of knowledge more or less shared by members of a society (Keesing 1981). In this sense, culture and society are mutually interdependent, and neither "cultures" nor "societies" are entirely separate or absolutely distinct units or "things" of a static nature. The knowledge, beliefs and rules that inform, shape and organize the activity patterns of particular societies are ever-changing, partly through external influences and partly through "feedbacks" from patterns of activity. To obtain a better grasp of these complicated interconnections, the term "sociocultural system" is sometimes used, referring to "the patterns of behavior characteristic of a population sharing a distinctive culture within an ecosystem" (Keesing 1981). This term does not imply that specific ecosystems create specific types of culture and society. Rather, ecological conditions simply shape the possible range of human activity while permitting great variation, as shown by cultural diversity within largely similar ecological contexts in Solomon Islands.

Cultural Diversity, Case Examples and Generality of Information

The great cultural diversity represented by Solomon Islands societies dictates that there are exceptions to most general statements presented below. However, some of the diversity is compensated for by the fact that practical daily life on the village level shows considerable uniformity throughout present-day Solomon Islands, shaped as it is by local and extralocal factors in combination. A note of caution is also in order relating to the role played by my own previous work: It is unavoidable that some of the presentations contained in this and other chapters are somewhat influenced by two years' close involvement in village life in Western

[1]For detailed material on the topics addressed in this chapter, see SIG (1989), population; Larmour (1979), land legislation; Larmour and Tarua (1983), politics; Laracy (1989), history and general ethnography; Ipo (1989), local economies; Scheffler and Larmour (1987), land tenure; Baines (1985 [1990]) and Hviding (1988), marine tenure; and Jones et al. (1988), agriculture and household economy.

Province, in particular the Marovo Lagoon area. This bias will be balanced wherever possible by data from elsewhere in the Solomons. However, it must be noted that the field visits made in the course of the present study to locations in other provinces in many cases confirmed that the picture from Western Province was representative of more Solomons-wide patterns.

On this background it seems justified to present a number of detailed cases derived mainly from the Marovo Lagoon throughout the following chapters, not least because the cases represent insights that could not have been obtained only through the brief field visits carried out directly under this study.

A Sketch of Coastal Village Life in Solomon Islands

Population and Settlement

Solomon Islands is a far-flung archipelago consisting of seven main islands and a great number of small ones including several atoll outliers (Fig. 2.1). The main islands are high and volcanic, densely forested and partly fringed with coral reefs, lagoons and mangroves. An independent nation since 1978, the country has a total population estimated today as exceeding 300,000. Population growth is very high at 3.5% per year (SIG 1989).

More than 70 different indigenous languages are spoken, each roughly representing a distinct and localized ethnic group. The majority of Solomon Islanders live in rural villages of

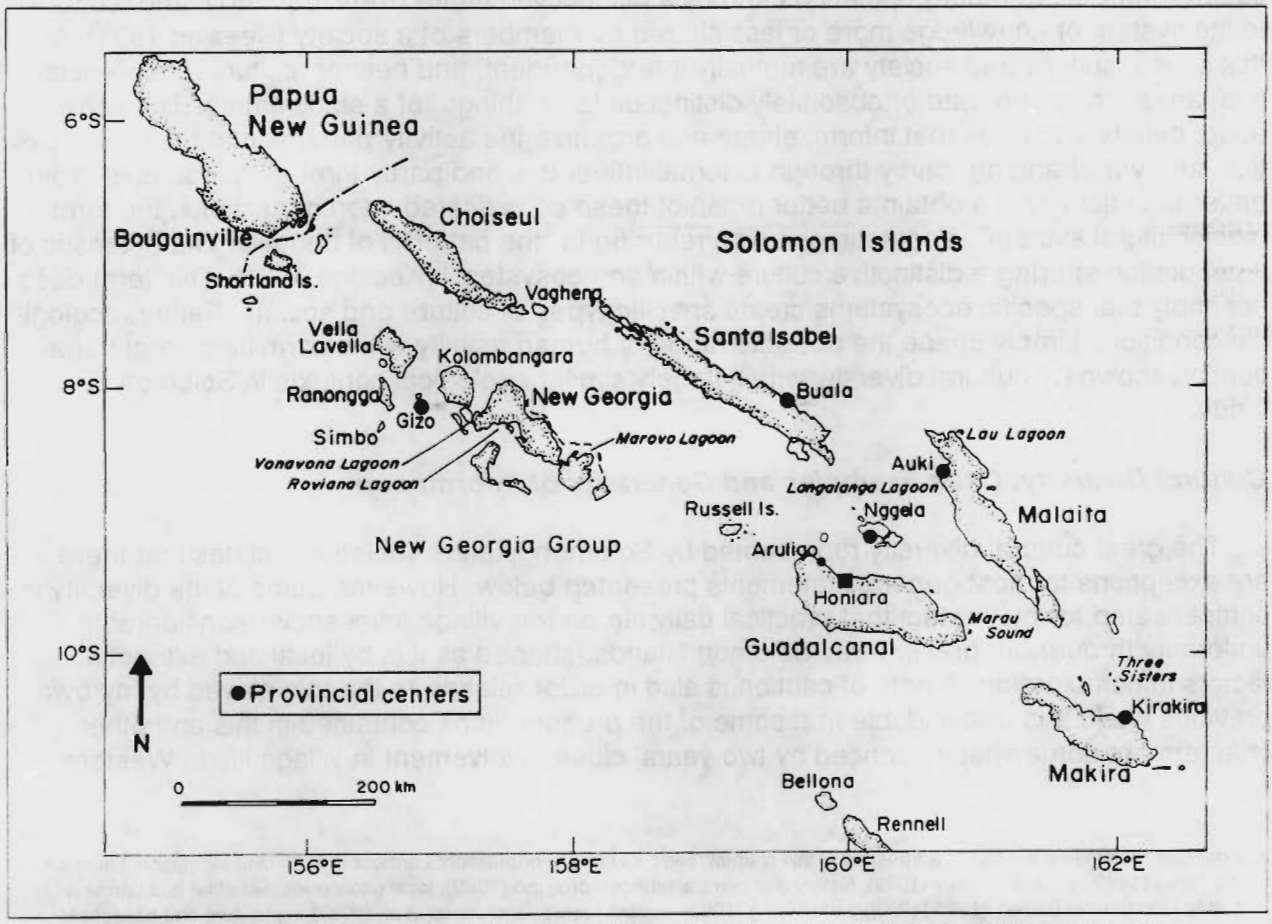

Fig. 2.1. Solomon Islands (Main Group Archipelago excluding outer islands), showing principal locations mentioned in the text.

small-to-medium size, most of which are located on the coast, though there are considerable inland populations on some of the major islands. At present, there is an increasing trend of dispersal whereby extended families settle in coastal hamlets some distance away from the main village, partly in order to intensify entrepreneurial activities like cash-cropping.

Management of Land and Sea

In Solomon Islands, land and nearshore reefs remain largely in the hands of local people. Most rural land is controlled through customary law by the descent groups (lineages, clans or "tribes") residing in a particular area, and leaders of such landholding groups allocate more or less permanent use rights to each family over specific sections for cultivation as garden land, coconut groves, etc. Exclusive communal rights of control or ownership have been handed down through many generations, and descent group members feel a strong sense of attachment to their ancestral territory. Mangrove areas, reefs and lagoon areas are controlled in a similar fashion, though usually with less subdivision of the overall area delimited by the boundaries between different communal holdings. Whereas many coastal groups control an area of both land and sea, other groups of so-called "bush people" have only land under their control.

Typically, although groups of bush people may have secondary fishing rights in the sea adjacent to their land, those seas remain under the control of groups of "salt-water people" who have a long-standing maritime association. Groups of this kind are found, among other places, in the lagoon areas of New Georgia and Malaita. They have a strong reliance on marine resources, and applicants for village trials are likely to emerge from such groups and from groups that have more all-encompassing control of both land and reefs. Customary systems of reef tenure and their relevance for mariculture are dealt with in detail in chapter 6.

Community Leadership

Traditional leaders of descent groups, usually termed "chiefs," act as managers of the resources contained within the customary territory of the group, and often take it upon them to enforce restrictions on harvesting stocks that are considered to be in danger of depletion. Chiefs are assisted in their work by other elders, mostly men, although senior women often command considerable respect particularly in societies that follow matrilineal descent. In contemporary Solomon Islands villages, traditional leadership is supplemented and often rivaled by a variety of more specific, task-oriented leaders tied to the "modern world," like church pastors, school teachers and businessmen.

Access to Resources

Access to productive natural resources of land and sea is invariably obtained through membership in the corporate groups controlling those resources. Generally, Solomon Islanders acquire at birth certain primary entitlements as a member in the descent group of either father or mother, or both, depending on locally specific cultural rules. These entitlements give ideally undisputed rights to cultivate gardens and to fish within the boundaries of the customary territory of the group(s), and also includes varying degrees of influence over the allocation of resources to others. Secondary rights to use land and sea resources, but not to participate widely in decisionmaking, are granted by corporate groups to individuals who become attached through marriage and adoption. Still other permanent or temporary resource use entitlements may be granted to nonrelatives as part of reciprocal exchange or alliance-making.

In the contemporary climate of increased rural entrepreneurship, rights to land and other natural resources are increasingly subject to dispute, particularly when an individual member of a community wishes to monopolize a section of communally held land or reef for his own commercial purposes. Although the majority of such disputes have involved land for intensive cash-cropping, this field of conflict must also be kept in mind concerning mariculture development (see chapter 6).[2]

The Organization of Rural Production: Household, Community, Church

Rural systems of economic production in coastal Solomon Islands are based on the household, which usually consists of a more or less extended nuclear family occupying one or several residential houses and sharing a kitchen. With access to land and sea resources through group membership, rural households form fairly independent units of production.

However, work is also regularly carried out on a more communal level, often organized by the church which is a main focus of village life. A variety of church denominations are represented in Solomon Islands, most of which have been established there for the better part of this century. Roman Catholics, Anglicans, Methodists, Seventh-day Adventists and others all have their characteristic beliefs and organizational forms, and inter-denominational rivalry is fairly common. Apart from some small, recently established evangelist churches, all denominations normally involve entire village populations (or even larger clusters of villages), and thus constitute significant organizational factors on the local level and beyond. The indigenous Christian Fellowship Church (CFC), a powerful influence in Western Province, is a notable example. Another significant aspect of church influences are the taboos on shellfish and other invertebrates contained in the doctrines of the Seventh-day Adventist church (see chapter 3).

Subsistence and Cash Sectors

In Solomon Islands, virtually all rural households function both in the subsistence and cash-earning sectors, with the former normally given priority. Most households produce their own supply of root crops and other vegetables through shifting cultivation in hillside gardens, with additional plant and animal food obtained from the rainforest, which is also the source of house-building materials and medicinal plants. The sea is the main source of protein for coastal households. A large variety of fish, molluscs and crustaceans are obtained through fishing and gathering on reefs, in lagoons and on the open sea, and in mangroves and rivers. The sea also provides a variety of cash incomes through the harvest and sale of "marine products" like trochus, pearl shell and bêche-de-mer, and through the marketing of fish.[3]

Among other sources of cash are the marketing of garden produce (mainly on the local level), the sale of handicrafts to tourists (often via middlemen), remittances from relatives working in the urban sector, and not least, smallholder-based cash-cropping activities. The latter has for over a century been dominated by copra production, more recently supplemented by cocoa farming. With reference to mariculture it is important to acknowledge that Solomon Islands villagers, through their near-universal experience of coconut planting and copra production, tend to be well aware of the delay between initial inputs and later outputs. A time frame of five to seven years from planting to first harvest is a well-established fact for rural

[2]In several cases, the proposed or actual establishment of village trials by ICLARM has been accompanied by some degree of conflict over who has primary rights over the reef area(s) in question.

[3]Appendix 1 lists the most important molluscs in the rural subsistence and cash sectors, and gives information on their relative importance in four locations in Solomon Islands.

copra producers (though it has to be admitted that most young households have access through kinship ties to coconut groves already in production).

It is also notable that, beyond the realm of largely extinct large-scale plantation systems owned by foreign capital, copra production in the rural Solomons contains many examples of durable community-based plantation enterprises. Long-term planning, finance and credit institutions, infrastructural arrangements and organized rotation of labor are integrated elements of these enterprises, of which the most famous are the impressive communal plantation schemes run by the indigenous CFC in the Western Province.[4]

Rural Entrepreneurship

Rural households experience increasing cash needs for expenditures like children's school fees, clothes, imported supplementary foodstuffs (mainly rice and tinned fish), lamp kerosene and outboard motor fuel. Aspirations toward greater capital investments such as outboard motors, fiberglass canoes and iron-roof houses are also on the rise. These needs and aspirations presently promote a variety of rural entrepreneurial initiatives involving individuals, single families or larger organized groups. Ideas about "projects" and "development" are firmly established in Solomon Islands villages today. This is reflected in the variety of attempts (many mediated partly through government extension agents and financed by loans from the Development Bank of Solomon Islands) to intensify and diversify cash-cropping, commercial fishing and livestock-raising, and to organize the marketing of agricultural produce, marine products and handicrafts. These enterprises meet with varying degrees of success and are only rarely able to provide sustained regular incomes on a long-term basis. However, many individuals with entrepreneurial leanings show a seemingly never-ending preparedness to try out new "projects," and participation in ICLARM's village trials is one such alternative.

Gender, Division of Labor and Implications for Mariculture

Patterns relating to work and gender roles in rural Solomon Islands are based on a division of labor common throughout the Pacific (especially on high islands), whereby men carry out most of the fishing, clear new gardens and go hunting in the upper forest, while women handle most of the gardening and domestic tasks. Of particular importance for mariculture development is the fact that most women in coastal Solomon Islands also spend considerable amounts of time gathering molluscs and other organisms from mangroves and nearshore reefs. In all villages visited during fieldwork, it was firmly stated that the gathering of food shells is carried out mainly by women. These statements were verified through participant observation. The conclusion can be drawn that it is rural women who know and identify most closely with those reef areas which are likely locations for mariculture development.[5]

Since village women throughout the Solomons also run a variety of efficient organizations, usually church-based and focusing on mutual help and communal work, their potential role in mariculture development deserves more attention than that given so far by ICLARM's village trial programme. On the other hand, here and elsewhere (see ICLARM and GTZ 1991 for an African example) it is men who tend to be most closely involved in entrepreneurial activities, as reflected by the virtually all-male participation in village trials as of early 1992 (cf. Table 3, chapter 5).

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[4]Significantly, the establishment of village trials involving community and women's groups at the large CFC village of Madou in the Vonavona Lagoon was initiated in January-February 1992 with the close involvement of the Rev. T Boso, who is the General Secretary of the CFC as well as a community leader at Madou.

[5]This is in line with a widespread Pacific Islands pattern in the sexual division of labor, described by Schoeffel (1985) with reference to fisheries and mariculture development.

Occupational Multiplicity

Finally, another key aspect of rural economy must be highlighted with reference to mariculture and its "opportunity costs" (cf. chapters 5 and 7): Very few villagers are engaged in a full-time occupation. A small number of rural entrepreneurs have chosen to devote their entire attention to one major activity, such as commercial fishing and fish-marketing, and to cover other household needs with the cash obtained. Most villagers, however, follow economic strategies whereby a great number of productive activities alternate throughout any given period of time. There is thus "always" room for new activities, which must, however, somehow be integrated into the existing multiplicity of part-time occupations. This is particularly important for "development"-type projects that require time to be set aside for new routine activities, such as the twice-weekly inspection and cleaning of clam cages involved in village trials.

The Background for Rural Mariculture

This brief sketch of village life in Solomon Islands has highlighted some main opportunities for mariculture development:

- food production and most other economic activities are largely based on the household unit, with community-level organization playing an important secondary role;
- a high degree of flexibility and multiplicity characterizes household-based production, with participation in a large variety of both subsistence and cash-earning activities;
- reefs suitable for mariculture are controlled by local groups, who generally have a strong interest in the well-being of those reefs and the resources there;
- a variety of organizational frameworks relevant to mariculture exist throughout Solomon Islands;
- rural women have intimate knowledge of those reef areas that are often the most suitable for giant clam mariculture;
- molluscs (including giant clams) are of high importance as both food and cash source;
- there is widespread and increasing interest in local-level entrepreneurial activities in the rural Solomons;
- long-established cash-cropping routines have led to an appreciation among villagers of certain "time lags" between input and output in smallholder-based farming activities.

Recent Initiatives in Seaweed Farming

Although there are some notable traditional precedents in the "domestication" of reef invertebrates, not least tridacnids (see chapter 4), few attempts have so far been made at developing organized mariculture anywhere in Solomon Islands. However, under a project funded by the United Kingdom Overseas Development Administration, a small number of mariculture trials for seaweed (*Eucheuma* sp.) were established by the Solomon Islands Fisheries Division in the late 1980s, mainly in Western Province. Some of these were organized communally and others family-based, and cultivation took place on shallow reefs near participants' settlements (cf. Govan 1989d). A number of the participating groups and families made several harvests,

until most abandoned their "farms" owing to various problems. Although still nominally operating from a base at the provincial subcenter Munda on the Roviana Lagoon, the seaweed project is now widely regarded as being a bygone thing.

During a field visit to the Vonavona Lagoon in Western Province in January 1992 we met with several former seaweed trial participants, in their new capacity as applicants for giant clam village trials. They explained that the failure of their seaweed attempts were largely to be blamed on ecological parameters beyond human control. If it had not been for persistent invasions of herbivorous rabbitfish (*Siganus spinus*) that ate up the seaweed in some locations, and a year dominated by heavy rains and little sun with few opportunities for drying those seaweed harvests that escaped the rabbitfish, they felt that the project would still have been running successfully. A major motivation behind their present applications to ICLARM was that they consider giant clams to be immune to such troubles. As one unlucky former seaweed farmer with his copra shed now full of rotting seaweed explained: "I have my family organized now to grow things in the sea, so we might as well change over to planting clams on our reef here!"

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harvesting reef molluscs - see Case 1, this chapter). Although this category is likely to include a certain volume of crustaceans (mainly mangrove crabs, *Scylla serrata* and small land crabs, *Cardisoma* spp.), it is reasonable to assume that staple molluscs (cf. Appendix 1) constitute most of the "shellfish" consumed. The average consumption for all households surveyed on a national basis is given as 1.61 kg/household/month,[3] with a range from 0.00 - 5.07.

However, several parameters of the survey are unclear, and it may be safely assumed that actual average consumption of molluscs is considerably higher among those households to which this form of food consumption applies. The report cited states that "...there is known to have been some under-reporting of consumption of own produce in this survey..." (SIG n.d.). And undoubtedly, among the households surveyed and included in the estimate were a number in inland settlements without access to significant mollusc resources, thus not consuming "shellfish" or fish. The highest figure quoted is from Western Province, where virtually all settlements are coastal and where reef resources are abundant.

Thus, the monthly shellfish consumption estimate of >5 kg/household may be seen as indicative of the types of communities most likely to participate in mariculture development, with even higher consumption rates likely in a number of coastal villages. For example, the particular estimate in question is known to be based on a sample that includes a significant number of households in Seventh-day Adventist communities where no shellfish is consumed.

Patterns in the Harvesting of Molluscs

Though some level of shellfish gathering and reef gleaning goes on throughout the year, the general intensity of these activities is strongly influenced by rhythms in nature and is tied up with the requirements of other types of work. The main climatic factor is the annual cycle of two fairly distinct seasons, that dominated by the regular breeze of the southeasterly trade winds (roughly April-September), and that dominated by the irregular squalls of the northwesterly monsoons (November-March). The seasons of the different winds are coupled with changes in the diurnal cycles of the tides.

The following case, from Western Province but representing patterns familiar throughout Solomon Islands, illustrates the complex associations between climate and human activities that in turn generate annual patterns in the harvesting of molluscs. Of particular relevance to giant clam mariculture are the annual shifts in tidal cycles that make nursery cages fixed on the bottom less accessible for part of the year, when tides are at their highest during the day.

ANNUAL RHYTHMS IN THE GATHERING OF FOOD MOLLUSCS

In Marovo Lagoon, shellfish gathering and reef-gleaning are at their most intense during the period of low tide in daytime - from April to September, when the southeast trade wind blows regularly. In this period, reefs and mangroves are at their most accessible with less need for diving, and stocks of the burrowing clam *Tridacna crocea* can easily be worked by women in only waist-deep water. Also, there are fewer gardening obligations for women since most garden work consists of harvesting and weeding. Moreover, the persistent trade winds frequently prevent intensive fishing activities by the men for several days in a row, and the need for alternative protein is so much stronger. As the season of northwesterly monsoons and low tide at night approaches, less emphasis is given

[3]It was not possible to ascertain whether the figures refer to whole shellfish, or to flesh only. Judging from qualitative impressions of shellfish harvests in coastal villages in Western, Central and Malaita provinces, and from the fact that shell weight makes any reasonable individual harvest of molluscs reach several kilos, it seems warranted to interpret the statistics as dealing with net weight, i.e., edible flesh.

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Thus, the monthly shellfish consumption estimate of >5 kg/household may be seen as indicative of the types of communities most likely to participate in mariculture development, with even higher consumption rates likely in a number of coastal villages. For example, the particular estimate in question is known to be based on a sample that includes a significant number of households in Seventh-day Adventist communities where no shellfish is consumed.

Patterns in the Harvesting of Molluscs

Though some level of shellfish gathering and reef gleaning goes on throughout the year, the general intensity of these activities is strongly influenced by rhythms in nature and is tied up with the requirements of other types of work. The main climatic factor is the annual cycle of two fairly distinct seasons, that dominated by the regular breeze of the southeasterly trade winds (roughly April-September), and that dominated by the irregular squalls of the northwesterly monsoons (November-March). The seasons of the different winds are coupled with changes in the diurnal cycles of the tides.

The following case, from Western Province but representing patterns familiar throughout Solomon Islands, illustrates the complex associations between climate and human activities that in turn generate annual patterns in the harvesting of molluscs. Of particular relevance to giant clam mariculture are the annual shifts in tidal cycles that make nursery cages fixed on the bottom less accessible for part of the year, when tides are at their highest during the day.

ANNUAL RHYTHMS IN THE GATHERING OF FOOD MOLLUSCS

In Marovo Lagoon, shellfish gathering and reef-gleaning are at their most intense during the period of low tide in daytime - from April to September, when the southeast trade wind blows regularly. In this period, reefs and mangroves are at their most accessible with less need for diving, and stocks of the burrowing clam *Tridacna crocea* can easily be worked by women in only waist-deep water. Also, there are fewer gardening obligations for women since most garden work consists of harvesting and weeding. Moreover, the persistent trade winds frequently prevent intensive fishing activities by the men for several days in a row, and the need for alternative protein is so much stronger. As the season of northwesterly monsoons and low tide at night approaches, less emphasis is given

[3]It was not possible to ascertain whether the figures refer to whole shellfish, or to flesh only. Judging from qualitative impressions of shellfish harvests in coastal villages in Western, Central and Malaita provinces, and from the fact that shell weight makes any reasonable individual harvest of molluscs reach several kilos, it seems warranted to interpret the statistics as dealing with net weight, i.e., edible flesh.

2. ***Opportunistic collecting of clams encountered on outer reefs during other activities.*** This is most often engaged in by men while fishing, diving for pearl shells or bêche-de-mer, or simply traveling, and mainly yields *Tridacna squamosa, T. maxima, T. gigas* and presumably *T. derasa* where applicable. When a clam is sighted during diving it is quickly removed from the reef and brought into the canoe. Alternatively, a large clam may be first sighted from the canoe while paddling over shallow reefs, in which case a diver goes down to check whether the clam may be brought whole into the canoe, or whether is so large and heavy that it must be killed on the spot and only the meat taken into the canoe. In the latter cases, a stone or a paddle is jammed between the valves of the clam to prevent them from closing, the adductor muscle is severed with a knife and the entire meat lifted out, whereas the shell is left on the reef. If in very shallow water, the empty shell is sometimes turned over, so as not to pose a danger to barefoot reef walkers. Opportunistic collection of giant clams takes place throughout the year and is the main source of tridacnids for nearshore clam gardens, where they are stored for shorter or longer period of time and from which they can be harvested at will for special occasions (see chapter 4). For such purposes, even very large *T. gigas* may sometimes be brought up to the canoe live, requiring several men's labor.

Giant Clams as Food: Rural Preferences

The species *Tridacna gigas, T. squamosa, T. maxima, T. crocea* and *Hippopus hippopus* are all found in reasonable numbers in most parts of Solomon Islands. *T. derasa* has a more limited distribution, and several of the other species have been subject to localized depletion either from subsistence gathering or from intensive harvesting (in most cases illegal) by Taiwanese clam boats. All species are eaten by coastal villagers, and in addition the valves have a variety of traditional uses.[5]

The Relative Importance of Different Tridacnids as Rural Food

One aim of the field investigations reported here was to reach some assessment of local preferences for different tridacnids as food, and of the relative importance of the species in rural diets. Such an assessment is presented here by the following list, where the six tridacnid species found in the Solomons are ranked in order of decreasing importance as normal food.

1. *Tridacna crocea*
2. *Hippopus hippopus*
3a. *Tridacna squamosa*
3b. *Tridacna maxima*
4. *Tridacna gigas*
5. *Tridacna derasa*

Although certain local variations do exist, the list is an attempt at generalizing on the basis of primary and secondary data from throughout the Solomons, and presents several points worthy of note and elaboration.[6]

[5]See Govan et al. (1988) for more detail on distribution and the state of stocks in Solomon Islands.

[6]Since so little information is available on the relative importance of different tridacnids as food in Solomon Islands, the assessment made here is purely qualitative and is based on a number of first-hand impressions from field visits, plus statements by Solomon Islanders from all parts of the country. The field impressions derive from conversations, from observations of actual clam harvests, from village shell middens and from general insights obtained during previous long-term field research. Except for the rather evident status of *T. crocea* and *H. hippopus*, the assessments should be seen as provisional, and as guidelines for detailed quantitative investigations.

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Tridacna squamosa *and* Tridacna maxima*: Taste and Texture*

Tridacna squamosa and *T. maxima* are ranked together as two species of medium importance as food. This, it was pointed out by villagers in a number of locations, is largely owing to the fact that they are not as abundant as *H. hippopus* (with which they are generally ranked in terms of food "quality"), nor are they as easy to collect, since they are found mainly on outer reef flats and slopes. For this reason, they are subject mainly to the form of "opportunistic," nonsystematic harvesting described above. However, *T. maxima* in particular is regarded by many as the "sweetest-tasting" tridacnid, and larger specimens of *T. squamosa* are esteemed for having what is regarded as "big meat" (i.e., voluminous with a crunchy texture) without the stringiness and massive flavor, nor the associated taboos, of large *T. gigas*.

T. squamosa in particular is often collected for clam gardens where it is kept mainly with *T. gigas* and *H. hippopus*, and more detailed comparative investigations would probably identify this species as being overall slightly more important than *T. maxima* today. Contrary to statements from biological research (e.g., Munro and Heslinga 1983), several villagers stated that according to their own long-term observations from reefs and more lately clam gardens *T. squamosa* is the fastest-growing of all tridacnids - at least for the middle-size growth stages most commonly observed in clam gardens.

Tridacna gigas*: Food for Important Occasions*

The relatively slight importance of *T. gigas* as food reflects its prime importance in other terms, and its low ranking on this list does not nearly reflect its overall traditional role. This tridacnid is a preferred food for feasts, nowadays often weddings, Christmas celebrations and similar occasions, and is rarely eaten for everyday meals. After having been harvested from outer reefs, *T. gigas* are often kept for long periods in clam gardens, awaiting such special occasions.[10]

The largest tridacnid is remarkable for being subject to a number of traditional taboos on its harvest and utilization for food and other purposes. Various forms of taboos on *T. gigas* are found throughout the Solomons. In some areas, like in Langalanga, Marovo and Marau, entire descent groups are still forbidden from eating it, with reference to ancestral taboos. Taboos regarding the consumption of giant clam meat (mainly *T. gigas*) by women are also widespread, possibly reflecting old institutions whereby the largest clams have been reserved for men at feasts. On a more pragmatic and informal level, many women interviewed said that they do not like the taste (of any specimen, large or small) and texture (of large specimens) of *T. gigas*, and that they much prefer *H. hippopus* anyway.

Some taboos on eating *T. gigas* are no longer as strong or general as they used to be.[11] In several villages visited in Western Province, people stated firmly that *T. gigas* was never eaten in former times, but that it is now established as a delicacy for festive occasions. And from investigations at the Honiara fish market, it is apparent that urban Solomon Islanders who would normally have to follow taboos against eating *T. gigas* back home in the village increasingly disregard this in town. Thus, despite the resilience of traditional taboos (and their Christian "reinvention" in the form of food taboos followed by the Seventh-day Adventists), the

[10]Large *T. gigas* held in clam gardens are often viewed as domestic animals analogous to pigs, sharing the latter's importance as ceremonial food. In Marovo Lagoon, "to kill *T. gigas*" (*va legua ose*) usually refers to the practice of selecting, killing and cooking a large domesticated specimen from a clam garden for a festive occasion. In this sense the term corresponds to that of "killing a (domesticated) pig" (*va legua moa*). Both practices are contingent on long-term planning and advance announcements, and are subject to eager anticipation.

[11]In an unpublished CAC trip report from Marau Sound on NE Guadalcanal, Govan (1987c) reports that "[s]ome of the local villagers, until recently, regarded *T. gigas* as a sort of god and therefore it was tambu. This custom is not strong anymore."

largest tridacnid may be on the way up as far as its importance as food in Solomon Islands is concerned.

Changes in Relative Importance

The picture presented here from present-day Solomon Islands is part of ever-changing historical processes. The increasing food importance of the previously widely tabooed *T. gigas* has been mentioned. Another example is the apparent change in the role of *T. crocea*: Archaeological excavations of middens throughout the archipelago made during the Solomon Islands national sites survey (1976-1978) indicate a picture different from today in that not only *T. gigas*, but even today's staple *T. crocea*, are absent from virtually all sites. Instead, considerable numbers of *H. hippopus* and *T. maxima* shells (and a few *T. squamosa*) were found in the majority of coastal sites (Miller 1979). In his early dictionary of the Roviana language of the western Solomons, Waterhouse (1928) lists *T. maxima* and *H. hippopus*, and secondarily *T. crocea*, as food sources, whereas *T. gigas* and *T. squamosa* are not mentioned as food but only as sources of shell material for traditional valuables.

The case of *T. crocea* in Western Province bears further examination, as it illuminates some possible patterns in historical change, as well as possible lessons to be learnt from examining old and recent middens. In 1992, I observed a small and scattered number of *T. crocea* shells in an open midden (estimated to be from around mid-19th century) in secondary forest uphill in central Marovo Lagoon.[12] This contrasted strongly with the many thousands of recent *T. crocea* shells dominating present-day middens in a village just downhill. With reference to the conspicuous absence of *T. crocea* in the national sites survey, it may be tentatively speculated that some misidentification as *T. maxima* has taken place. However, a more likely hypothesis is that the open midden observed in Marovo may represent a transitional period, during which the exploitation of *T. crocea* was taken up following the mid-to-late 19th century introduction of iron tools, which made the removal of these clams from the reef less difficult. This hypothesis gains some additional support from the observation that this species was an established food source in nearby Roviana Lagoon in the early years of this century (Waterhouse 1928).

As a final point, the absence of *T. gigas* valves from old middens may be not only owing to taboos on eating it, but also to the fact that valves of any specimens eaten are likely not to have been left in middens, but reserved for important material uses (see this chapter), or possibly just left on the outer reef once the meat had been cut out.

On the Wider Role of Giant Clams: The Case of Protein Food in the South Pacific

A general comment on the role of protein food in rural diets in the Solomons is required. In local languages, fish, shellfish and other sources of animal protein are typically defined as "that which is eaten with food," the latter being root vegetables (sweet potato, taro, cassava, yams) and, lately, rice. This division of a proper meal as consisting of a main "food" component of carbohydrates supplemented by a much smaller volume of "extras" in the form of animal protein is typical for South Pacific cultures. One implication of the distinction is that relatively little protein "goes a long way". Thus, even a small quantity of mollusc meat in a main meal can feed many, and its presence allows the meal to be regarded as a proper one. Giant clams and the other sources of animal protein, then, have an importance in rural Solomon Islands diets far beyond the absolute nutritional value of any given quantity of protein food.

[12]Typical for such old middens, this one was dominated by smaller coastal and mangrove bivalves and gastropods such as *Codakia tigerina*, *Saccostrea cucullata*, *Strombus carnarium* and *Terebralia palustris*.

Traditional Postharvest Methods

The meat of giant clams is prepared as food in a diverse number of ways throughout Solomon Islands. Virtually all parts of it are eaten, except the kidneys. This section summarizes information on the traditional preparation of giant clams for a range of food purposes, from daily staple diet to highly ceremonial occasions.[13] Techniques for preserving tridacnid meat are also briefly described, while first, the butchering of the clam and further preparation of the meat is described in a general fashion.[14] The presentation given here is based mainly on information from the Melanesian populations on the main islands of the Solomons, and gives generalized patterns in this regard. Therefore, the consumption of raw tridacnid meat does not figure prominently in this account of postharvest treatment, since in the Solomons it appears mainly confined to the small populations on the Polynesian outliers.

Butchering Giant Clams

Most villagers interviewed state that in general, one should always try to bring tridacnid clams of all species live from the reef to the village, to ensure that they keep fresh. As mentioned, all but the very largest *T. gigas* are normally brought ashore live and killed right before preparation. Clams are butchered by first cutting the adductor muscle on one side with a long sharp knife. To achieve this with larger clams, the valves may have to be locked open while the clam is still submerged, by means of a piece of wood or a stone. Sometimes, and usually when the tightly locking *H. hippopus* is concerned, a piece of the shell lip is knocked off instead so that the knife can be inserted. Care is taken not to cut the mantle meat and viscera when severing the adductor, and piercing the kidneys must be avoided.[15]

The meat is loosened from the valves by cutting around the edges of the mantle, and the kidneys are removed carefully. Most villagers leave the gonads and cook them with the clam meat, but some prefer to remove the gonads of larger *T. gigas* - partly because they tend to "make a mess" out of boiled clam dishes, and partly owing to traditional beliefs found in some locations (for example, that eating the gonads of large *T. gigas* may affect your genitals in strange ways). Finally, the mantle meat and viscera are rinsed in fresh water.

The Adductor Muscle

Generally speaking, the adductor muscle, so highly prized in Southeast Asia, is not a particularly favored part of the giant clam among Solomon Islanders. While preparing the rest of the meat, people often simply eat the muscle as a snack, either roasted in the kitchen fire or raw (one of the rare occasions when raw seafood is eaten by the Melanesian majority population). Raw or roasted adductor muscle may also be given to children as a special treat. On occasion, when large clams are butchered on the reef, the adductor muscle may be eaten raw

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[13]Appendix 2 gives more information on traditional postharvest treatment mainly in the Marovo Lagoon, so as to provide one detailed example of the complex procedures and multiple alternatives for handling tridacnids as food.

[14]This presentation is based primarily on participant observation by Karen Leivestad of giant clam butchering and preparation in Tamaneke village, North New Georgia, in December 1991 (see Appendix 2, Leivestad 1992, Hviding and Leivestad 1992). Subsequently, the generality of the principles was verified through discussions with Solomon Islanders from other parts of the country, and through examining a very small number of written records. An early unpublished trip report by ICLARM CAC staff mentions the practice of parboiling in Marau Sound (Govan 1987c), and Moir (1989) reports the same practice from the Polynesian outlier Takuu, in Papua New Guinea. All stages described in the butchering and preparation of *T. gigas*, *T. squamosa* and *H. hippopus* were eventually carried out under K. Leivestad's supervision at the ICLARM CAC as part of postharvest studies.

[15]Villagers detest the sour taste of the kidneys, which is bound to spoil the results of any cooking. In the Marovo language, clam kidneys are actually called *chime* or "gall bladder," classed with that of fish.

immediately, in the canoe or on the beach. If not eaten as a snack, the muscle is simply cut up and cooked with the rest of the meat.

Tenderization, Parboiling and Cooking of Giant Clam Meat

After butchering and cleaning as described above, the clam meat may be prepared immediately. Or, especially when large clams are concerned, it may be left hanging for a while (preferably overnight, to minimize exposure to sun and flies) so that excess saltwater drips out of it and the meat becomes more tender. In some locations, people sometimes also beat the meat of large clams with sticks to tenderize it.

Whether tenderized overnight or freshly removed, clam meat is usually parboiled before final preparation. This is achieved by bringing the meat to a quick boil in a pot of fresh water, then pouring out the cooking water and rinsing the meat in cold water. The clam meat (including viscera and, for smaller clams, gonads) is now sliced into suitable pieces, first lengthwise then crosswise. Small clams may be left whole or cut in two lengthwise. Alternatively, clams of any size may be cooked whole and then sliced before being eaten. From this stage of preparation, there are two main ways of cooking tridacnid meat:

1. By *boiling* in fresh water until tender, with a variety of possible ingredients added. Salt is not used, because the clam meat is regarded as having enough salt of its own. Many village cooks have their own special, "secret" recipes for giant clam stews. There are also regional specialities. Possible ingredients include:

- coconut cream (nearly always used);
- chopped leafy greens such as "slippery cabbage" (*Hibiscus manihot*), wild ferns, shallots, watercress and green shoots of the ornamental shrub *Polyscias* spp. (said in the Reef Islands to be "married to clams" [Henderson and Hancock 1988]);
- diced root crops, vegetables and fruits such as tapioca, pawpaw (recognized as a meat tenderizer), pumpkin, tomato and beans;
- grated mangrove pods (of *Bruguiera* trees);
- spices, mainly ginger, chillies or curry powder.

2. By *baking* slowly in leaf parcels (with various ingredients added) in the stone-earth oven characteristic of village kitchens. *Pandanus* leaves are preferred for the parcels, which are sewn tightly together with coconut leaf midribs. In the parcels may be added thick coconut cream, grated mangrove pods and other ingredients. Stone-earth oven baking of giant clam meat also has its subspecialities. There are, for example, old recipes for the baking of whole, very large *T. gigas* for ceremonial purposes in large ground ovens otherwise reserved for pigs (or occasionally, in former times of warfare, humans).

Preservation of Giant Clam Meat

Normally, villagers regard and treat giant clam meat as highly perishable. Occasionally, the meat may be preserved by smoking it slowly over a smouldering fire after having softened it by beating. This is also done with turtle meat and fish. Formerly apparently restricted mainly to the Polynesian outlying islands and the Gilbertese immigrant populations of the Western Solomons, this technique has become more widespread, and small quantities of smoked clam meat are sometimes shipped to Honiara for marketing.

Lessons from Traditional Postharvest Methods

Clearly, the proper traditional postharvest treatment of tridacnid meat is a complicated process and subject to strict guidelines, far more so than indicated by the "take-your-clam-and-cook-it" approach found in educational material on "local food" currently provided by NGOs in the Solomons (see, e.g., Danchurchaid n.d.). A recent ICLARM report states that "a thorough literature survey has revealed very few references to giant clam as food, and no technical details of its properties with respect to processing" (Parry et al. n.d.). From the preceding paragraphs, it should be evident that the traditional postharvest process contains elements of considerable interest for future research on the processing of tridacnid meat - notably the practice of parboiling.

Giant Clam Shell in Material Culture

Tridacnids are not only important as food. The considerable body of folklore and mythology relating to them has already been touched upon, and will be dealt with again in the next section of this chapter. Here, the direct uses of giant clam shells for ceremonial and pragmatic purposes and for the manufacture of a range of important artifacts are described, based on field observations and interviews and secondary information.[16] *T. gigas* shells are undoubtedly the most widely used, owing to their size and to their suitability in fossilized condition for the artifact manufacture.

Sacred Containers

The role of nonfossilized *T. gigas* shell in traditional religious practices include the use of large valves as containers and/or covers for ancestral skulls, as ritual washing basins for priests during sacrifices,[17] and in at least one case as a water container in which to keep a focal ancestral spirit in the shape of a new-born shark. These uses are embodied in tribal history and oral tradition, and skull containers and washing basins can still be seen at old sacred sites. Indeed, the "shark spirit container" just mentioned may actually be examined at a house in Langalanga Lagoon, Malaita.

Clamshell Rings and Other Important Valuables

Fossilized clamshell, mainly of *T. gigas*, was the material used in the large-scale manufacture of a range of different shell rings in the Western Solomons. Such rings were used as traditional exchange currency and ceremonial objects in the New Georgia Group and Choiseul. Clamshell rings remain important in Western Province in that every "chief" or hereditary leader of a descent group is supposed to maintain a collection of old rings as tribal heirlooms, underpinning land ownership. The rings are also still sometimes used for important ritualized exchange at burials and for the manifestation of friendship and alliances.

Valuable carvings and sculptures (usually of sacred nature) were also made from fossilized *T. gigas* valves. Examples of this are the famous *barava*, large carved clamshell plaques with intricate reliefs, used to cover chiefly skull chambers in Choiseul and the New Georgia islands.

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[16]Sources include Waterhouse (1928), Russell (1972) and Miller (1979).

[17]Cf., again, the old use of giant clam valves for baptismal or holy water fonts in Catholic churches of Europe (Pauly 1988) and the Philippines (Gomez and Alcala 1988).

It is also reported that certain smaller valuables, including arm rings, were carved from valves (presumably fossilized) of *T. squamosa* (Waterhouse 1928).

Fossilized tridacnid valves were obtained mainly from lowlying coastal forest and from raised reef islands, where they are still occasionally found. It may be hypothesized that the high importance also of large nonfossilized *T. gigas* valves in material culture and for ceremonial purposes may have promoted traditional restrictions on the harvest of live specimens, except for fully grown clams for very special occasions.

Tools

Giant clam shell was traditionally used also as material in tool manufacture. Clamshell adzes figure prominently in archaeological excavations from the Polynesian outliers, especially Ontong Java Atoll (Miller 1979). These adzes are generally presumed to be made from *T. gigas*.[18] Smaller numbers of clamshell adzes are also known from the Melanesian populations on the main islands of the Solomons. It is interesting to note that in Marovo and Roviana, the two main languages of New Georgia, the names for *T. maxima* (*chavi* and *peqopeqo*, respectively) mean "adze". New Georgian elders explained that in olden times, *T. maxima* shells were used widely for smaller adzes, both because they have the right size and shape and thus need little modification for use as adze blades, and because they were regarded as more durable than other types of *Tridacna* shell. The very dense and heavy nature of even medium-sized (20 cm) valves of the slow-growing *T. maxima* may be significant in this regard.

Certain other uses for giant clam shell in traditional technology may be mentioned: An early report on warfare in Simbo of the Western Solomons mentions that large clam valves were accumulated in hillside fortifications and used as weapons, to throw down at any approaching assailants (Hocart 1931). Also in the Western Solomons and very possibly beyond, selected cuts of *H. hippopus* shells were sometimes used for the polished shanks of tuna lures, as a substitute for or variation on the pearl shell (*Pinctada* spp.) material normally preferred.

Present-day Uses

Today, tridacnid valves are still used for a variety of purposes in Solomon Islands villages. Large valves of *T. gigas* and *T. squamosa* are widely used as containers for drinking water in enclosures for domestic pigs. Small and large valves of all species are favorite items of decoration around houses and along village paths. And shark rattles, an item of fishing technology said to be introduced from Papua New Guinea, are made by stringing *T. crocea* shells on a circle made of cane or wire.

The manufacture of smaller clamshell artifacts has been revived in recent years, now as the making of replicas (or approximations) of "custom" valuables for sale to tourists and expatriates. Recent innovations have also been made in Honiara in the carving of new styles of expensive, polished sculptures from tridacnid shell. Villagers in a number of locations, particularly in Western Province where most styles of clamshell artifacts originated traditionally, have expressed interest in the possibility of using valves of cultured *T. gigas* for such purposes.

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[18]The process of ageing and fossilizing of *T. gigas* shells for adze material is analyzed in detail by Moir (1989) for Takuu (Mortlocks), a Polynesian outlier in Papua New Guinea. There are cultural ties between Takuu and Ontong Java in the Solomons (cf. Bayliss-Smith 1978). Clamshell adze manufacture and use in these outliers are likely to have been part of a wider cultural complex, particularly since clamshell adzes were also common in the eastern outlier of Tikopia (Firth 1974).

Religious and Spiritual Attitudes to Giant Clams

Tridacnids occupy important roles in the traditional religious lives of many Solomon Islanders, and the introduction of Christianity has also influenced people's attitudes to tridacnids in several cases. With reference to the latter, postharvest techniques are likely to have been somewhat modified by missionary insistence on not eating raw seafood. This is known from New Georgia, where *T. crocea* meat is no longer consumed raw as it was reported by Waterhouse (1928) from the early 20th century. More important, however, are the various religious influences on people's general attitudes to the uses of giant clams for food or other purposes.

Taboos Relating to Tridacna gigas

It has been described above how *T. gigas* has probably been subject to widespread food taboos throughout the Solomons. Many taboos are still in force today. Such prohibitions seem to be partly tied to the religious importance of the animal, entailing a so-called totemistic relationship between certain tribes or lineages and this clam, which is seen as in some way ancestral to the human groups. This type of relationship was summed up by a number of villagers as implying that *T. gigas*, the most impressive animal found on the reef, is "just like a human being".

Further, for anyone who has ever seen a live giant clam, it should come as no surprise that many Solomon Islands languages contain powerful sexual metaphors associated with tridacnids and *T. gigas* in particular, and that such metaphors often are associated with taboos on explicit sexual references and connotations.

Food prohibitions and other taboos may thus render it somewhat problematical to view tridacnids as "normal" food that can be eaten by anyone at any time. These cultural factors thus have some potential implications for target species options in mariculture development. It is, for example, an open question whether increased availability of *T. gigas* through mariculture will immediately lead to a significant increase in domestic consumption among villagers who have so far eaten it rarely or not at all. In this sense, *H. hippopus* and the smaller tridacnids are far more central in traditional and contemporary rural consumption patterns.

General Prohibitions, Old and New

A variety of traditional "blanket" prohibitions on eating all tridacnids are known to exist in the Solomons. For example, a large segment of the "saltwater" people of Langalanga Lagoon in Malaita is said to maintain an old taboo against eating any type of large or small tridacnid, for important religious reasons tied to ancestral spirits. A more recent form of "blanket" prohibition is entailed in the set of food taboos introduced by the Seventh-day Adventist church. The church's doctrine prohibits its followers from eating (and, it is argued by staunch fundamentalists, from handling altogether) any form of mollusc or crab, in addition to a number of other marine and terrestrial animals.

General prohibitions on eating tridacnids could be taken to promote conservation of stocks. This seems to be the case (although to a limited degree) for central and southern Marovo Lagoon where most reefs are controlled by the church's groups, but not for the Langalanga Lagoon, where all species of tridacnids are now said to be heavily overexploited, probably because the taboo does not apply to the other segment of saltwater people. Anyhow, such prohibitions, be they traditional or Christian, may act as important constraints for the development of clam mariculture in locations that may otherwise be ecologically or logistically

favorable. This particularly applies to the Christian forms: Since the Seventh-day Adventist doctrine basically also prohibits selling tabooed animals to non-Seventh-day Adventists who intend to eat them, some senior church officials have expressed negative attitudes toward giant clam mariculture.[19] Also, several examples are known from the church-dominated parts of central and eastern Marovo Lagoon where individuals who have expressed interest in applying for ICLARM village trials have been discouraged from doing so by community church pastors. As for taboos based on traditional religion, however, they often seem to confer a sacred status on tridacnids (particularly *T. gigas*), which in turn commands people to behave respectfully toward these clams. This leads us to the high symbolic importance attached to giant clams.

Giant Clams as "Symbolic Capital"

Beyond the issue of food importance, the considerable spiritual value attached to *T. gigas* (and more secondarily, to other tridacnids) continues to promote strong local concerns over stock degradation and depletion, and consequent enthusiasm for restocking through mariculture. It may be argued that the multiple roles of *T. gigas* for ceremonial purposes and as an animal vested with a wide range of traditional values makes this species a form of "symbolic capital,"[20] i.e., a highly prestigious possession (in not directly material terms) for village-level mariculturists. It is reasonable to believe that this prestige may strengthen the level of commitment, and symbolic value thus is far from irrelevant as a parameter in mariculture development.

[19]A more pragmatic "nonofficial" attitude tends to prevail among SDA villagers, many of whom collect and sell "marine products" in the form of molluscs such as pearl shell and trochus, although they throw away the meat.

[20]This concept is used by anthropologists in attempts to explain a multitude of culture-specific approaches to the accumulation of more or less tangible wealth, far beyond the definitions propagated by neo-classical economics. See Bourdieu (1977).

CHAPTER 4

INDIGENOUS KNOWLEDGE OF GIANT CLAMS AND TRADITIONAL MARICULTURE

This chapter expands on the multiple values attached to tridacnids by Pacific Islanders, and describes local perceptions of these clams in Solomon Islands. Among other things, it will be shown that tridacnids are in many ways viewed as focal organisms in the reef environment. In an attempt to fill significant gaps in existing information, the chapter provides detailed examination of indigenous environmental knowledge and other beliefs relating to the biology and ecology of giant clams, and also discusses local precedents to mariculture in the form of "indigenous clam husbandry," with particular reference to the relevance of such forms to proposed "farming systems" research.

Recognizing Multiple Realities

Invariably, images and interpretations of the natural environment are in some way simplified, ordered representations of patterns in observed environmental phenomena (cf. Ellen 1979). It comes as no surprise, then, that there should also be multiple orderings of the "reality" constituted by those phenomena. Consequently, the biology and ecological relations of giant clams may be perceived and interpreted differently by coastal villagers and mariculture researchers, who have widely contrasting approaches to the organisms in question. This has consequences for the communication taking place between these two parties, in the Solomon Islands case most notably through ICLARM's village trials. Establishing the "local point of view" concerning biology and ecology and identifying associated opportunities and constraints must be a key element in any research approach aiming at developing locally appropriate farming systems. This requires communication through a minimum of mutual understanding of relevant categories.

First in line in this chapter, as should be the case for any such research approach, is a documentation of local terms for different tridacnids, so that ICLARM staff and villagers may at least feel secure that they are discussing the same animal. The chapter then proceeds to presenting important beliefs held by Solomon Islanders about the biology of giant clams and their ecological role. This presentation takes the form of a listing of indigenous hypothesis-like assessments about the life of giant clams and about causal linkages in coral reef ecology. Subsequent sections examine traditional management measures, and deal with a number of traditional precedents of mariculture, most notably the widespread phenomenon of "clam gardens". Finally, some indigenous concepts of husbandry of relevance to mariculture are discussed, with particular reference to a "Farming Systems" approach of the type promoted by ICLARM.

Vernacular Taxonomies

Table 4.1 (compiled from Govan 1992 and from the present author's field material) lists vernacular names for tridacnids in 18 of the more than 70 languages found in Solomon Is-

lands, plus in Pijin, the nationwide *lingua franca*.[1] The primary languages of most village trial participants as of 1992 are represented.

Table 4.1. Vernacular names for tridacnids in Solomon Islands languages.

Language	Area	*T. gigas*	*T. derasa*[3]	*T. squamosa*	*T. maxima*	*T. crocea*	*H. hippopus*
Marovo[1]	E. New Georgia	*ose*	-	*veruveru*	*chavi*	*hulumu*	*hohobulu*
Hoava[1]	N. New Georgia	ose	-	*veruveru*	*peqopeqo*	*gulumu*	*hohobulu*
Roviana[1]	W. New Georgia	*hio*	-	*veruveru*	*peqopeqo*	*gulumu*	*hohobulu*
Zabana[2]	N.W. Isabel	*bebenga*	*fafalehe tovu*	*fafalehe*	*paehe*	*kasipotu*	*siepila?*
Bughotu[2]	S. and E. Isabel	*tungi*	-	*fafalehe*	*tunuga*	*kaspot*	*siepila*
Nggela[1,2]	Nggela	*ghima*	*ghighi*	*talinga*	*pukumau*	*kunuga*	*masiravu*
Langalanga[1]	W. Malaita	*ime*	?	*tatakarade*	*abuli (lao'e fou?)*	*abuli lao'e fou*	*abuli lao'e lamo*
Lau[2]	N. and S. Malaita	*dolo*	?	*takalade*	*unu*	*unu fou*	*abu'abuli*
'Are'Are[2]	S. Malaita, E. Guadalcanal (Marau)	*piawai*	*sisi keni*	*sisi mane*	*taura/ unu mane*	*unu panu/ unu keni*	*apuri*
Ghari[2]	W. Guadalcanal	*ghima*	-	*inuvi tasi*	*kapichi*	*kapichi*	*koakoa*
Lavukaleve[2]	Russell Islands	*bano*	*meovala*	*veruveru*	*tai*	*talea*	*suta*
Vaghua[2]	W. Choiseul	*meka*	*meka*	*ziku*	*qeto*	*kasiputu*	*mamasivu*
Lungga[2]	S. Ranongga	*iavo*	*iavo*	*tatakiru*	*tatakiru*	*gulumu*	*moso*
Mbilua[2]	Vella Lavella	*siavo*	*siavo*	*veruveru*	*temotemoko*	*tupitupi*	*moso*
Mono-Alu[2]	Shortland Island	*posa*	*posa*	*sakete*	*katuhi*	?	*babage*
Luangiua[2]	Ontong Java	*kena ohu*	*kena ohu?*	*kamamulai*	*keunu*	*keunu*	*kevasua*
Sikaiana[2]	Sikaiana	*te tane*	*te tane*	*te kete hatu*	*te veniveni*	*te kunu*	*te pasua*
Gilbertese[2]	Vaghena and W. Province	*te kima*	-	*te were matai*	*te were*	?[4]	*te nei toro*
Pijin[1]	Nationwide *lingua franca*	*open sela*	*open sela*	*open sela*	*open sela*	*open sela long ston*	*open sela*

Notes:
[1]Source: author's field notes.
[2]Source: compiled and adapted from Govan (1989a, 1992) and from unpublished material provided by Hugh Govan, ICLARM CAC.
[3]Govan et al. (1988) reports that *T. derasa* "has only been observed in the Marau Sound and the northern Marovo Lagoon although it is reputedly present in other areas." However, this author's own detailed ethnobiological field data from the Marovo, Roviana and Vonavona lagoons do not indicate any presence at all of *T. derasa*. The classing of *T. derasa* with *T. gigas* in several languages of Western Province cannot be regarded as conclusive evidence for *T. derasa* presence. Thus, in the absence of dedicated biological surveys, *T. derasa* presence of this species is assumed as not verified beyond the locations where a distinct vernacular term exists (W. Isabel, Nggela, Marau and Russell Islands [Govan 1989b]).
[4]The Gilbertese speakers of Solomon Islands are migrants from the Micronesian archipelago of Kiribati. In Kiribati, neither *T. derasa* nor *T. crocea* occur, whereas the four other species have the same names (at least in the capital Tarawa) as they have in the Solomons (J.L. Munro, pers. comm.)
?= information on name not available or uncertain, presence of species in area presumed or known.
-= species not named in local taxonomy, presumed rare or not present in area.
A standardized orthography has not been attempted for the above list. However, some general remarks can be made to facilitate pronunciation:
- The "q" found in the spelling of some languages is pronounced "ngg".
- The "g" in Roviana and Hoava spelling is pronounced "softly," like the "gh" in other languages.
- "ch" is pronounced as in English, e.g., "chair".

Vernacular Names: General Remarks

Field experiences showed that the recording of local terms for tridacnid clams is in many ways simpler than for many other organisms. This applies both to the clarification of criteria for distinguishing among indigenous categories, and to attempts at equating vernacular "species" with Linnaean species. Tridacnid species are few in number, and each one has fairly distinct

[1]The information contained in the table is of preliminary nature, and spellings in particular need further checking, as well as standardization. Different parts of the rural Solomons are dominated by various church dominations that maintain distinct spelling systems for vernacular languages, and this range of variation is too complex to be represented adequately here. See, however, the final section of notes to Table 4.1.

characteristics both regarding appearance and habitat. Thus the overlap between vernacular and Linnaean "species" categories appears greater than that experienced regarding fishes,[2] although some cautionary notes are required and will be given in the following discussion.

Generic terms covering all species, corresponding to terms like "tridacnid" or "giant clam" have not been documented widely from Solomon Islands languages, and appear not to be common. From Marau, the term */meno/* is reported as being generic for "clam or oyster" (Govan 1987c), but this bears further examination and may be too nonspecific. Pijin, in which the term */sela/* is generally considered to cover all mollusc species (bivalves and gastropods), uses the term */open sela/* generically for all tridacnids, sometimes with a modified and additionally descriptive term for the rock-burrowing *T. crocea*. Govan (1989a) gives */klamsel/* (commonly used in New Guinea Pidgin or "Tok Pisin") as the generic Pijin term for tridacnids, but this term appears to be a more recent introduction in use mostly among village trial participants.

Classification Schemes

The above listing of vernacular names provides a number of general insights. A slight majority (10) of the vernacular languages represented have distinct exclusive terms for all tridacnids present in the area where the language is spoken. Provided that this represents a more general pattern throughout Solomon Islands, it could be taken to reflect the importance attached to tridacnids and to highlight indigenous perceptions of different species as "leading different lives". However, further comparative investigations are needed to substantiate or qualify this.[3] In the other languages there is some overlap between terms. In most cases (5) this relates to *T. gigas* and *T. derasa*, in that the latter is classed with the former under one name. There are two cases where *T. squamosa* and *T. maxima* are classed under one name, and similarly two cases of overlap between *T. maxima* and *T. crocea*. However, there are indications that in such cases, distinction is still achieved by adding modifiers, typically the terms "small" and "large". Another example of this are cases where paired species share one basic term but are distinguished as being "male" and "female," as in Marau (cf. Govan 1987c).

When these two-level modifying capabilities of vernacular taxonomies are taken into account, it may be safely said that there is generally a high degree of correspondence between vernacular and Linnaean taxonomies for tridacnids in Solomon Islands. This should facilitate discussion between villagers and mariculture staff, by allowing for shared understandings of which species is being discussed. The further recording and verification of vernacular names for tridacnids, based on Govan's pioneering work (Govan et al. 1988; Govan 1989a, 1992) should be continued by ICLARM as an integral part of village trials and other extension-related activities, with the eventual aim of publishing a booklet containing such material.

Ethnobiology of Giant Clams in Solomon Islands

Indigenous Environmental Knowledge in Oceania

The detailed and sophisticated environmental knowledge possessed by indigenous peoples throughout Oceania has received much recent attention by outside observers, and is documented by a burgeoning scientific literature dealing particularly with traditional knowledge

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[2]For discussion and exemplification of some difficulties in equating vernacular taxonomies for fishes with Linnaean taxonomy, see Hviding 1988 (chapter 4).

[3]An expanded list recently published by Govan (1992) provides information on tridacnid taxonomy for 31 vernacular languages throughout the Solomons. This information could be interpreted to imply that taxonomies with distinct terms for all or most tridacnid species are characteristic mainly of those groups that have strongly maritime historical orientations. Govan also suggests that vernacular "'species' are differentiated primarily by size, byssal attachment, habitat and shell scutes" (Govan 1992).

of tropical marine environments (see, e.g., Johannes 1978, 1980; Ruddle and Johannes 1985, 1990; Gray and Zann 1988; Hviding 1988). Much of this literature deals primarily with the knowledge of important food fishes and their patterns of behavior, in which regard traditional knowledge in a number of documented cases surpasses Western scientific knowledge. It is also clear that the resources of the coastal-marine zone in general are intimately known by the people who depend on them for sustenance. For example, the intensive utilization of molluscs mainly by women is underpinned by detailed knowledge held by those women about seasonal patterns in occurrence, abundance, palatability and other factors.

Ethnobiology and "Cognized Environments"

The intensive study of local perceptions and classifications of the natural environment is often referred to as "ethnobiology" (or "ethnoecology" when focusing more widely on perceived linkages between organisms and environmental phenomena) by the scientists, mainly anthropologists, who study such systems of knowledge. The anthropologist Roy Rappaport, a pioneer within the broader field of cultural ecology, has argued for a distinction between a "*cognized environment*," being the sum of environmental phenomena perceived and interpreted by a human population, and an "*operational environment*," being the total sum of ecological relations in which organisms, or entire human populations, are involved (Rappaport 1963 [1979]).

Turning back to the comments in this chapter's opening paragraph, it is clear that the "multiple orderings of reality" regarding the natural environment refer to the different cognized environments perceived by coastal villagers and mariculture researchers. Considering nature's complexities, it is fair to state that no cognized environment can possibly include all aspects of the operational. Thus, even Western science, striving to unravel "everything," must be seen as one way of constructing a cognized environment.

The Role of Ethnobiological Information

We shall approach here the cognized environment of rural Solomon Islanders, with specific reference to giant clams. Ethnobiological understanding by researchers and extension workers is of vital importance for further farming systems research on giant clam mariculture, in a number of ways. First, discussions with villagers about giant clams and their husbandry do not take place only in the context of the scientific "facts" on which the Giant Clam Mariculture Project builds. Villagers' own notions also inform the discussion, and for a two-way flow of communication to be established, these notions must to some degree be known by the professional mariculturist. Ethnobiological parameters could in turn influence the approach to, for example, village trials or even the overall planning of mariculture development. Second, an awareness among mariculturists of existing local knowledge should be used to identify information gaps or misconceptions that may be addressed through rural mariculture extension services. Third, the recognition that aspects of tridacnids and their lives remain insufficiently documented by Western science highlights the need for taking seriously the knowledge of giant clams held in rural communities, where villagers have observed these animals at close hand through generations.

Local Perceptions of "The Good Life" of Tridacnids

To indicate the scope of Solomon Islanders' ideas about the lives of giant clams, an example is given below of local perceptions of *Tridacna gigas* as having certain specific preferences

in life, and of how conditions for a continued "good life" for the clams were shattered through depletion in 1983 by Taiwanese clam harvesters (who operated under a legal licence and in liaison by a minority of local reef-holding groups, but whose activities were strongly opposed by other groups).

THE SOCIAL LIFE OF TRIDACNA GIGAS *AMONG STAGHORN CORAL*

Mr. Harold Jimuru of Chea village, central Marovo Lagoon, has been diving the outer reefs for fish, shells and bêche-de-mer for more than 20 years. In a discussion in January 1992 about the life of giant clams, he explained that before 1983 when the Taiwanese clam ship came, you would often find large *ose* [*T. gigas*] in dense groups, from five to ten and sometimes as many as 20 or 30, all in one place and not far from each other, "sitting down" in the staghorn coral thickets (*binubinuani*) on the ocean-facing side of the barrier reef. They grow there because such reefs are good for them. Groups of *ose* were found particularly in and around passages through the reef from the ocean to the lagoon where the tides flow freely. This is the way they prefer to live, Harold Jimuru explains, many together in places like that, and this makes them grow well and create young ones. When you went diving and encountered such large groups of *ose* living together on the bottom, it was a very nice sight, with all their different colors. But, he adds, this also made the Marovo *ose* stocks highly vulnerable to the Taiwanese divers who were able to take several hundred in just a few days in 1983, before they were chased away from the reefs of Harold Jimuru's group. After that, there was nothing much left but "graveyards" where many shells of dead *ose* are lying around in the coral, right where they used to live. These heaps of dead shells can be seen today. Since 1984, you can no longer see large groups of *ose* living together in one place. But this way of living, in groups in the staghorn coral thickets where the ocean water flows past, is the original, normal life preferred by *ose*, not the ones and twos here and there that you see today. They are just survivors.[4]

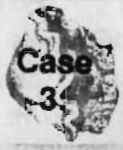
It must be pointed out that Harold Jimuru has never been in touch with any mariculturists, nor has he been particularly interested in giant clam mariculture beyond keeping a few clams as "pets" on the reef off his house, mainly since he is a Seventh-day Adventist. Thus the eloquent description of *T. gigas* as a sociable creature with strong selective preferences regarding ecological conditions reflects a genuine "cognized model" held by a Solomon Islander who as an expert fisher and diver has been in touch with the giant clams of the ocean reefs for his entire life, and who also (like so many villagers) has a strong personal liking for the giant clam far beyond its food role. Such views of giant clams as associated with particular, "good" reef habitats were encountered in all locations visited in Western, Central and Malaita provinces.

This is one significant example where ethnobiological conclusions regarding the preferred habitats of giant clams correspond with suggestions posed and conclusions drawn by Western biological science.[5] Although local "cognized" models of environmental relations are seldom

[4]A similar picture was observed by Govan (1989d) in another part of Marovo Lagoon from which clams were also intensively harvested in 1983 by the same Taiwanese vessel. Many large empty *T. gigas* shells and "a very small number of small clams" (presumably *T. gigas*) were observed on the seaward reefs.

[5]Localized aggregations of adult giant clams in staghorn coral thickets, resulting from the particularly favorable circumstances offered for settlement and survival of juveniles, have also been reported from the Great Barrier Reef and from Papua New Guinea (J.L. Munro, pers. comm.).

likely to correspond exactly to a Western "ecosystem" model (cf. Hviding 1988), what is worth noting is that organisms such as giant clams are perceived as components of a wider system of causal links, and as being dependent on certain environmental factors. The next case shows how giant clams may even be perceived as active ecological agents which, through maintaining their own preferred environment also produce further benevolent effects.



ARE GIANT CLAMS BENEFICIAL TO SALTWATER QUALITY?

Mr. Ronter Amos, also of Chea, Marovo Lagoon, one of Harold Jimuru's relatives and a similarly experienced fisher and diver, asks the following question, which he has given much thought to in recent years: Is it so that *ose* [*T. gigas*] do something very good to the sea, for example so that fish do not become poisonous in locations where there are *ose* on the reef? He has heard from a relative who lived in Vanuatu for some time that there are no longer any *ose* to be found on reefs there. Maybe, since they have no *ose* left, that is why they have so many fish that are poisonous there? Ronter Amos and other fishers of Chea village have heard that fish like *ihana orava* [*Lutjanus sebae*], *ringo* [*Lutjanus bohar*] and *batubatu* [large *Caranx* spp.] are poisonous in Vanuatu, and there are even some cases of this from Temotu Province in the eastern Solomon Islands. But maybe the *ose*, since they move the water around and cool it, add something to the water that makes reefs healthy and fish nonpoisonous? Ronter Amos has a strong feeling that the answer to his questions is a firm "yes". Certainly, he adds, in locations where there are a few or more *ose* the water is always cool and clear, and corals look very nice, healthy and colorful and grow very well.

Similar attitudes, though not often so well articulated, were met with in a number of communities visited. Interestingly, during ethnobiological conversations I was (owing to my association with Marovo) on numerous occasions defined primarily as someone who could speak about matters of the Marovo area, and I was thus asked for Marovo views on giant clams. Such information was considered more meaningful than information I might have been able to supply in my other capacity as "someone from ICLARM". This is an illustration of the frequency and intensity of interisland dialogue about natural phenomena - Solomon Islands villagers appear highly interested in discussing in comparative terms how their own environmental knowledge relates to observations made in other parts of the archipelago. Thus, fruitful ground was found during field visits for illuminating a variety of local observations and hypothetical suggestions relating directly to giant clams, and a certain level of generality was established for perceptions such as presented in the two cases above.

Indigenous Knowledge as Generalized Assessments

The following list presents generalized information on commonly held beliefs in rural Solomon Islands about the lives of tridacnids, relating to habitat, role in ecosystem, growth, reproduction, predation and other parameters. It is notable that a number of the beliefs relate to notions that tridacnid clams have some form of individual agency, such as embodied in statements that different species "like to" live in certain ways, and that they "prefer" and somehow choose locations in which to live. Though such views may appear exotic to many Western scientists, they are for the most part firmly observation-based and are not necessarily incompatible with the scientific search for optimum circumstances for settlement, survival and growth.

Thus, as will be argued in more detail toward the end of the chapter, this is potentially fertile ground for dialogue between mariculture scientists and villagers (not least trial participants, cf. chapter 5).

To facilitate the use of ethnobiological information as inputs into the mariculture research process, and to allow for attempts at testing the validity and generality of such information, the list consists of assessments that approach the levels of correlation and of hypothesizing about how and why things happen. They are generalized from unsolicited statements given by a number of people in conversations during field visits.[6] Cases where an assessment is based on statements of a less general occurrence are indicated by appending the statement's place of origin. A few explanatory brackets have been added.

Indigenous assessments about the lives of giant clams:

- *T. gigas* like to live many together in one group, preferably in thickets of staghorn coral, a few meters deep on reefs with good water flow from the ocean.
- *T. gigas*, *T. squamosa* and *T. maxima* all prefer to live on reefs close to the ocean, far from mangroves, with clear water and much coral. They require a good current in the water, and want to be where the water is clear and moving.
- *H. hippopus* can live anywhere, even in locations which are not "good reefs"; it grows well on muddy sand, among seagrass and even close to rivers.
- *T. crocea*, too, can live almost anywhere, as long as there is saltwater flow, not too muddy, and good stones to burrow in. *T. crocea* prefers to live in "dead stones" (i.e., in areas with little live coral), and in shallow water.
- The water near large *T. gigas* is cool and clear, because the clam circulates and rinses the water.
- Tridacnids add something to the water around them which contributes positively to the health of the reef.
- Where there are many *T. gigas*, coral growth is luxurious and dense.
- Good reefs have many tridacnid clams on them.
- The presence of large *T. gigas* on the reef prevents food fishes from containing toxins (Marovo Lagoon, Western Province).
- When giant clams are removed from reefs (i.e., depleted), the reefs turn bad, corals die and sea urchins proliferate (Ranongga, Western Province).
- Giant clams spawn after a small fish (unidentified) enters them and makes them pregnant (Faisi, Shortlands, Western Province).
- Baby clams are never seen, but small juveniles of *T. crocea* in particular can often be spotted on the reef not far from adult clams.
- Very small clams make their own decisions to settle and aggregate on reefs preferred by them.
- *T. crocea* grow rapidly from small juveniles to edible size; sometimes you will see many medium-sized ones on reefs where almost none were visible a couple of years ago.
- *T. squamosa* grow quicker from medium- to adult-sized than any other tridacnid.
- Sometimes, when the water turns red in nearshore locations where there are many *T. crocea*, the clams become poisonous, as do most other shells. This

[6]Information presented here was given by villagers mainly in the Marovo, Roviana, Vonavona, Kolobangara and Ghizo areas of Western Province, the Langalanga and Lau areas of Malaita Province, and the Gela and Sandfly areas of Central Province. Generality was substantiated by statements given by people from a number of other locations in the Solomons.

does not happen often (Marovo, Roviana and Vonavona Lagoons, Western Province).
Giant clams are not eaten by many animals, but "sleeping sharks" (IndoPacific Nurse Shark, *Nebrius concolor*) are sometimes seen eating larger tridacnids by sucking them from their shell.

While a number of these observations and assessments conform closely to Western biological knowledge, others postulate causal links that are unknown, contestable or refutable according to Western science. In any event, the list should serve as an ample demonstration of the range of mostly observation-founded beliefs held in Solomon Islands villages about giant clams. These animals are considered to be among the most remarkable in the complex world of coral reefs not only by biological scientists, but certainly also by the island dwellers who have their material and spiritual lives bound up with those reefs. The notion that giant clams are in fact perceived by Pacific Islanders as focal actors in the reef environment is a most fascinating one, and its implications are briefly explored below.

Benevolent Animals in Healthy Habitats

A significant number of people interviewed emphasized that "good reefs" have plenty of giant clams, and conversely, that "bad reefs" are characterized by the near or total absence of large clams, particularly *T. gigas*. The distinction between "good reefs," yielding abundant and varied seafood, as opposed to "bad" ones providing little reliable human sustenance, in fact seems to be a major concern among many coastal groups of present-day Solomon Islands. A case from Malaita highlights some interesting local perceptions of the relationship of giant clams to the degradation and rehabilitation of reefs.

USING GIANT CLAM MARICULTURE TO REVERSE REEF DEGRADATION

The Langalanga Lagoon on Malaita's southwest coast has been subject to environmental degradation through a number of factors such as widespread dynamite fishing, localized overharvesting by other methods and sedimentation caused by soil erosion. Disputes frequently arise over dwindling resources. To help reverse these trends, a group of land- and seaholders in one section of the lagoon in 1990 formed the Gwa'ata People Foundation Trust, an association intended to protect land and sea resources, promote social and cultural development, and assist in customary land disputes. The Trust runs the only village trial in the Province (as of early 1992), established in 1991. When I visited the trial, a spokesman explained views held by the association regarding giant clams, reef rehabilitation and mariculture: "We are saltwater people and do not have much land, so we rely on the sea. But the lagoon is not in very good shape now. Too much fish has been dynamited, and clams and other shells are scarce. Particularly giant clams, we want to bring them back on the reefs here, because when you have plenty of them there, the reefs are good. But, since everyone has been all around and taken most of the giant clams that used to be there, the reefs have just got worse and worse. When we get plenty of clams growing in cages, we can plant them back on the reef, and we will have food and good reefs in future. Then we can sell some clams, and keep others to make more young ones."

Giant Clams Perceived as Ecological Indicators and Agents

Although the exact causal links postulated in the above statements may be somewhat unclear, it is striking how the state of clam stocks and the state of reefs in general are perceived to be linked, i.e.: *"When you have plenty of giant clams on the reef, the reefs are good."* Giant clams are frequently stated to be main *indicators* of reef "health". And beyond that, they may be assigned an active role as *agents* of reef health which, through their filtering of seawater and through other less tangible habits, promote coral growth, prevent the occurrence of fish toxins and influence the reef environment in various benevolent ways.

Giant Clams as a Focus in Coral Reef Conservation

While the roles of tridacnids as ecological agents may not be a fully clarified topic in terms of scientific validity, the actual and potential role of these impressive, strikingly colored and spiritually important animals as highly visible indicators can hardly be doubted. Mariculture may thus be considered an opportunity for reversing environmental degradation on important reefs through the eventual "replanting" of cultured tridacnids, which initially raises the multiple values of the reefs. In turn, replanted tridacnids are presumed to generate more young clams, and may even influence the general state of the reef in positive terms - through the less tangible benevolent processes so well postulated by villagers. It is significant that such types of motives may be as strong among some current village trial participants as the cash crop motive more commonly mentioned in relation to mariculture. The potential role of giant clam mariculture in coral reef conservation is thus highly significant.[7]

The following section expands along these lines by examining whether the multitude of local beliefs about the lives of tridacnid clams also relates to an awareness that stocks may become depleted, and to traditional management measures.

Ideas about Growth and Depletion, and Traditional Management of Giant Clam Stocks

Without exception, villagers interviewed expressed concerns about the future of giant clam stocks, and emphasized the vulnerability to overharvesting. These concerns applied particularly to *T. gigas*, stated to be scarce in many locations.

Depletion of Tridacna gigas

T. gigas stocks are said to be depleted especially in the areas where legal or illegal commercial harvesting has taken place in addition to subsistence utilization, like in Marovo Lagoon, Marau Sound and Isabel (cf. Govan 1987c, 1989e; Govan et al. 1988). In Marovo, subsistence harvesting of this species has anyway always been very modest owing to Seventh-day Adventist dominance as well as traditional taboos, and the intensive Taiwanese harvesting in late 1983 of 1,318 *T. gigas* (Govan 1989e, quoting Fisheries Division data by Enekevu) seriously depleted

[7]Spokesmen of Madou village, Vonavona Lagoon, emphasized that they saw the establishment of giant clam mariculture in their area as a direct political means of reversing environmental degradation. They said that the Vonavona Lagoon is increasingly polluted from the tuna cannery at nearby Noro, with serious consequences for the fish and mollusc stocks of the lagoon. In their view, since the national government through its involvement in the ICLARM project actively promotes mariculture, relevant authorities in turn ought to react against the pollution at Noro caused by another government operation. In the words of a spokesman: "The government cannot be of two minds. If the oil spills from Noro continue, then there can be no farming of giant clams here. So if the government wants to promote one project, they have to clean up the other one. One arm of fisheries [i.e., the tuna industry] must not be allowed to spoil everything for another [i.e., giant clam mariculture]".

largely untouched stocks and may have had grave consequences for future recruitment (Govan 1989e, and see Case 2). Many Solomon Islanders also consider it likely that a number of instances of poaching by Taiwanese vessels have gone undetected but have caused similar depletion in other areas. Further, there are also instances where harvesting by villagers for domestic marketing has caused serious depletion, e.g., in parts of Langalanga Lagoon.

Indigenous views of giant clam stocks in the Solomons today often emphasize a sharp dichotomy between places where *T. gigas* is known to be heavily depleted,[8] and places where, according to observations or more often hearsay, enormous numbers of *T. gigas* are reputedly still found (e.g., Choiseul and the Shortlands). With this in mind, the enthusiasm for mariculture as a means of restocking can be even better understood.

Concerns over Other Tridacnids

While most local concerns thus focus on *T. gigas*, concerns are also expressed over *T. squamosa* and *T. maxima*, and to a limited degree *T. crocea*.[9] The latter is commonly regarded as an almost nondepletable staple food source, and several women interviewed in Central and Western provinces in fact expressed amazement at the high numbers of *T. crocea* that can actually be continuously harvested for decades from fairly limited areas (however, as discussed below, this may be partly owing to some informal management measures). Only in a very few locations, such as in parts of Langalanga Lagoon (where reefs were said to be in such "bad shape" anyway), and in Michi village in central Marovo (where this clam has in recent years become a highly important cash source for women with limited alternative sources of income) were strong concerns expressed over the future of *T. crocea* stocks.

The two outer-reef species, *T. squamosa* and *T. maxima*, were stated to be getting scarce in certain specific locations that used to harbor vast stocks (such as small uninhabited offshore islands). This is said to relate to relative food importance coupled with population pressure. In fact, there are indications that in some such locations where outer-reef tridacnids are regularly harvested, *T. gigas* stocks are now in better shape than those of *T. squamosa*, since the latter is preferred as normal food. This is the case in southwest Marovo Lagoon (where most villagers are Methodist and eager consumers of molluscs), for example, and is said also to apply to locations in the Sandfly Islands and Small Gela, Central Province.

Concerns were nowhere voiced over the abundance of *H. hippopus*. This is remarkable, since this species is indeed the second most popular in food terms. In Langalanga, where *T. crocea* is now scarce, *H. hippopus* is the most important food species of all tridacnids, and is still found in relatively large numbers, as evidenced by contemporary village middens. Some people say about this least conspicuous of the tridacnids that "it often lives in bad locations with muddy water, and does not look nice, so it is harder to find than the others, even though it does not hide among coral". Thus, the drab appearance of *H. hippopus* seems to protect it against overexploitation, despite its popularity as food.[10]

Perceptions of Growth

Most villagers explain that they have been surprised to find in recent years that tridacnids grow much faster than they thought previously. Although the erroneous notion that giant clams

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[8]However, even in areas characterized by depletion, active fishers (divers in particular) invariably have their own stories about huge single individuals of *T. gigas* in more or less secret locations - some said to be almost a "fathom" long!

[9]No relevant information was obtained for the scattered stocks of *T. derasa*. Indeed, as indicated by the overview of vernacular taxonomies, the exact identification of this particular species in discussions with villagers may be somewhat problematic.

[10]The inconspicuous appearance and preferred habitats of *H. hippopus* also make biological assessments of stocks difficult, with underestimation a likely result. Cf. the remarks by Govan et al. (1988) on the "cryptic nature" of this "least commonly observed" species.

grow "immensely slowly"[11] appears not to have been held by rural Solomon Islanders, people nevertheless express some amazement that, as one villager put it, "you can actually *see* them grow!". These conclusions have been reached mainly through long-term observations of clams kept in nearshore "clam gardens," and have been reinforced for village trial participants who have been closely involved with cohorts of small juveniles. As already stated, Solomon Islands ethnobiology of tridacnid life cycles seems to include beliefs about a somewhat mysterious phase covering the time leading up to the settlement on "proper" reefs by visible juveniles. Even so, it is widely recognized that the presence of a number of large adults on a reef is a condition for new recruitment, and that this cycle must not be broken by removing all adult clams.

Traditional Management of Tridacnid Stocks

Certain management measures for *T. crocea* observed in the Marovo Lagoon (and stated to be practised also in Vonavona) build on assumptions such as those described above.

WOMEN'S MANAGEMENT OF TRIDACNA CROCEA

In the Marovo Lagoon, so-called "*hulumu* reefs" (i.e., reefs that have *T. crocea*, *hulumu*, as the focal resident animal) which have been harvested intensively for a longer period of time tend to show a significant decrease in the number of edible-size (typically > 8 cm) clams present. This does not mean that clams are being wiped out entirely, the women say. As Mrs. Vivian Andersen of Mahoro Island, central Marovo (widely considered the lagoon's leading authority on food molluscs) explains: "When you can no longer find many clams of edible size, there are still great numbers of small ones left - but they cannot be seen among the stones, even though they have already settled there." When an important *hulumu* reef reaches such a state, the women decide to abandon it for some time - often a couple of years, going to other reefs instead. It is important to do so before adult clams have been totally wiped out, it is said, because some must remain to produce a steady supply of baby *hulumu*. Through these measures, the women say, great numbers of small *hulumu* are allowed to reach a good size (and maybe even reproduce as well), and the reef can be harvested again.

It is not known whether such traditional forms of management by rotation are practised beyond the areas mentioned. Certainly, such management may be one reason why *T. crocea* stocks appear so resilient to continuous harvesting - the exploitation simply is *not* so continuous within micro-areas. Such specialized forms of managing stocks of tridacnids and other molluscs merit further study. There appears to be a number of instances where the harvesting of substantial numbers of giant clams for marketing purposes, i.e., beyond that required for subsistence consumption, are subject to strict customary control. This has been reported from Marau (Ruttley 1987). In such contexts, one possible future scenario is that the harvesting (subsistence or commercial) of giant clams, particularly larger species, may become subject to

[11] A notion most likely introduced and perpetuated in recent years by well-meaning conservationists of the multitude of NGOs increasingly present in Solomon Islands. Though it is hard to substantiate this with references to literature published by NGOs and others, it was pointed out by villagers in several locations that they nad heard about the slow growth of giant clams from "European" (i.e., white) visitors from various organizations.

a greater variety of restrictions around the Solomons as expectations about mariculture potentials spread.[12]

On a more general level, giant clam stocks may be afforded some protection by the customary forms of reef tenure throughout Solomon Islands, through which holders of primary rights in reefs are entitled to restrict the utilization of any resource within their area (see chapter 6). However, whether customary reef tenure in the Solomons or elsewhere in the Pacific is associated with a general, conscious "conservation ethic" has been subject to considerable debate (Johannes 1978; Carrier 1987; Hviding 1989; Ruddle et al. 1992). This may be considered a largely irrelevant point as long as *de facto* limitations on exploitation are an indirect result, which often seems to be the case (Hviding 1989; Ruddle et al. 1992). In this light, even religious and spiritual prohibitions regarding tridacnids may, by implication, contribute to the long-term conservation of stocks.

In a general overview, Moir (1989) states: "Few detailed data are available on the traditional management of *Tridacna* resources by Pacific islanders. Where such practices exist today, and from what little information can be obtained concerning earlier activities, it appears that they have been employed primarily to enhance the accessibility of a food source, and to protect appropriated specimens from exploitation by others." This assessment leads us on to the single most important measure of relevance to giant clam management in the Solomons today: The local-level "domestication" of tridacnids by the establishment of "clam gardens" near village shores.

Clam Gardens and Traditional Mariculture

Indigenous Experiments in Domestication

I have commented on the great interest taken in the natural environment by rural Solomon Islanders, not just associated directly with day-to-day food gathering, but also on the level of comparative discussion about interesting environmental phenomena. Thus it comes as no surprise that enterprising persons have been known to initiate and carry out their own experiments involving important animals and plants. Rural women frequently test new cultivars of sweet potato and taro obtained from other islands, to see which grow best under which conditions, and attempts at domesticating important wild plants are common and often successful. This study has documented some attempts by people in Western Province at domestication and stock enhancement of direct relevance to mariculture, as summarized in the three cases below.

MANGROVE OYSTER CULTURE

In the lagoon areas of New Georgia, several people are known to have tried cultivating the large mangrove oyster, *Saccostrea cucullata*, called *roja* in Marovo (*roza* in Roviana and Hoava), which grows attached to mangrove tree roots or to nearshore stones. In these cases, people have transplanted large numbers of smaller oysters from more remote locations to mangroves or sheltered seashores near the village,

[12]Or conversely, it may be surmised that expectations of the restocking of clams through mariculture may instead induce some relaxation of restrictions, from an assumption that short-term depletion for cash purposes will eventually be circumvented by restocking in the long run. The range in time and space of degrees of enforcement of tenure rights over reefs and their resources in the Solomons is much too broad to allow for a countrywide generalization about this scenario or the alternative one.

leaving them there to grow big before harvesting them some at a time. One ambitious, but prematurely halted culture attempt was made in North New Georgia: In the early 1980s, Mr. Vincent Vaguni of Tamaneke village personally collected and had people collect for him (for a price of 10 c/oyster) around 1,000 small- to medium-sized *roza*, which he placed in the mangroves fringing the mainland shore near the estuary of the small Tamaneke River, close to his house. His aim was to watch them grow and eventually eat them. They grew well for several years, until most of them perished when first exposed to several days of extreme low tide and hot sun, followed by long-lasting heavy wave action that left most of the oysters covered in sand and sediments.

"PLANTING" COCONUT CRABS

Mr. Erik Andersen of Marovo Lagoon, a senior man of mixed Marovo/Norwegian descent, has for several years collected small coconut crabs (*Birgus latro*) from the barrier reef islands. Every time he has gone out there to catch adult crabs for food, he has taken all the small ones he could find, put them in a sack and brought them along to release them on his own island of Mahoro, a 70-acre raised coral island in the inner lagoon, covered with the coconut trees of an old plantation and now overgrown by secondary forest along the coast. Whereas coconut crabs used to be abundant on Mahoro, they were virtually wiped out during the decades up until the mid-1980s when this nearshore island was uninhabited and free-for-all. Several full bags of small coconut crabs have been released (or, translated from Marovo terms, "planted") on Mahoro, and they are now observed to grow and thrive. Andersen comments that the small crabs find plenty of food in the endless numbers of fallen coconuts that nowadays are just left to rot. These efforts amount to a restocking of coconut crabs on Mahoro. Andersen has announced in nearby Methodist villages (whose inhabitants were responsible for wiping out the original stocks of coconut crabs) a prohibition on catching these crabs on Mahoro, to allow the stocks of small crabs to grow big and harvestable. Many people, including the Seventh-day Adventists of nearby Chea village (whose doctrine prohibits them from eating crustaceans), remark that this is a very wise thing to do, that Erik through his efforts to "plant" coconut crabs (*choku tupe*) actually ensures a plentiful future supply of his own favorite food.[13]

THE DOMESTICATION OF TRIDACNA CROCEA

The Reverend T. Boso of Madou village in the Vonavona Lagoon is a senior leader of church and community who has taken a strong interest in the future of food mollusc stocks in the area. Noting that everybody brought the larger types of clams to their village shores to keep there, Boso thought that since *gulumu* (*T. crocea*) is the real favorite of so many people, they should be able to keep that as well. He decided to

[13]The question may be raised whether it is at all possible for Andersen to be sure that the increasing numbers of coconut crabs on Mahoro today are not an outcome of natural recruitment. However, the point made by him and other local commentators is not that restocking is solely a result of transplanted juveniles, but rather that this conscious "replanting" (*choku pule*) is the major factor in the present-day reemergence of coconut crabs on Mahoro.

conduct an experiment in "planting" or "taming" this tridacnid (*pausu gulumu*). So last year, he collected a large number of *gulumu*, maybe one hundred, over a few weeks. He was careful to remove them very gently from their stones so as not to break the shell, and took them home to "plant" them. He placed them all in shallow water off his own section of the Madou beach (where conditions are very suitable for *T. crocea*), and put them upright side-by-side among smaller stones so that the clams were partly supported by each other and partly by the stones. They all survived, and opened up again after a while. When he checked them after a few days, he was surprised to find that they were all firmly attached to the stones again with their byssal thread. This became his own *gulumu* farm - the clams were thriving and none died. As from then, he could take ten or fifteen every weekend to have for the family's Sunday meal. On the basis of these observations, the Rev. Boso feels that the *gulumu* should be a prime candidate for more organized farming.

Clam Gardens

In recent years, more and more people throughout Solomon Islands have built up small collections of live tridacnids in shallow water right off their own village shore, often adjacent to their seaside houses. Such "clam gardens" are usually the property of an individual family, and typically contain 10-20 clams of various sizes. The clams are taken from more remote reefs, mainly those controlled by the group to which the collectors themselves belong. This practice, widespread in many parts of the island Pacific and documented from locations in Melanesia, Polynesia and Micronesia (cf. Moir 1989), was initially reported in the Solomons from Marovo Lagoon (Govan n.d. [1987]; Hviding 1988). Clam gardens have since been documented in ICLARM CAC trip reports from a number of present and potential village trial locations, and were observed in every village and hamlet visited during field research for this study.

In Munda in New Georgia, I was told that collections of large *T. gigas* were kept by resident European traders, as well as by local chiefs, at least fifty years ago. The clam garden phenomenon appears to have a longer history in the Solomons than previously realized. Certainly, this is the case in neighboring Papua New Guinea, where clam gardens in the Manus Islands were described by Maclean (1978), who reports that "..the farming of clams has been a traditional practice for many generations...".

Clam Gardens and Mariculture Development

With few exceptions (cf. Maclean 1978, quoted above), the direct significance of indigenous clam cultivation practices for mariculture has largely been overlooked until recently. Notably, in local languages as well as in Pijin clam gardens are referred to by a variety of concepts that can be translated as "*planting*," "*nurturing*" or "*taming*" giant clams, or as simply "*keeping giant clams as pets*". The wider relevance of these indigenous concepts of clam "husbandry" is discussed in a following section.

Nearly always, clam gardens in the rural Solomons are established on an individual or household basis, rarely communal, and the collected clams are considered the sole property of the family or individual off whose beach section they are placed.[14] This entire complex contains

[14]It is common practice in the Solomons that villages are divided into named extended-family hamlets, each of which has primary control over the shallow reef and "canoe-landing" immediately off the beach.

numerous important parallels to the practical requirements of mariculture in terms of "husbandry" and "security of investment".

Species Kept in Clam Gardens

Although *T. gigas* is the species most commonly encountered (and most clearly visible) in clam gardens, most gardens examined contained more than one species. *T. gigas* was present in all cases. Other species gathered and kept were (in order of decreasing observed occurrence) *Hippopus hippopus*, *T. squamosa* and *T. maxima*.[15] *H. hippopus* in particular is considered by villagers to be well adapted to the ecological conditions found near village shores. With the exception of Rev. Boso's experiment in Madou, Vonavona (Case 8), no encounters of *T. crocea* in village clam gardens were made during field visits. There are, however, "transitional" examples where these clams inhabit coral boulders in the immediate vicinity of villages and as such are in some sense within the "domestic" realm, though wild. The nearshore reefs on which clam gardens are typically established are anyway a preferred habitat of *T. crocea*, villagers often say.

Observations of Growth in Clam Gardens

As already mentioned, villagers frequently express surprise at how quickly the transplanted clams grow, and several examples were pointed out where a particular *T. gigas* specimen which could easily be handled when gathered at the barrier reef only a few years ago had now grown to a size where several men would be required to move it into a canoe. Also, the increased popularity of clam gardens have also allowed for long-term observation of individual clams, and has increased knowledge about different growth rates among species of tridacnids. For example, a number of villagers state that in general, *T. squamosa* grows faster than any other tridacnid, but that *H. hippopus* has the best growth rates in clam gardens.[16]

Motives for Establishing Clam Gardens

Villagers' motivations for collecting live clams from the barrier reef and keeping them for longer or shorter periods of time in "gardens" off their village shores are diverse, and include:

- short-term storage for future consumption, perhaps in times of bad weather and shortage of fish;
- longer-term storage with the intention to let the clams grow considerably larger before eating them on special occasions;
- personal interest in the village-based mariculture trial developments now underway throughout the Solomons, anticipating own involvement in such activities;
- a desire to learn more about the habits and growth patterns of giant clams, particularly with reference to (and in anticipation of) the preceding point;
- an interest in keeping giant clams as a form of "pets," particularly among Seventh-day Adventist villagers who do not eat molluscs, but nevertheless are eager to have clam collections off their houses;

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[15] In addition, Govan (pers. comm.) has observed *T. derasa* kept in clam gardens, in the Russell Islands only.

[16] The reliability of such interpretations in absolute terms requires further checking - most notably since the actual transplanting itself may have consequences for growth. The conditions offered in nearshore clam gardens often do not correspond to natural habitats of tridacnids, particularly not to the species found in and near oceanic habitats.

- the view that giant clams "cool" and rinse the water around them, thus improving the quality of saltwater for bathing at the beach in villages with freshwater shortage;
- an undefined notion, arising from the emerging focus on mariculture trial efforts, of future monetary benefit from the sale of "one's own" clams;
- a concern that giant clams are now getting more and more scarce on outer reefs, and that they should be brought to the village to be allowed to grow under more secure circumstances.

These types of motivations thus correspond partly to Moir's generalized assessment (1989, see above) that clam gardens typically involve enhancing access to a food resource and protecting appropriated specimens from exploitation by others. A key motivation for Solomon Islands villagers in taking giant clams from outer reefs to "gardens" off village shore is to protect them from extinction in remote, unsurveilled areas. This motivation is as strong among Seventh-day Adventists who do not eat molluscs. Those "others" against whom remaining tridacnids are sought protected are not only fellow villagers; they are as likely to be more or less tangible outsiders. The following quote from the previously mentioned report from Papua New Guinea by Maclean (1978) could apply equally well to the concerns of many Solomon Islanders: "One islander wryly declared that he was gathering clams and putting them into his clam garden to prevent Taiwanese fishers from taking them".

It must also be pointed out that the present "climate" in Solomon Islands for giant clam mariculture, with a high level of awareness about ICLARM activities and with fertile ground for more or less realistic expectations, plays an increasingly significant role in the adoption among villagers of clam garden practices, with potential feedbacks into the direct adoption of giant clam mariculture.

Dialogues about Clam Gardens and Mariculture

Clam Gardens and Recruitment of Wild Stocks

Field observations of clam gardens indicate that most contain between 10-20 clams at any given time (some are usually taken for food every now and then), although some particularly interested persons may keep several times that number. The typical approximate size range of tridacnids kept in clam gardens is, for *T. gigas*, 25-50 cm (with each garden often also having a few considerably larger specimens) and, for *H. hippopus*, 18-30 cm. Estimates made on the basis of surveys of clam gardens in ten villages of Marovo Lagoon give a mean number of 1-1.5 "domesticated" clam per village resident (all counted). This figure may be used cautiously to reach aggregate assessments of numbers of clams brought in from outer reefs for "domestication" at village shores. In the case of Marovo Lagoon, it would not be unreasonable to assume that a total of at least 10,000 tridacnid clams (of which at least 7,000 *T. gigas*) were kept in clam gardens as of early 1992.

The consequences for wild recruitment of such removal of adult and sub-adult clams from outer reefs may be a relevant issue for investigation. Conversely, one might speculate that the concentration in clam gardens of otherwise scattered representatives of depleted reef stocks actually improve reproduction.[17] While mariculture scientists are likely to have a number of

[17]Cf. the much-discussed "clam circles" established by conservationists in Tonga (Chesher 1991; Chesher and 'Ulungamanu 1991). Whether the clam circles have actual beneficial effects on recruitment or not is the subject of some debate among biologists.

views on these matters, informed opinions based on empirical observation can also be encountered among Solomon Islands villagers. Consider the following example:

REPRODUCTION AMONG HIPPOPUS HIPPOPUS IN CLAM GARDENS

Off her family's bush garden and "weekend hamlet" a half day's travel from the village, Mrs. Amina Kada of Tamaneke village in northern Marovo Lagoon has since 1985 kept a varying number (usually around 10) of *T. gigas* and *H. hippopus* in about 1-2 m of water, on slightly muddy bottom with numerous dead coral boulders, and with considerable influence of mixed-water currents from the extensive mangroves nearby. A long mangrove passage through which the tides ebb and flow emerges not far from the clam garden site. From this garden, Mrs. Kada now and then takes one or two clams for consumption by her family, in turn replacing those eaten with new ones gathered mainly from the barrier reef. She collects both types, because her family prefers *ose* (*T. gigas*) whereas she herself eats *hohobulu* (*H. hippopus*) and not *ose* - the flavor of the latter makes her "sick". In 1990, she noticed that many small *hohobulu*, a few centimeters long, had suddenly turned up among the stones in the area, right in the middle of the clam garden. These have since grown, and new, small ones have continued to emerge from time to time. On 26 December 1991, when collecting one 50 cm *ose* and one 30cm *hohobulu* for eating during final Christmas celebrations, she showed us one of the small clams from what she reckons to have been the first spawning of the resident *hohobulu*; it was around 8 cm. Mrs. Kada is convinced that her *hohobulu* do reproduce here, since the environment is "precisely the right one" for this clam. However, she says, it is no wonder that her *ose* do not seem to reproduce: In the muddy inshore conditions offered by the clam garden, "*ose* can only live, but not grow well, and certainly not spawn!"

Clam Gardens and Environmental Preferences of Tridacnids

Most clam gardens observed in the Solomons are located in inshore waters, sometimes with considerable freshwater influence. Only in villages and hamlets located on or near outer reef islands were clam gardens seen in the oceanic environments that are the natural habitats of most tridacnids, i.e., clear saline water with ocean currents and live reef substrate. More often, clam gardens are located in the type of environment regarded by local people as being the right one for *H. hippopus* and *T. crocea*. Many villagers emphasize, like Amina Kada does in the case above, that they do not regard the ecological conditions usually prevailing in clam gardens as optimal for *T. gigas*, but that this cannot be helped, since the most important considerations in the establishment of a clam garden are not (ethno-) ecological.

The Need for Dialogues between ICLARM and Owners of Clam Gardens

The establishing of clam gardens is likely to continue in villages throughout Solomon Islands, resulting in increasing numbers of tridacnids being transplanted from outer reefs to inshore areas. On this background, ICLARM may have a role in conveying to villagers established scientific knowledge about the different tridacnids regarding stock recruitment and optimal habitats for reproduction.

On the other hand, villagers' own views on the most suitable habitats for different tridacnids, coupled with their assessments of social parameters and technical requirements such as protection against theft, practical accessibility, etc., as exemplified through clam gardens, generate a number of suggestions for the future directions of mariculture. In a number of the locations visited during field research for this study, we were strongly urged by villagers to advise ICLARM mariculturists that the project should now aim at cultivating *H. hippopus* and *T. crocea* in addition to *T. gigas*.[18] These initiatives point to opportunities for wider dialogue.

Building on What is There: Reflections on "Farming Systems" and "Husbandry"

Farming Systems Research

The examples of the "local point of view" relating to giant clams and mariculture presented in this chapter demonstrate a number of opportunities in rural Solomon Islands for the type of "investigative on-farm research" promoted by ICLARM's "Farming Systems Approach". As conceptualized by Edwards et al. (1988), this approach involves "... cooperation between farmers, researchers and extension workers from conceptualization through experimentation to analysis, publication, dissemination, and implementation of results...". Not least from lack of manpower, this has so far been only partly achieved in the village trial program of the ICLARM CAC. However, now that the technical feasibility of giant clam cultivation, at least of *T. gigas*, has been rather well established, it ought to be possible to give more attention to the opportunities for a two-way flow of suggestions and advice between ICLARM and rural Solomon Islanders.

Improving Communication

The village scene contains numerous examples of indigenous mariculture experiments and empirically based reflections on the biology and ecology of tridacnids, and villagers are eager to give suggestions to ICLARM on a range of important topics like target species, technological solutions and ecological parameters relating to farming sites.

Conversely, the widespread practice of establishing clam gardens appears to be in need of information from ICLARM on optimal habitats for different tridacnid species and conditions for stock recruitment. A further challenge is posed by village trial farmers' needs for more information on predators and clam husbandry, stated in terms that relate to existing local concepts. It is significant that the activities associated with giant clam farming, embracing the work carried out at the CAC and at Nusa Tupe as well as in village trials, are referred to by Solomon Islanders with terms that easily relate to the concepts of "husbandry" promoted by mariculturists.

Linguistic analysis of some Solomon Islands terms relevant to mariculture is instructive here. By knowing how local people talk about giant clam mariculture, an appreciation may be gained of how mariculture relates to concepts and practices already present in village life.

Villagers' Own Husbandry Concepts

Recent linguistic research has demonstrated that although Pijin terms are often technically adapted from English words, their actual meaning tends to be rather directly derived from

[18]By late 1992, a first cohort of *T. maxima* and *T. crocea* juveniles was indeed being reared at the ICLARM CAC (C. Oengpepa, pers. comm.). Experimental hatching and rearing of *Hippopus hippopus* has in fact been going on at the CAC (including the Nusa Tupe field station) for some time.

vernacular languages, and refers to indigenous cultural concepts that are often widespread throughout the Solomons (Keesing 1988). Therefore, before turning to vernacular terms for the mariculture process, we may note that in Solomon Islands Pijin the mariculture of giant clams is usually referred to by the terms */plentim/* (or */plendim/*), meaning (1) "to plant/domesticate a rooted organism in order to cultivate and nurture it" and (2) "to grow a crop," and */fidim/*, meaning "to domesticate/feed/protect and nurture a living animal". The former term presupposes eventual harvest of the organism planted, while the latter may also apply to animals kept as pets (or even, by extension, to adopted children). Whereas the former term applies also to seaweed mariculture, the twin use of both terms is specific for the cultivation of mainly sedentary, nonplant organisms.

Below, vernacular terms applied to giant clam mariculture by speakers of the Marovo language of Western Province are presented. Literal translations of the multiple layers of meanings are provided, so as to identify local "cultural content" of the terms and their relation to traditional practices. It should be self-evident to which stages of the mariculture process the different terms apply.

choku ose	to plant *T. gigas* (in clam gardens or mariculture trials); to cultivate it as a rooted crop; to domesticate it through cultivation; to nurture its growth to harvestable size.
pausu ose	to keep domesticated *T. gigas*; to keep it as a pet (also analogous to an adopted child); to protect it against any dangers; to cover any needs of the animal through feeding and nurturing it.
va manavasia ose	to "tame"/domesticate wild *T. gigas*; to establish domesticated stocks for further cultivation; to watch over the domestication process so that the wild animals do not die.
va lumochoa	to clean something (applied to the removal of algae and debris from village trial cages).
pita chuko	to look for and collect small reef snails (applied to the required work of removing predator gastropods from village trial cages).

The use of entirely corresponding terms has been verified in the field for Roviana, the dominant language of Western Province. The close correspondence with usages in many other languages of the Solomons can also be assumed, as evidenced by the Pijin terms routinely applied to giant clam mariculture.

Thus, despite the rather widespread notion (among mariculture researchers) that villagers are not very familiar with a "routine husbandry" concept as such, giant clam mariculture *is* actually being actively incorporated into local conceptualizations by means of a number of vernacular terms that involve *conscious human agency in domestication and nurturing.* Indeed, the concepts used also entail longer-term commitments to "look after" the crop or domesticated animal so that it thrives, grows and adapts well. A main challenge for further "Farming Systems" research and extension at the ICLARM CAC is to achieve integration of indigenous "husbandry" concepts into the project framework, thereby possibly achieving increased "localization" of work definitions, and more meaningful routine tasks.

A Note on Predator Removal and Women's Role

Vernacular categories may also correspond to specific key activities in the mariculture process. The important category referring to the removal of predator snails (in Marovo, *pita chuko*) illuminates a significant omission in the village trial program so far:

By a great number of villagers from several provinces, it was emphasized that searching for and collecting small reef animals such as gastropods is a typical "women's activity," associated with women's dominant role in the harvesting of mollusc resources from reef and mangrove. Several representatives of women's organizations, in villages and in Honiara, felt that women had only to a very limited degree been actively encouraged by ICLARM to participate in the village trial activities.[19] These representatives found this perceived lack of emphasis on women somewhat strange, and expressed the view that it is precisely village women who know best how to do the routine work required in the husbandry of juvenile clams. Considering the dismal record of routine checks apparent from a number of village trials and described in CAC trip reports, more efforts should be made at investigating such existing social and cultural frameworks for achieving reliable long-term husbandry.

[19]This view applies to the explicit involvement by women as leaders in village trial work. As is the case for other more well-established types of village-level livestock or cash crop project, however, there is every reason to believe that also in mariculture trials, female household members do much of the routine work whereas men (notably household heads) largely "front" the project activities (cf. Table 5.1, in chapter 5).

CHAPTER 5

THE VILLAGE TRIALS: RURAL PARTICIPATION AND INFORMATION FLOWS IN MARICULTURE RESEARCH

Introduction

This chapter examines the program of village-based ocean nursery trials, run as an integral component of ICLARM's Giant Clam Mariculture Project (GCMP) since 1988. The character of the village trials gives such a case study some broader relevance, in that what is examined is an example of "participatory research" involving the collaboration between scientists and villagers in the gathering of basic scientific data, with the eventual aim of developing a farming system for integration in subsistence-based village society and economy. Further, the organism concerned is one which already plays an important role in the lives of villagers and which evokes strong positive feelings relating to its well-being and growth.

Social Parameters and Communication in Farming Systems Research

In the Solomon Islands context and in the light of ICLARM's stated commitment to small-scale mariculture activities, data gathered and experiences gained on the village level are prerequisites for the development of locally appropriate farming systems for giant clams. This chapter, therefore, reviews the various components of ICLARM's village trial program as they are affected by important social and cultural parameters of the rural context. Many of the observations made specifically with regard to village trials are very likely to apply also to any wider future participation by Solomon Islanders in giant clam mariculture. Not least, some important general lessons are contained here as to how the two main categories of actors - villagers and mariculture scientists - try to "make sense of each other"; how they perceive and interpret each other's actions, communications, abilities and intentions.

Village Trials: Brief History and Profile

Origins and Development

From the early stages of the GCMP, the hatchery and other CAC operations have been complemented by a program of ocean nursery trials on the village level. As from late 1988, when juvenile clams of suitable size (20-30 mm) first became available from the hatchery, a growing number of village trials were established, in which rural participants were supplied with cage materials and juvenile clams and cages were constructed and husbandry advice conveyed by visiting ICLARM CAC staff. The program soon generated much interest among villagers throughout the country, and by early 1992 a total of nearly 30 trials had been set up (18 of which were still operating). Trial participants have been selected on the basis of individual application to ICLARM followed by interviews, village meetings and surveys of the potential reef sites they offer. They stay in touch with ICLARM through (ideally) fairly regular

visits by CAC staff who inspect the clams and collect data on growth rates, mortality, predation and other topics. Table 5.1 above gives a detailed overview of village trials and their participants, as of early 1992. Later sections of this chapter examine the information on trials and participants in some detail.

In addition to the 18 listed, a number of new trials were launched during 1992, mainly in Western Province. These are to be supervised and maintained from ICLARM's field station at Nusa Tupe in Gizo, the provincial capital.

Table 5.1. A profile of ICLARM CAC village trials in Solomon Islands, early 1992.

Trial number/ province	Location	Participant(s)/ occupation	Secondary activities of participant(s)	People involved in trial work	Other details
1 / Guadalcanal	Niu, Marau Sound	1 / highly active fisher	fish marketing in Honiara	participant, wife, five sons	est. 03/89; oldest clams now in grow-out
2 / Guadalcanal	Alite, Marau Sound	1 / n.a.	n.a.	n.a.	est. 08/90: floating cage/trestle cage
3 / Guadalcanal	Katou, Marau Sound	1 / businessman	gardening, fishing	participant + father	est. 01/91; bottom cages on raised coral
4 / Guadalcanal	Aohanipuma, Marau Sound	1 / fisher	gardening	participant + brothers	est. 01/91; bottom cages on raised coral
5 / Central	Tulagi, Fisheries Centre	several/fisheries officers	fishing	fisheries officer + 2 fisheries assistants	est. 03/91; intended as demonstration site; bottom cages on reef flat
6 / Central	Boroni, Sandfly I.	1 / village dweller	gardening, fishing, copra	participant, sons, daughter-in-law	est. 04/89; bottom cages on reef flat
7 / Central	New Tagini, Russell Island	1 / village dweller	gardening, fishing, copra	participant + son	est. 04/90; bottom cage/exclosure
8 / Isabel	Buala	1 / school teacher	gardening, fishing	participant's nephew	est. 03/91; floating cages
9 / Isabel	Kia	1 / Provincial Assembly Member	n.a.	caretaker	est. 05/89; bottom cages/exclosure
10 / Isabel	Dedeu	1 / village dweller	gardening, fishing, copra	participant + brothers	est. 03/91; floating cage/bottom cages
11 / Isabel	Samasodu	2 / fisher + school teacher	gardening, fishing, copra	one participant (fisher)	est. 05/89; bottom cages/exclosure
12 / Isabel	Horara	1 / village dweller	fishing, gardening	participant + friend	est. 03/91; bottom cages on raised coral
13 / Malaita	Gwaedalo, Langalanga Lagoon	Gwa'ata Foundation (land and reef owners' organization)		caretaker + sons	est. 1990; bottom cages on small island off village
14 / Makira	Tawarodo, Makira	1 / businessman	gardening, fishing, copra	participant's close relative	est. 05/91; bottom cages (intertidal)
15 / Makira	Three Sisters Island	2 / fishers	gardening, fishing	participants + brother of one	est. 05/91; two different sites; bottom cages
16 / Western	Tingge Island, Marovo Lagoon	1 / hamlet dweller	agriculture, livestock, copra	participant + family	est. 04/89; bottom cage/floating cage/ exclosure
17 / Western	Bunikalo, Marovo Lagoon (Gatokae I.)	1 / hamlet dweller	wood-carving, gardening, copra	participant	est. 04/89; trestle cage
18 / Western	Vavanga, Kolobangara I.	1 / village dweller	gardening, small-scale business	participant	est. late 91; bottom cage

Notes:

1. Sources: (a) "Socio-economic profile" (unpubl.) by J. Hambrey and H. Tafea, ICLARM, November 1991; (b) "A brief description on each trial site" (unpubl.) by H. Tafea, ICLARM, August 1991; (c) field notes by Edvard Hviding; (d) personal communications from ICLARM staff.
2. As far as possible, information in the table is up-to-date as of March 1992.
3. Exact details on cage types for certain trials are unclear.
4. The status of a couple of the trials listed was uncertain by March 1992, and they may since have been closed down. Several new trials have since been established in Western Province.

Objectives of the Village Trials

In order to state clearly how the general aims and principles of village trials have been presented to the Solomon Islands public, it is worth quoting at length from a news release in early 1989 by ICLARM (Govan 1989c):

> The objectives of the trials are to assess the optimum designs and local acceptability of village-based clam nurseries, to identify potential predators and pests of giant clams and devise adequate methods of control, and to test nurseries in a variety of ecological conditions.
>
> Participants in the village-based ocean nursery trials make a cage out of chicken wire and cement and supervised by ICLARM staff member and place it in an area of suitable shallow reef or seagrass bed. Between 200 and 1000 baby clams supplied by ICLARM are placed inside. In the beginning the clams need to be checked every day but later on twice a week may be enough.
>
> ICLARM provides the materials (...), clams and advice free of charge. People taking part in the trials contribute their time and labour and find a sheltered and shallow area of sea bed with clear water and no large rivers nearby. If the trial is successful then the clams and materials become the property of the participants, if not they revert to ICLARM.

The presentation quoted clearly defines the emphasis of village trials as being the gathering of basic data to identify parameters for the future development of mariculture. In many ways, ICLARM's GCMP is unique among projects of its kind in emphasizing the early involvement by village people at the stage of relatively basic research. This approach may be labeled a form of collaborative, "participatory" research where a two-way flow of information between the two parties involved, and fairly long-term mutual commitment, seem necessary conditions. The aim of this chapter is to throw some further light on the point of view of the rural participants in village-level ocean nursery trials, particularly in the light of certain "problems" experienced and expressed by ICLARM CAC staff, notably with reference to declining commitment in routine husbandry of the trials.

Experiences Gained from the Village Trial Program

After more than three years of village trial operations, a range of experiences have been gained, relating to biological and technological parameters affecting the survival and growth of clams, and to various social and cultural factors affecting the viability of individual trials. Declining commitment among trial participants to continuous routine husbandry, as well as some disillusionment from high and sometimes sudden mortality among juvenile clams, have been noted as major constraints on long-term trial viability.

Some concern has also been expressed by members of the ocean nursery staff regarding the logistic side of the program. Until recently, individual trials have been widely scattered throughout six of the eight provinces of Solomon Islands, and it has seemed increasingly difficult to maintain even a schedule of three-month intervals between visits by CAC staff. In this regard, it is noted by staff at the Nusa Tupe field station that the recent clustering of trials in Western Province allows for more regular visiting. The increased involvement by rural officers of the Fisheries Division, whose extension centers are ideally to function as "hubs" in village trial clusters, has a further potential for improving logistics and obtaining more regular attention to individual trials.

As of early 1992, several CAC staff commented that the time available on-site for each routine visit appears to have diminished, and that some initial visits made to applicants now appeared to be largely confined to relatively brief surveys of the ecology of potential sites. In contrast, the early years of village trial operations were characterized by a more comprehensive approach involving village meetings, discussions with chiefs and "reef-owners," and explanations of the terms and conditions of trials. While the importance of clarifying the ecological potential of a proposed trial site is not to be questioned, certain aspects of the "social feasibility" of the site should also be addressed at this early stage, through discussions with participants and community leaders about proposed husbandry routines, possible conflicts over reef tenure, and other factors that bear directly on the long-term viability of the trial. It is thus important to maintain active communication between visiting CAC staff and participants in terms that also involve the wider community. Again, it may be noted that the "hub-and-cluster" such as being established in Western Province seems to be an appropriate way of maximizing regular and broad contact with rural communities and village trial participants.

Failure in Trials

The failure of a number of village trials derives from a wide range of endogenous and exogenous factors affecting sites, participants, technology and husbandry, clam mortality and infrastructural organization. Of the trials that had failed and been closed down up until late 1991, it is estimated that about half had done so from purely techno-environmental factors, e.g., the destruction of cages by storms, or the unsuitability of sites or of technology.[1] The others are reckoned to have failed largely because of factors involving the participants, e.g., that the person responsible has left to live elsewhere, or that husbandry has been generally insufficient for too long.

Learning from Experience

The continued village-level involvement by the ICLARM CAC has the potential for yielding a mass of important data for the further development of farming systems. Trials as such are not viewed by ICLARM as actual "development" activities, particularly since a number of biological questions relating to the growth and mortality rates of juvenile clams appear still to be somewhat unresolved. While the focus of the village trials has so far been on biological and technical parameters, it is argued here that failure of some trials and other complications experienced in the program are far from just "problems" as defined in negative sense. These experiences are also important sources of information on a multitude of social and cultural parameters in mariculture development.

Why and how is it that problems and frustrations are experienced and expressed by ICLARM staff and village trial participants alike? Answering this question requires a closer look at a variety of processes at work in the village trial program: The selection of participants, sites and technologies; the approaches taken during routine site visits; the mutual communication between participants and CAC staff; and constraints posed by the overall infrastructure of the village trial program. In examining these processes, I argue strongly for paying increased attention to social and cultural parameters, and for their improved integration (alongside with biological and technical aspects) into the village trial activities, so that a more holistic analysis of the basis for farming systems research-and-development may be achieved. This discussion

[1] H. Govan (pers. comm.).

starts by examining the social and demographic composition of the group of present village trial participants, and certain implications of this, particularly concerning the role of women.

Social and Demographic Characteristics of Village Trial Participants

For a number of reasons, village-based giant clam mariculture in Solomon Islands (and beyond) is bound to remain an activity that is "not for everyone". This relates to the unequal distribution between rural communities of tenure rights over suitable reefs (see chapter 6), to limited freedom to establish individual enterprises in villages (see chapter 7), and to other factors. All this also impinges on, and is reflected in, the present village trials, whose participants do not represent any cross-section of the rural population. Whereas some of the limiting factors in mariculture adoption and participation are more or less fixed parameters of the rural context, others are less so. From this point of view, the lack of explicit involvement by women in mariculture trials is a pattern that bears further examination.

On the Lack of Female Participants in Village Trials

In Table 5.1, the most obvious fact about the range of participants is not even stated, since the all-male selection of official participants makes a separate column for "gender" irrelevant. No women are among those identified as "participants," i.e., the persons who have applied for and been given responsibility for village trials. This bias may be understood in several ways; on the one hand, few if any applications have been received from women, as groups or individuals, whereas on the other hand, too little attention may have been given to attempts at actively encouraging women to apply. Anyhow, the lack of female participation in trials was commented on by representatives of several women's organizations, who on the one hand found it strange that a new "development activity" containing elements of such female specialities as shellfish gathering, site-specific cultivation and routine tending had not been specifically addressed at women. In a review of women's role in traditional fishing, the author (a woman from the Roviana Lagoon working as a senior public servant in Honiara) indeed remarks that those Roviana people who traditionally collect clams and seaweed,[2] i.e., the women, apparently were never consulted when seaweed farms and giant clam village trials were started in the area (Gina 1992).[3]

From Table 5.1 we find that the involvement by women in the routine maintenance of a village trial is stated explicitly for only two cases (trials 1 and 6) and implicitly (through the involvement of "family") in one case (trial 16). Although some underreporting is likely here, the level of female involvement is nevertheless remarkably low. On the other hand, representatives of women's organizations also felt it to be quite typical for such new "projects" to be mostly concerned with men, who are usually quickest (and least discriminate, some women added) in jumping on to novel enterprises.

Male Entrepreneurs as Dominant Applicants

The lack of formal female participation in village trials is one artifact of the application procedure followed by the CAC, through which individual applications are invited from the

[2]The "sea grape" *Caulerpa racemosa* is widely gathered for food in lagoons around the Solomons, as part of women's reef-gleaning activities. In the lagoons of Western Province, this "seaweed" is an important supplementary food and by many regarded as a delicacy.

[3]By September 1992, however, Western Province had two new trials involving women only. None of these were set up on the basis of application, but rather on direct dialogue between community representatives and CAC staff.

public. Although, to avoid a bias toward literate persons it was originally stressed that applications need not be in the applicant's own handwriting, such a process anyway tends to favor the most enterprising individuals, often those who have experiences from similar "projects".[4] It is clear that any application process of this kind will by necessity be biased toward people who actively seek to get involved. That in itself does not have to be a problem. However, in the research-and-communication process aimed at in a "farming systems" approach, it is important to be aware of the resulting pattern of participant group composition, and to treat it as a nonfixed variable, rather than a fixed parameter, in mariculture development.

The bias toward entrepreneurial individuals is reflected in that only four of 18 participants are identified as "village dweller," a term that typically refers to people with a subsistence-based household economy and an activity pattern conforming more or less to the generalized description in chapter 2. The list of village trial participants instead includes school teachers (two cases), businessmen (two cases), a Provincial Assembly Member and several "fishers," among them a "highly active" one. All of these participants are persons who rely fairly strongly on monetized activities. This most likely applies also to the category of "fisher," since few Solomon Islanders would normally present themselves as such unless regularly involved in commercial fishing for markets. In addition, the three "hamlet dwellers" listed (trials 16, 17 and 18) are persons who run a variety of small-scale enterprises outside the subsistence sector. Small rural entrepreneurs typically settle in their own hamlets so as to be able to carry out their work more intensively and independent from community restrictions.

Community Projects, Wage Labor Systems and Fisheries Centres

The range of trial participants also covers one instance where a community organization has applied for a trial (13). Considering the prospects offered by village-level organizations for achieving regularity in husbandry, it may be fruitful to give higher priority to this type of participation.

Another type of "participant" is the Solomon Islands Fisheries Division, which maintains one trial at its Provincial Fisheries Centre in Tulagi, and which has several trials planned for its extension centers in Western Province. Intended as a demonstration site with husbandry routines integrated into the wage labor system of the fisheries extension officers and assistants, the Tulagi trial has not been as successful as was hoped for. Nevertheless, testing the viability of giant clam mariculture within organized wage labor and similar institutional systems is an option that might well be further explored, and in this regard recent initiatives from an indigenous plantation owner, from resort managers and from a church-operated vocational school (all in Western Province) may be worthy of attention.[5]

In general, the allocation of more trials to provincial and subprovincial Fisheries Centres (under the ICLARM/Fisheries Division collaborative agreement) is an important step toward institutional diversification as well as having demonstrative potential. Fisheries Centre trials are envisaged as an integrated part of the "hub and cluster" concept planned for future village trial operations, a scenario where village trials are clustered around a series of Fisheries Centre "hubs" from which fisheries officers can easily visit and assist the trials.

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[4]In rural Solomon Islands, various local renderings of the English term "project" are increasingly established as generic terms for all types of organized, development-oriented initiatives, usually aiming at increased cash production and involving a government ministry through its extension agents, and often arising more or less directly from development aid. The implication of this term as applied to the activities of the ICLARM CAC are discussed in a later section of this chapter.

[5]By September 1992, trials had been set up both at Mr. Martin Wickham's large plantation at Rendova, and at the Catholic Training Centre on Logha Island in Gizo harbour.

Some Implications of Involving Entrepreneurs in Village Trials

The individualistic entrepreneurs who constitute the majority of village trial participants tend to be persons eager to grasp novel opportunities that turn up, and so are likely early adopters of, for example, giant clam mariculture. This has a number of potential consequences for their long-term commitment to husbandry of clams. On the one hand, for those who interpret the village trial as the first stage of a profitable commercial venture, subsequent frustrations over the somewhat unclear future prospects for giant clam mariculture in the Solomons may lead to eventual loss of interest.[6] Alternatively, a genuine interest in giant clams (which, as we have seen, are animals with a very special place in many Solomon Islanders' perceptions) and previous experiences from various enterprises may facilitate organized husbandry among entrepreneur participants. In several cases, such people have had their enthusiasm for giant clam mariculture first established during a visit to the CAC at Aruligo, after which they acted as important middlemen in the procurement of broodstock (see Govan n.d. [1987], 1987b).

The heavy bias toward a particular type of participant in village trials has several implications. One is that this pattern simply reflects what would happen anyway if mariculture development was to be launched on a wider scale with recruitment based on applications; namely, that most adopters would be individually minded entrepreneurs adding giant clam mariculture to their existing "project portfolio". Alternatively, this selection process may be actively modified by somehow abandoning the approach that focuses on handling any number of individual applications, and instead adopting an approach whereby ICLARM actively identifies "target" candidates and invites them to participate.[7] To some degree, adopting the latter would seem to be a prerequisite for any future attempts at covering a wider range of not just the overall rural population, but also of important social parameters such as the various possible management units for village-based mariculture (cf. chapter 6).

As pointed out previously, CAC research has so far focused on technical feasibility, but an integration of socioeconomic and cultural parameters is a logical further step in a broader "Farming Systems"-approach (cf. Edwards et al. 1988) when and if this line of mariculture research is taken. Actively promoting the participation of women's organizations and women in smaller family groups, of church and community associations, and even of various wage labor systems, is consequently required if village trials are to serve also as indicators of a range of social and economic parameters.[8] Finally, it is self-evident that no firm conclusions on villagers' commitment to clam husbandry can be drawn on the basis of a sample of participants that ignores 50% of the population and favors a small proportion of the other 50%. In any event, it seems unlikely that people who possess numerous well-defined traditional concepts of husbandry, who have for generations demonstrated the motivation to look after young coconut trees for more than five years, and who have more recently found time also to weed and clean cocoa farms regularly, should be unable to look after growing clams for similar periods of time.[9]

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[6]This is what may have happened in March 1992 when a considerable number of smooth and decorative *T. gigas* valves, all of the same size (approximately 25 cm) were suddenly for sale in Honiara handicraft shops. Shopkeepers said that all the clams had come from Marau. A week before, CAC staff visiting the most successful trial in Marau Sound were surprised to find that most of the subadult clams in growout had disappeared; and the trial participant stated that he had sold them, but did not specify the buyer. Of course, this instance may be related not to a loss of interest in clam-keeping, but rather to an enterprising attempt to convert clams into cash at an early stage.

[7]In Western Province, I met with four applicants who were much concerned about the final outcomes of their written applications. The sites of three of them had been surveyed by Nusa Tupe staff about five months earlier, after which nothing had been heard from ICLARM. The fourth had sent a written application even earlier, but had heard nothing at all. This indicates that the application process as it functions today, focused on a multitude of individuals, may not provide sufficient feedback to applicants, thus potentially causing misgivings.

[8]Cf. the statement by the person responsible for the inception and original implementation of village trials that the program initially "envisaged establishing about ten trials covering as wide a range of ecological and socio-cultural conditions as possible" (Govan, unpubl.). During expansion of the program, attention to sampling sociocultural conditions has diminished.

[9]To gain further insights, examples of successful husbandry of new "farm" organisms by rural Solomon Islanders should be examined, for example, the very successful honey bee project that has been developed in recent years and now involves rural bee keepers in many locations. For wider comparative insights, the successes and (mostly) failures in seaweed farming trials also merit attention.

Motivations and Expectations

ICLARM's motivations for implementing and running the village trial program should be fairly clear from printed policy statements. They primarily focus on the data needs of basic research. A secondary focus, of course, influenced by the structure of the GCMP as being a collaborative effort between ICLARM and the Solomon Islands Fisheries Division (but not explicitly stated in CAC policy), is to introduce giant clam mariculture to the rural public and to familiarize target groups for future mariculture development with important aspects of such activities. The motivations among rural people for participating in village trials, however, are of a more complex and varied nature, and are based on a number of more or less tenable expectations.

Expectations, Uncertainties and Frustrations

Disappointing results in recent ocean nursery work at ICLARM's field station on Nusa Tupe, Gizo, indicate that it may be difficult to achieve "commercially viable" survival or growth rates even under dedicated, full-time husbandry and expert supervision. At the same time, village trial experiences after more than three years suggest that it may be problematic to maintain commitment to regular husbandry routines over a long-term period. Some of this lack of commitment has been tied to frustrations among individual participants over high and sometimes sudden clam mortality. What this indicates is that, on the one hand, giant clam mariculture still contains a number of unresolved biological parameters relating to growth and survival. On the other hand, the motivations and expectations held by village trial participants apparently do not take these uncertainties into account. Before discussing these issues in some detail, we may briefly summarize the main factors of motivation for participation in village trials, as evident from discussions with actual and prospective trial applicants and with staff of the CAC and Fisheries Division.

Main Motivations for Village Trial Participation

- a wish to participate from an early stage in a new "cash cropping" development, in anticipation of future economic benefit;
- a specific, strong interest in giant clams and their lives;
- a feeling that giant clam mariculture is an ideal family-level enterprise;
- a general concern over the depletion of giant clam stocks and its consequences for food supply and reef conditions;
- plans for the restocking of reefs after intensive rearing of large numbers of clams in protected surroundings.

To these factors may be added other less tangible ones, namely:

- a wish to expand one's entrepreneurial profile;
- the prestige associated with adopting a novel type of "development project";[10]
- prestige connected with obtaining clams and cages as "gifts" from an impressive partner or "friend" like the ICLARM CAC;
- political benefits (e.g., in terms of reef rights or community standing) of possessing a village trial; and more specifically,

[10]Prestige as a motive for adopting innovations is known from research on aquaculture development elsewhere. See ICLARM and GTZ (1991) for examples relating to inland pond aquaculture in Africa (Malawi).

- a wish to consolidate individual claims over reef areas by establishing a "project" there.

Diverging Views on Responsibility for "Proper Husbandry"

All these more or less explicitly stated motivational factors are based on the *a priori* assumption that "growing clams" is a straightforward matter, and that after a period of five to six years harvests may be reaped or reefs restocked with adult clams. This is in many ways analogous to the cultivation of land-based cash crops like copra and cocoa. According to these notions, proper husbandry following ICLARM guidelines will in due course produce the expected results. Such a view is also implicit from ICLARM's side in the requirement that lack of "success" will make clams and materials revert to ICLARM.[11] What this says, in effect, is that "abnormal" mortality or growth rates must be blamed on "poor husbandry". What, then, if cases of sudden mortality or unexpectedly slow growth rates turn out actually to be owing to unresolved biological and/or technological problems?

A number of points raised here need to be addressed. One way of doing so, again, is for ocean nursery staff to engage in closer communication with actual and prospective trial participants, to listen to their views and expectations and respond by clarifying which parameters of giant clam mariculture are certain and predictable and which are not. In this, two types of information provided by villagers are particularly important.

Assessing Local Views of ICLARM's Role

One is information about trial participants' expectations from ICLARM. In a sense, participants *expect* their clam cohorts to grow and develop according to the stages outlined in the information material distributed locally by the CAC. Some express the view that it is ICLARM's ultimate responsibility to ensure this through regular visits, and that their own regular checks and removal of predators are not sufficient. Some also wish that ICLARM would provide more advice on matters such as future scenarios for the eventual marketing of giant clam harvests and for the restocking of reefs. It is important to realize that such concerns have direct influence on how expectations are formed, and that this process has led its own life as long as village trials have existed, despite a reluctance from ICLARM to create unrealistic hopes. Visions about commercial opportunities in mariculture are generated and upheld in the Solomons anyway by development-minded politicians and civil servants, without any direct contribution by ICLARM. Knowing more about these processes and the ways in which they influence expectations among trial participants and applications for new trials will help prevent misunderstanding and frustration. It may also steer rural expectations onto more realistic paths.

The other, more low-key form of information that can be obtained by paying closer attention to mutual communication in village trials relates to the practical sides of mariculture. This is examined below.

Participants' Contributions: Labor, Information, Reefs - and Cash?

ICLARM requires trial participants to contribute their time, labor and a suitable site, specified as: "... to provide research results and maintain a constant, albeit low, level of labor input

[11] It is clear, however, that the threat of actually revoking clams and cages from failing trials is normally not fulfilled by CAC staff. The negative consequences of such action for ICLARM's general image and for enthusiasm about the project would most likely exceed any positive signal effect to other trial participants.

for possibly more than five years before clams attained harvest size and returns could be expected." (Govan and Tafea n.d. [1992]). In return, participants may benefit according to a vague statement by ICLARM, to the effect that "If the trial is successful then the clams and materials become the property of the participants" (Govan 1989c). We shall examine more closely the variety of inputs required from village trial participants.

Routine Inspections, Opportunity Costs and Alternative Technologies

At first glance, the twice-weekly inspections of clam cages, weekly inspections of net exclosures and general monitoring of unprotected clams in grow-out do not appear to be particularly laborious or time-consuming tasks. However, those who have observed the routine checking of a bottom ("benthic") cage on the reef flat in water a fathom deep and with choppy waves, gain another impression of the effort involved. The fact that CAC staff have on (albeit rare) occasions resorted to SCUBA gear for their underwater work on routine visits to trials make examples of proper husbandry by village trial participants equipped at best with simple diving goggles all the more admirable.[12] Diving down to the cages to clean them of seaweed and debris and to search for and remove predators is indeed often an unpleasant task, and a number of trial participants complained that they usually felt cold, and often cut their fingers on the wire mesh or on the clams (or on the oyster juveniles that quickly attach to the cages).

For these "human reasons," in addition to the fact that predators have easy access from the reef, bottom cages in less-than-shallow water must be reckoned as an unsatisfactory technological solution. Maintaining them requires a significant amount of work with relatively high opportunity costs[13] for villagers, particularly during the season for high tide during daytime.

One solution to the problem would be to use floating cages in village trials, as has been attempted in a number of cases. This also brings clam juveniles much earlier from hatchery to village, and so increases cost-effectiveness (cf. Hambrey 1992). However, a number of mishaps in village trials where "floaties" were destroyed by bad weather or simply by long-term wave action or lack of attendance have cast doubts on the suitability of floating cage technology, at least for village circumstances (for which they have not generally been promoted anyway). The pontoon-based arrangements are, anyhow, quite expensive to manufacture (unless the plastic pontoons could be substituted by suitable local wood).

Thus cages on trestles, or placed on the reef bottom in the intertidal zone, appear most suitable for village use. They require less arduous work, and since diving is not required they can be more easily inspected and cleaned by women (who, in many Solomon Islands societies, are reluctant to dive). In this, women may draw on their experience from reef gleaning. Trestle cages are indeed in use in a number of trials (cf. Table 5.1).

Two-way Dialogue about Technology

On this background, more dialogue should be sought with all villagers involved in trials (also the women who do not figure as "participants" but who no doubt often take part in the

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[12]At one village trial visited in Central Province, it turned out that the household had not possessed any diving goggles for several months. In remote locations, goggles (which break easily) are often not available in the village trade store. Whereas diving goggles (and cleaning brushes) were provided by the CAC in the early stages of the village trial program, this practice appears not to be universal any longer, although the supply of goggles and brushes seems a prerequisite for the survival of village trials with benthic cages in less-than-central locations.

[13]In line with conventional economic theory, "opportunity costs" are defined as "the value of other utilities that have to be foregone to pay for the chosen option" (Cottrell 1978). In this example, what is meant is that the husbandry of clams in bottom cages requires so much time that significant amounts of other productive work have to be abandoned. These issues are examined more closely in chapter 7.

work anyway) on the comparative advantages of different technologies, with a view to minimizing labor requirements. Questions to be addressed are, among others:

- Which parameters of the village-level mariculture process are fixed, and which may be flexibly designed and adapted to varying rural preferences? (Examples to be discussed include: location, reef type, water depth, cage types, materials, husbandry practices, clam seed sizes)
- Is it possible to construct lighter cages that can be brought ashore for routine inspections?
- Can more cages be placed in the intertidal zone, to allow for easier access (and possibly increasing women's participation)?
- What are the benefits offered and limitations posed by intertidal locations, especially considering the tidal cycles prevailing throughout the year in the Solomons (cf. Case 1, chapter 3)?
- Which local woods are the most suitable for trestles? (Some partcipants claim that iron or steel poles are required since it is too difficult to anchor wooden poles securely in the reef, but the question should be investigated anyway.)
- Are there other technological options that have so far not been investigated?

With reference to the last question, local initiatives regarding mariculture technology are probably encountered by most touring CAC staff who stay overnight in participants' villages. There seems to be keen interest taken in the improvement of appropriate technology, and this opportunity for dialogue should be more fully exploited, perhaps with the eventual aim of producing written reports of local initiatives and evaluations of existing technology.

Also, ethnobiological dimensions (cf. chapter 4) should be kept in mind regarding the various aspects of village trials. For example, villagers possess much useful knowledge relevant to the predator problem. One participant in Isabel told visiting CAC staff that he had problems with snails when he kept the cages on dead coral "bommies," but that this problem disappeared when he moved the cages to live bommies (Shearer 1992). Conversations with a range of trial participants revealed interesting observations and interpretations about the behavior and perceived role of sea urchins, hermit crabs, miscellaneous gastropods, pufferfish and triggerfish, and other reef animals found in or near clam cages. Since the main categories of known predators all have corresponding terms in the languages of the coastal Solomons, such terms should be compiled and form the basis for further dialogue that may in turn yield information on unrecognized predators.

Focusing more strongly on the two-way flow of information between ICLARM CAC staff and village trial participants now seems to be required of the "participatory research" process, particularly with regard to addressing and solving numerous "problems" and frustrations. In the original proposal for a village trial program, emphasis was given to the role of information from villagers in the production of an instruction manual, for distribution among participants and other interested parties in and beyond Solomon Islands: "It is expected that the villagers will eventually be able to provide a great deal of practical tips which will be incorporated into the manual" (Govan 1987a). Given the present attention to developing a "Farming Systems" approach, it is high time that these original goals, since overshadowed by a more one-sided transfer of technology, are revived.

Reef Sites as a Contribution to Village Trials

We now briefly turn our attention to participants' "contribution" of reef sites for village trials. Although this is not normally mentioned in ICLARM communications, the use of reefs for trials

is in fact subject to the participant holding recognized rights over the reef concerned, either as an individual subsection within a larger tribal reef area, or in the form of acceptance from the reef-holding community that the reef space in question may be used by the participant for establishing a trial. Thus, this input involves significant "social investments" by the participant in terms of utilizing his or her (usually) inherited entitlements (cf. chapter 6). This, although recognized by all indigenous CAC staff and given some attention in criteria for site selection (e.g., Govan 1989d), is rarely taken into account when measuring the overall "inputs" provided by participants.

Should Participants Pay for Clams?

Certain modifications of the current pattern where participants provide time, labor and tenured reef space (and, I would add, information beyond the formal data collection) have recently been suggested. One topic of discussion has been whether trial participants should be expected to pay a fee for clams supplied by the CAC. This suggestion has been met with considerable opposition from most CAC staff, and is indeed quite untenable given the present state of the project as firmly within the stage of research where a number of biological parameters are unresolved. If it cannot be adequately guaranteed to villagers that proper husbandry will give a specified survival rate or otherwise a particular form of return, then they cannot be expected to pay for clams, however nominal the fee may be.[14] Should charges be made for clam seed today, participation would be even more heavily skewed toward that small minority of rural businessmen who have cash to spare - provided that they do not then choose to ignore giant clam mariculture altogether, given the numerous uncertainties. To the contrary, it may be argued that participants should receive some form of benefit in addition to the somewhat nebulous prospect of gaining control over clams and material if the trial succeeds.

Mutual Benefits?

The village trials represent a form of collaborative research with great advantages to mariculture researchers of gaining an early insight into possible problems arising under realistic conditions. The concept of research collaboration, however, is new to most Solomon Islanders, not least to the villagers themselves, who have only recently become firmly aware of the nature of commercially oriented "development" projects and who may tend to put the GCMP in this category. Here is potential for misunderstanding. In a sense, village trial participants are virtually working as research assistants, with no guarantee of any return, beyond the personal satisfaction and community prestige they may obtain from being involved in an interesting, novel issue. This may well be hard to grasp, especially from the widespread notion that trial participants do in fact "help" ICLARM.

As a first step in clarifying this situation, simple standardized contracts (such as tried out in Western Province during 1992) should be used to define the relationship between ICLARM and trial participants. The contracts should cover the nature of the trials in terms of expectations and obligations involved from both sides, and the ownership of clams. Such an approach fits well with the increasingly legalistic approach taken in the rural Solomons in defining important matters of potential disagreement, like land ownership. A subsequent step might possibly be discussion on whether trial participants could be paid a modest cash sum in return for regular husbandry. This is a most contentious issue, with a high potential for discord, but it

[14]Financial analysis by John Hambrey (1992, and pers. comm.) gives initial estimates of an actual price of 33 cents (S.I.) per 30 mm clam seed delivered to farmer. The implications of such financial figures for rural mariculture scenarios are briefly discussed in chapter 7.

remains significant that several trial participants interviewed stated that there will not be proper husbandry among the majority of them until "there is money in it".

Where do all these notions about the GCMP as a commercial venture come from? This question leads us into a discussion of certain concepts common in rural Solomon Islands of development and its agents, and in the next instance, to the general question of the relative emphasis to be put on "research" and "development," respectively, in the designation of the village trial program as "research for development".

Research and Development: On Definitions and Contexts

A Commercial Image?

A number of misconceptions about the nature of the village trials exist among the Solomon Islands public. In particular, expectations are high about imminent economic benefits. The scale of the GCMP, and the involvement of ICLARM as an international agency (normally described as a "company"), for many seem to imply great commercial potential. This has been reinforced by media, by politicians' statements, and no doubt on occasion by project staff themselves. There is little awareness that the GCMP is any different from other projects, and that village participants are actually being involved at a very early stage of basic research. The direct purchase of broodstock for cash from the rural public, carried out from time to time, may further reinforce a commercial rather than a nonprofit research image for ICLARM, and obtaining broodstock might fruitfully be decommercialized and form part of continuous exchange of information and items between ICLARM staff and village trial participants.

Research vs. Development

CAC senior staff have tended to emphasize that the GCMP is "research," not "development". This is true in one important sense, and needs to be pointed out. However, ICLARM's own definitions aside, there are processes whereby the GCMP has for a long time been defined as a "project" of the "development" type. We need to take a closer look at these definitions, to understand better the complex web of expectations and interpretations arising from ICLARM's presence in the Solomons and further activated by the increasing numbers of village trials.

Rural "Projects" In Solomon Islands

There is a long and well-known history in Solomon Islands of aid-funded (often unsuccessful) "projects" involving new types of livestock or cash crops. The GCMP is widely perceived as falling within this wide category of novel and promising but failure-prone "projects". Moreover, local perceptions of the relations between the GCMP and national and provincial government, and of ICLARM's nature as a nonprofit research organization rather than a commercial "company," seem unclear sometimes. It is important, therefore, that the close links between ICLARM and Solomon Islands government, and the nature of the GCMP as basically a research project, should be better and more widely publicized.

Village people frequently express amazement at "what they have been able to do with clams at Aruligo," and assume that there are economic benefits to be expected from giant clam cultivation in the future. But many have no clear idea of who will reap those benefits, despite ICLARM's stance that trial participants own any reared clams. Also, uncertainties are ex-

pressed by some villagers over how any future market-and-export ventures are going to be run. Scenarios where the government agency involved in a rural development project purchases the "finished product" as offered by village participants have precedents in Solomon Islands. Small-scale rural cattle enterprises, where a government agency provides juvenile animals to villagers applying for a "cattle project," then buys fully grown cattle raised by the villagers and subsequently markets the beef through its own system, are one example. Seen in this light, giant clam mariculture may be interpreted by villagers as falling in the category of "livestock project," involving a series of exchanges between ICLARM (seen as "government") and local people, and aimed at improving rural cash incomes.[15]

Public Awareness, and the "Company" Concept in Solomon Islands

In Solomon Islands beyond Honiara and Aruligo, ICLARM and the GCMP are to a large degree represented and defined by the village trials, and by perceptions of commercial and other potentials of giant clam farming in the rural context. This raises some issues relating mainly to greater public awareness of aims and contexts of the GCMP.

In a number of villages visited in the Western Province, we were approached by interested people, particularly senior community leaders and spokesmen, who wanted to know about the origins and motives of the activities based at the CAC at Aruligo and now becoming increasingly visible in the province through the Nusa Tupe field station at Gizo. The main question posed by these people, whether from localities with established or proposed trials or no involvement with ICLARM whatsoever, was whether the CAC (or ICLARM) is an overseas "company" or a government project. Such a need for clarification was also frequently apparent in conversations with politicians and government officials (most of whom were not involved with the project), on both provincial and national levels. These uncertainties, and the implicit dichotomy between "government" and "company" is more than just a theoretical matter of interpretation.

What does a popular Solomon Islands definition of ICLARM as "company" imply? The implications relate to perceived precedents. First, that the activities of a "company" are profit-motivated, without regard for the wider issues of rural development. Second, that a "company" exports its profits, not reinvesting in the country. Third, that a "company" wishes to maximize its profits by contributing as little as possible to the local parties involved. These views are not at all new in the Solomons, but have been formed from innumerable lessons learnt by villagers through involvements with foreign capitalist enterprises like logging companies, mining companies, fisheries enterprises and tourism operators. In their relations with Solomon Islands resource owners and laborers, some of these "companies" have become notorious for their lack of fair dealings.

Unlike "government," which according to ideal definitions aims at providing infrastructure to promote rural incomes, "companies" are widely regarded as having no obligation to further the well-being of local people, and projects apparently run by a "company" may be viewed with suspicion. Therefore, it is important that the overall structure of the GCMP as a collaborative effort with the Solomon Islands Government should be further clarified to the public. This may be reached partly by intensifying the day-to-day collaboration with the Solomon Islands Fisheries Division, for example by allocating more trials to provincial Fisheries Centres and giving the Division's extension officers responsibility for routine visits to nearby trials, and by

[15]The important and possibly unique characteristic of giant clams in rural mariculture is that they provide both subsistence and cash "crops". Basically, Solomon Islands villagers eat the mantle meat, whereas the adductor muscle goes to export markets (cf. chapters 3 and 7). This aspect deserves more emphasis in the general dissemination of information about the GCMP and its potential opportunities for rural people.

involving a greater number of indigenous staff in ocean nursery work, also as supervisors and in the dissemination of information.

Although many of the GCMP's parameters are still at the stage of clarification through basic research, the village trials themselves are a form of applied research which by its very nature involves people in thoughts and aspirations about "development". Thus, whereas ICLARM staff tend to think and talk on the conceptual level of "trials for research," villagers, politicians and public servants may be more likely to think, talk and act on the level of "clam farming development" as enterprises beyond the trial stage. These gaps in perception may cause misunderstandings and should be addressed.

Village Trials: An Indispensable Focus in Farming Systems Research

In order to address both the research challenges and the dynamics of the "ICLARM -village trials - Solomon Islands public" relationships, the design of a more comprehensive "Farming Systems Research" framework for the trials should focus on "sites" in the widest possible context, examining social, cultural and economic parameters in addition to those of more narrowly biological and technological kinds.

Rural Solomon Islands provides an exceptionally complex context for research on farming systems for giant clams and other aquatic organisms. Viable and dynamic subsistence sectors, multiplicity and nonpermanence of occupations, and strong systems of exclusive reef tenure are dimensions that provide important challenges and are likely to yield research results with relevance for many parts of the Indo-Pacific region. The pioneering approach taken by the ICLARM CAC in the village trial program provides much-needed insights into the often bewildering complexity of the context for mariculture development in the rural South Pacific. The village trials provide unique opportunities for long-term basic and applied research on these complexities, and must be the backbone of intensive farming systems research.

It is the emphasis on long-term research and close attention to villagers by actively involving them that gives ICLARM's approach so much of its unique character.[16] Research results from the village trial program should therefore be more widely disseminated, particularly as a closer integration of biological and nonbiological parameters is obtained in due course.

[16]See Alcala (1988) for another collaborative approach to giant clam mariculture, in the Philippines.

CHAPTER 6

CUSTOMARY MARINE TENURE: A FRAMEWORK FOR VILLAGE-BASED MARICULTURE

Customary Marine Tenure in a Changing World

Any development of mariculture in the Pacific Islands region must take into account the fact that more often than not, the reef areas suitable for such development are under the firm control of rural people.[1] The local means of such control are systems of customary marine tenure (CMT)[2] that regulate the access to and utilization of coastal seas, reefs and lagoons. A burgeoning literature[3] indicates that, rather than being overwhelmed by recent and present changes caused by population growth, state formation, capitalist intrusion and ecological pressure, CMT systems in many cases are able to face such challenges. In the nation-states of Melanesia, for example, any commercial inshore fisheries development by nonlocal parties has to seek the consent of local groups who define themselves as the exclusive owners of nearshore seaspace and the fishery resources there, and who are recognized as such also by the state. In Papua New Guinea and Solomon Islands, the harvesting of live baitfish from coastal lagoons by industrial tuna fishing operations is subject to formal agreements with, and cash payments to, customary "reef owners". This has posed severe constraints for the tuna industry in a number of cases, also where the industry (as is the case in Solomon Islands) is a joint venture between national government and foreign capital.[4]

Mariculture and the Intensification of CMT

This chapter examines opportunities and constraints posed by CMT for mariculture development in Solomon Islands. CMT systems around the country are presently in a process of intensification, caused not only by the baitfishing operation mentioned, but increasingly by localized overfishing and population pressure, local-level commercial fishery enterprises, and - not surprisingly - by expectations fostered by ICLARM's Giant Clam Mariculture Project. What CMT systems and their intensifying politics make clear is, among other things, that giant clam mariculture in Solomon Islands is not for everyone, nor can it ever be. However, CMT systems may ensure the protection of farmed clams against poaching, may form the basis for reef enhancement and restocking, and are probably the most directly important among the range of rural institutional frameworks for mariculture development.

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[1]See Fairbairn (1991) for a comparative (though somewhat cursory) review of CMT and its implications for giant clam mariculture in Fiji, Vanuatu, Tonga and Western Samoa.

[2]In this concept, as defined by Hviding (1989, 1991), "customary" refers to principles that emerge from traditional roots, constitute part of what is often termed "customary law," and have continuous links with local history as it adapts to changing circumstances; "marine" refers to the system as dealing with reefs, lagoon, coast, and open sea and including islands and islets contained in this overall seaspace; "tenure" refers to a social process of interacting activities concerning control over territory and access to resources. See also Hviding and Ruddle (1991) and Ruddle et al. (1992) for extensive discussion.

[3]For recent reviews, see, e.g., Ruddle and Johannes (1990), Ruddle et al. (1992) and SPC (1992).

[4]See Otto (1989) and Turner (1991) for the problems and politics of tuna baitfishing in Papua New Guinea; Meltzoff and LiPuma (1983), Hviding (1988) and Ruddle et al. (1992) for similar information on Solomon Islands.

Customary Marine Tenure in Solomon Islands

This section attempts a brief overview of CMT systems and their present role in Solomon Islands. In the absence of detailed countrywide information, the overview is mainly based on field observations from four provinces in 1991-1992 and on the author's detailed previous study from the Marovo Lagoon (Hviding 1988), plus on the limited written (mostly unpublished) information otherwise available.[5] A fuller comparative account of CMT systems in Solomon Islands is in preparation and will be published elsewhere.

Inalienable "Ownership"

To clarify some of the most important attributes of CMT in Solomon Islands, a brief excursion into comparative views of land and ownership is first required. Contrary to the often-held view that what is here termed "CMT" is basically composed of "fishing rights," I wish to point out that in the eyes of Solomon Islanders their customary rights over marine areas comprise much more than only fishing. As is common in the Pacific Islands, Solomon Islands languages tend to classify land and nearshore sea as belonging to one overall category, often translatable into something like "nurturing soil," from which the ancestors of the people presently in control somehow originated. Dry land and submerged land thus have a deep spiritual quality for its customary owners, whose entitlements and obligations to their "land" exceed those entailed in European concepts of property and ownership. Generally, neither land nor reefs can be freely sold or otherwise transferred.

In other words, customary tenure over land and sea is not tied to concepts of freely alienable property, but rather to an inalienable, ancestral estate to which "owners" stand in a custodial relationship.

Land and Sea

As described in chapter 2, the majority of Solomon Islanders are coastal villagers, and many have access to resources of both land and sea through ascribed or acquired membership in a localized group that controls a joint land-sea territory. A minority of the population are bush dwellers, still others are "saltwater people," most of whom live on small islands off the coast and rely mainly on fishing. The latter two groups control predominantly land and sea, respectively. Yet, the diets of most Solomon Islanders are based on the twin components of marine protein and garden carbohydrates, and access to the fruits of both fishing grounds and gardens is ensured for all through systems of exchange, barter and reciprocal sharing of use rights. For mariculture, however, the picture becomes one of greater exclusivity. Only those with recognized rights of control over relevant reefs are likely adopters of giant clam mariculture, whether in the present form of village trials or in the potential form of future commercial operations.

To illustrate the range and content of recognized rights of control over reefs, we need to have a look at some widespread general principles of CMT in Solomon Islands, relating to the levels of territorial control and powers of resource management exercised by different social units.

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[5]Baines (1985 [1990]) reviews customary law and formal legislation regarding fishing and marine areas; Ruttley (1987) summarizes survey information on "customary fishing rights" throughout the country, and Collenson (n.d.) in a similar review provides some interesting contemporary examples. Allan (1957) briefly examines marine tenure in the context of a colonial land tenure survey, and High Court of the Western Pacific (1951) is a "benchmark case" defining attitudes of the court system to customary claims to reefs and their resources.

Demarcation of Marine Boundaries

CMT in Solomon Islands is usually based on "communal control" by a kinship-based group over an area of coastal reefs and seas demarcated by lateral and seawards boundaries. Common markers of lateral boundaries are river estuaries or other prominent topographical features on the coast of main islands, aligned with natural markers on outer fringing or barrier reefs, such as coral islets, exposed rocks or reef channels. Seawards boundaries of marine territories are often vague, and some groups claim that their marine territories extend indefinitely toward the horizon. In other more well-defined cases, the seawards boundary is considered to follow the edge of outermost fringing reefs, or as may be the case in large lagoons, to follow the outer submerged fringes of the offshore reef islands that delimit the lagoon from the open ocean. Often, such sets of boundaries in effect divide a coastline and adjoining reefs, islands and sea into discrete sections located side-by-side and held by adjacent social units. However, there are also many examples in the Solomons where the boundary principles of CMT are exceedingly complex, involving outer and inner zones of lagoon and barrier reef held by different groups, and remote offshore reefs or islets jointly controlled by groups from different main islands.

In general, it appears that CMT boundaries have a considerable degree of flexibility wherein adjacent groups have varying degrees of mutual access to each other's territories. Joint use and sharing are important components of Solomons CMT systems, and boundaries are rarely absolute or all-exclusive in a practical sense although their existence and location may be firmly established in villagers' perceptions.

Unequal Distribution of Marine Holdings

Contrary to the claim by Ruttley (1987) that in the Solomons "ownership of reef and lagoon areas almost invariably lies with the owners of the adjacent land," actual organizational patterns - outcomes of long historical processes - often entail that an area of reef and lagoon and its adjacent lands are controlled by different groups. It is true that in many areas fringing reefs are held as an extension of land, by one and the same group. In many other cases, however, "saltwater" people hold reefs, lagoon and parts of the coastline, while "bush" people hold much of the coast (sometimes including mangroves and estuaries) and all of the interior. This is the case in the Langalanga and Lau Lagoons of Malaita. In the Marovo and Roviana Lagoons of New Georgia, even though all present-day villages are coastal, only a portion of villages are inhabited by actual reef-holding groups and many village communities on the seashore have little or no control over reef and lagoon, though they have access through use rights.

Thus, control over nearshore and outer reefs is not necessarily tied to control over land, nor is CMT based on village units. Rather, reef tenure is based on descent-based groups, in Pijin ambiguously termed "tribe"(*/traeb/*), "line" (*/laen/*), or "clan".

Resource Management Practices

Within its demarcated territory, a reef-holding group (most of whose members usually reside within the boundaries on small islands or mainland coast) normally enforces a variety of regulations on the access to and use of all kinds of rescurces, both living and nonliving. For example, the use of certain fishing technologies may be prohibited or severely restricted on a permanent or temporary basis, and nonmembers of the group may be required to ask permission before taking any resource - fish, shells, firewood, sand and whatever else - from the sea, reefs and islands within the boundaries. Often, commercial harvesting of fish and "marine

products" like trochus, pearl shell and bêche-de-mer by any nonmember of the group is subject to rigid regulation, and customary sanctions may be levied on trespassers.[6] The same applies to any harvesting by "outsiders" of particularly valued resources such as turtles, dugong or giant clams. Sometimes, temporary taboos are placed on all exploitation by anyone of a certain resource, for example a known aggregation of an important food fish or locally depleted shell stocks, in order for stocks to build up. And as mentioned, local CMT systems increasingly act as constraints on large-scale commercial developments by outside interests. This includes recent attempts by Melanesian reef-holders to halt the development of land-based activities that threaten the marine environment, such as mining (cf. Hviding 1992).

The relationships between customary law and government jurisdiction in coastal-marine areas are of particular interest today and are briefly described in the next section of this chapter. What we now briefly turn to are microlevel perspectives; the role of individuals and smaller family-based groups within CMT systems, with particular reference to the inner shallow reefs that are potential sites for village-level mariculture.

CMT on the Microlevel

Normally, any recognized member of a reef-holding group is free to carry out most forms of resource use within the territorial boundaries of the holdings.[7] This is often slightly modified by restrictions applying to the intensity of commercial fishing or harvesting of "marine products". For some groups, customary or religious taboos may also apply to any harvesting of certain special marine animals. This general freedom of access to resources within the area of one's own group (subject to the restrictions mentioned) also applies to "affiliated" members who have gained their status not through birth but through marriage and settlement. People wishing to fish or gather shells or other things from a marine territory not controlled by their own group must generally ask permission before making any harvest of marine resources (though long-established use rights in many cases simplify this procedure).

Although specific control over certain fishing grounds by individuals or families exists in some parts of Solomon Islands,[8] the general picture appears to be one of little internal subdivision of group territories. Most fishing grounds are open to all group members, unlike agricultural land which from its site-specific nature tends to be finely subdivided with individual garden blocks allocated in a rather permanent fashion to households and extended families.

However, the CMT systems operating in the Solomons commonly contain provisions for assessing more individualized primary claims over reefs in the immediate vicinity of one's own settlement site or other land. Usually, the beach and shallow reef immediately in front of a family's house site are considered to be "theirs" and forming part of that site. And families living on their own in smaller hamlets are similarly regarded as having a primary claim to the reefs just off the beach. These primary rights are in the first instance related to the practical necessities of canoe access and anchorage, but also often to stone fish traps (which are not as widespread as in former times). Thus the establishment of permanent structures on reefs off one's own beach tends to derive from and further define some level of primacy in control. This is nowadays increasingly applied to clam gardens, and may be assumed to underpin the existence of most village trials throughout Solomon Islands. Often-recognized claims to individual

[6]Despite a century or more of Christian influence, customary reactions to trespass in most parts of the Solomons retain strong elements of traditional spiritual beliefs. The presence of ancestral sharks or crocodiles and other protective spirits in many cases acts as a deterrent for prospective poachers. This was pointed out by a number of village trials participants as a useful measure in protecting clam farms against poaching, and its importance should not be underestimated.

[7]Indeed, this sometimes leads to assessments by "insiders" to the effect that no regulations exist on marine resource use. This, however, is a gross understatement from the point of view of more disadvantaged persons such as "outsiders".

[8]Akimichi (1978) mentions examples of individual and family "ownership" of net sites in the Lau Lagoon of Malaita. See also Collenson (n.d.).

primacy also apply to shallow reefs immediately adjacent to subdivisions of land outside settlements, such as coconut groves or smaller offshore islands.

Generally speaking, all such microlevel rights to reefs exist firmly within the framework of supreme control by the descent group, in a way similar to that of agricultural plots. The household, family group or even individual who asserts primacy over a subdivision of larger communal reef holdings does not usually control this area to the extent of being able to transfer it to outsiders. However, rights on the microlevel may allow for the exclusive enjoyment of benefits from any permanent structures established on the reef, a principle of key relevance to mariculture.

The Legal Context

Like most Pacific Islands nations, Solomon Islands lacks a legal framework covering the acquisition of exclusive rights over areas reef or over artificial structures placed in the sea for mariculture purposes. On the other hand, it has just been shown that the CMT systems operating in the archipelago do contain a number of opportunities and more or less explicit provisions relevant to mariculture development. Before examining the direct links between CMT and mariculture, a brief review is given here of the relationships between customary law and formal legislation applying to marine areas and the resources there.

Legislation Relevant to Fisheries

Few explicit provisions exist in the formal legal system of Solomon Islands with respect to CMT. Although the *Fisheries Act 1972* (amended 1977) does not deal with customary fishing privileges, the *Fisheries Regulations 1972* and related legislation specify certain requirements for foreign and local commercial vessels to seek agreements with customary "owners" before fishing within one nautical mile of a "fishing" (i.e., coastal) village (Moore 1987). The *Lands and Titles Acts* and the *Penal Code* furthermore give some recognition to customary rights over fish and shellfish (Moore 1987). A vaguely defined concept of provincial jurisdiction over the sea within three nautical miles of shorelines exists in provincial legislation, but the *Provincial Government Act 1981* specifies that such jurisdiction cannot override customary law (Baines 1985 [1990]).

Thus, for all practical purposes the reefs and inshore seas of Solomon Islands are held under customary law, and CMT systems remain the major mechanisms for regulating the uses of these areas. Increasingly, customary leaders enlist the support of administrative and legislative powers (Area Councils, Provincial Government, courts) to obtain added formal recognition of customary privileges and management measures.[9] This is to some degree encouraged by Fisheries authorities (see Hviding and Ruddle 1991).

Land Legislation: Alienated Land and Customary Reefs

Solomon Islands perceptions of customary reefs are strongly tied to customary, but also legal, definitions of land ownership. Of particular interest are the attitudes to alienated land, that is, land which mainly through colonial purchase has been removed from the customary system and to which transferable freehold ownership applies. Such land in the form of old plantations is found scattered in coastal locations throughout the archipelago, but particularly

[9]See High Court of the Western Pacific (1951), an early case where customary reef-holders of the Marau Sound on Guadalcanal brought a European trader to the High Court for having harvested trochus without their permission.

in Western Province, Guadalcanal and Makira.[10] In most rural areas it appears to be well known that according to prevailing land legislation (adapted from English law), alienated land extends seawards to high water mark only. Thus, reefs adjacent to alienated land are still often claimed by customary "owners," often the descendants of those who sold the land to European traders.

In several cases, such privileges have been strongly asserted by local groups in confrontation with foreign managers of alienated land. The Australian operators of a diving-based tourist resort located on alienated land in the Marovo Lagoon have found it impossible to prohibit local villagers from carrying out regular underwater spearfishing on the reefs surrounding the resort island. They have repeatedly been confronted by these village fishers' solid knowledge of the relevant portions of Solomon Islands law briefly sketched above, and local reef-holding groups strongly oppose any modification of customary fishing privileges taking place from a basis of overinterpreted extensions of alienated landholdings.

Definitions may be less contested in cases involving part-European families who descend from traders and who still live on land bought from local groups several generations ago. Collenson (n.d.) comments that foreign plantation companies usually obtained no control over reefs adjacent to the land bought by them, but that, in contrast, a part-European family owning a plantation on Rendova in Western Province through their original land purchase also gained recognized control over the reefs there.

The question of whether or not land owners have local origins[11] indeed seems to play a key role in such matters, as evidenced by more recent cases in Western Province where former plantation land has been purchased as "perpetual estate" by "local" individuals, often urban returnees, who are at least Solomon Islanders, and often members of local landholding groups. In some examples, such new owners of alienated land are actual descendants of those who originally sold the land long ago. Owners of alienated land that has been thus "reclaimed" for indigenous ownership (though retaining its status as alienated) may be recognized as having primary rights over the adjacent reefs. This is significant for mariculture development in that reclaimed former plantation land is often found on smaller lagoon islands, such as in Marovo, Roviana and Vonavona, many of which offer good conditions for giant clams (cf. the detailed discussion in a later section). Several village trials have been established in such locations.

A case of special relevance here is the establishment of rural Fisheries Centres in all provinces. These are likely sites for new "village" trials, one of which is in fact operating at the provincial Fisheries headquarters in Tulagi, Central Province. The *Fisheries Act* gives some provision for the compulsory acquisition of land for the purpose of developing fisheries, but any use by the Fisheries Division of adjacent reefs, again, seems subject to agreements with the customary landholders who retain control over the reefs. At Tulagi, the Fisheries officers have posted a sign warning that people who disturb the clam trial may be prosecuted, but they also recognize that the entire reef flat below high water mark in actual fact belongs to the original owners of the alienated land, with whom Fisheries has a "working arrangement".

In this regard, the acquisition by ICLARM of exclusive leaseholds over reefs adjacent to alienated land at the Coastal Aquaculture Centre (Aruligo) and the Nusa Tupe field station

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[10]The Russell Islands group of Central Province is a special example. Here, most land was alienated through purchase by the Levers plantation system in the early years of this century. However, a number of the smaller islands in the group remain customary holdings of the indigenous Russell Islanders who live there.

[11]"Local origins" is a term that may be interpreted more or less ambiguously. Gilbertese settlers, for example, though having their "origin" in what is now the nation of Kiribati, appear to be considered more or less "local" by indigenous Solomon Islanders, depending on the degree to which they have settled in a previously uninhabited area or not. Since many Gilbertese settlements are located on government-held alienated land with few or no Melanesian occupants, a certain degree of primary entitlement over adjacent reefs may well apply also to Gilbertese groups.

(Gizo) are interesting examples of purpose-designed agreements involving provincial governments, and may in themselves provide useful lessons.

Revised Legislation and the Continued Importance of Customary Law

As the issue of customary rights has become more politically sensitive (cf. the problems of tuna baitfishing), efforts have been made at defining their status more explicitly and at including some legal recognition and protection of such rights. Revised fisheries legislation for Solomon Islands (Moore 1987), not yet implemented by 1992, includes requirements and suggested procedures for consulting customary "owners" of fishing rights, and for the enforcement of such rights and customary regulations. Legal procedures for the establishment of aquaculture operations are also formulated, though not referring to customary reefs.

Thus, CMT systems remain a major parameter in the establishment and security of mariculture sites in Solomon Islands, particularly on the village level where there is little alienated land and even less alienated reef. Partly in their own capacity and partly by interplay with implicit provisions in formal legislation, CMT systems have an active role to fulfil in any development of mariculture in Solomon Islands.

Customary Marine Tenure and Giant Clam Mariculture

Opportunities and Constraints

CMT in Solomon Islands poses constraints to mariculture development by limiting the number of persons who have access to relevant reefs, by a potential for fostering dispute over primary rights to reef sites, and by severely constraining the possible level of large-scale development since reefs cannot generally be leased or otherwise transferred from customary holders.[12] Conversely, the latter point may be viewed as a safeguard against widespread appropriation of reefs by foreign investors and against capitalist monopolies over mariculture development. In this respect, CMT may constitute a positive opportunity; a guarantee for long-term rural benefit from small-scale farmer-controlled mariculture.

Other opportunities offered by CMT systems for giant clam mariculture include protection against poaching; permanent security of the customary "title" held over inalienable reefs; long-term security of established mariculture structures; equitable distribution of reef rights within each reef-holding group; and the availability of a range of existing, well-defined local-level management units often with proven organizational capabilities (cf. chapter 2). These opportunities are worthy of attention also with regard to other forms of mariculture and, for example, reef fish ranching.

The existing, long-established social and physical boundaries in CMT systems of coastal Solomon Islands (and elsewhere in the Pacific) provide a framework for mariculture development based on discrete reef holdings under the control of local cooperative groups. In this sense, the organizational potential of CMT in the Pacific Islands contains a number of lessons for the wider world.

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[12]See Fairbairn (1991) for a similar view referring to other Pacific Islands nations. However, like most other approaches to the "socio-economic" context of mariculture development (see, e.g., Tisdell and Menz 1988), Fairbairn's analysis gives primacy to the needs of "developers" of major projects, particularly for securing investments by obtaining the consent of traditional reef-holders. Options for small-scale mariculture and the corresponding benefits offered by CMT systems are examined to a lesser degree.

Contemporary Developments and Conflict Potential

In a 1988 report for the South Pacific Forum Fisheries Agency (FFA) on CMT in the Marovo Lagoon, I made an initial assessment of likely implications of CMT for possible developments in seaweed and giant clam mariculture (Hviding 1988). I there argued that fixed-site mariculture development was likely to lead to the emergence of a range of social units adopting such enterprises, including individuals, families and larger communities, as well as new arrangements in the individualization and microlevel exclusivity of reef rights. Also, I suggested that potential conflicts over the multiple uses of reefs would arise from individualization. These predictions have to a large degree been fulfilled in locations throughout the Solomons, as evident from ICLARM's village trials and from the ODA seaweed project.

In the Solomons today, mariculture that involves more or less permanent investment in reef areas is developing at a time when issues relating to CMT intensify. This intensification and its associated conflicts do not arise only from the mariculture potential of coastal reefs. The processes are, rather, tied up with many changes relating to the role of customary resource ownership in a modern nation-state with multiple levels of formal legislation, to a widespread desire to maintain local autonomy over resources, to the conflicting aims of subsistence self-reliance and increasing cash aspirations, and to divisions between rural populations and urban elites, among other factors. This picture is a common one throughout the island Pacific, reaching its greatest proportions in the ethnically fragmented Melanesian nations of the Western Pacific.

Management Units in Mariculture and in CMT

The institutional frameworks of CMT systems allow for a wide range of potential management units in mariculture. The potential of some of these has yet to be explored by ICLARM's village trial program. Below, a variety of possible mariculture management units are listed, together with typical corresponding levels of customary entitlement to relevant reefs. As indicated, it may be assumed that all village dwellers by virtue of their recognized status as community members have rights in reefs, provided that the community (i.e., descent group) itself holds such rights. In this perspective, women too are regarded as having secure reef rights, though their stated entitlements may vary according to the descent and tenure principles prevailing.

Mariculture unit	Sources and types of customary reef rights
Community (descent-based group)	Highest-level, corporate control over entire defined territory; supreme decisionmaking power held by leaders on behalf of all members
Task-oriented organization involving most or all villagers	Combined group memberships of all participants; potential access to sites in all or most of communal territory; often also strong backing from higher, "community" level by virtue of being a primary focus of organized activity (e.g., derived from church)
Women's organization	Combined group memberships (inherited or affiliated) of all participants; potential access to sites in all or most of communal territory (modified by access to transport); often also backing from higher level by virtue of being derived from church

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Other task-oriented groups involving segment of villagers	Equivalent to women's organizations; in cases where members are co-residents of village subsection or hamlet spatial choices may be more restricted
Household, family-based group in village	Combination of individual memberships; access primarily to sites on reefs close to own subdivision of land
Hamlet dweller with family	Individual membership(s); primary claim over reef adjacent to hamlet
Indigenous settler on alienated land	Entitlement often considerable, depending on relationship with any recognized customary holders of adjacent land and reefs
Non-indigenous settler on alienated land	No formal entitlement to adjacent reefs; subject to agreement with any customary claimants; considerable potential for conflict
Government agency (e.g., Fisheries)	No formal entitlement to reef immediately adjacent to site of government facility (e.g., Fisheries Centre); subject to arrangement with customary holders

All-exclusive rights over reefs exist, as we see, mainly on the communal level of group holdings that are demarcated against adjacent holdings. Further, there is potential for asserting exclusivity on lower levels, from subgroup through family and household to individual. It is important that proposed management units in mariculture should be organized so as to correspond to recognized management units in CMT systems, and that the usually supreme decisionmaking role of reef-holding descent groups is taken into account. Despite the general freedom of recognized members to "do as they please" on reefs held by their own group, intensified entrepreneurship and the establishment of new "projects" at least require that the chief and other key leaders be notified.

While it is not in any way the responsibility of ICLARM CAC staff to assess the legitimacy of claims to a proposed mariculture site, nor to obtain permissions from chiefs, care should be taken to maximize "community" awareness also when village trials are established with individual applicants. Since most village trial applicants by necessity act on the basis of their position within a communal CMT system, the consent of the whole reef-holding "community" represented by its leaders is at some stage required for the trial to be established at all.

Individualization of Mariculture Sites: Potential for Conflict

For ease of access and surveillance, mariculture initiatives (both indigenous and introduced) are based on proximity to settlements. Therefore, few potential problems relate to the intergroup levels of CMT. What may be problematic, however, are relations *within* a community or reef-holding group.

Even if a descent group has recognized and undisputed communal control through customary law over a particular area of reef and lagoon (and usually also over the adjacent coastal land), conflict may arise within that group over claims to individual aquaculture sites by families or single persons. The issue at stake often is to what extent an individual member of a reef-holding group may convert his (or her) part in the communal estate into individually held,

exclusive property over modified reef plots enhanced by mariculture. This particularly applies if the mariculture sites are others than the reefs immediately off the enterprising villager's own foreshore. Problems may arise in cases where the most suitable locations for aquaculture are nonindividualized sections of the communal estate; for example, fringing reefs off uninhabited shores or lagoon islands that have not so far been subject to attempts at individual appropriation.

For reasons like these, areas that already possess some degree of identification with individuals or family groups, and that are to some extent subdivisions within communal holdings, have considerable potential as mariculture locations that cause minimal intragroup conflict. Reefs adjacent to settlement sites have been mentioned already, as have shallow reefs off individually- or family-held coconut plantations on customary land. Such plantation holdings are, more often than not in the Solomons, long-established along the coastlines along main islands and, in lagoon areas, on part or whole of smaller lagoon or reef islands.

Mariculture off Alienated Land Under Indigenous Ownership

A special variety of such subdivisions are reefs off islands and coastlines that are formally alienated, i.e., that have been removed from the customary holdings through purchase and the transfer and registration of formal ownership title as vested in a named individual (or, less frequently, a small group of persons). Along the coasts and lagoons of the main islands of the Solomons there are a large number of such alienated holdings. Whereas most of them were formerly held by foreign plantation companies or by individual European planters and their families, a majority have now been transferred to Solomon Islanders and now constitute the individual, registered property of these citizens (under national law, foreigners cannot own land in Solomon Islands, and can only obtain temporary leases).

I have mentioned the tendency through which long-alienated plantation land has been sold (often after a transitional period under government control) to Solomon Islanders who are themselves descendants of the people who originally sold the land to planters, often in the 19th century. These people have in effect reclaimed their ancestral land through a process involving cash payments, registration fees and the vesting of individual title to the land in question. Thus, the land remains effectively outside the control of customary authority, although its new owners may identify on the whole with the customary holders of surrounding areas.

Given, thus, that owners of legally registered coastal lands retain an undefined, yet unchallenged primary authority over fringing reefs, and that ecological circumstances are amenable to ocean nursery and growout establishments, such locations may offer high potential for mariculture. Certain factors add to this potential. The title holders tend to live directly on their land, and owing to the nature of their previous undertakings in obtaining the title they tend to be somewhat enterprising individuals with a commitment to following up "new projects". Further, through long experience from coconut planting and copra production these families tend to be well used to the time horizons of cash-cropping, with no immediate output for years to come after planting.

Multiple-use Issues

Conflict over multiple uses of reefs that are mariculture sites relate mainly to ways in which the establishment of mariculture prevents other activities from taking place. As for giant clam mariculture, the widespread adoption of clam gardens gives some relevant indications. Clam gardens are not considered to interfere with neither canoe passage nor with modest fishing.

For example, children are sometimes seen fishing with hook and line right in the middle of locations where clams are being kept, and some people claim that fishing is actually better there among a group of giant clams. Indeed, the only use of the sea which appears to be significantly hampered by the presence of a clam garden, is the dumping of household refuse, organic and nonorganic:[13]

CLAM GARDENS LIMIT THE DUMPING OF RUBBISH INTO THE SEA

In the Marovo Lagoon of Western Province, it has become common practice to refrain from throwing rubbish into the sea in or near clam gardens, in order to ensure that the clams have a healthy habitat. In villages where freshwater shortage is a problem (particularly those on small lagoon islands), one supplementary reason for having clam gardens is the wish to have clean sea water off one's house for bathing. This, people say, is obtained by leaving the clams alone so that they can do their good work of cleaning and cooling the water around them, and while doing this clams should not be bothered by having rubbish thrown onto them. Although household refuse is always dumped in the sea somewhere else, the point is that a clam garden strongly motivates people against polluting their own immediate shore, which by the pure existence of the clam gardens is viewed as even more exclusively "theirs".

Protection of Mariculture Sites and Deterrents to Poaching

The establishment of a mariculture operation, however small, on a reef already under some level of exclusive control is bound to increase that exclusivity. I have examined a number of possible processes in individualization of communal reef-holdings and have indicated how even the implementation of a village trial in most cases will lead to stronger assessment of primary control over the mariculture site and immediately surrounding areas. Provisions contained in CMT give considerable security to any artificial structures placed on the reef. Customary notions of trespass and stealing are still strong in most parts of Solomon Islands, and even clam gardens tend to be relatively secure from poaching. The prestige attached to participation in a novel enterprise like the GCMP appears to reinforce the maintenance of privileges over one's "own" reefs, whether on the level of individual, hamlet or community.

It is notable that very few rural people interviewed expressed any fears over potential theft of clams under culture on their reef. Both present and potential village trial participants emphasized that they had a range of methods at their disposal to prevent poaching. Evidently, the protection of reefs against trespass and poaching derives partly from more or less explicitly stated warnings that offenders who are observed and caught must pay compensation and run the risk of public shame or even violent reprisal.

The range of deterrents available to village mariculturists is greater than what is indicated by superficial investigations. During long conversations, a number of village people in all areas visited emphasized that anyone attempting to steal clams would be foolish to do so, considering the potentially dire consequences of such acts, beyond the "normal" sanctions described above. Indeed, certain elements of traditional spiritual beliefs are very relevant to the issue of

[13]In coastal villages in the Solomons, rubbish is invariably dumped into the sea, which also functions as toilet. This ancient practice has caused increased pollution of the intertidal zone in village settlements owing both to population increase and to the growing volumes of nonorganic household refuse such as food tins and batteries.

surveillance. Beliefs in sorcery remain strong in rural Solomon Islands, and sorcerers are said to be able to infuse specific areas of significance (such as a mariculture site) with malevolent powers that cause disease and maybe even death for intruders. Many coastal groups are also widely known for their power over dangerous animals like sharks and crocodiles, which may be invoked against anyone attempting trespass or theft. Beliefs in such magical forces often presuppose that trespassers are attacked also if they have not been directly observed by the owner of the site. Thus, even mariculture sites that are relatively far from where the "owner" lives may be afforded protection by such measures.[14]

CMT: "A Situation, not a Problem"

Every reef in Solomon Islands is "owned by someone" and is on a day-to-day basis guarded more or less closely by their customary "owners" or custodians. The existence and resilience of CMT are inescapable facts for any scenario in mariculture development, being such a major component of the overall rural context. A wise statement by two fisheries biologists with long experience from the South Pacific region comes to mind as relevant also for CMT and mariculture: "...the social and political setting of a fishing community is not a problem; rather, it is a 'situation'. It would prove very costly and time-consuming to try to change that 'situation'. (Munro and Fakahau 1987). This advice should be heeded by anyone attempting to integrate mariculture into the multiple levels and complex settings of village life.

[14]The protection of unsurveilled areas by vesting them with malevolent powers to which outsiders are vulnerable is a well-known practice with regard to coconut plantations and gardens. The measures are thus logically extended to mariculture.

CHAPTER 7

MARICULTURE, HOUSEHOLD-BASED ECONOMY AND MARKET SCENARIOS

This final chapter summarizes some important organizational and economic circumstances for rural mariculture development in Solomon Islands. Particular attention is given to the dynamics of household-based rural economies, and to how giant clam mariculture may be integrated into these subsistence-oriented systems as a form of small-holder cash crop. Addressing and understanding these issues must precede any attempt at predicting the roles of possible cash flows arising from future mariculture development.[1] The chapter therefore aims at providing a baseline overview from which more focused assessments of mariculture potentials may take place. Opportunities offered by a range of markets for giant clams are also discussed.

Giant Clams as a Cash Crop

Research Needs

The multitude of more or less realistic expectations regarding the future commercial potential of giant clam mariculture has been discussed mainly in chapter 5. It is clear that more basic research is needed before any firm predictions can be made. These research needs are concerned with biological and technical parameters of the mariculture production itself, as well as with domestic and overseas market potentials and infrastructural requirements.

Also, more information is needed on the circumstances at the local level that provide opportunities and constraints for the development of mariculture in coastal villagers. By providing an overview of "the rural context," this study should fill some of these information gaps. More will be filled in due course as a better-focused "Farming Systems" approach is achieved by ICLARM for the village trial program. Coupled with financial analysis already under way at the CAC (cf., e.g., Hambrey 1992), this synthesis of information can be used to assess potential marketing strategies, alternative options for when to transfer juvenile clams from hatchery to village-level husbandry, and other key questions for mariculture development.

Large-scale or Small-holder Production?

In various sections of the preceding chapters, I have argued that the narrow range of social conditions so far sampled in village trial research needs to be expanded, to include other types of mariculture management units than individually based enterprises. Such ex-

[1] While the roles of potential cash incomes to "farming households" from giant clam mariculture undoubtedly need to be investigated in economic terms and otherwise, it seems premature to attempt to do so until a better understanding has been achieved of the multiple opportunities and constraints for viability arising from the overall rural context. For these reasons, the present study does not address specifically the cash flows potentially accruing from future giant clam mariculture.

pansion relates directly to the corresponding range of possible scenarios for future mariculture establishment.

This study does not deal with options for large-scale mariculture of giant clams for export markets. ICLARM's Giant Clam Mariculture Project is focused firmly on village-based farming systems. Further, the scattered nature of the Solomons archipelago, the frequent lack of reliable domestic transport, the absence of direct long-haul air connections to important Asian markets and a range of other geographical and infrastructural factors all discourage the development of intensive export production. These constraints can be removed only to a limited degree, at high cost.

Also, many of the components of the rural context examined in this study, such as the predominance of customary, local-level control over potential mariculture sites, confound any easy implementation of export-oriented large-scale mariculture by foreign interests. Turning back to the concluding comments in chapter 6 about the social and political setting of rural communities as being a "situation" and not a "problem," we may consider the multitude of constraints on large-scale mariculture development instead as *opportunities* for small-scale developments. The enthusiasm for giant clams and for their cultivation for food, cash and restocking, the rural organizational frameworks that may facilitate mariculture and the range of other opportunities examined in previous chapters all point to the need for assessing future mariculture scenarios not just in a strictly economic sense.

Therefore, this chapter discusses a broad range of patterns within rural systems of production and community organization in Solomon Islands, with a view to assessing the possible integration of giant clam mariculture into these already existing systems. Village-based mariculture is one innovative option for achieving more diversification of the cash sector of rural economies.[2] As will be shown, in their potential as a small-holder "cash crop," giant clams share attributes with long-standing, low-risk and low-income cash staples like copra, but also with high-risk but potentially high-income novelties like iced fish.

The Dynamics of Household-based Economies

Contrasting Views on the Economic Potential of Small-holder Production

Orthodox approaches to economic development in the South Pacific long maintained that rural economies lacked the potential to meet national development needs or satisfy rural income aspirations.

> Smallholders were criticised on a number of grounds including their poor standards of management, their inability to gain access to vital information about production techniques and marketing opportunities [...] and the constraints posed on them by the traditional socio-cultural environment of villages (Jones et al. 1988).

More optimistic views have been expressed in later years, to the extent of arguing, for example, that small-holders in Solomon Islands have the potential "to become the powerhouse of economic growth" (Jones et al. 1988). Villagers are indeed able to access and use information about markets, and the sociocultural "constraints" may alternatively constitute significant opportunities for the consolidation of local-level management units.

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[2]See Jones et al. (1988) for a detailed analysis of the rural agricultural economy in Solomon Islands, and for policy recommendations.

The "subsistence affluence" (Sahlins 1972) characteristic of rural households in circumstances of egalitarian access to land and other productive resources and limited cash needs makes "surplus" a nebulous entity, at least according to the definitions of conventional economics. Nevertheless, the rural production systems of Solomon Islands commonly display an ability to generate more output than that immediately required by producers. One illustration of this is the varieties of exchange and barter systems for surplus fish and garden produce and ceremonial objects.

The Rural Household

A "household" can be loosely defined as the group of persons, usually centered on and extending from a nuclear family, who share daily domestic arrangements relating to production and consumption.[3] In the rural Solomons, sleeping arrangements are often more flexible, and vernacular terms for "kitchen house" are often used in a way analogous to that of the English term "household". Thus, "those who belong to one kitchen" tend to form "one household".

The composition of a household varies through time, as development cycles unfold through the years with the birth and growth of children and their subsequent marriage, and on a more short-term basis as close and distant relatives visit and stay temporarily. The needs and capacities of a household vary according to these long- and short-term fluctuations, most importantly expressed by the ratio between dependents and producers.

Household Decisionmaking

It is important to realize that the household-based economies of rural Solomon Islands have their own internal politics relating to decisionmaking. Patterns in the sexual division of labor were described in chapter 2. Related to these patterns are different domains of control over produce. For example, while both men and women participate in monetary activities to supplement subsistence production, they may differ in their contributions of cash to the overall needs of the household. It is characteristic that cash obtained by men is often channeled by them into solitary capital investments, whereas cash earned by women more often goes straight into the day-to-day needs for household basics. Correspondingly, decisionmaking for economic strategies is not always carried out jointly by all productive members of a household, and the assessment of alternative "opportunity costs" takes place on several simultaneous levels, not necessarily in harmony.

Nevertheless, some general patterns can be identified, relating most notably to the minimizing of economic risk, to occupational multiplicity, and to requirements from seemingly "nonproductive" activities.

Economic Strategies: Minimizing Risk

In rural household economies of Solomon Islands, production is based on minimizing risk rather than maximizing profit, and the cash and subsistence sectors are closely interdependent. This does not mean that profit is not taken into account in decisionmaking. Rather, it means that most households are likely to accept lower profit for higher reliability of income, and to give priority to the subsistence sector so that its minimum requirements are at any time met. Indeed, it can be said that most rural households in Solomon Islands operate on the

[3]Cf. chapter 2, where rural households are described with reference to their role as basic units of rural economic (subsistence/cash) production.

basis of more-or-less fixed cash needs, and that it is not at all certain that moneymaking activities will necessarily be pursued beyond the level of satisfaction of these needs (typically for household "basics" like soap, salt, kerosene and matches, and for children's school fees).

With regard to moneymaking activities, the decisionmakers of many rural households are wise from previous damage. They have learnt to avoid investing time and committing themselves to the production of commodities that are known to be overvulnerable to sudden price fluctuations or that have infrastructural requirements of a level that makes any profit precarious. One example is that of village-based commercial fishing, where endless infrastructural collapses (in ice supplies, shipping schedules, etc.) have tended to make any enterprises short-lived. Another example is cocoa production, in which case increasing numbers of rural farmers feel that too much labor has been put into an end result that is unpredictable in any way but its notorious low level of profit.

Copra, a mainstay of the cash economy since early colonial times, has at times been the only reliable cash source available to rural Solomon Islanders, and still occupies such a position in some remoter areas. It is the classic provider of modest cash amounts to cover "basic needs" as well as the detested "head tax" levied on all adult men in colonial times and living on as the "basic rate" of post-colonial times. However, copra prices have since the mid-1980s remained so low that more and more rural households have explored other means of obtaining cash.

Choosing Among a Range of Cash Income Options: Occupational Multiplicity

In choosing among a huge variety of temporary cash-earning activities, rural households show a high degree of flexibility in their adaptation to changing opportunities, easily switching among the economic niches that at any given time are perceived to offer the highest profit with the lowest risk, and that can be exploited with the least opportunity cost in relation to the multitude of subsistence requirements.

In this regard, the varied cash niche termed "marine products" (largely nonperishable items like pearl shell, trochus, bêche-de-mer and shark fins) is generally highly stable, provided that one is willing and able to switch from harvesting one product to another as individual prices rise and fall. The weekly "World Market Report" provided in national radio broadcasts and detailing present prices offered in Honiara is a focus for the planning of such short-term strategies within the area of "marine products" in most corners of the archipelago, near and remote. Sudden "booms" in the prices offered for marine products may provide opportunities for brief, intensive efforts in order to make capital investments (outboard motor, sewing machine, etc.) or, for large families, school fees.

In areas blessed with an abundance of otherwise scarce raw materials (and/or with specialized craftsmanship traditions), such a range of opportunities are also offered by the intensive manufacture of marketable handicrafts and traditional exchange items (e.g., wood carvings in the New Georgia Group, shell money in Malaita). These products may be made and sold either regularly on a modest level, or in "bursts" of intensive effort leaving little time for subsistence activities. Finally, market gardens are a fairly reliable source of income, in that their products (which are nonperishable in the short run) can often be sold locally with a minimum of middlemen involved.

Long-term and short-term monetary activities coexist in the aggregate economic strategies of most rural households. It is notable that villagers seem to prefer to have a range of different activities under way simultaneously and in addition to subsistence production. Copra production, the local marketing of garden produce or fish, handicraft manufacture, marine

products and even some temporary wage labor may all form part of a household's day-to-day activity profile at any given point in time.

Labor and Social Investments

For the range of cash-earning activities described here, rural households invest the labor time of their productive members and the use of any productive technology owned, while most natural resources (garden land, fishing grounds) are obtained through the bundle of customary entitlements held by all households through their members' inherited rights in communally held land and sea estates. This does not mean that access to resources is "free" in the sense of requiring nothing in return, nor that resources can be exploited in an unlimited fashion.

Continued rights to cultivate gardens, to fish and to dive for marine products, and to obtain other raw materials from the forest and sea are contingent upon the continued close and respectful association with one's relatives and fellow resource holders. Thus, access to resources demands time spent on social obligations. Also, the availability of time during the week and the enjoyment of outputs are also limited by the need for allocating labor and produce to forms of more or less "forced" contributions to the community. Examples of this are organized community work, and the tithe obligations within several church denominations, most notably the Seventh-day Adventists.

This constitutes a feedback process, where the allocation of time to activities that appear to be "nonproductive" from the perspective of direct subsistence or cash benefits to the household (visiting, social events) and to organized or ad-hoc assistance given to others actually consolidates household members' own rights to productive resources.

Adopting New Economic Activities

Some important, more direct, considerations for decisionmakers of rural households when choosing among shorter-term economic strategies and longer-term commitments include:

- ease and reliability of access to raw materials;
- reliability and ease of access to market;
- level and security of price;
- labor, technology and costs required of primary production;
- perishability of product;
- complexity of, and degree of own control over, infrastructure; and
- substitutability of product (i.e., as food vs. cash crop).[4]

These and other factors may occur in complex overlapping combinations. It follows that the adoption by rural households of new commercial activities beyond the trial-and-entrepreneuring stage is often a slow and complicated process, where a great deal of certainty has to be demonstrated before a majority of households decide to introduce and establish the new activity in their existing system of production. This has clear implications for the development of giant clam mariculture, which still needs greater clarification of some basic parameters.

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[4]As remarked in chapter 5, giant clams have a particularly interesting potential through combining dual functions as both subsistence food and cash income, unlike other cash crops like cocoa and spices.

Adopting Giant Clam Mariculture

Mariculture Compared with Commercial Fishing and Copra Production

If we are to assess the nature of economic activities with reference to a "low risk/reliable income" consideration, it is clear that fresh perishable products have a high-risk character. To take the example of fishing: Even if prices are fairly high, there may be little incentive for commercial fishing aiming at the precarious export of catches to urban markets. Although fishing is so much of a mainstay in the subsistence economy of rural communities, lifting it into the long-term cash sphere (as a preferred cash-earning activity) requires such a complex infrastructure as to render the prospect unlikely in most cases.

A similar argument may apply to giant clam mariculture, if the object is to supply high-value meat (adductor muscle, and secondarily mantle) to export markets. In terms of labor and temporal horizons giant clam mariculture is more comparable to copra, though having more requirements of routine work. But otherwise, giant clams are like fish in terms of perishability and infrastructural requirements. It seems reasonable, then, to state that any assessments of viable solutions must include the value of the giant clam shell as a non-perishable product as well.

Assessing Opportunity Costs

Considerations of opportunity costs of various enterprises, then, have to take into account not only the predictable benefits and opportunities that define the potential of a new product. The need for "spare time" to spend on activities which from a narrowly economic perspective are "nonproductive," but which in actual fact have highly productive results, must also be considered. The availability of time to fulfill community obligations, or to participate directly in communally organized productive activities are important dimensions.

The village trials have highlighted certain problems related to maintaining a strict commitment to routine husbandry over time. One main challenge in this regard seems to be to minimize the opportunity costs of routine inspections. This can be achieved not just by simplifying the time and labor requirements, but also by maximizing the perceived contribution of giant clam husbandry on the community level. One way of doing so is to increase the involvement by cooperative, community-based groups of various types. A particularly important example, not least in the light of several failures of trials involving cooperative groups, is that of women's organizations.

Women's Involvement in Mariculture: Time to Spare?

Throughout the chapters of his study, the needs for and potential of involving women in giant clam mariculture have been discussed, and it has been shown that their orientations, practical knowledge and organizations provide many opportunities for improving husbandry standards and long-term commitment.

However, I wish to reiterate here a point made in a previous assessment of potential mariculture development (Hviding 1988), namely the fact that many rural women of Solomon Islands do not necessarily have much spare time to spend on yet another type of routine work. They are already heavily occupied in gardening, domestic work, reef gleaning and other activities such as the gathering of firewood, and introducing yet another item on the routine agenda of individual women is not likely to be very fruitful.

It is in this regard that the potential of women's organizations, church-based and otherwise, must be given due attention.[5] By virtue of their often good record of successful long-term cooperation, their recognized position in local society, their task-oriented nature and their frequent focus on rotational labor arrangements (for example, in the joint cultivation of market gardens), rural women's organizations are the proper channel through which to involve women in mariculture. These organizational frameworks ensure that participating women will have the necessary time available.

Potentials Offered by Domestic Markets

The range of domestic markets for giant clam meat is greater than often realized.[6] Fresh giant clam meat is regularly sold at Honiara markets, at prices equivalent to or slightly above those of first-grade reef fish. According to sellers and consumers, there is a preference at the Honiara market for *H. hippopus* and *T. squamosa*, for reasons tied to the rural preferences described in chapter 3, and to supplies. As mentioned, there are indications that *T. gigas* meat may have increasing potential as a market item in Honiara, particularly with mariculture as a source.

A number of rural entrepreneurs met with during field visits suggested commercial options for cultivated giant clams also on the local level. In Langalanga, Malaita, for example, clam meat from the now severely depleted wild stocks of tridacnids is sold cooked and raw at a variety of intervillage markets. Such markets emphasize the sale and barter of produce from land and sea offered by saltwater and bush people, respectively, and play a very important integrative role in regions such as west and north Malaita. Additionally, Langalanga people sell considerable quantities of raw tridacnid meat, not least adductor muscle, to the increasing number of Japanese and other Asians working in and around Auki on aid projects or as employees of logging companies. The prices obtained from these consumers are reputed to be high.

The part-indigenous owners and managers of the Maqarea tourist resort near Munda in the Roviana Lagoon emphasize the innovative use of fresh local seafoods on the menus offered to visitors. Smaller tridacnids, mainly *T. crocea* and *H. hippopus*, figure quite frequently, and in 1991 the owners were amazed when a fax came in from a restaurant owner in Cairns in Australia who intended to fly over to the Solomons with the sole purpose of eating giant clams at the Roviana resort. The two Australians who shortly after came over from Cairns on Solomon Airlines, connecting in Honiara to Munda, had heard the news from previous visitors, and happily indulged in quantities of *T. crocea* prepared by the resort owners in a variety of ways, before ending their two-day visit and flying home. This remarkable story is supplemented by remarks from the indigenous manager/owner of the Gizo Hotel that he would be glad to put cultivated giant clams on the menu, and that he saw considerable potential in doing so.

Giant clam mariculture is thus a potential source of supplies for a large and increasing variety of domestic markets, ranging from general local marketing of cooked and fresh meat, to specialized uses by an expanding tourist industry. The interest shown by up-market tourists for smaller tridacnids is yet another argument for exploring the diversification of mariculture into covering several giant clam species.

The close linkage of mariculture to rural food production through local markets is in any case advisable from the point of view of integration into local economy. Such an approach provides a greater range of nutritional and monetary benefits with lesser vulnerability to the fluctuations of overseas markets.

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[5]As mentioned, two trials run by women's groups were established in Western Province during 1992, and as of late 1992 another was planned for Marau in Guadalcanal Province.

[6]The potential commercial use of giant clam shells also needs further investigation. A certain demand for subadult and juvenile shells, preferably polished, exist in the Honiara souvenir-and-handicraft sector, and the use of larger valves as a source of shell material for the carving of expensive contemporary sculptures was mentioned in chapter 3.

Infrastructural Requirements

Provided that giant clam mariculture is to supply urban markets as well as local ones immediately accessible, small-scale village-based operations requires a minimum of external infrastructural support. These requirements include:

- routine assistance to village-level mariculturists;
- organized supplies of juvenile clams from hatcheries; and
- organized postharvest handling of clams (including collecting and storage).

These and other related requirements are likely future responsibilities of government extension agents, probably those of the Solomon Islands Fisheries Division. The prospect of involving provincial Fisheries Centres and their staff more closely in the routine visits to village trials through the "hub and cluster" concept (see chapter 5) may provide a useful precedent for the eventual development of infrastructure for rural mariculturists.

APPENDICES

APPENDIX 1: MOLLUSCS OF KEY IMPORTANCE IN RURAL SOLOMON ISLANDS FOR SUBSISTENCE FOOD AND CASH INCOME

The following table presents a preliminary synthesis of information from field research in a number of villages in the Marovo and Roviana areas of Western Province; Small Gela/Sandfly Island, Gela, Central Province; and Langalanga Lagoon, Malaita Province. For the two areas in Western Province, information is based on detailed, long-term participant observation. For the two other areas, informants' statements are the primary source. In all cases observations of village middens provided a check on people's statements, which were normally verified. A remarkable consistency is evident in that all four locations shared the same basic inventory of important molluscs, though with some slight differences owing to local variation in abundance and preference. In all cases, information derives mainly from fairly sheltered locations with extensive shallow reefs and a variety of coastal-marine ecological zones represented and utilized.

In view of the lack of other published information, and the general lack of attention to the roles of molluscs in village nutrition and economy in the South Pacific, the table is intended as a provisional baseline profile of mollusc usage in contemporary Solomon Islands, giving an initial assessment of the relative importance of different molluscs for food purposes and as sources of cash through sale mainly as "marine products" in Honiara.

The table lists bivalves and gastropods separately, in each case alphabetically. Scientific identifications were in most cases provided by Hugh Govan, ICLARM. Several identifications need further checking. The columns for "Food" and "Cash" contain entries for each of the four locations, which are abbreviated thus:

R = Roviana Lagoon; M = Marovo Lagoon; G = Small Gela; L = Langalanga Lagoon

For each of the four locations, the relative importance as food is indicated thus:

1 = of primary importance as food; usually collected and eaten several times a week
2 = of secondary importance as food; collected and eaten fairly regularly
3 = of lesser importance and collected/eaten irregularly, though often regarded as good food
X = rarely eaten
N = not eaten
? = status uncertain

The relative importance of molluscs for cash purposes is similarly indicated:

1 = normally a primary source of cash, somewhat depending on market conditions
2 = of secondary importance as a cash source, owing to limited market, abundance, or other reasons
0 = not utilized because of depletion
N = cash use not applicable

Species	Food RMGL	Cash RMGL	Comments
Bivalves			
Anadara cf. *erythraeonensis*	1123	NNNN	sand ark shell
Anadara granosa	1131	2201	mud ark shell, shell money material, sold to Langalanga
Asaphis violascens	212?	NNNN	
Atactodea striata	232X	NNNN	small beach shell, eaten by children
Batissa fortis	32XX	NNNN	freshwater shell classed with *Polymesoda*, found only in rivers
Beguina semiorbiculata	XXXX	2220	shell money material, sold to Langalanga, where it is depleted
Chama iostoma	3233	NNNN	
Gafrarium tumidum	1133	NNNN	
Hippopus hippopus	1121	NNN2	marketed in Langalanga
Hyotisa hyotisa	33?2	NNNN	giant ("Lion's Paw") oyster
Pinctada margaritifera	XXXX	1112	blacklip pearl shell
Pinctada maxima	XXXX	2222	goldlip pearl shell
Polymesoda erosa	1121	N2N2	mangrove shell, marketed in Marovo and Langalanga
Polymesoda expansa	1121	N2N2	mangrove shell, marketed in Marovo
Pteria penguin	NNNN	22?0	brownlip pearl shell
Saccostrea cucullata	1132	NNN2	mangrove oyster, marketed in Langalanga
Saccostrea cf. *commercialis*	2233	NNN2	small mangrove oyster, marketed in Langalanga
Tridacna crocea	1113	N1NN	depleted in Langalanga, marketed in Marovo, very important staple
Tridacna gigas	3223	NNNN	food for special occasions, scarce in Roviana and Langalanga
Tridacna maxima	2233	NNNN	
Tridacna squamosa	2223	NNNN	
Gastropods			
Lambis lambis	3323	NNNN	
Nerita spp.	3322	NNNN	
Strombus carnarium	211?	NNNN	favored by children
Strombus luhuanus	222?	NNNN	
Terebralia palustris	2232	NNNN	
Trochus niloticus	3333	2222	Trochus shell
Turbo marmoratus	XXXX	2220	Greensnail
Turbo argyrostomus	3233	NNNN	

APPENDIX 2: TRADITIONAL POSTHARVEST PREPARATION OF GIANT CLAMS IN SOLOMON ISLANDS.[1]

Karen Leivestad

Introduction

Giant clams of all species are important as food in the Pacific Islands, and detailed instructions for the preparation of the clams are handed down by villagers through generations. However, very little information has been recorded about local preparation of tridacnid meat. A number of traditional recipes were collected by Karen Leivestad and Edvard Hviding, in the Marovo Lagoon of Solomon Islands.[2] Additional information subsequently obtained from a number of other locations throughout the Solomons indicates that the Marovo recipes follow a general pattern.

The majority of recipes collected are notable for their emphasis on the stages prior to the actual cooking of the clam. These stages are: killing and butchering, cleaning, rinsing, and parboiling. The proper handling of the clam meat through all these preparatory stages is stated to be main prerequisite for ensuring the cleanness, tenderness and preferred final taste of the meat.

These comparative investigations of giant clams as traditional food are being continued. The effect of parboiling on the physical properties of tridacnid meat should be given attention in postharvest studies.

Basic Recipe

The following basic recipe for preparation of giant clam meat is used for *Tridacna gigas*. The main principles also apply to the smaller tridacnids *Hippopus hippopus*, *Tridacna squamosa*, *Tridacna maxima* and *Tridacna crocea*.

1. Butchering

Butcher the clam, preferably onshore in the village if the clam is not too big to transport, as this ensures freshness and inhibits driploss. (Only especially large *T. gigas*, and specimens of *T. maxima* fully embedded in reef substrate, are killed on the reef.) Place the clam with its base on the ground and jam a piece of wood between the valves. With a long sharp knife, cut the adductor muscle where it is attached to the shell, and then loosen the mantle. Lift the whole meat out while being careful not to soil it. (Among most Solomon Islanders, the adductor muscle is not regarded as important meat, but is either eaten raw on the spot, cut up and roasted quickly in the fire, or sliced and cooked with the rest of the meat.)

2. Cleaning

From all species, remove the kidneys (which will otherwise give a bad taste and discolor the meat), while being careful not to pierce them. Remove the adductor muscle from the mantle and viscera. This completes the cleaning procedure for the smaller clam species.

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[1] Reprinted (with minor revisions) from original, "Traditional giant clam recipes from Solomon Islands," Clamlines 10:13-16 (March 1992).

[2] I gratefully acknowledge the information given by the following mollusc experts of Marovo Lagoon on the preparation and cooking of giant clams: Erik and Vivian Andersen of Mahoro Island, Amina Kada and Vincent Vaguni of Tamaneke village.

3. Rinsing, parboiling and final cleaning
Wash the cleaned clam meat in fresh water. Then place the meat in a pot filled only partly with cold fresh water. Bring to a boil quickly. This removes any dirt and decreases the saltiness of the meat (but also causes the meat to retract considerably). Throw away the water. For medium-to-large T. gigas, the gonads, gills, palp, etc. are usually removed at this stage and not eaten. If cooked with the meat, these parts of the clam may cause the dish to be murky, and according to some local beliefs, strange things may happen to your genitals if you eat gonad or palp of *T. gigas*. However, some people consider these parts of the clam a delicacy, and will prepare a separate dish from them that only requires brief boiling. After final cleaning, rinse again in fresh water. Throw away the water.

4. Slicing
Slice the mantle meat and attached viscera into suitable pieces, first lenghtwise, and then crosswise. Also slice the adductor if not already eaten. Small clams are left whole.

5. Cooking with all ingredients
Mix the sliced clam meat with the desired ingredients, but use only small amounts of liquid so as to keep the taste and leave the sauce rich and creamy. Below are two examples of dishes using different ingredients.

Clams with coconut cream and *tagala* (aromatic leaf):

Follow the procedures listed under 1-5. Mix clam meat and one medium bowl of cleaned and chopped shoots and young leaves of the *tagala* shrub,[3] or leafy greens like "slippery cabbage" (*Hibiscus manihot*), or wild ferns. Add cream squeezed from one to four grated coconuts. Add fresh sliced ginger, a little salt and (if available) chopped shallots and chili. Bring to a boil and simmer until meat is tender (for 15 minutes or more if a large *T. gigas* is used, and about 10 minutes for the other species). Check the tenderness. Serve with root crops or rice.

Clams with coconut cream and green pawpaw:

Follow the procedures listed under 1-5. Mix clam meat with the diced flesh of one half peeled green (ripening) pawpaw. Mix the clam meat and pawpaw with the cream of one to four coconuts. Add a little salt (and other spices and vegetables of your liking), bring to a boil and simmer until done. Serve with root crops or rice.

This is a favored dish, since the flesh of half-ripe pawpaw (which contains "papain") is known as a tenderizer of mantle meat, especially of medium-to-large *T. gigas*.

Other Recipes

In the Marovo Lagoon (and elsewhere in the Solomons, where seafood is rarely eaten raw) giant clam meat is most often boiled, according to the main procedure described above, but with a number of variations. For example, *T. crocea* are often boiled in salted water without coconut cream. However, Marovo people also use a number of other techniques for preparing tridacnid meat. All species are sometimes baked in tightly sealed pandanus leaf parcels in

[3]The shrub *tagala* has been identified as *Polyscias* sp. There are several species in the Solomons, and the edible ones are often planted among houses in the village. Shoots and young leaves of this plant have a mild, curry-like taste and are widely regarded in the Solomons as particularly suitable for giant clam dishes.

stone ovens, either whole or sliced but always parboiled. Short-term preservation of fresh clam meat, to prepare for market days or shipment to Honiara, is obtained by light smoking and drying over a slow-burning fire, usually overnight. Traditionally, very large *T. gigas* were baked whole in underground earth ovens (after removal of kidneys and gonads) for important ceremonial (usually male-dominated) occasions.

Local Food Preferences

Among the shell-gathering villagers of the Marovo area (and in many other parts of the Solomons), the most preferred and consumed Tridacnid is *T. crocea* (*hulumu*). It is collected at low tide mainly by women, regarded as fairly abundant, and is *de facto* a staple protein food in many household diets. Next in line of importance is *H. hippopus* (*hohobulu*), then *T. squamosa* (*veruveru*) and *T. maxima* (*chavi*), whereas the presence of *T. derasa* has not been verified in Marovo (nor is there a local name for it). Large (>60 cm) *T. gigas* (*ose*) retain a status as mainly ceremonial food. As reported from elsewhere in the Solomons and beyond, *T. gigas* are often collected and kept (with *H. hippopus*) in temporary "clam gardens" awaiting a special occasion such as Christmas, New Year or a wedding. Most Marovo women state that they do not like to eat large *T. gigas* because they perceive the taste and texture as too strong and tough. Therefore, it may happen that during the same feast men eat *T. gigas* whereas women stick to *H. hippopus.*

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