

# RESEARCH REPORTS IN THE ECONOMICS OF GIANT CLAM MARICULTURE

**Working Paper No. 26**

**A Report on the Test Marketing of Giant Clams as  
Aquarium Specimens in Brisbane, Australia**

by

**Clem Tisdell**

**November 1991**



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**Clem Tisdell<sup>2</sup>**

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The technical feasibility of culturing giant clams for food and for restocking tropical reefs was established in an earlier ACIAR project. This project is studying the economics of giant clam mariculture, to determine the potential for an industry. Researchers will evaluate international trade statistics on giant clams, establish whether there is a substantial market for them and where the major overseas markets would be. They will determine the industry prospects for Australia, New Zealand and South Pacific countries, and which countries have property right factors that are most favourable for commercial-scale giant clam mariculture. Estimates will be made of production/cost functions intrinsic in both the nursery and growth phases of clam mariculture, with special attention to such factors as economies of scale and sensitivity of production levels to market prices.

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# **A Report on the Test Marketing of Giant Clams as Aquarium Specimens in Brisbane, Australia**

## **ABSTRACT**

Reports on the results of research based on the test-marketing of giant clams as aquarium specimens in Brisbane, Australia, in the third-quarter of 1991. Giant clams were distributed through six cooperating retail aquarium outlets and sold at a reasonable commercial price. This was considered to be \$10 – 13 for *T. crocea* of 2.5 - 5cm (1 – 2") in size. Clams were supplied free of charge to cooperating retailers. In return they were required to complete survey forms and to try and ensure that purchasers of their clams did likewise, and to take care of the clams in their possession.

The results indicate that giant clams are rated as very good aquarium specimens and in that respect were considered to be about as equally desirable as coral and anemones. The most desired size of clams was considered to be in the range 5 – 10cm (2 – 4") and purchasers on average thought that a price of around \$19 would be reasonable for such clams, even though retailers suggested a slightly lower price.

The margin of mark-up available to retailers in Queensland for sales of giant clam aquarium specimens in the size range 2.5 – 5cm seems quite low, particularly given the cost of the permit required from the Queensland Department of Primary Industries. The permit and regulations enforced by the Queensland Department of Primary Industries are a major impediment to the development of the aquarium market in Queensland for giant clams. Apart from the expense involved for the retailer, purchasers are also required to hold permits from this Department. This places a major dampener on sales in Queensland given that permits must be obtained in advance by potential purchasers. Although commercial farming of clams exists in Queensland, farmers find it easier to export their products rather than to attempt to sell them in Queensland.

This report also provides information about a number of other issues affecting the market for giant clams as aquarium specimens e.g. availability of information on keeping them in home aquariums, characteristics of purchasers and so on. The results also indicate that the Australian market for giant clams as aquarium specimens is about 5,000 per year. This is a

similar estimate to that made in 1989 on the basis of a different survey.

Keywords: Giant Clam as aquarium specimen, Australian market for giant clams

JEL Classification: Q57, Q31

# **A Report on the Test Marketing of Giant Clams as Aquarium Specimens in Brisbane, Australia**

## **1. BACKGROUND**

The biological and technical feasibility of farming giant clams is now well established. This has occurred in Australia, for example, through research and development undertaken by James Cook University and as a result of the operation of commercial farming ventures such as that of Reefarm near Cairns in Australia. Farming techniques have also been developed in Palau (Micronesia Mariculture and Demonstration Center), in Fiji, in Japan, in the Solomon Islands and elsewhere. However, for the industry to be successful, commercial viability is also necessary. The potential commercial market for the giant clam lies in three main areas; as a source of meat, for shells and as aquarium specimens. Of these three possibilities, meat appears to offer the greatest potential for profit but the other markets may prove worthwhile as supporting outlets.

This paper reports the results of a test marketing survey undertaken in Brisbane, Australia, in the third quarter of 1991 to estimate potential demand for the giant clam as an aquarium specimen and to highlight issues in marketing clams. The survey was conducted by Professor Clem Tisdell of the Economics Department at the University of Queensland with the assistance of Ms Thea Vinnicombe. It was intended to complement a similar project undertaken in Hawaii by Professor Y.C. Shang of the University of Hawaii.

Commercial farming of giant clams began as a response to the over exploitation of several species in the wild. Giant clams are now recognised as threatened and listed as endangered in terms of the Convention on International Trade in Endangered Species (CITES), to which Australia is a signatory. International trade in 'wild clams' has thereby been restricted. Their cultivation may therefore serve a twofold purpose. Firstly it may help save the species from extinction as well as re-establish clams in areas where they have become locally extinct. And secondly, it may represent a new primary industry for less developed countries located in tropical areas as well as for more developed countries located in tropical areas, such as parts of Australia, e.g. Queensland, parts of Japan, e.g. Yaeyama group of islands and United States Associated Territories, e.g. Marshall Islands.



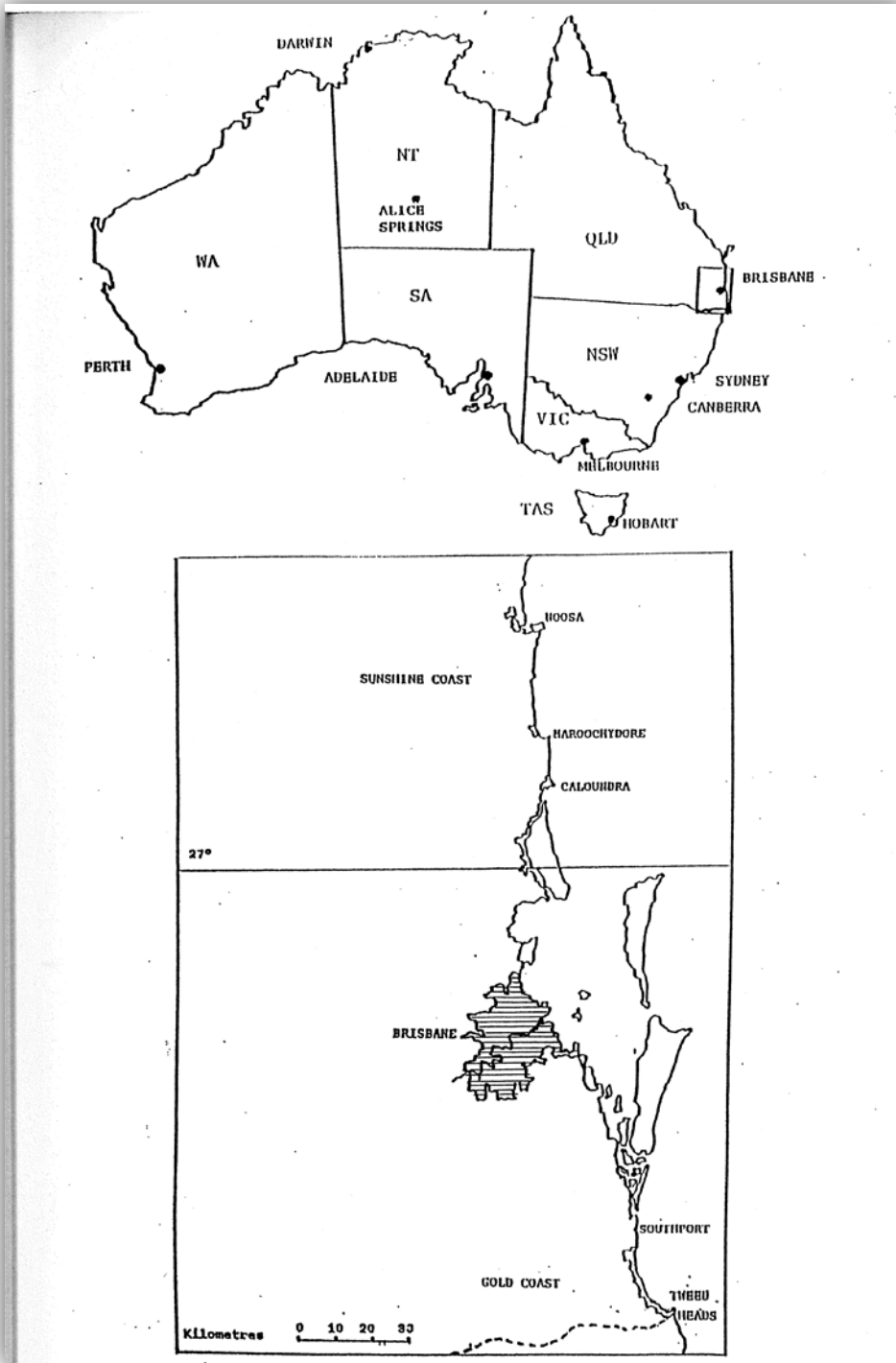
Several traditional approaches to estimating demand have proven inadequate in the case of the giant clams (Tisdell, Feb. 1990). These include analysis of international trade statistics and investigation of the demand for substitutes. International trade statistics are insufficiently disaggregated to provide significant information about the market for giant clams. The degree of substitutability between giant clams and other species is too uncertain for the demand for substitutes to be a useful guide to potential demand for the giant clam (Cf. Stanton, 1990). A further problem is the degree to which international trade in giant clam products has been illegal. For instance, Dawson refers to clam meat as being illegally imported into Taiwan to avoid import duties (Dawson and Philipson, 1989, p. 111).

Although limitations of past historical data create problems for estimating demand for all products derived from giant clams, they are perhaps more acute in the case of the market for aquarium specimens because in the past this has involved little trade. The market has been very thin. Consequently a marketing survey involving direct test sales of giant clams was deemed to be the most appropriate means of estimating demand for clams as aquarium specimens and identifying market issues and problems.

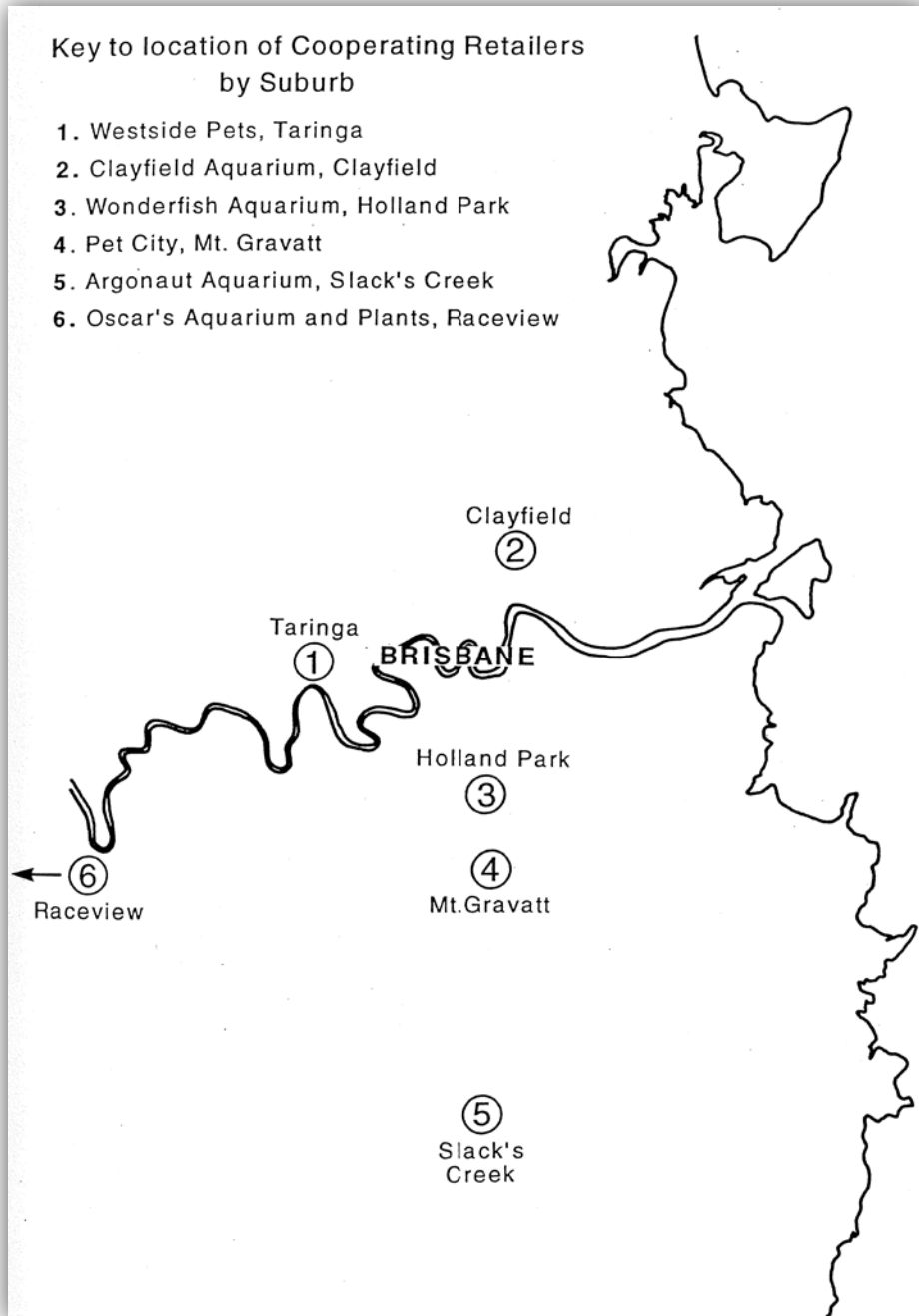
The Australian project was intended to take place in the early months of 1991. However, the legal requirements enforced by the Queensland Department of Primary Industries caused considerable delay because of the need to apply for and obtain appropriate permits. The test marketing was planned for the Brisbane area through aquarium outlets. They were asked whether they would be willing to participate and be supplied free of charge with the number of clams requested by them. In return for the supply of these clams, they were asked to collect data, complete survey forms and arrange for customers to complete survey forms. The survey forms (See Appendix III) were the same as those used in Hawaii by Professor Shang, merely modified for Australian conditions. Both the principal researcher and the retail outlets were required to have permits and these were paid for from project funds. Outlets could retain any income earned.

The survey was confined to the Brisbane metropolitan area where the researchers were located largely to minimise problems associated with the transport and distribution of live molluscs. This was also logical given that this was the primary target area of an initial survey conducted by Professor Tisdell and which had established contact with most Brisbane retailers (Tisdell, 1989).

Brisbane has a relatively large population (1.3 million in 1989), is a state capital and serves much of the surrounding country region. Map 1 indicates the general location of the survey. Of the seven retail outlets in Brisbane known to supply saltwater aquarium specimens, six agreed to participate in the project. Their suburban location is shown in Map 2. However, had the exact legal requirements of the Queensland Department of Primary Industries been known from the outset, the survey might have more effectively taken place interstate. The same licensing conditions, fees and regulations do not apply in other Australian states.



**Map 1: General location of Brisbane. Suburban locations of outlets cooperating in test marketing in Brisbane shown on Map 2.**



**Map 2: Suburban location of cooperating aquarium retailers**

While it was known that permits could be required in Queensland for the sale and distribution of giant clams, the nature, and in particular, the cost of these permits and procedures were unknown to the project administrator prior to commencement of the project. After a lengthy application period, the Department of Primary Industries determined that regulations currently applying to the sale and distribution of giant clams would apply in this case, despite

the non-profit and pure research nature of the project, and its potential benefit to Queensland. Thus, all retail outlets were required to hold a permit at a cost of \$100 per outlet (these were paid from project funds) and potential customers were required to apply for and receive 'holding' permits **before** being able to make a purchase. Although customers were not required by the Department of Primary Industries to pay a fee for their permits, the fact that these had to be applied for individually in advance put a 'dampener' on purchases. An earlier survey had estimated **maximum** sales of 100 clams per year per retailer (Tisdell, 1989, p. 8). But there was a definite possibility of the permit system reducing potential sales of retailers significantly. In addition, customer inconvenience undoubtedly had a detrimental effect on sales. Nevertheless, retailers were prepared to persevere, given that the permits would be paid from the project funds.<sup>1</sup>

## 2. DETAILS OF PROJECT EXECUTION

One hundred *Tridacna crocea* clams were delivered by air to Brisbane airport from Cairns on 4 July, 1991. The clams were obtained from Reefarm, a commercial farming venture located on Fitzroy Island near Cairns, (and approximately 2000 kilometres from Brisbane). They were packed in small plastic bags filled with saltwater and delivered by Ms Thea Vinnicombe, research assistant for this project, directly to the six participating outlets in Brisbane.<sup>2</sup>

Airfreight of \$126 was an essential part of the cost of the project. The wholesale purchase price for this batch of clams was \$4.50 per clam. A smaller batch would have involved an additional per unit cost of \$1. The clams were of a small size, between 2.5 and 5 centimetres. Any increase in size would have involved an increase in price. Retailers had stressed excessive size of clams as a disadvantage for aquarium specimens, but it may be that the size delivered erred at the opposite extreme. Delivery from Brisbane airport to retailers was arranged by the project. Note that otherwise delivery would constitute further costs in terms of time and inconvenience for the individual retailer. Retailers were asked to price the clams for sale to customers on a commercial basis. They were allowed to retain any income earned.

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<sup>1</sup> See Appendix 1 for copies of with the Queensland Department of regarding permit requirements.

<sup>2</sup> Appendix 2 gives names and localities of participating aquariums and numbers of clams requested by each. Each outlet was supplied with two or three extra clams because Reefarm supplied 100 to us, 15 extras, to allow for any losses in transit.

Their resulting **retail prices ranged from ten to thirteen dollars.**

Each aquarium owner or manager completed a specific survey form for his or her retail outlet and agreed to provide survey forms to customers and ensure their completion (see Appendix III for copies of survey forms). The purpose of the forms was to gather data about demand and provide practical information about marketing giant clams as aquarium specimens. To ensure compatibility with the Hawaiian project, the survey forms used for the Australian project were the same as those used in Hawaii, with only slight modifications.

### **3. RESULTS FROM RETAILERS**

#### *3.1 Introduction to survey of retailers*

Retailers were asked to rank giant clams as aquarium specimens according to a number of attributes, these were specified as colourfulness, exotic value and attractiveness of their shell. They were also questioned about the size of clams which they would prefer to sell, the price at which they thought it would be reasonable to sell them, any difficulties which they anticipated in holding giant clams in their aquariums. In addition they were asked about the substitutability of other aquarium specimens for giant clams, how they rated giant clams in relation to other selected aquarium specimens and how many clams they expected to sell on a monthly basis. Let us consider the responses received from the six co-operating retailers.

#### *3.2 Ranking of attributes of giant clams as aquarium specimens*

On a scale ranging from 'poor' to 'excellent', most retailers saw giant clams as varying between 'good' and 'excellent' for colourfulness, exotic value and attractiveness of their shell. Giant clams are also a possible source of nitrate removal in the home aquarium. However, the general feeling of respondents was that insufficient time had elapsed to prove their efficiency in this regard.

The detailed pattern of responses is indicated in Table 1. Retailers rated colour and the exotic nature of giant clams more highly than the quality of their shell. On the whole, the ability of giant clams to remove nitrate from water was given the lowest rating but three retailers did not rank this attribute and three suggested that the ability of giant clams to remove nitrate was uncertain or unknown. Although retailers could mention any other attributes of importance, none did.

**Table 1 Ranking by retailers of attributes of giant clams as aquarium specimens – frequency of responses and average rating**

Attribute	Ranking - Frequency					Average Rating	
	Exc.	Very Good	Good	Not Very Good	Poor	(a)	(b)
Colourful	1	2	2	0	0	3.66	2.66
Exotic	1	2	3	0	0	3.66	2.66
Shell	1	1	3	1	0	3.33	2.33
Nitrate removal <sup>(c)</sup>	0	0	3	0	0	3.00	2.00

- a) Using a linear scale of 1 - 5 for categories from 'Poor' to 'Excellent'  
 b) As above but using a scale of 0 - 4  
 c) Three respondents said this was not known accurately

### 3.3 Preferred size and reasonable retail price

All retailers expressed a preference for giant clams not exceeding 15cm (6") in size with the size 5 10cm (2" - 4") being the size most frequently preferred. But the size 10 15cm (6" 8") was also popular. The distribution of preferred clam sizes is shown in Table 2 together with the range of retain prices considered to be reasonable.

**Table 2 Sizes of clams preferred by aquarium retailers and range of retail prices for clams thought to be reasonable**

Size of Clam	Number of retailers expressing a preference for this size <sup>a</sup>	Reasonable retail price per clam. Range in \$A
2½ - 5cm(1 - 2")	2	10 - 13
5 - 10cm(2 - 4")	5	15 - 18
10 - 15cm(4 - 6")	4	18 - 20
15 - 20cm(6 - 8")	0	20 - 25
20 - 25cm(8 - 10")	0	25 - 30

- (a) Some retailers sizes of clams expressed a preference for several sizes of clams. One respondent ranked all 5 sizes. So in this case only the three most desired sizes were included in the above distribution.

Our initial contact with retail outlets had indicated concern that clams for the home aquarium not be excessively large. Croceas were favoured because their maximum expected size was

only 15 centimetres and those actually tested in the survey were very small, between 2.5 and 5 centimetres. However, it appears that this may have been too small, with retailers indicating a preference for larger sized clams of 5 to 10 centimetres or even 10 to 15 centimetres in width. Suggested reasonable prices for small clams ranged between \$10 and \$15, while a price range of \$15 to \$20 was considered reasonable for those of larger size.<sup>3</sup>

#### *3.4 Difficulties anticipated by retailers in having clams in their aquariums*

While retailers did not believe that it would be difficult to keep giant clams in their aquariums all but one said they would need extra lighting and all expressed concern about the lack of available literature on the keeping of giant clams in aquariums. In general retailers expected no difficulties. However, as can be seen from Table 5, the giant clams of four out of the six retailers experienced fatalities. Two retailers lost their complete stock or almost so due to a 'toxic-substance' in the water, one had losses due to the accidental introduction of a predator (a cone shell) and another had losses due to unspecified causes. Overall mortality of clams in the aquarium outlets were high (30- 40 per cent). To some extent these losses were due to lack of previous experience in keeping giant clams. With more experience few losses might be expected. One outlet experienced no losses.

#### *3.5 Substitutable species for giant clams in aquariums and rating of giant clams in comparison to selected other aquarium species*

Retailers were asked whether anemones, corals, oysters or any other species could be regarded as a substitute for giant clams as aquarium specimens. There were five responses to the effect that anemones and corals can be regarded as substitutes for giant clams in aquariums but only one response that oysters could be so considered. No other substitutable species were mentioned. But one retailer responded that no other species could be regarded as a substitute for giant clams in aquariums and so did not list any substitutes.

An attempt was made in discussions with retailers to assess the degree of substitutability between giant clams and alternative aquarium specimens. It may be that giant clams and other aquarium specimens are actually complements, rather than substitutes. For instance, people with established coral tanks are more likely to purchase a clam than those without. Retailers described customers as interested in variety in their aquariums, with the main

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<sup>3</sup> All dollar values used in this report are Australian dollar values.



concern being compatibility between species. Clams for instance are vulnerable to attack from a number of other species due to their immobility. Where such incompatibilities do not exist, customers think in terms of extending the range of their specimens, rather than substituting one for another.

Retailers were also asked to rate giant clams, anemones and corals as aquarium species using a ranking from poor to excellent. The distribution of responses is given in Table 3 and the average rating is also indicated. Giant clams, anemones and corals were rated highly but oysters were rated poorly as aquarium specimens.

**Table 3 Rating of giant clams in relation to selected other aquarium species by retailers – frequency of responses and average rating**

Species	Ranking - Frequency					Average Rating	
	Exc.	Very Good	Good	Not Very Good	Poor	(a)	(b)
Giant Clam	3	2	1	0	0	4.33	3.33
Anemone	4	1	1	0	0	4.50	3.50
Coral	4	1	1	0	0	4.50	3.50
Oyster	0	0	0	2	4	1.33	0.33

(a) Using a linear scale of 1 – 5 for categories from ‘Poor’ to ‘Excellent’

(b) As above but using a scale of 0 - 4

On average, giant clams were rated slightly below anemones and corals as aquarium specimens. Nevertheless they fall into a similar niche. On the other hand oysters were rated as decidedly inferior to all the other aquarium specimens indicated in Table 3.

### 3.6 Expected quantity of sales of giant clams as aquarium specimens

Retail aquarium outlets were asked how many clams they could sell on a monthly basis. After possible high initial sales due to novelty value, most retailers felt regular monthly sales would be small, generally ranging from four to six clams. Two retailers distinguished between the number they could sell given the prevailing permit situation and the numbers they could sell without permits. One claimed monthly sales of between ten and twenty clams without permits as opposed to four clams with these requirements imposed on customers. The responses of retailers are listed in Table 4.

**Table 4 Individual responses retailers to the question "How many clams can you sell on a monthly basis?"**

Respondent	Responses
1	Not many
2	After initial interest about five
3	Not known. Small numbers
4	Plenty. But permits taking too long to come through to move these
5	4 - 6
6	With paperwork for permits: 4 Without paperwork and need for permits: 10 - 20

From the responses given in Table 4, average annual sales for retail outlets of 50 giant clams seems likely in the Brisbane area, given present Queensland Government impediments to sales imposed by the permit system. Without such restrictions, sales seem as though they would be more than doubled. This would give a similar level of potential sales to that estimated from direct interviews with retailers in 1989 (Tisdell, 1989). It is clear that Government Regulations in Queensland are a substantial impediment to sales of giant clams in this state.

### *3.7 Experience of retailers with their batches of clams and with completion of survey forms by customers*

Table 5 indicates the number of giant clams distributed to individual retailers as part of the project. Although only 85 clams were ordered from Reefarm, 100 were sent and the 'extras' were distributed amongst the retailers who co-operated. Several retailers lost clams due to a variety of causes specified in Table 5. The exact number of clams lost due to mortality is not known but it is between 30 to 40.

Customers were requested to complete survey forms but a number failed to do so, either because of their own reluctance and/or because retailers did not press them in this matter. All told 12 survey forms were received from customers but since several purchased a number of clams this accounted for 37 clams. This meant that between 23 and 33 clams taken by customers were not accounted for by survey forms. Nevertheless, the response rate from customers for clams actually sold exceeded 50 per cent.

**Table 5 Experience of retailers with their batches of giant clams and with completion of survey forms by customers**

Retail outlet	Number of clams delivered to retailers		Number of customers completing survey forms	Number of clams accounted for by customer responses	Comments
	Ordered	Extras			
1	15	2	0	0	Clam fatalities due to the introduction of a toxic substance in a water change. Customer non-cooperation.
2	10	2	0	0	Clam fatalities soon after delivery – unknown toxic element in the aquarium presumed.
3	15	3	5	12	Clam fatalities due to a predator (cone shell) inadvertently introduced into the aquarium. Multiple sales. Customer non-cooperation (approx. 12 clams accounted for).
4	20	3	7	23	Multiple sales. All clams accounted for.
5	10	2	1	2	Customer/retailer non-cooperation. Multiple sales. 2 clams accounted for.
6	15	3	0	0	Customer/retailer non-cooperation – clam fatalities due to unspecified reasons.

## 4. RESULTS FROM SURVEY OF CUSTOMERS

### 4.1 Introduction

Customer survey forms were similar to those of retailers in format and to some extent in information required and appeared to elicit similar responses. For instance, customers recorded a preference for larger clams particularly in the 5 to 10 and 10 to 15 centimetre ranges and similar levels of pricing were indicated but with some differences highlighted later. Lack of literature was regarded as the major foreseeable difficulty in keeping clams, with some buyers also mentioning the possibility of changed lighting requirements. Again the question about the degree of substitutability between the giant clam and other products was poorly understood.

Let us consider in turn selected characteristics of purchasers of giant clams as aquarium

specimens, their rating of selected attributes of giant clams, and any difficulties anticipated by purchasers in keeping giant clams. In addition, consider the comparative ratings given to giant clams by purchasers, the number of giant clams that purchasers would like to have in their aquarium, the sizes of clams preferred by them and their views about reasonable retail prices.

#### *4.2 Purchasers of giant clams as aquarium species selected characteristics*

Thirteen customers completed survey forms. Most of these had coral reef tanks (11 out of 13) and most had wet dry trickle filter systems (10 out of 13). Therefore most sales of giant clams as aquarium specimens are likely to be to owners of coral reef tanks. Sizes of tanks of customers varied widely. The minimum size was 57 litres and the maximum was 750 litres.

Most purchasers described themselves as ethnically Australians (11). In addition, one stated that he was an English-born Australian and another one was said to be European. It seems likely that racially all purchasers were Europeans. Their average age was 32. Six were in their twenties, four in their thirties and two in their forties and the age of one was unknown. Nearly all sales were to persons under 40 years of age, and to males (11 persons). One sale only was made to a female and one sale was made to a couple.

Two purchasers of clams did not reveal the level of their family income but of those indicating their level of family income most had an income of \$40, 000- \$60,000. The number of respondents in each income category was <\$20,000 (1); \$20,000 – \$40,000 (3); \$40,000 – \$60,000 (6); >\$60,000 (1).

#### *4.3 Anticipated difficulties in keeping giant clams*

While no great difficulties were anticipated by purchasers in keeping clams, most (7/13) said that absence of literature on the care of clams was a disadvantage. One said that they would need extra lighting in their aquarium. Another found that her long- nosed butterfly fish ate her clams.

#### 4.4 Ranking of attributes of giant clams, comparison with other aquarium species, and substitute species by customers

Customers were asked to give their ratings of various attributes of giant clams as aquarium species. The colourful and exotic nature of the giant clam was rated highly with its shell quality and ability to remove nitrate ranked much lower. But many customers mentioned that they were unsure of the ability of giant clams to remove nitrate from the water. These ratings are similar to those of retailers and are detailed in Table 6.

Comparisons of giant clams, anemones, corals and oysters as aquarium species by customers resulted in giant clams being ranked highest followed by corals and anemones with oysters being ranked much lower and being considered to be poor or not very good as an aquarium specimen. Details of the responses are given in Table 7.

Four respondents said that the giant clam was not a substitute for any other aquarium specimen. But there were 5 responses that it was a substitute for coral, 4 that it could be regarded as a substitute for oyster and 3 that it is a substitute for anemone. One respondent mentioned that it could be substituted for pipis (*Plebidonax deltoides*) and another said it could be a substitute for fish. It seems however that giant clam is not a close substitute for any other aquarium species. It fills a niche not closely filled by other aquarium specimens.

**Table 6 Ranking of attributes of giant clams by purchasers – frequency of responses and average rating**

Attribute (a)	Ranking					Average Rating	
	Exc.	Very Good	Good	Not Very Good	Poor	(a)	(b)
Colourful(13)	4	5	4	0	0	4	3
Exotic(12)	5	2	5	0	0	4	3
Shell(13)	1	1	10	1	0	3.15	2.15
Nitrate(8) <sup>(d)</sup>	2	1	3	1	1	3.25	2.25

*Notes*

- a) Number of respondents in brackets
- b) Ranked on a scale of 1 to 5 corresponding to 'Poor' to 'Excellent'
- c) Ranked on a scale 0 to 4 corresponding to 'Poor' to 'Excellent'
- d) A number of respondents stated that they lacked knowledge about the ability of giant clams to remove nitrate

**Table 7 Customers' ranking of giant clams and other aquarium species – frequency and average rating**

Species (a)	Ranking					Average Rating	
	Exc.	Very Good	Good	Not Very Good	Poor	(a)	(b)
Giant Clam(8)	6	2	0	0	0	4.75	3.75
Anemone(9)	3	3	2	0	1	3.78	2.78
Coral(10)	5	1	3	0	1	3.90	2.90
Oyster(9)		1	3	3	2	2.33	1.33

*Notes*

- a) Number of customers responding indicated in brackets
- b) Ranked on a scale 1 to 5 corresponding to 'Poor' to 'Excellent'
- c) Ranked on a scale 0 to 4 corresponding to 'Poor' to 'Excellent'

*4.5 Customers' preferred sizes of clams, views about a reasonable retail price and desired number of clams for their aquariums*

Most customers expressed a preference for giant clams of 5 – 10cm (2 – 4") in size but clams slightly smaller or slightly larger were also of interest to most customers. Nevertheless, clams larger than those test marketed which were in the range 2.5 – 5cm would have been preferred by most customers. Table 8 sets out sizes preferred by buyers and the range of prices which they thought to be reasonable. Note that the range of prices suggested is wider than that indicated by retailers. At the bottom of the range these suggested prices are lower and at the top of the range higher than those suggested by retailers.

**Table 8 Sizes of clams preferred by customers and range of prices suggested as reasonable by them**

Preferred size	Number preferring this size	Retail price range suggested as reasonable (\$/clam)
2.5 – 5cm(1 – 2")	4	5 – 13
5 – 10cm(2 – 4")	8	9 – 25
10 – 15cm(4 – 6")	5	15 – 30
15 – 20cm(6 – 8")	3	15 – 50
20 – 25cm(8 – 10")	1	30 – 80

Because of the variation in prices suggested as reasonable by customers it may be useful to

set out the array of actual prices suggested by them and estimate the arithmetical average. This has been done in Table 9.

**Table 9** Array of prices (\$/clam) suggested as reasonable retail prices by customers

Customer	Size of Clam in cms.				
	2.5-5	5-10	10-15	15-20	25-30
1		20-25			
2					
3		20	30	40	
4				15+*	
5	13	25			
6	5	10	18	25	30
7		20-30			
8	8-10	10-15			
9	13				
10	5-9	9-15	15-20	25	40-60
11		20-25			
12 <sup>(a)</sup>			30	50	80
<b>Simple average</b>	<b>9.4</b>	<b>19.3</b>	<b>23.9</b>	<b>31.0</b>	<b>53.3</b>

\* Unsure

(a) Customer 13 did not suggest any prices

As for the number of clams which purchasers would like for their aquariums the most frequently mentioned number was 3. Presumably a cluster display was intended. The desired numbers of clams were as follows: one customer – one clam; three customers – two clams; five customers – three clams; one customer – four clams and two customers – six clams. One customer did not specify a number but merely writes that it all depends on the size of the clams. On average, sales of about 3 clams per potential customer seem achievable.

#### 4.6 Further comment on customers' responses

Questions specific to the customer focused on the size of the home aquarium and consumer income. It was interesting to note a significant number of buyers were located in the relatively high income groups, A\$40,000 to A\$60,000 and over A\$60,000. Some retailers had previously suggested a concentration of low income earners amongst aquarium enthusiasts due to the relatively low cost nature of the hobby. Once established an aquarium may be virtually self-supporting and the collector is then able to concentrate on adding to his stock as finances allow. However, marine aquariums have comparatively high set up costs, relative to

fresh water tanks. Filtration systems and special lighting requirements intended to reproduce the marine environment are necessary. Enthusiasts can indeed devote considerable time and money to their hobby. Retailers, for example, spoke of regular customers living a considerable distance from Brisbane who, nevertheless, frequently arrived in search of new specimens. The tanks of buyers varied considerably in size from the relatively modest to a large 750 litre aquarium. This may reflect the variation in income with one respondent on social security benefits and others in the high income brackets described above.

A small number of customers were contacted after having their clams for some weeks. Most reported their animals as being in good health and were very happy with their purchase. Most said they would like to have a number of clams, rather than one, particularly of the small size. One customer, however, had lost her clam as a result of it being attacked by a cone shell.

## **5. DISCUSSION OF RESPONSES GENERALLY**

While the responses of customers and retailers to overlapping questions in their survey forms are broadly similar, there are some differences that are worth mentioning. For example, retailers rated anemones and corals ahead of giant clams as aquarium specimens but customers rated giant clams as superior to these species. Both groups thought the colourfulness of giant clams and exotic nature were very good attributes but the quality of the shell and nitrate removal ability was not rated highly as an attribute. All agreed that the unavailability of suitable literature on the keeping of giant clams as aquarium specimens was an important problem.

Similar preferences about clam sizes were expressed by both retailers and customers. But customers seemed to be more interested in the availability of bigger sizes of clams than retailers. Also on average they were prepared to pay somewhat more for bigger sized clams than considered reasonable by retailers, but for the smallest sized clams they suggested a somewhat lower price to be reasonable in comparison to that suggested by retailers. These features can be seen from Table 10. It seems likely that clams of 5 – 10cm in size could be sold at \$20 and that this size of clam might be generally, the most suitable for retailers to stock.



**Table 10 Comparison of sizes of clams preferred by retailers and customers and of reasonable retail prices suggested by them (\$/clam)**

Preferred size in cms.	Retailers		Customers	
	Ranking <sup>(a)</sup>	Price Range	Ranking <sup>(a)</sup>	Average Price
2.5 - 5	3 (2)	10-13	3 (4)	9.4
5 - 10	2 (5)	15-18	2 (8)	19.3
10 - 25	1 (4)	18-20	1 (5)	23.9
15 - 20	- (0)	20-25	4 (3)	32.0
20 - 25	- (0)	25-30	5 (11)	53.3

(a) Ranking on the basis of number of respondents indicating that a size is a preferred one. The numbers of such respondents are shown in brackets.

While over 50 per cent of customers purchasing giant clams completed survey forms, many did not. A factor limiting the response rate by customers was an apparent reluctance on the part of some of them to be involved in an exercise requiring completion of a survey form. This was reported by aquarium owners as being due to a concern regarding confidentiality in the context of the additional permit requirements of the Department of Primary Industry. Some customers were therefore concerned about the amount of information required from 'official bodies'. In some instances, it appears that retailers may have been reluctant to enforce the completion of a customer survey form as a requirement of clam purchases, particularly when customers insisted on taking the form home for completion. This seemed in many cases to be simply a means of avoiding completion of the survey form. One retailer spoke of a young buyer whose parents refused to allow him to complete the form. Ensuring a high response rate was difficult for the project organisers who were necessarily removed from this part of the work. In addition there were quite a number of multiple purchases so that one form frequently represented the sale of more than one clam.

The rate at which clams sold varied markedly between aquariums, and it was interesting to note that the outlet showing a particularly slow rate of sales was of a significantly larger scale than the others. While most specialised in aquarium supplies, the larger retailer was a more generalised pet shop. This outlet also appeared to have a comparatively large paid workforce and to generate a high sales turnover. Customer service may therefore have been of a

different nature to that occurring in the other outlets. These were characterised by a smaller scale of operation and staff were familiar with many of their customers who were typically described as regulars. This familiarity seems to be particularly common in the saltwater aquarium trade, which is quite specialised and therefore confined to a relatively small number of customers. Saltwater tanks are more expensive and have more complex requirements than freshwater tanks and customers are often quite dedicated to the collection of interesting specimens. Familiarity with customers enabled smaller retailers to advertise through word of mouth, an avenue not as readily available to a larger concern. And it was in the smaller outlets that the clams sold quickly and in the largest numbers.

One such retailer had in fact sold almost his entire stock within a week of their being delivered. Regular customers had been kept informed of their impending arrival and were consequently keen to purchase. This shop has since made independent arrangements for additional stocks. Two further outlets sold clams steadily and felt continuing demand would be constant if small. A major concern however was the Department of Primary Industry permit requirements which were seen to significantly diminish sales. The 'red tape' involved raised questions for them as to the desirability of continuing to stock giant clams.

All retail outlets recorded sales lost due to the permits with most claiming to be able to sell at least twice the number without these requirements. Inconvenience arises as customers are required to apply to the Department of Primary Industries for permits **before** being able to make a purchase. Once having made the application they must then wait some time for its approval and their receipt of the actual permit. They can then return to the shop, show their permit and make the purchase. Often the wish for a clam is insufficiently strong to complete this procedure which adds significantly to transaction costs. Retailers were often understandably reluctant to hold clams when they could not be sure the buyer would return. Customers therefore had no guarantee of a clam still being available after receipt of the permit, which naturally affected their incentive to take the necessary trouble to apply.

## **6. OBSERVATIONS ON ECONOMICS OF RETAIL SALES AND MARKET SIZE**

From the information given above, it seems that the margin available to aquarium retailers on sales of giant clams in the size range 2.5 – 5cm is likely to be quite small and that the licence fee payable to the Department of Primary Industries is a major impost. Licensing

requirements are a major addition to costs and seem likely to seriously reduce sales.

On average it would seem that each retailer might expect to sell 50 clams annually. If these were purchased in one batch, their cost would be at least that set out in Table 11.

**Table 11 Estimated minimum cost of 50 giant clams of size 2.5 – 5cms size to Brisbane retailer**

Item	Total \$	Cost/Clam\$	%
Air freight	63	1.26	13.75
Cost of clams at \$5.50 each <sup>(a)</sup>	275	5.50	60.00
Department of Primary Industries Permit	100	2.00	21.83
Local delivery charge	20	40	4.30 <sup>(b)</sup>
<b>Total basic cost</b>	<b>458</b>	<b>9.16</b>	<b>100.00<sup>(b)</sup></b>

(a) Includes an extra dollar for a small batch

(b) Does not exactly add to 100 because of rounding

Given the basic cost shown in Table 11, there is very little margin left for retailers if clams sell at a retail price of \$10 – \$13 each. This is the actual range of prices charged by retailers in the test marketing and is the range of prices they thought to be reasonable. The price thought reasonable by customers was an average of only \$9.40 per clam. This price would leave virtually no margin for retailers.

The profit margin for retailers of giant clams of 5 – 10cm could be higher. The licence fee for example does not vary by the size of the clam and freight costs would not rise proportionately and on average purchasers thought that a price of \$19.30 per clam to be reasonable for clams in this size range.

It is clear that within Queensland, given the marginal nature of the market in giant clams, government regulations and charges are a major impediment to the marketing of **farmed** giant clams as aquarium specimens. Current regulations appear to have been framed to protect wild stocks and have not been adjusted to take account of mariculture developments. It is ironic that Queensland, which stands to gain most amongst the Australian states from giant clam farming, has the most restrictive regulations limiting the marketing of giant clams

and that this legislation does not discriminate between farmed and other stock in its general provisions. The legislation seems to be out of step with modern developments, provides considerable bureaucratic discretion and is uncertain therefore in its operation, causes delays and adds to costs in operations involving the marketing of giant clams in Queensland.

The above information also enables us to provide an estimate of demand for giant clams as aquarium specimens in Australia. Given current regulations in Queensland, the current demand for giant clams as aquarium specimens in Brisbane has been estimated to be about 50 annually per retail outlet. This is about 300 clams per year in sales for Brisbane, given six outlets selling clams. Brisbane's population is around 1.3 million and that for Queensland 2.9 million. Possibly an additional 300 clams would be sold in the rest of the State, thus making annual sales in Queensland of 600 clams as aquarium specimens. The population level in the rest of Australia is about 4.88 times that of Queensland but in other States regulations restricting giant clam sales do not occur. So around twice the **relative** level of demand might be expected there, that is sales of 5,856 clams per year. With the Queensland sales added this suggests sales of around 6,500 per annum for Australia. However, if sales in other Australian States were at similar levels to that estimated for Queensland, given Queensland Department of Primary Industries regulations, for example because of extra air freight costs, annual Australian demand would only be 3,600 clams for aquarium specimens. Considering all factors, annual sales of around 5,000 giant clams as aquarium specimens seems achievable in Australia. This is not a large number but could provide a useful sideline activity for a clam farm. It is interesting to note that this is the same figure as was suggested in 1989 as a result of interviews (Tisdell, 1989). Thus the present survey supports a similar prediction to the earlier one.

Because of government regulations in Queensland, Reefarm located near Cairns in Northern Queensland has found it easier to export giant clams as aquarium specimens to the USA and Europe, especially Germany, where a larger market exists, than to sell these in Australia, especially Queensland.

## **7. CONCLUDING COMMENTS**

The viability of a market in products from protected species such as giant clams depends not only on the natural forces of supply and demand but is affected by government regulations. The possibility of over exploitation of protected species seems to have resulted in the

legislation imposed by the Queensland Department of Primary Industries. The actual application of the legislation is, to a large extent, discretionary (as can be seen from perusing copies of correspondence from the Department of Primary Industries set out in Appendix I). While licences may be issued for up to 12 months, they need not be. In this case they were only issued for one month and other requirements were stipulated. The time required from the date of initial contact with the Department of Primary Industries by telephone in early January 1991 to the issue of permission for research to proceed was six months. Written letters of consent to cooperation from all participating retail outlets were required by the Department of Primary Industries and customers of retailers also had to obtain permits via the method previously outlined. \$600 was paid to the Department of Primary Industries from project funds to enable retailers to obtain permits and so make it possible for the research to proceed. Considerable effort was, therefore, required by the researchers in getting necessary permission.

While a market exists for giant clams in Australia as aquarium specimens, it is not a large market. Government restrictions can have a considerable influence on market viability as demonstrated above. Ironically despite CITES (Convention on International Trade in Endangered Species) which applies to giant clams it is easier to export giant clams to overseas markets than to sell them in Queensland. Whereas trade in farmed clams in Queensland could provide a springboard for developing overseas markets for giant clam products elsewhere, Queensland Government regulations have restricted opportunities for Australian clam producers to follow such a strategy.

## **8. ACKNOWLEDGEMENT**

I wish to thank Ms Thea Vinnicombe for considerable research assistance with this project and Mr Luca Tacconi for assistance. Also thanks to aquarium retail outlets and customers for their cooperation in completing survey forms and for other assistance. I am grateful to The Research Corporation of the University of Hawaii for its financial support for this research and Professor Yung C. Shang, Department of Agriculture and Resource Economics, University of Hawaii, for his advice and patience given unforeseen obstacles to my speedy completion of this research. The study is part of the Research Project "Market Study of Pacific Giant Clam Products" for which Professor Yung C. Shang is the coordinator. The usual caveats apply. This paper should be regarded as a working paper and comments are

welcome.

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- Tisdell, C. (1989) Market for Giant Clams as Aquarium Specimens: Report on a Survey of Retailers of Supplies for Saltwater Aquariums. *Economics of Giant Clam Mariculture*, Research Report or Paper No. 3, Department of Economics, University of Queensland, Queensland, Australia.

## APPENDIX I

Copies of some correspondence with Queensland Department of Primary Industries clarifying requirements about permits for research involving test marketing of giant clams

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*Head of Department.*

R.C. Jensen, M.Ag.Ec.(N.E.), A.Ed., B.Econ., PhD.

J. Foster, B.A.(Cov Poly), M.A.Econ., PhD.(Manc).

DATE : 5 March 1991

TO: Fax No: 229-8146  
 Name : Malcolm Dunning  
 Firm : Fisheries Branch, DPI

FROM: Name : Clem Tisdell

Number of pages being transmitted  
 including this sheet : Two

Dear Mr Dunning,

Following our telephone conversation today I tried to contact your superior officer but I must have written down the incorrect telephone number, so I thought the easiest way to proceed may be to Fax you.

As discussed on the telephone, we would like to have permission to undertake research on the market for giant clams as aquarium specimens. To do this we need to undertake a short trial which would involve aquarium outlets in Brisbane and the offering of 80 - 100 clams which we intend to purchase from Reefarm, a registered clam farming establishment.

I understand that normally retailers are required to pay a \$100 licence fee in order to sell giant clams. At the most each retailer would be offered 20 clams for trial. It is unlikely that they would find it worthwhile to co-operate if they have to pay the licence fee. No allowance has been made for the licence fee in our research grant which, as I explained to you, is not a consultancy but a pure research grant which has come from the University of Hawaii\* for the Center for Tropical and Subtropical Aquaculture. The purpose of the grant is to cover absolutely necessary costs. In the circumstances I am requesting that a special case be considered for waiving the licence fee for this particular exercise.

I expect the clams will be sold within a relatively short period of time, possibly no more than six weeks. The retailers and purchasers will be required to provide us with

\* to our University



certain information which we hope will be useful to us in assessing the future potential market for this clam species.

I feel it is in the interests of the State of Queensland to support this research and in the interests of the Department of Primary Industries, and I hope that the Minister will consider my request favourably.

Would you please inform me, if possible by Fax, of your decision in this matter so I can decide how to proceed.

Thank you for your consideration.

Yours sincerely,

*Clem Tisdell*

Clem Tisdell,  
Professor of Economics.

*Please note that I receive no personal payment for this research. It is pure academic research.*

310. DHIKY & FISH FISHERIES  
184033234 (WED) 3. 6. '91 10:26 PAGE 1

Queensland  
Department  
of Primary  
Industries

PRIMARY INDUSTRIES BUILDING, 30 ANN STREET  
GPO Box 46, Brisbane Qld 4001  
Telephone: (07) 239 3111 Telex: AA41630  
Facsimile: (07) 221 2490

# FISHERIES BRANCH



## FACSIMILE

DATE: 6 MARCH 1991

TO: DR. C. TISDELL  
DEPT. OF ECONOMICS

FROM: DR JOHN BEUMER

NO. OF PAGES FOLLOWING: ONE

MESSAGE: GIANT CLAM PERMITS

For difficulties in transmission please phone (07) 239 3420

[Our facsimile number: (07) 229 8146]

2084033234 (WED) 3. 6. '91 10:27



INDUSTRIAL BUILDING 80 ANN STREET  
GPO Box 46, Brisbane Qld 4001  
Telephone: (07) 239 3111 Telex: AA41620  
Facsimile: (07) 221 2490

Our Reference: 91/FB 11F.006 (JB:PMM)  
Your Reference:  
Contact: Dr J. Betzner (Ph. (07) 239 3417)



6 March 1991

Dr C. Tisdell  
Professor of Economics  
Department of Economics  
University of Queensland  
ST LUCIA Q 4072

Dear Dr Tisdell,

I refer to your facsimile of 5 March 1991, to Dr Dunning of the Fisheries Branch, detailing the marketing project to be undertaken by your Department.

Fisheries legislation require the granting of a Section 58 Fish or Marine Products Permit for a commercial activity. This is a general provision within the legislation but it has specific application to commercial activity involving protected species such as giant clams. The issue of such a Permit may only occur after assessment of an application and the payment of the assessment fee of \$100.00/permit. This requirement has been strictly adhered to in other situations where retail outlets were/are selling giant clams.

For your proposed project to be undertaken on a basis that would satisfy the legal requirements of the fisheries legislation of this State, I would request the payment of the relevant amount for the number of permits being sought. Please note that each outlet requires a permit. I would also request that a letter of agreed participation from each retail outlet accompany the fees.

I would add that other parties within Queensland are also exploring marketing of giant clams. In each case, the required Permit has been sought and granted with compliance in terms of payment of assessment fee.

I await your advices.

Yours faithfully,

(B.R. Pollock)  
DIRECTOR  
FISHERIES BRANCH



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J. Foster, B.A.(Cov Poly), M.A.Econ., PhD.(Manc).

15th March, 1991.

Dr John Beumer  
Fisheries Branch  
Queensland DPI  
GPO Box 46  
BRISBANE 4001

Dear Dr Beumer,

Thank you for your letter of 6th March and for faxing a copy of it to me, and for your indication that Section 58 of the Fisheries Legislation applies to our research. We have been consulting with the various outlets which have agreed to co-operate with us in this research. At this stage most have agreed to co-operate, however one outlet has asked, before making a decision, how long the permit is likely to be valid for. Would you please let us know this.

I am also arranging for Letters of Agreed Participation to accompany the University's payment of the fees which you propose. I hope that there will be no further delays for this research due to legislative requirements.

Yours sincerely,

Clem Tisdell,  
Professor of Economics.

cc Mr B.R. Pollock  
Director  
Fisheries Branch



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J. Foster, B.A.(Cov Poly), M.A.Econ., Ph.D.(Mauc).

15th March, 1991.

The Manager  
Wonderfish Aquarium  
101 Seville Road  
HOLLAND PARK QLD 4121

Dear Madam,

Thank you for agreeing to co-operate with us in our research into the market for giant clams as aquarium specimens. This is purely scientific research and we are not being engaged as consultants to any commercial organisation. As indicated earlier, in return for your co-operation we will supply you free of charge with a limited number of giant clams for testing purposes. However we have been informed by Dr John Beumer of the Fisheries Branch, Queensland Department of Primary Industries, that it is necessary for us to have a Marine Products Permit in order to involve you in this research. A permit is required for each outlet and they cost \$100 each. No allowance was made in our original research grant for such a permit so we have had to draw on money set aside for other purposes to make it possible for us to obtain these permits. It is unfortunate that it is necessary but if you are willing to continue to co-operate we will arrange to pay the necessary fee. If you can see your way clear at some future date to donating some small amount towards the research, as discussed with you, this would be appreciated.

Dr Beumer insists that a Letter of Agreed Participation from each outlet accompanies the fees. In order to assist you in this regard we are enclosing a proforma letter which we would be pleased if you would kindly sign and return to us so that we can get the necessary permission.

I am sorry that this exercise is taking so long but it is due to unexpected difficulties beyond our control.

Yours faithfully,

Clem Tisdell,  
Professor of Economics.

cc Dr J. Beumer  
Mr B.R. Pollock, Director, Fisheries Branch, QDPI.

15th March, 1991.

Mr B.R. Pollock  
Director  
Fisheries Branch  
Queensland DPI  
GPO Box 46  
BRISBANE QLD 4001

Dear Mr Pollock,

This is to indicate that we are willing to co-operate with the University of Queensland in its research concerning the possible market for giant clams as aquarium specimens. We understand that this research is of a purely academic nature and is not being undertaken by the University of Queensland on a consulting basis.

In return for Professor Tisdell supplying aquarium specimens for test marketing we shall provide him with appropriate information to enable him to complete a report on the market. We expect that overall we will be involved in selling no more than twenty giant clams. We would appreciate it if the necessary permission could be given. Please let us know if there are any difficulties.

Yours sincerely,

Our Reference: 91/FB.11F.006 (JB:JO'S)  
Your Reference:  
Contact: Dr John Beumer [Ph. (07) 239 3417]



5 April 1991

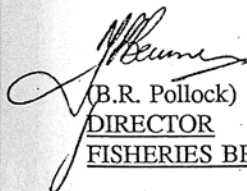
Professor Clem Tisdell  
Department of Economics  
University of Queensland  
ST LUCIA Q 4072

Dear Sir,

I refer to your recent letter regarding the proposed project on market research of giant clams and requesting details of the tenure of Section 58 Permits.

The Permits, if granted, would be for a maximum period of 12 months. I note that you have arranged for "Letters of Agreed Participation" from six retail aquarium outlets.

Yours faithfully,



(B.R. Pollock)  
DIRECTOR  
FISHERIES BRANCH



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J. Foster, B.A.(Cov Poly), M.A.Econ., PhD.(Manc).

or (07) 371-2265

26 April 1991  
Your Ref: 91/FB.11F.006 (JB:JO'S)

Mr B.R. Pollock  
Director  
Fisheries Branch  
QDPI  
GPO Box 46  
Brisbane 4001

Dear Mr Pollock,

**Market Research of Giant Clams**

Thank you for your letter of 5 April and for letting me know that Permits under Section 58 would be for a maximum period of 12 months. We shall pass this information on to the retailers concerned.

Yours sincerely,

Clem Tisdell,  
Professor of Economics.

cc Ms Thea Vinnicombe





Your Reference:  
Our Reference: 91/FBR 11F 006  
Contact Officer: Ms Kym McKauge PH: (07) 239 3461

4 July 1991

Professor C.A. Tisdell  
Department of Economics  
University of Queensland  
ST LUCIA QLD 4067

Dear Sir,

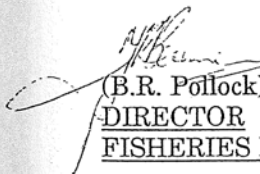
Please find enclosed Fish or Marine Products Permit No. 4209 enabling you to carry out your project involving eighty-five (85) protected clams (*Tridacna gigas*, *Tridacna crocea*, and *Tridacna maxima*).

Please note that this Permit is valid for one month, from date of issue only. As a condition of this Permit, you must also provide a report on activities regarding these clams within fourteen (14) days to the:

Director, Fisheries Branch  
Queensland Department of Primary Industries  
GPO Box 46  
BRISBANE QLD 4001

Please contact Ms Kym McKauge on (07) 239 3461 should you have any queries regarding this Permit.

Yours faithfully,

  
(B.R. Pollock)  
DIRECTOR  
FISHERIES BRANCH



**FISH OR MARINE PRODUCTS PERMIT**

THIS IS TO CERTIFY that..... Professor C.A. Tisdell, & persons under his direction  
of..... Department of Economics University of Queensland ST LUCIA QLD 4067  
is permitted for the purposes of..... RESEARCH PURPOSES.....  
to carry out the activities listed in the First Schedule hereto, subject to the terms conditions and  
restrictions set out in the Second Schedule hereto.

Unless sooner cancelled, revoked, suspended or surrendered, this permit shall remain in force  
for a period of ~~XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX~~ from date of issue from 03/07/91 until 02/08/91

Issued at BRISBANE this ..... 3 ..... day of ..... July ..... 19..... 91

  
.....  
Authorised Officer

**FIRST SCHEDULE**

AS DESCRIBED IN ATTACHMENT 1

**SECOND SCHEDULE**

AS DESCRIBED IN ATTACHMENT 1

Attachment to Fish and Marine Products Permit Number 4209

First Schedule

1. To purchase hatchery-reared clams (*Tridacna gigas*, *Tridacna crocea*, and *Tridacna maxima*) produced by Fitzroy Island hatchery of Reefarm Pty. Ltd.
2. To hold hatchery-reared clams and distribute these to permitted resellers.

Second Schedule

1. Only eighty-five (85) clams in total (*Tridacna gigas*, *Tridacna crocea*, and *Tridacna maxima*) may be held in possession at any one time.
2. All clams must bear a permanent identification number attached at the hatchery.
3. This permit does not extend to the sale of any clams.
4. The permittee shall maintain a full record of the numbers of clams bought and provided to resellers throughout the tenure of this permit including individual identification numbers. This record shall be made available to officers authorised under the *Fisheries Act 1976-89* on request and a summary detailing total numbers of each species purchased, provided to resellers and still in possession, shall be forwarded to the Director, Fisheries Branch, Queensland Department of Primary Industries, GPO Box 46, Brisbane, Q, 4001 within 14 days of expiry of this permit.

  
3/7/91

## APPENDIX II

### List of participating aquarium retailers with addresses

<b>Participating Retailer</b>	<b>Number of clams requested</b>
Westside Pets 179 Moggill Road Taringa QLD 4068 Tel: (07) 870 7829	10
Clayfield Aquarium 57 Park Avenue Clayfield QLD 4011 Tel: (07) 357 7334	15
Wonderfish Aquarium 101 Seville Road Holland Park QLD 4121 Tel: (07) 343 6427	20
Argonaut Aquarium 250 Kingston Road Slacks Creek QLD 4127	15
Pet City 224 Wishart Road Mt Gravatt QLD 4122 Tel: (07) 349 2086	15
Oscar Aquarium and Plants Shop 14 64 Raceview Road Raceview QLD 4305 Tel: (07) 288 9371	10

## **APPENDIX III**

### **Copies of survey forms completed by cooperating aquarium retailers and purchasers of giant clams**

	<b>CONTENTS</b>	<b>Page No.</b>
1.	Survey form for retailer	41
2.	Survey form for customers	43

UNIVERSITY OF QUEENSLAND  
 MARKET STUDY OF GIANT CLAM AS AQUARIUM SPECIMENS  
 (RETAILERS)

1. Name of distributor \_\_\_\_\_  
 Address \_\_\_\_\_  
 Telephone \_\_\_\_\_

2. In your opinion, what are the attributes of the giant clam as an aquarium specimen and how do you rank the importance of the attributes:

<u>Attributes</u>	<u>Ranking (Please tick)</u>					<u>Comments</u>
	Excellent	Very Good	Good	Not Very Good	Poor	
Colourful						
Exotic						
Shell						
Nitrate removal						
Others (specify) _____						

3. What would be your preferred size of clams and what price would you regard as reasonable?

<u>Preferred size</u>	<u>Reasonable retail price (\$/clam)</u>
2½ - 5 cm (1-2") _____	_____
5 - 10 cm (2-4") _____	_____
10 - 15 cm (4-6") _____	_____
15 - 20 cm (6-8") _____	_____
20 - 25 cm (8-10") _____	_____

4. Do you anticipate any difficulties in having giant clams in your aquarium? Please indicate YES or NO.

Extra lighting requirement \_\_\_\_\_  
 Lack of literature \_\_\_\_\_  
 Other (specify) \_\_\_\_\_

5. In your opinion, which of the following are closely substitutable species for the giant clam as an aquarium specimen? Please tick if appropriate.

Substitutable species

Anemone \_\_\_\_\_ Oyster \_\_\_\_\_  
 Coral \_\_\_\_\_ Other (specify) \_\_\_\_\_

6. How would you rank the giant clam and its substitutable species?

	<u>Ranking (Please tick)</u>					<u>Comments</u>
	<u>Excellent</u>	<u>Very Good</u>	<u>Good</u>	<u>Not Very Good</u>	<u>Poor</u>	
Giant Clam						
Anemone						
Coral						
Oyster						
Others (specify)						

\_\_\_\_\_  
 \_\_\_\_\_

7. How many clams can you sell on a monthly basis?

\_\_\_\_\_

Thank you for your time and co-operation.

UNIVERSITY OF QUEENSLAND  
 MARKET STUDY OF GIANT CLAM AS AQUARIUM SPECIMENS  
 (CUSTOMER)

1(a) What kind of marine aquarium do you have? Please indicate YES or NO as appropriate.

- Fish only .....
- Coral Reef tank .....
- Size of aquarium (litres) .....

(b) What kind of filtration system do you have?

- Traditional .....
- Wet dry (trickle filter) .....

2. In your opinion, what are the attributes of the giant clam as an aquarium specimen and how do you rank the importance of the attributes:

Attributes	Ranking (Please tick)					Comments
	Excellent	Very Good	Good	Not Very Good	Poor	
Colourful						
Exotic						
Shell						
Nitrate removal						
Others (specify) _____						

3. What would be your preferred size of clams and what price would you regard as reasonable?

Preferred size	Reasonable retail price (\$/clam)
2½ - 5 cm (1-2") _____	_____
5 - 10 cm (2-4") _____	_____
10 - 15 cm (4-6") _____	_____
15 - 20 cm (6-8") _____	_____
20 - 25 cm (8-10") _____	_____



4. Do you anticipate any difficulties in having giant clams in your aquarium? Please indicate YES or NO.

Extra lighting requirement \_\_\_\_\_

Lack of literature \_\_\_\_\_

Other (specify) \_\_\_\_\_

5. In your opinion, which of the following are closely substitutable species for the giant clam as an aquarium specimen? Please tick if appropriate.

Substitutable species

Anemone \_\_\_\_\_ Oyster \_\_\_\_\_

Coral \_\_\_\_\_ Other (specify) \_\_\_\_\_

6. How would you rank the giant clam and its substitutable species?

	Ranking (Please tick)					Comments
	Excellent	Very Good	Good	Not Very Good	Poor	
Giant Clam						
Anemone						
Coral						
Oyster						

Others (specify)

\_\_\_\_\_

\_\_\_\_\_

7. How many clams would you like to have in your aquarium?

\_\_\_\_\_

8. Buyer's background

Ethnic group \_\_\_\_\_ Sex \_\_\_\_\_ Age \_\_\_\_\_

Annual Family income: (Please answer at your discretion)

Less than \$20,000 \_\_\_\_\_ \$40,000 - \$60,000 \_\_\_\_\_

\$20,000 - \$40,000 \_\_\_\_\_ more than \$60,000 \_\_\_\_\_

Thank you for your time and co-operation. Enjoy your clam.

## **APPENDIX IV**

### **Advice on keeping clams in home aquariums**

<b>CONTENTS</b>	<b>Page No.</b>
“Aquarium Care for Clams” by Merle Brown	46
“Keeping Giant Clams in Home Aquaria” by Dr. John S. Lucas	48

## AQUARIUM CARE FOR CLAMS

As suggested by Merle Brown from Wonderfish Aquarium

Suggested water quality, lighting and feeding requirements for giant clams as aquarium specimens are set out below.

### WATER QUALITY

pH 8.1 – 8.3 (below 8.0 can result in loss of zooxanthellae)

Ammonia	0
Nitrite	0
Nitrate	below 20 ppm
Salinity	SE 1.020 - 1.022

### LIGHTING

In aquariums up to 18" deep, fluorescent lighting can be successfully used.

Tubes commonly used in combination include:

#### **Phillips 03 Actinic Blue Tubes**

These peak at 420nm which is the wavelength which closely resembles that of the blue chlorophyll absorption peak utilised in photosynthesis. Usually we would use two of these tubes (available in 2' 40W or 4' 40W) in combination with two of either of the following:

#### **Thorn 'Triton' Tubes or Hagen 'Power Glo' Tubes**

Very similar broad spectrum tubes with a high lumen output (40W 2480 lumens), a long life (40W average 20000hrs) and little drop-off in intensity (less than 9% during life of tube).

Other tubes used include NEC Triphosphor, G.E. Chroma 75. Very shallow water species may benefit from one of the many 'Grolux' type tubes which peak in the red end of the spectrum.

Because of the drop-off in intensity of lighting in water depths over 18", metal halide lighting is usually used in aquariums 2' deep. Criteria for this lighting is a Kelvin Degree Rating of 4300K or higher, a CRI of 65 plus and a lumen output of at least 13500 for a 150/175W bulb. Usually one 175W bulb is required for each 2' x 2' of surface area.

## **FEEDING**

Where appropriate lighting is used, the photosynthesis process is likely to be adequate – as with coral tanks.

However, some controversy exists on this issue preferred option maybe to introduce a drop of a commercial liquid invertebrate food in the vicinity of the clam on a weekly or twice weekly basis.

## KEEPING GIANT CLAMS IN HOME AQUARIA

**By Dr John S. Lucas, Department of Zoology, James Cook University, Townsville, Queensland 4811, Australia.**

There are eight species of giant clams, which range in adult size from 10 centimetres shell length to more than a metre in length and half a tonne in weight. They occur in the tropical regions of the Pacific and Indian Oceans, in the shallow waters of coral reefs. Only small specimens are suitable for home aquaria and the giant clams most commonly kept in aquaria are the smaller species, particularly *Tridacna crocea*, the borrowing or crocus clam, and *Tridacna maxima*, the rugose clam.

Giant clams have symbiotic algae (zooxanthellae) in their exposed tissue (mantle tissue) and they obtain most of their food as organic molecules transferred from the algae. This method of nutrition is unique among bivalve molluscs (oysters, mussels, scallops, etc.), but it is common among other attached, bottom-dwelling animals of coral reefs, including the hard (reef building) corals.

Because of their dependence on symbiotic algae for food, giant clams are like plants in their environmental requirements. What is good for their algae is good for them. Thus, they need high levels of light to promote photosynthesis by the internal algae and they need low levels of plant nutrients (nitrate or ammonia, phosphate, trace elements, etc.), which are absorbed by the giant clam and passed to the algae to synthesise into various organic molecules.

Giant clams also need salinities close to seawater salinity and they do best in the temperature range 25 -30°C. They will die at temperatures below 20°C and above 33°C. They can stand being out of water for hours, provided they are not allowed to become too hot or cold nor to dry out. If they are loosely wrapped in damp cloth or paper this will keep them from drying out.

The environmental requirements of giant clams are thus very similar to most hard corals: intense light, dissolved nutrients, marine salinity and warm temperature. They are, however, not so dependent on plankton food as are some corals. If you have an aquarium in which hard corals are surviving and growing, then the chances are that giant clams will survive and grow.

If hard corals do not survive in your aquarium, the chances are that there is insufficient light. Our eyes are very good at adapting to different light levels and even an apparently well-lit aquarium may be quite dim compared to natural sunlight levels. One way of coping with the light requirements of giant clams is to have them close to the surface or to a glass wall and specifically focus a light on their mantle for many hours each day. (You may need to watch that the glass does not get too hot and crack if the light is close.) Intensity of light is more important than particular wavelengths.

There is a bonus in having giant clams in your aquarium, especially if you keep fishes. Giant clams are adapted to living in seawater with very low nutrient levels and they have great ability to take up nitrogen compounds, such as ammonia and nitrate, waste products from fish. They also filter feed with their gills, like other bivalve molluscs, and thus they are a biological filtration system, removing nitrogen wastes and particles from the water. Their requirements for trace elements, etc, will be met by occasional replacement of part of the aquarium water.

The key to judging whether a giant clam is healthy is the appearance of its mantle. The giant clam mantle is a unique structure developed to contain millions of symbiotic algae and expose them to light. The mantle has two apertures to allow seawater to be passed over the gills below. Seawater is drawn in through the long aperture for respiration and filter-feeding by the gills. Water is then expelled through the round, elevated aperture. Seawater usually passes through the mantle apertures and over the gills continuously, except when the shells are closed together.

Healthy clams have their mantles projecting well beyond the edges of the shells. Unhealthy clams have discoloured mantles, which tend to remain between the shells. A healthy clam will react to movements in its vicinity, even to shadows passing over it, by quickly retracting its mantle and closing the shells. It has tiny 'eyes' along the mantle. The bright colours of some giant clam mantles are due to pigment cells at the surface of the mantle tissue. The mantle would otherwise be coloured dull brown, due to high densities of brown symbiotic algae.

Adult giant clams are hermaphrodites. When sexually mature they contain both sperm and eggs in profusion within one gonad. In spawning they shed sperm first and then eggs an hour or so later. They are extremely fecund. Even the smallest species shed millions of tiny eggs

(0.1 mm diameter) with each spawning and the largest specimens may shed a thousand million eggs. Spawning giant clams and then rearing their larvae requires quite specialized facilities and is not recommended for the aquarist. Specialised hatcheries for giant clams are being developed in the Pacific region in countries where overfishing for food and shells has severely depleted the natural stocks of giant clams.

## Research Reports and Papers in: Economics of Giant Clam Mariculture

### Previous Working Papers

1. "Market for Giant Clam Shells: Report on a Survey of Retailers and Wholesalers in Southeast Queensland, Australia." Clem Tisdell with the assistance of Rene Wittenberg, November, 1989.
2. "Seafarming as a Part of Indonesia's Economic Development Strategy - Seaweed and Giant Clam Mariculture as Cases." Carunia Firdausy and Clem Tisdell, November, 1989.
3. "Market for Giant Clams as Aquarium Specimens: Report on a Survey of Retailers of Supplies for Saltwater Aquariums, Southeast Queensland, Australia." Clem Tisdell with the assistance of Rene Wittenberg, November, 1989.
4. "Aquaculture as a Use of the Coastal Zone: Environmental and Economic Aspects, Giant Clam Farming as a Development." Clem Tisdell, December, 1989.
5. "Pacific Giant Clams and their Products: An Overview of Demand and Supply Factors." Clem Tisdell, December, 1989.
6. "Marine Property Rights in Relation to Giant Clam Mariculture in the Kingdom of Tonga." Dr T'eo I.J. Fairbairn, February, 1990.
7. "Exploring the Demand for Farmed Giant Clams and Their Components: Approaches and Problems." Clem Tisdell, February, 1990.
8. "Report on possible Demand for Giant Clam Meat by Tongan Descendants in Australia: Inferences from interviews conducted in the Brisbane Area". Clem Tisdell and Rene Wittenberg, February, 1990.
9. "Evaluation of International Trade Statistics on Giant Clams and Related Products and the Market for Giant Clam Meat." Dr John Stanton, March, 1990.
10. "Assessing Species for Mariculture in Developing Countries: A Review of Economic Considerations." Carunia Firdausy and Clem Tisdell, April, 1990.
11. "An Analysis of the Cost of Producing Giant Clam (*Tridacna gigas*) Seed in Australia." Tisdell, C.A., Lucas, J.S. and Thomas, W.R., May, 1990.
12. "Marine Property Rights Fiji: Implications for the Development of Giant Clam Mariculture." Dr T'eo I.J. Fairbairn, August, 1990.
13. "Reef and Lagoon Tenure in the Republic of Vanuatu and Prospects for Mariculture Development". Dr T'eo I.J. Fairbairn, August, 1990.
14. Progress Report No. 1 to ACIAR, Project No. 8823. Professor Clem Tisdell, August, 1990.
15. "The Potential Market for Giant Clam Meat in New Zealand: Results of Interviews with Pacific Island Immigrants." Clem Tisdell and Rene Wittenberg, October, 1990.
16. "The Potential Demand for Giant Clams in Indonesia and Their Status: A Report on a Survey of Four Coastal Villages in Bali and Java." Carunia Firdausy and Clem Tisdell, November, 1990.
17. "Traditional Reef and Lagoon Tenure in Western Samoa and Its Implications for Giant Clam Mariculture." Dr T'eo I.J. Fairbairn, February, 1991.
18. "Ocean Culture of Giant Clams (*Tridacna gigas*): An Economic Analysis." C.A. Tisdell, J.R. Barker, J.S. Lucas, L. Tacconi and W.R. Thomas, February, 1991.
19. "Aid for Village-Based Rural Projects in LDCs: Experiences, Project Appraisal and Selection, ACIAR and Giant Clam Culture as a Case". Luca Tacconi and Clem Tisdell, March, 1991.
20. "Customary Marine Tenure in the South Pacific Region and Implications for Giant Clam Mariculture". Dr T'eo I.J. Fairbairn, April, 1991.
21. "ACIAR-Supported Research on the Culture of Giant Clams (*Tridacnidae*): A Multi-Faceted Economic Assessment of Research Benefits (Draft Appraisal)". Professor Clem Tisdell, April, 1991.
22. "Economics of Ocean Culture of Giant Clams: Internal Rate of Return Analysis for *Tridacna gigas*". Tisdell, C.A., Tacconi, L., Barker, J.R. and Lucas, J.S., April, 1991.
23. "Socio-Economic Aspects of Giant Clams in The Lau Group, Fiji, and Farming Prospects: Results of Field Research". Veikila Vuki, Clem Tisdell and Luca Tacconi, June, 1991.



24. "Subsistence Economic Activities and Prospects for Clam Farming in Ono-i-Lau, Fiji: Socio-Economic Factors". Veikila Vuki, Clem Tisdell and Luca Tacconi, June, 1991.
25. "Giant Clams in Tuvalu: Prospects for Development". Luca Tacconi and Clem Tisdell, July, 1991.
26. "A Report on the Test Marketing of Giant Clams as Aquarium Specimens in Brisbane, Australia". Clem Tisdell, November, 1991.
27. "Economic Returns from Farming Different Types of Seaweed (Eucheuma) and for Farms of sizes in Nusa Penida, Bali, Indonesia." Carunia Mulya Firdausy and Clem Tisdell, December 1991.
28. "The Market for Giant Clams as Aquarium Specimens in Sydney and Melbourne: Results of a Telephone Survey of Retail Outlets." Clem Tisdell and Thea Vinnicombe, January 1992.
29. "Domestic Markets and Demand for Giant Clam Meat in the South Pacific islands - Fiji, Tonga and Western Samoa". Luca Tacconi and Clem Tisdell, January 1992.
30. Economics of Giant Clam Production in the South Pacific - Fiji, Tonga and Western Samoa". Luca Tacconi and Clem Tisdell, February 1992.
31. "Exports and Export Markets for Giant Clam Products in the South Pacific: Fiji, Tonga and Western Samoa". Luca Tacconi and Clem Tisdell, March 1992.
32. "Institutional Factors and Giant Clam Culture and Conservation in the South Pacific: Observations from Fiji, Tonga and Western Samoa". Luca Tacconi and Clem Tisdell, March 1992.
33. "Giant Clams in Wallis: Prospects for Development". Nancy J. Pollock, May 1992.
34. "Current and Potential Markets for Giant Clam Meat in Fiji - A Case Study of the Market in Suva". Vina Ram, August, 1992.
35. "Interest of Asian Restaurants in Queensland in Using Giant Clam Meat in their Cuisine and Their Knowledge of It." Clem Tisdell, September, 1992.
36. "Notes on the Use of Giant Clam Meat for Food in Taiwan". Clem Tisdell and Cheng Ho Chen, October 1992.
37. "Interest of Japanese Restaurants in Brisbane in Using Giant Clam Meat in their Cuisine and their Knowledge of It". Clem Tisdell and Yoshihiro Kuronuma. November, 1992.
38. "Business Strategies for Commercial Giant Clam Growing". Clem Tisdell and Jeremy Barker, December, 1992.
39. "Giant Clams in Japanese Cuisine - Brisbane Trials and Use in the Ryukyus". Clem Tisdell and Yoshihiro Kuronuma, December, 1992.
40. "Final Report and ACIAR Project No. 8823 (ROU 259) 'Economics of Giant Clam (Tridacnid) Mariculture". Clem Tisdell, March, 1993.