Report of a pearl oyster survey of W. Vanua Levu, Beqa, Totoya, and Makogai, in the Fiji Islands.

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November, 1995.

ACKNOWLEDGMENTS

The author would like to acknowledge the assistance of the Fiji Fisheries Division in conducting the survey. In particular, Esaroma Ledua for organising the logistics of the survey, including organising the availability of the Fisheries Division Reasearch Vessel "Gonedau". If it were not for the attention paid to these details by Ledua, the survey would not have achieved as much as it did. As team leader of the research/survey staff, he did a commendable job.

Other members of the team, Apisai Sesewa, Saiasi Yabakibou, and Joevesa Korovulavula, were also of great assistance. Apart from their support as divers during the survey, they also collected valuable information from the villages in the area of the surveys. The crew of the Gonedau also gave their fullest cooperation, and assisted the survey team in many ways..

All those mentioned in the list of people contacted assisted with their time, information, and expertise. In particular Phil Woodward and Les Allinson at SOPAC for assisting with map production, and Henry Yuen for his information viewed from his position as a shell buyer. Thanks also to Bob Gillett, Ed Lovell, and Patricia Kailola for proof reading the text, and also to Bob for providing some logistical support. The Australian Center for International Agricultural Research provided funding assistance, which was administered through the South Pacific Commission.

1. SUMMARY AND RECOMMENDATIONS

1.1 Summary

- Western Vanua Levu, Beqa Is, Totoya Is., and Makogai Is. were surveyed for stocks of pearl oysters. Two species of commercial importance were noted, the black-lipped oyster *Pinctada margaritifera* (Fijian name *civa*) and the giant winged oyster *Pteria penguin* (Fijian name *melamela*).

- Abundance of *P. margaritifera* was low at all the survey sites, with parts of W. Vanua Levu having the highest densities. *P. penguin* could be considered locally abundant in W. Vanua Levu and parts of Totoya lagoon.

- Based on the survey results, present stock numbers of *P. margaritifera* are considered too low to support an expansion of pearl farming in the areas surveyed. It is possible that higher stock densities occur elsewhere in Fiji. Anecdotal information suggests that north west and northern Vanua Levu may have higher densities. Lau Islands have also been mentioned as perhaps having higher densities. Further surveys would be needed to verify these reports.

- An increase in the use of hookah diving compressors for collecting marine resources may be contributing to the low stock density.

- One pearl farm is currently under construction in northern Vanua Levu. At best, *P. margaritifera* stocks may be able to support this single operation. Expansion of round pearl culture using *P. margaritifera* would only be possible within the next 5 to 10 years in Fiji if hatchery reared stock were available. Such hatcheries are now being experimented with in the South Pacific, and there have been some recent successes.

- *P. penguin* is probably of sufficient localised abundance to be utilised in half pearl or mabe culture. Experience in Tonga suggests that this could be successful. Spat collectors could be deployed for this species. Expertise exists already for this type of pearl culture in Fiji, and could possibly be utilised to begin mabe pearl production in the near future.

1.2 Recommendations:

The following recommendations are not presented in any particular order of priority.

1. A total ban on hookah compressor diving for commercial fishing. There should be no discretionary exemptions. These are only providing short term gains, at the expense of long term sustainability of marine resources. This ban should be enforced at the village level, as well as a national level.

2. A ban on the collection of both *P. margaritifera* and *P. penguin* for mother of pearl (MOP). Remaining stocks should be conserved to support the possible expansion of pearl farming. The ban could best be enforced at exporters and button manufacturers. The ban could be lifted, with limitations, when stock numbers increase. This is not expected to occur in the short term, if at all. At least 10 years would be required.

3. An extensive education campaign in the villages should be undertaken prior to the introduction of the bans mentioned above. The bans will only work if the people realise why they are being instituted, and if they are enforced at the village level. It should be pointed out that future generations will only be able to benefit from the marine resources if their sustainability is ensured. Pearl farming can be quite lucrative, but only if there are sufficient pearl oysters (*P. margaritifera* and *P. penguin*) to support it.

4. Fiji should investigate the viability of establishing a pearl oyster hatchery, either at Makogai or elsewhere where conditions are favourable. This hatchery, **if successful**, could allow Fiji to enter into round pearl farming using *P. margaritifera* much more rapidly than by waiting for natural stocks to recover.

5. Additional survey work should be carried out in other parts of Fiji. Northern Vanua Levu, northern Lau, and Wailagilala Atoll should be considered. Additional information should be gathered from buyers prior to another survey to determine other areas to target.

2. INTRODUCTION

The Fiji Fisheries Division has been approached by commercial interests who have expressed interest in initiating pearl farming in Fiji waters utilising the black lip pearl oyster *Pinctada margaritifera* or *civa*. In order to assess the viability of pearl farming ventures in Fiji, the Fisheries Division decided additional stock abundance survey work was required. Although a previous pearl oyster survey had been carried out (Murray, 1992), it was felt that this should be expanded upon. The fisheries division asked the South Pacific Commission (SPC) to provide technical assistance to carry out a pearl oyster survey, so that the investors could be given accurate advice on the potential of pearl farming here.

A consultant with extensive experience with pearl oysters in the Cook Islands was recruited by SPC for a period of 5 weeks to assist the Fisheries Division with the survey, and to recommend what future steps could be taken to initiate pearl farming in Fiji

3. METHODOLOGY

The Fiji Fisheries Division selected 4 locations to be surveyed prior to the arrival of the consultant. Criteria for selection were:

1. Areas in which previous resource surveys using SCUBA, (eg. giant clam surveys) had indicated possible suitable habitat for *P. margaritifera*.

2. Areas where potential investors had expressed some interest.

3. Areas within a reasonable range of Suva for the Fisheries vessel Gonedau.

4. Areas where, if a spat collection, a farming operation, or hatchery work was deemed to be worthy of further investigation, a fisheries station was located in the vicinity to oversee a pilot project

5. Areas shown to be productive in a previous pearl oyster survey of Fiji (Murray, 1992)

Based on one or more of these criteria, western Vanua Levu, Beqa, Totoya, and Makogai islands were selected.

Aerial photographs were ordered to assist in more localised selection of dive sites in these areas. However, these were not available until after the field work was completed. Nautical charts were therefore used for this purpose.

Based on anecdotal information and the results of the 1992 survey, it was not expected that high densities of *P. margaritifera* would be found. The laying of transect lines was therefore not considered to be an appropriate method for this survey.

Upon selection of a reef site, a buoy was placed at the spot where the survey dive was to begin. 4 or 5 divers, using scuba, swam along the reef edge, separated by approximately 4 metres. After several dives, each diver was asked to estimate the width of reef slope that they considered that they could survey. A general agreement of 3 meters per diver was reached. At the completion of each dive, and estimate of the distance covered was obtained by visual sighting back to the buoy, and also by timing the skiff in returning to the buoy at an estimated speed of 8 knots. An estimate of reef area covered was obtained by multiplying the number of divers by the width surveyed by each diver, and then by the total distance covered. A rangefinder would have made this estimate more accurate, but was unavailable. Similarly, a GPS would have been useful to confirm the estimate[1]. However, the GPS available was found to be unsuitable for installation in an open skiff.

An additional measure of catch rates was made by dividing the total number of pearl oysters found by the total number of diver hours, to give number of shells per diver hour.

[1] Assuming an accuracy of around 50 meters for a GPS location.

While it is realised that this may not be a strictly accurate method of survey, it was felt that it was the most appropriate given the available resources and low stock numbers.

Initially, the survey only considered *P. margaritifera*. However, after the first 3 dives, numbers of the giant wing oyster, *Pteria penguin*, were observed. Recognising the potential of this species in half pearl (mabe) production, these were subsequently included in the survey.

P. margaritifera were measured (approximate) and the water depth noted. *Pteria penguin* were counted only.

4. RESULTS

Figure 1 shows the location of the survey sites, and figures 2a to 2f show the approximate locations of the dives at each survey site..

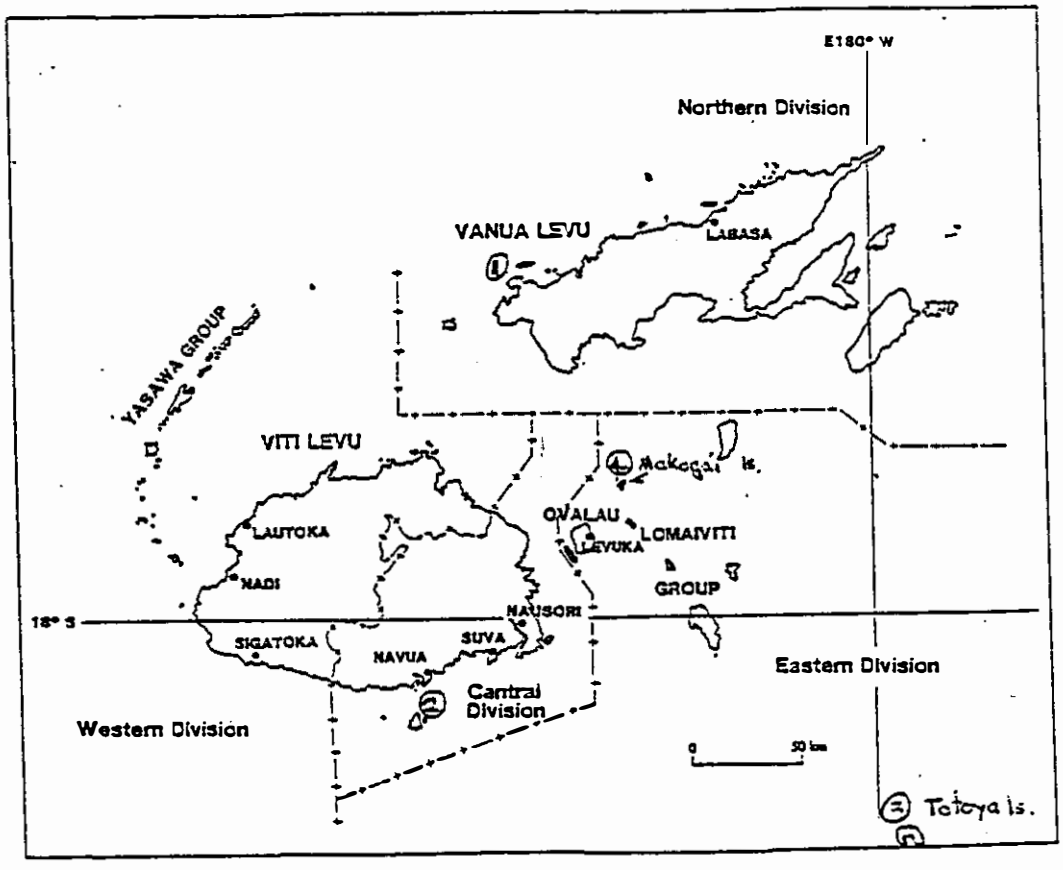


Fig. 1 Map of Fiji showing central, western, northern, and eastern divisions, and the 4 areas surveyed.

Fig. 2a. (dives 1 to 4) W. Vanua Levu.

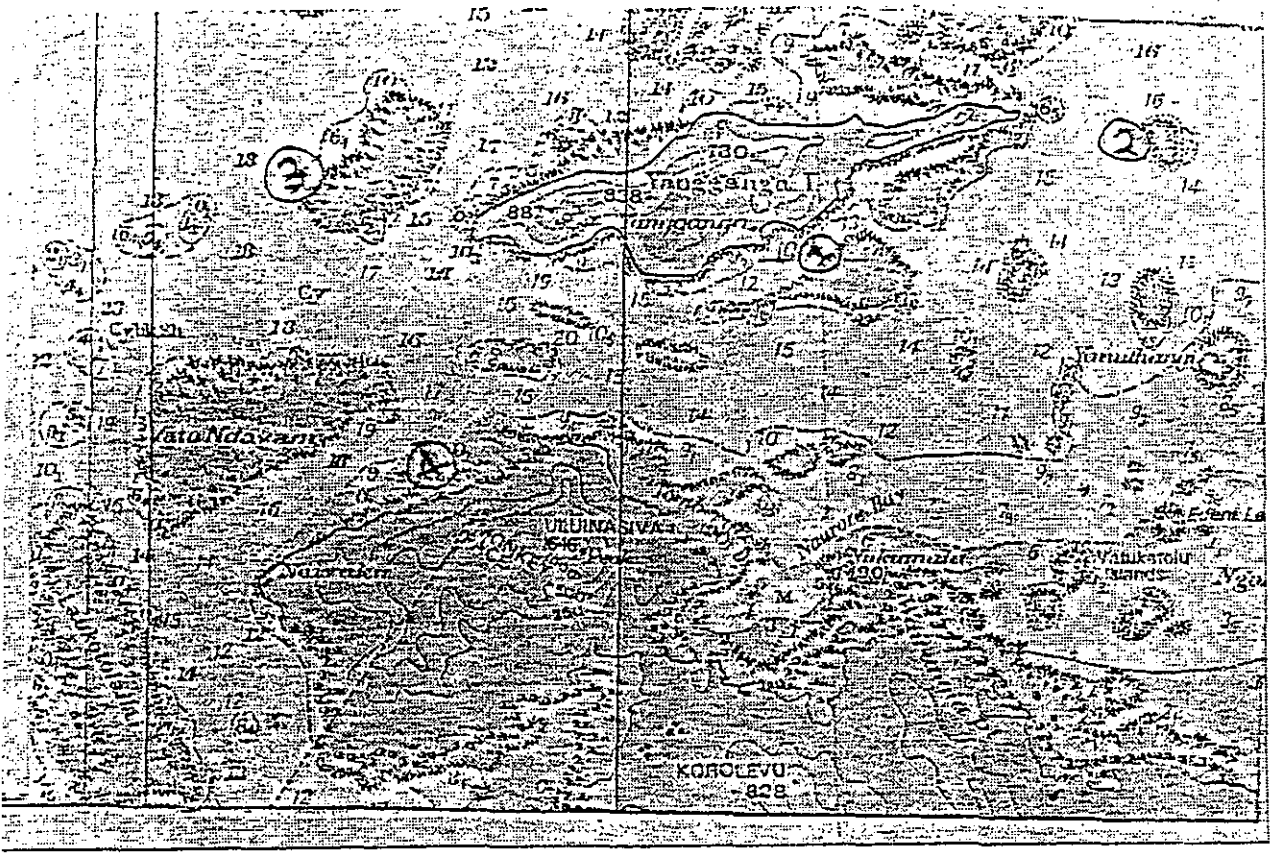


Fig. 2b (dives 5 to 8)

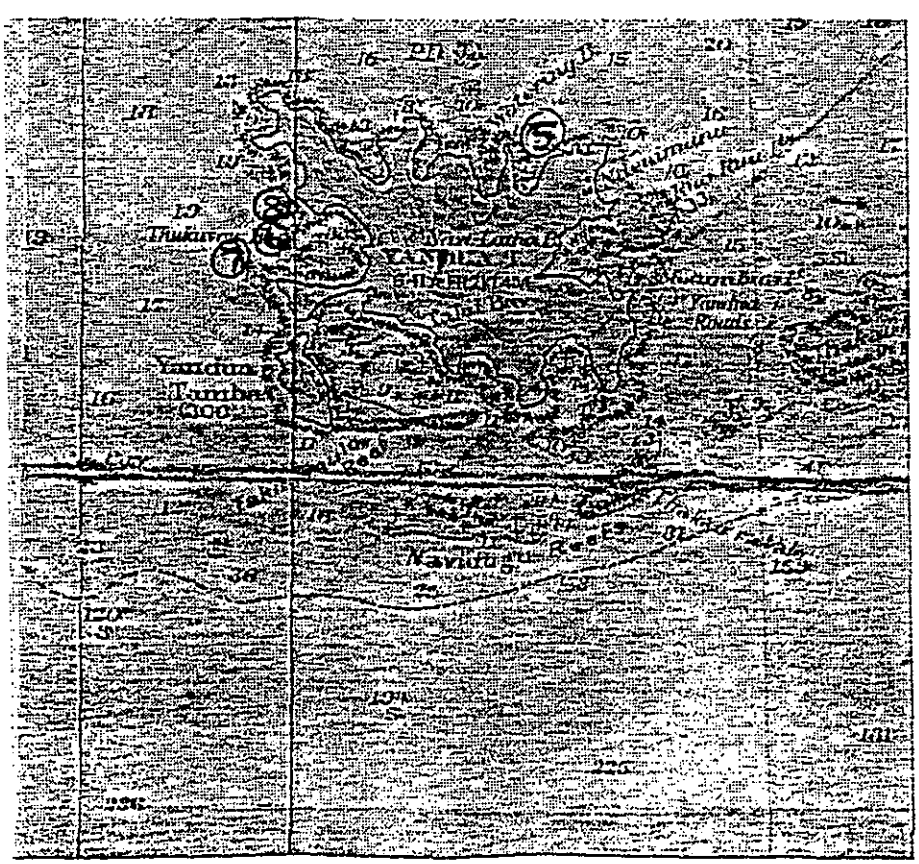


Fig 2c. (dives 9 & 10) W. Vanua Levu.

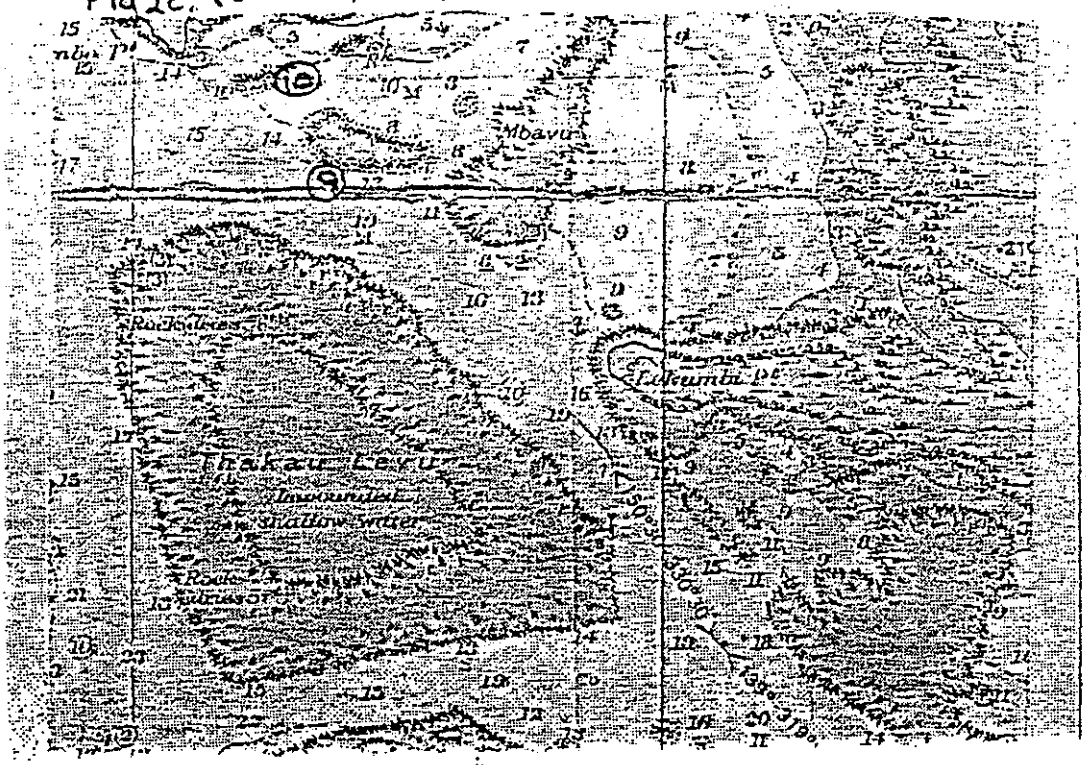


Fig 2d. (dives 11 to 17)

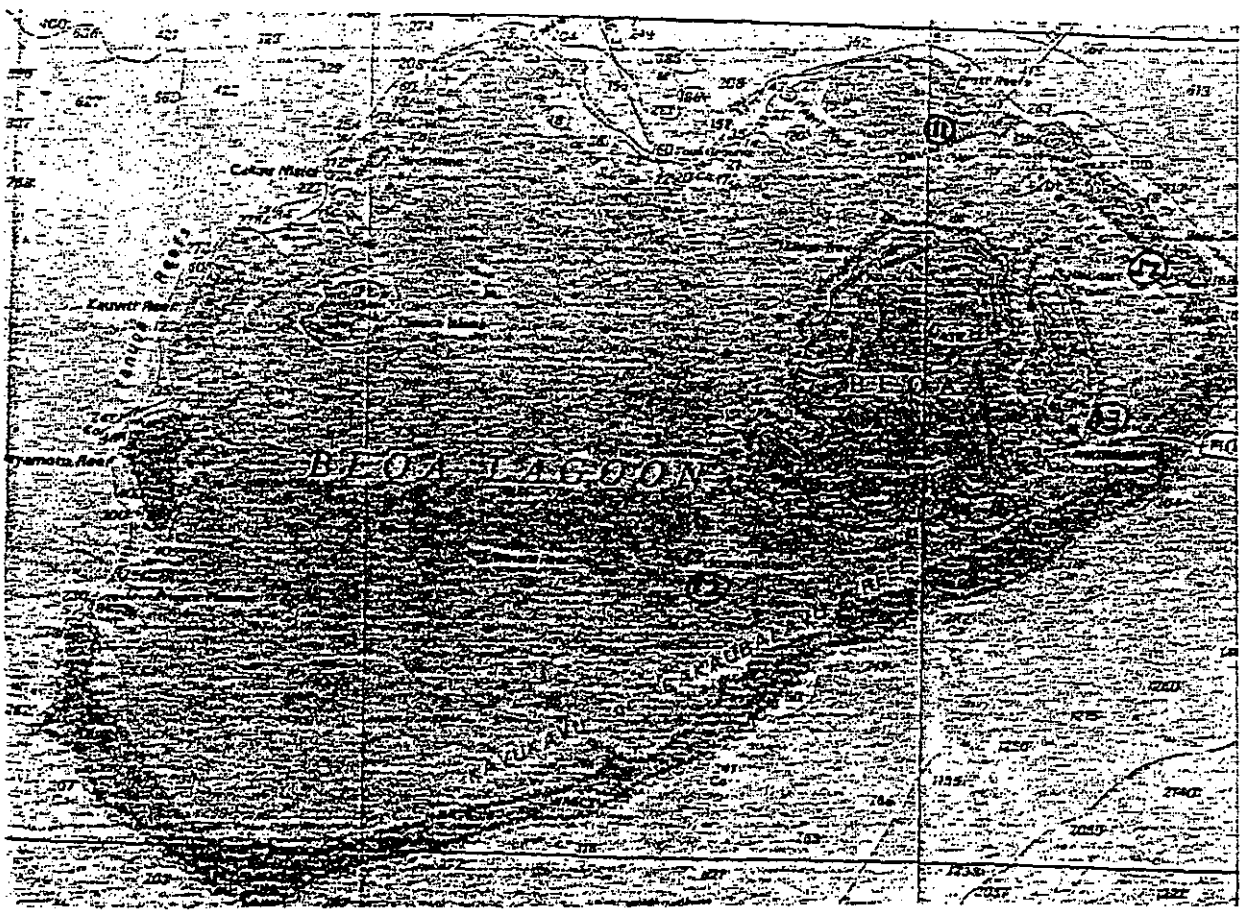


Fig. 2e (dives 18 to 27)

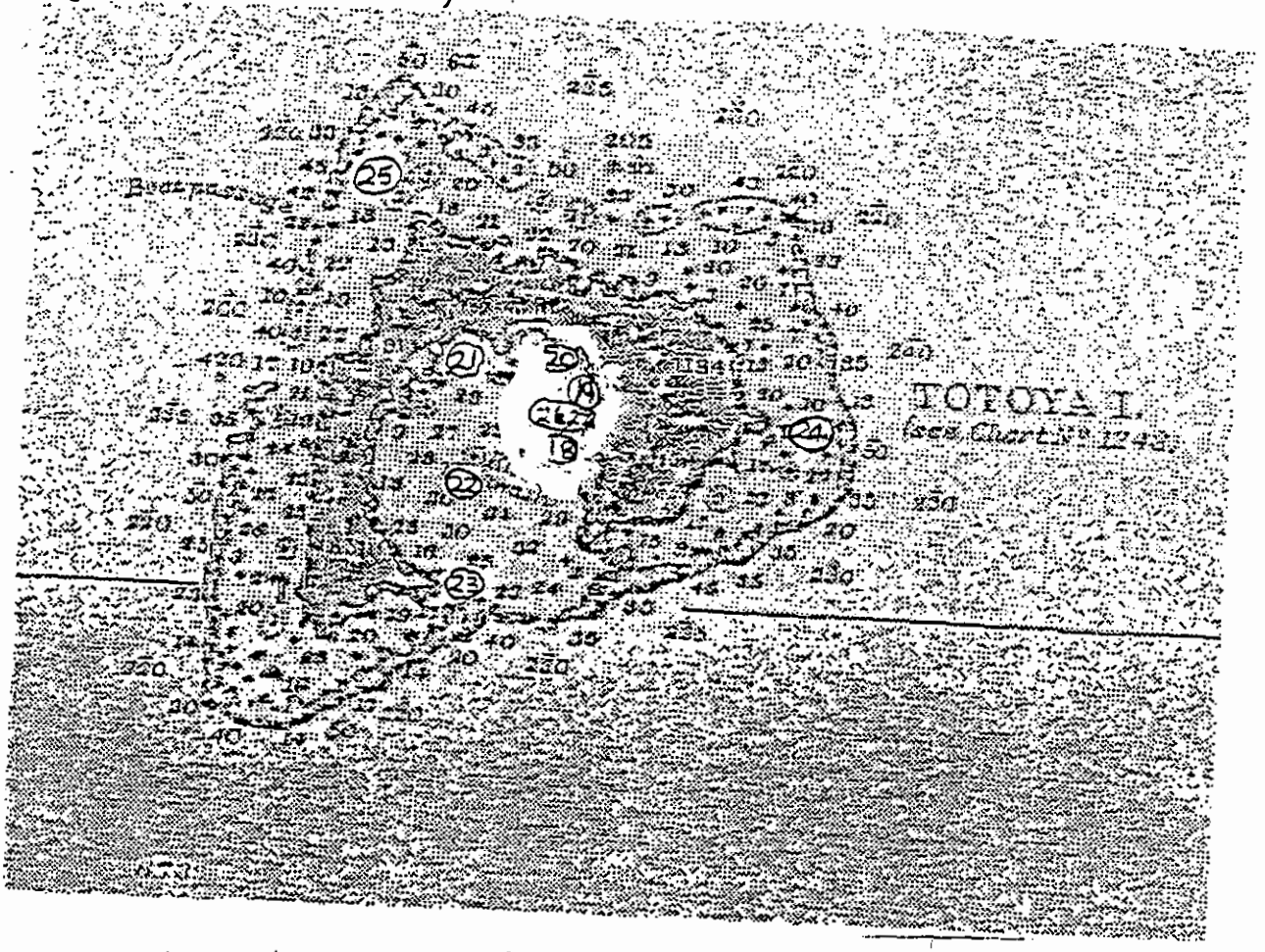
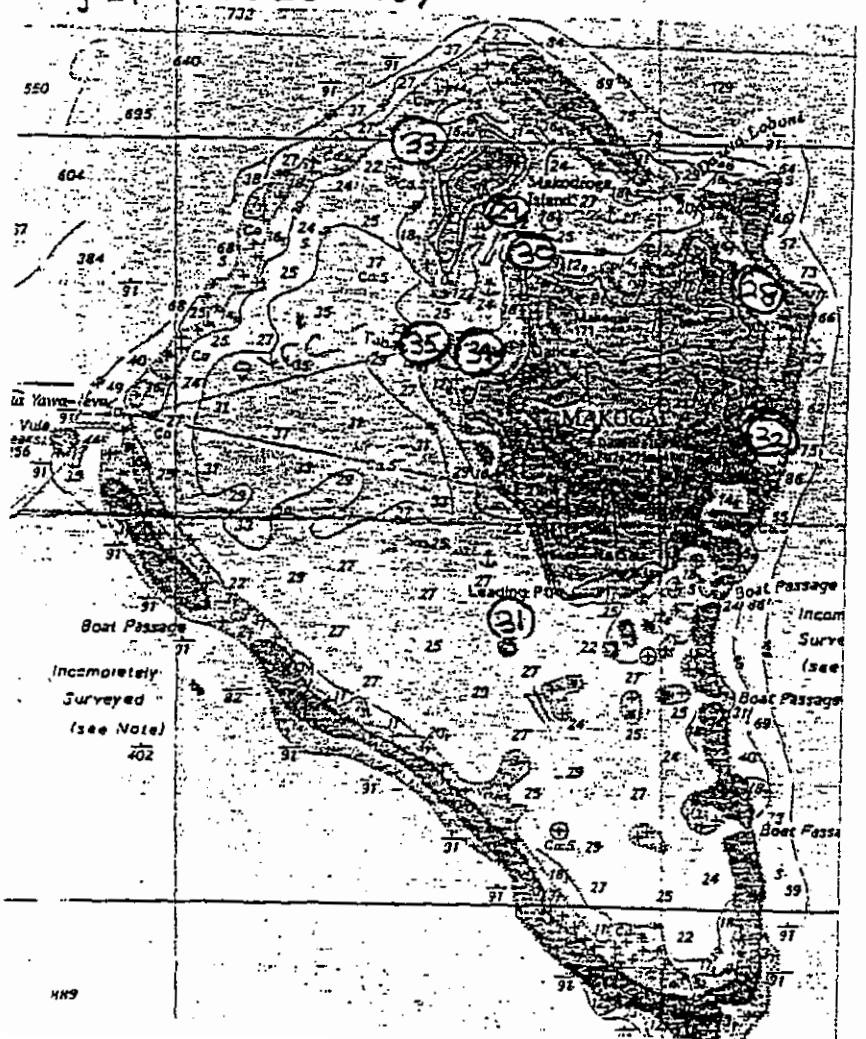


Fig 1f (dives 28 to 35)

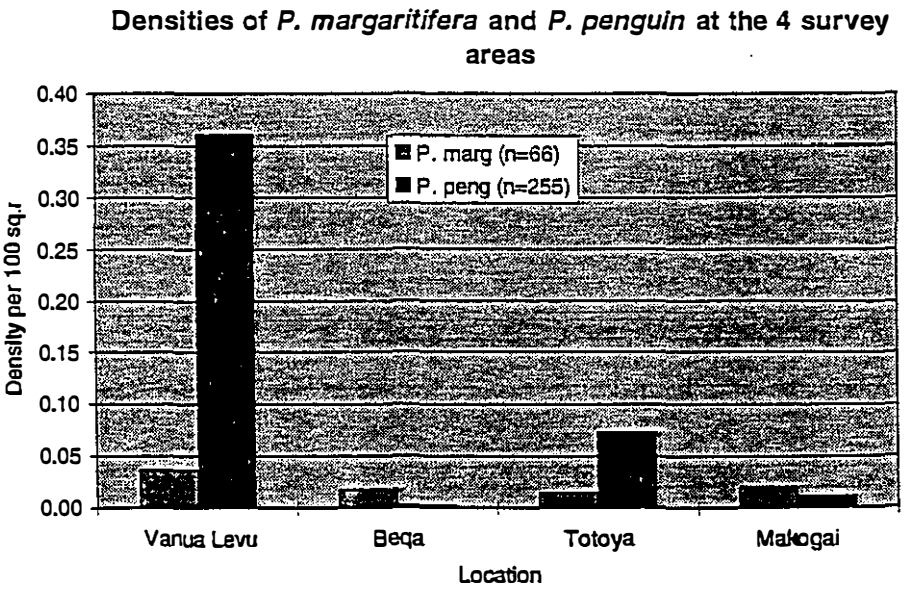


A total of 35 dives for 5 divers, of an average duration of 40 minutes gave an overall dive time of around 116 diver hours. A total 66 *P. margaritifera* were found, or around 0.56 per diver hour. For the 32 dives (107 diver hours) in which *P. penguin* were counted, 255 were found, or 2.4 per diver hour. The average density per 100 sq.m. for *P. margaritifera* was 0.02, and 0.08 for *P. penguin*. *P. penguin* was therefore approximately 4 times more abundant than *P. margaritifera* overall for the survey sites.

Overall oyster densities were very low, particularly for *P. margaritifera*. Vanua Levu had the highest densities for both species, with 0.04 per 100 sq.m. for *P. margaritifera*. *P. penguin* could be considered locally abundant in parts of W Vanua Levu, where a maximum density of 0.33 per 100 m^2 was recorded.

Figure 3 shows the average densities per 100 sq. m. by location.

Figure 3.



Most of the *P. margaritifera* found were in the range of 15 to 17 cm dorso-ventral measurement (DVM). Fig 4 shows the size frequency relationship for all *P. margaritifera* found.

Figure 4.

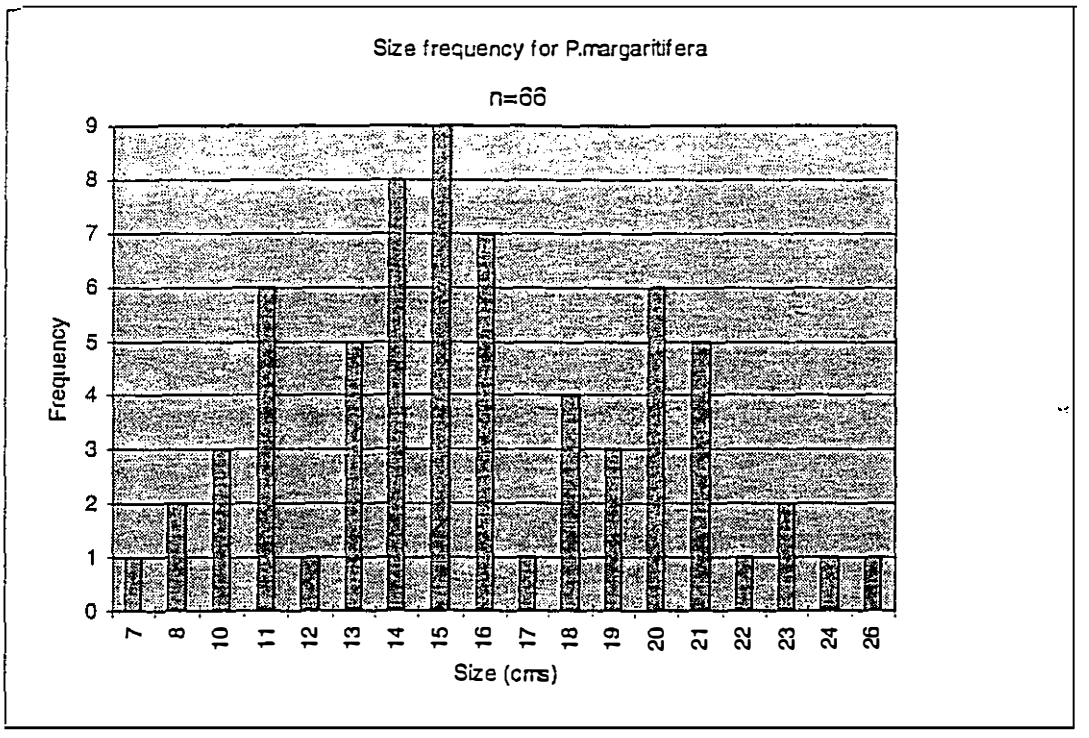
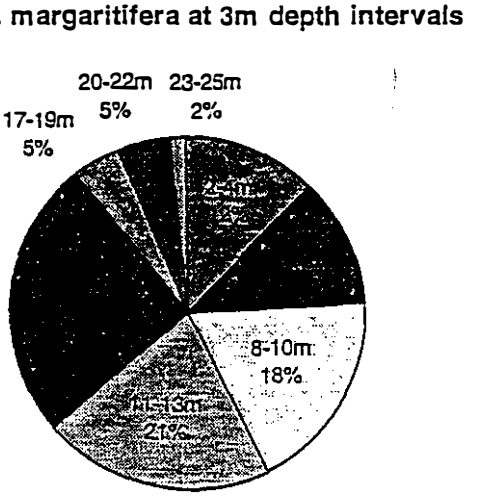


Figure 5 shows the depth distribution of *P. margaritifera*. The majority , 64%, were found between 8 and 16 metres depth, with only 12% found deeper than this.

Figure 5.



The other major large bivalves found on the survey, with their common English and Fijian names, were:

Lopha cristagalli or cocks comb oyster (*dio vatu*)

Hyotissa hyotis or honeycomb oyster (*vasua vatu, dio vatu*)

Spondylus squamosus or ducal thorny oyster (*kalokalo*)

Chama sp. or jewel box oyster (*su*)

5. DISCUSSION

The following is a discussion of results, combined with other relevant information, for each location This is followed by a discussion on P. margaritifera and P. penguin. Some areas of concern are noted, and recommendations are also made.

5.1 Locations

5.1.1 West Vanua Levu

Of the sites surveyed Vanua Levu had the highest stock numbers for both species. Discussions with locals at Naivaka Village, Yaggaga Island, indicate that a middle man is present. He buys *P. margaritifera* at $4.00 per kg, and the villagers collect about 80 kg per month. This is apparently collected by 3 or 4 villages in the area. There is also a middleman in Galoa and a cooperative store which buys shells in Yadua.

5.2.2 BEQA

Beqa had low densities of both species of pearl oyster. Its proximity to Suva, and popular site for diving, may have some effect. It is reported that aquarium fish collecting is also widespread there, and it is possible that divers incidentally pick up pearl oysters, though no evidence of this was obtained. One company advised that penalties are severe for any collector from their company caught taking anything other than aquarium fish (J. Maloney, pers comm.).

Beqa has around 11 villages in 2 districts. Apparently there are about 6 hookah compressors operating from Beqa. These are supplied by middle men. Apparently these middlemen also provide boats and outboards in some cases. The presence and entrepreneurial nature of middle men, while assisting in providing a market for marine resources from remote areas, would appear to be having a negative impact on the high value sedentary resources, including pearl shell, sea cucumbers, trochus, and lobsters.

In the past, there have been a number of FAO designed 28 ft fishing vessels bought by people in Beqa. Some were financed by Fiji Development Bank (FDB) loans. One plausible scenario given by fisheries staff is that a high level of exploitation of Beqa's marine resources was the result of fishermen attempting to service these loans.

Despite this, the vessels were all repossessed because fishermen defaulted on payments. The sedentary resources of high value, including pearl shell, would have been the obvious choice of fishermen.

It is also reported that Beqa is regularly visited by poachers who also utilise compressors.

5.1.3 Totoya

Totoya has 4 villages. By locally decreed and enforced legislation, compressors are not allowed to be used on the island. Although compressors are not used, pearl oysters are still uncommon, even at depths beyond free divers cap abilities. Pteria

penguin were common in some deeper areas of the lagoon. There is one villager who buys pearl oysters (*P. margaritifera*) for use as MOP. He reports that he gets approximately 20 bags (around 1400 kg) per year. This would equate to around 4500 shells per year. Our survey would suggest that this is perhaps an overestimate. It is possible that he is including trochus and *P. penguin* in his figures.
P. penguin were found in reasonable densities immediately in front of Ketei village, in at a depth of 25 to 30 metres. Spat collectors set in this area, below 15 meters, may have positive results.

5.1.4 Makogai

Makogai is the site of a Government agriculture station and the Fisheries Division giant clam hatchery. It was chosen as a survey site because, if spat collector trials or a trial farm was set up, there would be staff to oversee the project. Security would also not be a problem. Parts of the lagoon are kept as a reserve, in which it was hoped we would find unfished stocks of pearl oysters.

Results for Makogai were no better than for the other sites. By the end of the survey, 20 oysters had been collected and placed in the front of the hatchery. Research and hatchery staff were to continue collecting any *P. margaritifera* and *P. penguin* found. These would then be available for brood stock should hatchery trials ever eventuate.

5.2. General Discussion

5.2.1. *P. margaritifera*

The depths at which *P. margaritifera* were found tell us something about their preferred habitat and fishing pressure. In an unfished population, you would expect to find the majority of oysters above 8 metres in depth. The lower numbers found in these depths in this survey (24% of the total) would probably be the result of fishing pressure at these depths. Below 8m, free diving is more difficult. Although there is no doubt that hookah compressors are used to some extent, these are probably more

often used on the sandy sea floor where the sea cucumbers are more common, thus leaving the pearl oysters on the deeper reef slope relatively unfished.

The number of *P. margaritifera* found in the study areas are insufficient to consider establishing commercial pearl farming based on the wild stock of this species. It is unclear if low stock numbers are due to overfishing, or other causes. It is difficult to ascertain wherther there have ever been large stocks of *P. margaritifera* in Fiji. Exports from Fiji have never been high. From 1930 to 1938, an average of 4.1 mt was exported per year, with a high of 10.9 mt in 1931 (Hornell, 1940). From 1975 to 1985 an annual average of 18.6 mt was exported. Exports reached a peak in 1988 of 57.5 mt, and have since declined, with a 1994 export of 12.5 mt (Anon, 1995). The peak in 1988 may have been due to several factors. The price for MOP in Fiji nearlydoubled from $6.34/kg in 1987 to $12.48 in 1989 (Anon., 1988; Anon., 1990) Increased access to bank finance allowed more villagers to purchase boats, engines, and equipment (Richards, 1994). Government vessels were utilised extensively after the 1987 coup to travel around Fiji waters collecting marine resources from villlages, some of which may have previously had limited access to markets. It is possible that this high rate of exploitation was unsustainable, resulting in lower stock densities today.

The number of *P. margaritifera* found is also too low for spat collection to be considered economically viable. The number of spat collected would probably not justify the time and expense involved in setting up and monitoring spat collectors.

However, discussions with Mr Tokito, who previously operated a pearl farm in Fiji and is currently setting up a farm near Labasa, indicate that their may be some locations with greater stock numbers in other parts of Vanua Levu. He is optimistic about establishing a farm utilising around 15,000 oysters per year for the next 5 or six years, although it is unclear how he arrives at these figures. Locations he suggested that may have higher stock densities were Galoa Is., Navidamo village near Raviravi, and Nadogo Reef, in Northern Vanua Levu . Dependant on results of further surveys, spat collection may be possible in these locations. However, the question of who

would maintain them and ensure their security so far from a Fisheries Division station would need to be addressed. Perhaps village level management would be possible.

5.2.2. *P. penguin*

The number of *P. penguin* found in the survey around W.Vanua Levu was more promising. If pearl farming were to start on a wider basis than at present, it may be possible to begin with mabe (half pearl) utilising this species. Mabe are being produced in Vava'u in Tonga on *P. penguin* that was introduced from Japan in the 1970's. Apparently the project is going well. Some published figures indicate a 65% return of marketable mabe pearls which had an average value of $US37 each ((Gillett, 1993).. Up to 3 nuclei can be implanted in 1 oyster. This would provide a yield of around $US72 or $FJ100 per oyster. Mr Tokito has also produced these mabe pearls in Fiji, and was employed to show the Tongans how to seed their *Pteria penguin*. He has indicated that he may be available to assist a similar project in Fiji depending on his work load at his own farm. Pearl farming in Fiji could possibly start off with *Pteria penguin* mabe pearls, and proceed to round pearls when sufficient stock of *P. margaritifera* are available.

Spat collectors could also be set for *P. penguin* in areas where natural stock has been found to settle. These should be set deep, between 50 and 80 ft, as *P. penguin* shows a preference for these depths. Deeper than this could cause problems with diving safety.

P. penguin was found to settle almost exclusively on black coral trees (SPECIES). This should be kept in mind in the event of any requests to collect black coral by coral collectors and exporters. The present status of black coral collection in Fiji is unknown.

5.3. Other Issues

5.3.1. Location for pearl farms

Given the results of this survey, it may be a little premature to discuss sites for pearl farms. However, for the record, and perhaps future use, it should be noted that satellite images are available for Fiji waters which can indicate areas of high productivity which would be beneficial to a large number of filter feeders such as pearl oysters. One of these images (Nimbus 7 Coastal Zone Satellite Image, May 7, 1981) was observed which showed areas in northern Vanua Levu to be very productive. Interestingly this was also the area found to have the highest concentration of large bivalves, including *P. margaritifera* and *P. penguin*, of our 4 survey sites. There is currently a joint ORSTOM/ USP project investigating carbon fixation and productivity in some areas of Fiji, and publications may shortly be available (Peter Newell, pers. comm.).

A number of sites were observed during the survey that have the physical requirements for pearl farms, ie good water exchange, protected from bad weather. There should be no trouble with suitable locations if stocks of oysters are available. Security of sites however is another issue which cannot be addressed in this report.

5.3.2. Hookah Compressor Diving

Although it is difficult to get absolute numbers on hookah compressors operating in Fiji, one of the compressor retailers in Suva indicated that they are selling approximately 4 hookahs per month, and have been doing so for about the last 6 months. Another retailer has recently been asked to quote on 10 complete hookah diving sets, as well as associated underwater fishing gear such as spear guns.

Discussions with locals from Yaggaga indicate 3 to 5 hookahs working from their village. 8 hookahs are reported to operate from Galoa, where there is also a

middleman buying on behalf of Fijian/Chinese businessman. Yadua residents indicate that there are no hookahs in the village. However, the 3 hookahs from Yaggaga have been utilised extensively this year to help raise money to build the Yadua village church. Beqa is also reported to be regularly visited by poachers who also utilise compressors. Of the sites visited, only Totoya has a locally enforced ban on the use of compressors.

Fisheries staff indicate that there is an official national ban on compressor diving in Fiji. However, exemptions can be given at the discretion of the Minister for Fisheries, and during our survey we found the use to be widespread in two of the areas, Beqa and Vanua Levu. The exemptions are apparently given so that communities can raise funds for some community project such as to help fund a community hall or new school building. However, the resources may not outlast the number of community projects that need funding. Other resources such as sea cucumbers and trochus would probably greatly benefit from a total ban on hookah, with no discretionary exemptions. Localised bans, such as in Totoya, which are decreed and enforced at the village level, would have the best chances of success.

5.3.3. Total ban on collecting *P. margaritifera* and *P. penguin* for mother of pearl.

From observations and discussions with villagers during the survey, it is apparent that nobody is relying on *P. margaritifera* for a living. At the most, people may pick up 1 or 2 occasionally while fishing for other resources. It may therefore to be appropriate to place a total ban on killing pearl oysters for export as MOP. This may assist stocks to grow over the long term to eventually support pearl farming. The best place to police such a ban would be through controlling exports and at button blank factories.

One buyer was interviewed on the effects of ban. They pay $3.00 per kg for *P. penguin*, and between $5 and $6 for *P. margaritifera*. Most *P. penguin* appears to

come from south Vanua Levu and north Viti Levu. They export some unprocessed, and use some in button manufacture, usually only when they cannot get enough trochus for their production capacity. Only about 20 % of their production is from pearl shell, the other 80% being from trochus.

A ban on pearl shell processing and exporting would affect their operation, but not critically so, as the bulk of their raw material is trochus shell. Their main concern is in the sustainabilty of the resources, as they have made a major investment in setting up their factory.

Eventually, if pearl farming did start, shells would again be available for button manufacture or export, when they were no longer suitable for culturing pearls.

The same argument could be put forward for *P. penguin*. However, as these would be utilised for mabe pearls, they would not be suitable for button manufacture afterwards as the shell is cut to harvest the mabe pearls. However, they would still have some value as MOP.

5.3.4. Hatchery

It appears that the only opportunity for an expansion of pearl farming in the near future in Fiji lies with the hatchery production of spat. Even if areas with more wild stock than that found on this survey were located, these would still probably at best support the one farm that is currently being set up in Vanua Levu.

The Fiji Fisheries Division has a giant clam hatchery on Makogai Island. This could possibly be modified to cater for pearl oyster spawning. The one drawback is limited power supply. An algae lab should require air conditioning on a 24 hr basis. There is a generator available that could run for 24 hrs per day during spawning runs if

required. However, depending on the attempts at producing a micro encapsulated diet, an algae lab may not be necessary Discussions with the hatchery manager indicate that giant clam spawning finishes around October. Based on findings in Cook Islands, August to October may be the best times for spawning *P. margaritifera.*

The FAO South Pacific Aquaculture Development Programme (SPADP) indicated they would possibly be able to assist in setting up a hatchery, using expertise from Okinawa. However, Makogai would not be considered because it is too isolated. An ACIAR project in Kiribati has also recently had success in spawning *P. margaritifera* in a comparatively low cost hatchery (Ito et al, 1995). The Tongareva hatchery in the Cook Islands has also had some spawning success, as has a commercial hatchery in Hawaii.

6. Conclusion

" The only abundant pearl-shell of sufficient size for commercial use in Fijian waters is the inferior quality known as black-lip" (Hornell, 1940).

Mr Hornell may have been correct in this statement in 1940, although the term "abundant" is relative. The status of *P. margaritifera* stocks in Fiji could not be termed abundant relative, for example, to stocks in Manihiki and Penryhn lagoons in the Cook Islands..

Based on information from local buyers and middlemen, around 2800 *P. margaritifera* may be collected per year from Totoya, and similar numbers from the other localised areas.. Information from villagers and buyers in W. Vanua Levu suggests that around 3,000 kg per month are collected from this area or perhaps around 9000 shells depending on the size. The percentage of these that would be suitable for growing pearls is unknown, but based on the size frequency data collected during this survey, only around 50% may be suitable. It could therefore be expected that a farm may get as few as 4000 useful shells per year from this area, if they were all sold to the farm.

Based on the Cook Islands, experience, this is insufficient for a commercial farm. Technicians can be the most difficult component of a pearl culture enterprise to arrange. They are expensive, and usually a large number of shells are required to make it worth while paying their travelling and other expenses. A farm or farms with a combined total of around 10,000 oysters would normally be needed to make it worthwhile engaging the services of an experienced seeding technician on a commercial basis.

A spat collector programme would be a costly affair, and the results are unlikely to justify the expense or effort involved in setting collectors for *P. margaritifera*. However, for *P. penguin*, it may be worth doing some trials in W. Vanua Levu or Totoya, with collectors set below 15 m..

It is possible that higher densities of *P. margaritifera* exist in other parts of Fiji. The best indicator of where these places may be would be from the buyers of MOP. However, the final buyers often purchase from middlemen, making the origin of the shells hard to find. Possibilities include Wailagilala (the only atoll in Fiji), and northern Lau. Reports from buyers and other anecdotal information gathered during this survey also suggest higher stock numbers in northern Vanua Levu.

On a more positive note, there are sufficient *P. margaritifera* to be utilised as brood stock in a hatchery. Skilled hatchery personnel are available in Fiji, and with some technological transfer of information from an experienced pearl oyster hatchery specialist, they could probably successfully operate a pearl hatchery. Although the existing giant clam hatchery at Makogai may not be considered the ideal location by everyone[2], the fact that it already exists would make it the logical site for the hatchery, at least until a more suitable site is located. Significant changes to the existing design should not be necessary. ACIAR has recently sponsored a small scale successful pearl oyster hatchery in Kiribati, and may be in a position to assist Fiji with finance and/or technical expertise.

[2] Mr Tanaka of SPADP indicated that they would not be able to support any attempts to initiate a pearl oyster hatchery on Makogai, principally because of its isolated location and lack of regular transport.

References.

Anon. 1988. Fiji Fisheries Division Annual Report 1987.

Anon. 1990. Fiji Fisheries Division Annual Report 1987.

Anon. 1995. Fiji Fisheries Division Annual Report 1987.

Gillett, R. 1993. Half pearls from Vava'u oysters. *in* Matangi Tonga, May-June.

Hornell, J. 1940. Report on the Fisheries of Fiji Government Printer, Suva.

Ito, M., J. Whitford, B. Tioti, and T. Tabee. 1995. Artificial Propagation of Pearl Oysters: Present Status and Future Development in Oceania. Technical Paper S7-1, presented at the JICA/Ministry of Fisheries Aquaculture Workshop, Nov. 20-24, 1995, Nuku'alofa, Tonga.

Murray, P. 1992. Pearl Oyster Survey of Fiji Waters. (Preliminary Report only) FFA/Fiji Fisheries Division Report.

Richards, A. 1994. Fisheries Resource Profiles FFA Report 94/4. Forum Fisheries Agency, Honiara.

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Loel Peters (Fiji Recompression Chamber Operator)
Newton Yuen (Yon Tong Company, peal shell buyer)
Clyde Equipment (hookah diving compressor supplier)
Bob Gillett (Gillett, Preston and Associates)
Professor Peter Newell (USP Biology Dept).
Hydeyuki Tanaka (SPAPD)
Ed Lovell (Biological Consultants Fiji)
Robert Smith (Marine Geologist, SOPAC)
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Phillip Woodward (Chief Cartographer, SOPAC)
Kenneth Seeto (beche de mer buyer)
Jim Maloney (Aquarium Fish Fiji)
Jamie Whitford (Hatchery Specialist, Kiribati)
Vukila Vuki (Oceanography Lecturer, USP)
Tim Pickering (Marine Biology Lecturer, USP)

Itinerary

Nov 1, 7.25pm depart Rarotonga
Nov 2, 9 pm arrive Nadi, overnight in Nadi
Nov 3 11 am, depart Nadi
12 am arrive Nausori, proceed to Nabua, meet Ledua, pick up per diem
2pm. Meet with Ledua, Sesewa, Apisai, and Joe to discuss trip needs.
8 pm. depart fisheries wharf on Gonedau.
Nov. 4. 10 am. Arrive Nabouwalu, Vanua Levu. Meet with local fisheries officer. Apisai and Joe depart by 4 wd to present Sevusevu to Tui Bua, and also the traditional owner of Yadua, and one other chief.

Nov 5. Depart Nabouwalu. Arrive Yaggaga. Sevu sevu presented.

Nov 6. Do 3 dives around Yaggaga.

Nov. 7 1 dive in morning, then move to Yadua Is. Sai etc present Sevu sevu. Ledua, Joe and myself complete 1 dive (dive no. 5).

Nov. 8. Strong wind warning. Complete 3 dives at 2nd anchor position (North Yadua). Also snorkelled along about 500m reef edge in shallow water, but saw nothing.

Nov. 9. Strong wind warning continues. The skiff is damaged when it overturns on its way back from Yadua village. The 15hp engine is also damaged. The crew manage to repair the skiff temporarily to allow for 2 dives at Bua Bay., using the spare 25 hp engine. Move to Bua Bay. Do two dives here. 2 rivers flow into the bay. Move to Nabouwalu and refill freshwater. Freshwater pump is found to no longer work

Nov 10. Head for Natovi landing, where we meet the mini bus and travel back to Suva. The boat will arrive in Suva tomorrow, where repairs to freshwater pump can be made. Another skiff and engine will be picked up in Suva.

Nov. 11. Report writing. Identify some shell specimens.

Nov 12. Continue report writing, meet with Julian Dashwood.

Nov. 13. To Lami Fisheries. Meeting with research dive team to organise next trip logistics. Met with acting Director Tui Laucala to brief him on progress so far. Into Suva and met with Tanaka. We discussed several issues, including hatchery technology, the Pteria penguin project in Tonga. Also failed to find Thunder's report. Went to USP library to see what information available on pearl oysters in Fiji (none).

Nov 14. To Marine Studies, USP. Discussions with Vukila Vuki regarding what would be necessary for pearl farming development in Ono I Lau. PM, see boat off to Beqa. They will do Sevusevu tonight.

Nov 15.. Meet boat at Navua. Some delay due to problems getting the fibreglass skiff. Eventually reach Beqa after lunch. Do two dives.

16. Do 4 more dives. Evening ashore talking to Dukuibeqa villagers.

Nov 17. One dive AM. then depart for Suva. Friday PM. enter data for Beqa.

Nov. 18 Report writing, Suva

Nov. 19 day off.

Nov. 20 Preparation for evening departure. 9 pm depart Suva for Totoya.

Nov. 21 12:15 pm, arrive Totoya. Sevusevu presented; 2 dives in afternoon

Nov. 22 4 dives.

Nov. 23 Compressor playing up. Manage only 2 dives.

Nov. 24 Compressor still playing up. Another 2 dives only;
4 pm depart Totoya for Suva

Nov. 25 Arrive Suva 6 am. Data entry and report preparation.

Nov. 26 Day off.

Nov. 27 Met with Tanaka again regarding *P. penguin*. Showed him some samples. Preparation for early AM departure on Tuesday .

Nov. 28 AM depart Suva. Arrive Makogai at 9:30 AM. 3 dives.

Nov. 29 3 dives. Discussions with Ledua and Ben (hatchery manager) on requirements to spawn pearl oysters.

Nov. 30 2 dives AM. Pearl oysters collected for potential brood stock and aggregated in front of hatchery. PM departure for Natovi landing, mini bus to Suva.

Dec. 1. At Lami fisheries discussing and training in analysing data on Excel.

Dec. 2. Report preparation.

Dec. 3 Day off.

Dec. 4 Report preparation. Interview buyers eg Yon. Tong. To SOPAC to see if map preparation is possible on computer.

Dec. 6 Report preparation. To USP, Peter Newell, regarding lagoon productivity tests. Visit SCUBA shops regarding compressor sales..

Dec. 7. Complete first draft for submission to SPC.. Suppose to depart today. However, have elected to stay on for 1 more week to finalise report, -