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Tridacna derasa Introduction in American Samoa

Mariculture Pilot Project Report November 1986 to February 1988

prepared by

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OFFICE OF MARINE AND WILDLIFE RESOURCES
AMERICAN SAMOA GOVERNMENT

INTRODUCTION

IMPETUS FOR PROJECT

In an effort to develop and enhance local reef resources, the Office of Marine and Wildlife Resources (OMWR) of American Samoa has considered supplementing the native giant clam populations (family tridacnidae) by importing seed clams from the Micronesian Mariculture Demonstration Center (MMDC) in Palau. A successful mariculture operation would require considerable agency/village cooperation. Before attempting a large scale project, it was decided to run a small scale test project. The giant clam species chosen for the introduction is *Tridacna derasa*. The coordination of the project was conducted primarily by OMWR, Marine Division.

This report documents the project preparation, *T. derasa* transfer operation and provides information on giant clam biology and fisheries especially for future reference by OMWR staff. A complete bibliography of scientific papers dealing with various aspects of giant clams has been compiled by Munro and Nash (1985).

TRIDACNIDS IN SAMOA

Hippopus hippopus appears to be recently extinct in American Samoa, but *T. maxima* and *T. squamosa* are still found. Because of economic and cultural changes, traditional subsistence fishing and reef conservation practices are being replaced by organized commercial reef fishing with no regulation. This systematic reef fishing is conducted mainly by experienced divers from other Pacific Island Nations. An improved road system allows easier access to remote areas and easier transportation of the catch to markets. SCUBA divers are able to harvest giant clams that are too deep for skin divers. These deeper clams were a "protected" breeding population that helped restock the shallower reef areas before they became easily accessible by SCUBA diving.

Around the main island of Tutuila, the native stocks of *Tridacna* have been heavily expoloited. This has not been accurately documented but is evident for several reasons. *T. maxima* is the more common native giant clam and is most often found in the remote, unpopulated areas of Tutuila, or in deeper waters not accessible to commercial free divers. Also, surveys in the sparsely populated Manu'a Islands have found much higher densities of *T. maxima* compared to areas of similar habitat around Tutuila. Fishermen report increased difficulty in obtaining giant clams near the more populated villages, and currently harvested clams are smaller than in the past. It is also interesting to note that the majority of clams now harvested around Tutuila have drab brown mantles that are difficult to see from the surface. The undisturbed stocks of *T. maxima* at Rose Atoll show a wide range of mantle colors, many of which are irridescent blues and greens (Radtke 1986).

The decline in Samoa's giant clam stocks will continue without management regulations or enhancement programs. In order to preserve this traditional food source it was decided that the OMWR should investigate management and enhancement options.

PLANNING AND PREPARATION

EXOTIC SPECIES INTRODUCTION

T. derasa is not native to American Samoa although it is found in Tonga and Fiji and has been recently introduced to the Cook Islands. Tonga lies only 200 nautical miles south southwest of American Samoa and the Cook Islands are 300 miles to the east.

The introduction of a foreign species deserves careful consideration and caution. It is doubtful that introduced T. derasa will ever compete with native tridacnids for space or food requirements. However, there is always the possibility of introducing diseases or undesirable organisms along with an introduced species. Pernetta (1987) and other authors describes this and several other possible detrimental effects. These possible adverse effects were investigated before a decision was made to proceed with the project.

Tissue samples from native T. maxima and T. squamosa were preserved and sent to the National Marine Fisheries Service Oxford Laboratory in Oxford, Maryland for analysis. The MMDC also sent tissue samples from 51 juvenile T. derasa to the Oxford facility for histological examination and comparison with the Samoan samples. The samples from Palau were from the same cohort and had the same culture history as the clams that were reserved for the potential shipment to American Samoa. A 5-6 mm cross sectional sample of each clam was taken through the visceral mass and preserved in 10% formalin in filtered seawater at a ratio of no more than 1 part tissue to 10 parts fixative.

The results of their analysis showed no harmful pathogens in either sample and nothing in the MMDC clams that could pose a threat to native organisms.

NURSERY SITE EVALUATIONS

Tutuila has no true barrier reef system or lagoon suitable for Tridacna culture. The narrow fringing reef offers little protection from high swells and much of the coastline consists of rugged basalt cliffs. The only suitable sites for a Tridacna nursery lie in the deeper bays that have comparatively wide reef flats. The important considerations for possible rearing sites were proper water quality and the close proximity of a concerned village that would be responsible for the security of the project. The site should also be easily accessible to OMWR staff for regular monitoring and maintenance. Twelve village areas (Figure 1) were evaluated according to 15 biological and practical categories (Table 1). The importance of these criteria can be explained as follows:

1. Wave Energy: Tridacna nurseries utilize plastic trays lined

1. Fagaitua
2. Alofau
3. Masefau
4. Aoa
5. Vatia
6. Aua
7. Utulei
8. Faga'alu
9. Coconut Point
10. Fagasa
11. Afono
12. Leone

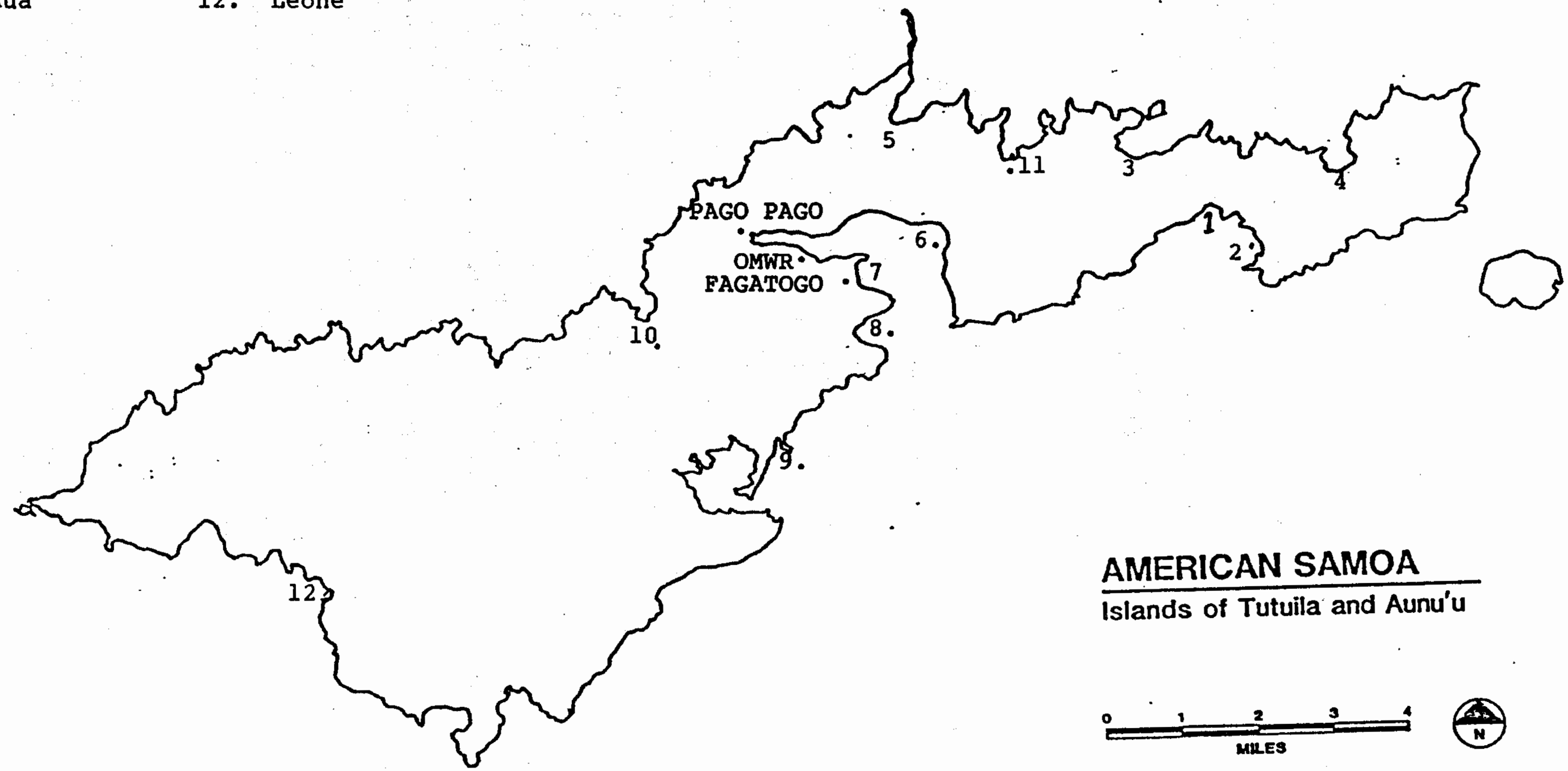

FIGURE 1 : Locations of possible *Tridacna* nursery sites.

Tridacna Mariculture

Nursery Location Survey - Tutuila

Criteria	Fagaitua	Alofau	Masefau	Aoa	Vatia	Aua	Utulei	Faga'alu	Coconut Pt.	Fagasa	Afono	Leone
Wave Energy	+	+	-	OK	-	OK	+	OK	+	-	-	-
Current	OK	+	OK	OK	OK	OK	OK	-	+	OK	OK	-
Live Coral	-	+	OK	+	-	OK	+	+	+	OK	+	OK
Depth	OK	+	-	-	-	OK	+	+	+	OK	OK	OK
Salinity/Fresh Water Intrusion	OK	+	-	OK	-	-	OK	OK	OK	OK	OK	-
Temperature	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
Water Clarity	OK	+	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
Water Quality	-	+	OK	+	+	-	-	OK	OK	OK	+	OK
Substrate Type	-	+	OK	+	-	-	+	OK	+	OK	OK	OK
Sediment Siltation	-	OK	OK	OK	-	-	OK	OK	+	OK	+	OK
Trash & Esthetic	-	+	+	+	OK	-	OK	OK	OK	OK	+	OK
Access by OMWR	OK	OK	-	OK	-	OK	+	+	+	+	+	+
Monitoring by OMWR	OK	OK	-	OK	-	OK	+	+	+	+	OK	+
Near Village	+	+	+	+	+	+	-	+	+	+	+	+
Monitor by Village	+	OK	+	+	+	OK	-	OK	+	+	+	+
Total	-2	10	-2	7	-5	-4	3	4	10	3	6	1

TABLE 1 : Evaluation of possible sites for Tridacna nurseries. For each location and criteria a designation of +(1 point), OK (0 points), or - (-1 point) is given.

with gravel for rearing the juvenile clams. Sites were carefully evaluated by interviews and experience as to their yearly sea conditions. Predictable Southeast Tradewinds create high surf conditions in areas that are otherwise quite calm. Also, large winter storms produce high surf conditions usually from the north and every year. The rearing trays become unstable in even slight swell conditions and it only takes one wave to ruin and entire project.

2. Current: Same as above.
3. Live Coral: Tridacnids are usually found living near beds of live coral and their basic requirements are very similar. The presence of live hermatypic corals at a site is an excellent indication that the area is suitable for tridacnids. Tridacnids and corals derive energy from algal symbionts and thrive in clear, sunlit waters. The presence of delciately branching, high profile corals is also an excellent indicator of low wave energies.
4. Depth: This pilot project was set up to be maintained by the local Villagers using already existing technology. It was therefore desirable for the rearing areas to be in shallow waters adjacent to reef flats where trays could be transported for cleaning and predator removal without the use of SCUBA or hookah gear.
5. Salinity: Same as live coral.
6. Temperature: Same as live coral.
7. Water clarity: Same as live coral.
8. Water quality: Same as live coral.
9. Sustrate type: Same as live coral.
10. Siltation: The biological requirements of salinity, temperature, water clarity, water quality, substrate type and siltation are self explanitory. The presence of live coral addresses all of these considerations.
11. Trash and Esthetics: This project was set up as a pilot demonstration nursery that would undoubtedly gain much publicity and would attract tourists and visiting researchers. The value of the project could be unjustly marred by litter nearby which is a serious problem in some areas of Tutuila.
12. Access by OMWR: The proximity of the site to the OMWR Office in Fagatogo and its accessability by road was a consideration.
13. Monitoring by OMWR: Same as above.
14. Near Village: The proximity of the site to a strongly unified, traditional village was considered desirable. Generally, villages farther from the downtown center of commerce in the Fagatogo/Pago Pago area will exercise more control over their adjacent reef areas and would be more effective in protecting the project.
15. Monitoring by village: Same as above.

Each site was given a designation of + , - or OK and scores resulted from the number of minus marks subtracted from the number of earned plus marks. A designation of OK did not alter the score. The villages of Alofau and Nu'uuli (Coconut Point) earned equally high scores of 10 and Aoa and Afono scored 7 and 6 respectively. Aoa and Afono experience some rough seas every year and are more remote from Pago Pago. It was therefore decided to limit this pilot project to outplant sites at Alofau and Coconut Point if these villages were in favor of the project.

The village mayors, village councils and district representatives of both villages were invited to discuss the project and to voice their concerns. Representatives from Alofau came to all of the meetings and voiced a great deal of enthusiam and support for the project. Nu'uuli village representatives never attended a single meeting as there always seemed to be something else that took precedence. It was decided to proceed with the meetings and concentrate on the Alofau site.

The officials of Alofau were given a slide presentation on the biology and life history of giant clams and the theories of giant clam mariculture. Explanations of the site selection process and the monitoring that was required were given and discussed, and a cooperative plan was developed. The OMWR would plant a portion of the shipment in trays in Alofau Bay and would train Alofau villagers in the care and maintenance of the site. OMWR biologists would conduct periodic monitoring to record growth and mortality but the daily care of the clams would be the responsibility of the village.

AQUARIUM

A 1000 gallon saltwater aquarium was obtained from the American Samoa Department of Education and set up at the OMWR compound in Fagatogo. The system can be quickly filled from PVC pipe entering Pago Pago Harbor and be allowed to overflow into the harbor or recirculate. Usually the system is closed off to the harbor and and allowed to recirculate through a four cartridge swimming pool filter and over a three layer suspended gravel filter/aerator. Live specimens of *T. maxima*, *T. squamosa*, *Trochus pyramis* and assorted fish and crustaceans were placed in the aquarium to test for toxicity and dissolved oxygen. All test animals remained in good condition and no harmful effects from the aquarium were noted.

SHIPMENT

One thousand juvenile *T. derasa* were shipped from the MMDC in Palau to Honolulu in November 1986. Age at shipment was 16 months and mean size was 71.69 mm with a standard deviation of 9 mm (Appendix I). The clams were packed dry in doubled plastic bags filled with pure oxygen. These bags were evenly distributed in four styrofoam containers and shipped as air freight. Upon arrival in Honolulu, the clams were transported to the Waikiki Aquarium and placed in filtered seawater.

On November 26, 1986 they were repacked by Waikiki Aquarium staff in the same manner described above and shipped by air freight to American Samoa. The shipment was received by OMWR staff that evening and transported to the OMWR compound in Fagatogo. The boxes were unpacked and the clams were placed in culture trays and immersed in clean, filtered seawater in the aquarium at OMWR.

OUTPLANTING

The clams were removed from the aquarium and redistributed into covered, gravel lined trays at densities of 15 per tray for the 671 clams destined for the Alofau site and 20 per tray for the 201 clams that would remain in the OMWR aquarium. The gravel adds weight to the trays for stability and prevents the byssal threads from attaching to solid substrate so the individual clams can be measured and moved more easily. The plastic mesh lids help protect the juvenile clams from predators. The 45 trays for Alofau were loaded onto a flat bed truck and transported to the village. They were placed in an area of the reef flat that was easily accessible and visible from the shore, and had good water circulation.

MONITORING

The success or failure of the project is dependent on the cooperation and interest of the village in monitoring the clams. Policing the area to be sure the clams are not taken is probably the most important function. Frequently searching through the gravel in the trays for *C. muricinum* could reduce the mortality rate dramatically. If this is too laborious to retain cooperative interest, it is also beneficial to snorkel over the clams once or twice a week (1) to check the security of the protective mesh covers and (2) to detect the possible presence of *C. muricinum* by a single dead or sick looking clam, before the entire tray of clams is consumed.

When a mortality is discovered, the tray should be brought to the surface and searched for *C. muricinum*. The snails should be saved for inspection by OMWR staff and the clam shell should be cleaned of meat, put back in the tray and returned to the bottom. This allows the OMWR staff to keep a record of the number of clams lost to predators in each tray. When mortalities appear frequently, or unusual observations are made, the OMWR should be contacted immediately.

The OMWR biological staff made monthly site visits to Alofau to collect data on mortality and growth. The trays were arranged on the reef flat in a grid pattern to be easily counted and each tray was assigned a number. Mortalities had their tray number and any evidence as to the cause of death recorded. Trays with empty clam shells that were not cracked or sick clams that had their mantles retracted were searched for *C. muricinum*. All specimens of *C. muricinum* were measured along their axis and recorded for later analysis. When *C. muricinum* began to occur in high numbers, bimonthly inspections were made to specifically search and remove them.

Growth data was collected in a semi-randomized fashion. Tray numbers were chosen randomly, but were not sampled two

	ALOFAU REEF (n=671)					OMWR AQUARIUM (n=201)				
MONTH	THEFT	*C. muricinum*	CRACKED	UNKNOWN	TOTAL	ACCIDENT	UNKNOWN			TOTAL
NOV.					0					0
DEC.			3		3		1			1
JAN.			5		5		1			1
FEB.			5		5					0
MAR.		2	2		4	3	1			4
APR.		1	2	1	4		2			2
MAY			3		3		5			5
JUN.	39				39		4			4
	39	3	20	1	63	3	14			17
						THEFT	*C. muricinum*	CRACKED	UNKNOWN	TOTAL
JUL.				3	3				5	5
AUG.		10		2	12		3		7	10
SEP.		6			6		7	3		10
OCT.		3		1	4		6	2	1	9
NOV.				26*	26					0
DEC.		1			1			1		1
JAN.		4			4				5	5
FEB.		3			3		6		10	16
TOTAL:	0	27	0	32	59	0	22	6	28	56

* Counting all clams reveals 26 clams not accounted for.

TABLE 2 : Monthly summaries and totals for mortalities. See text for details.

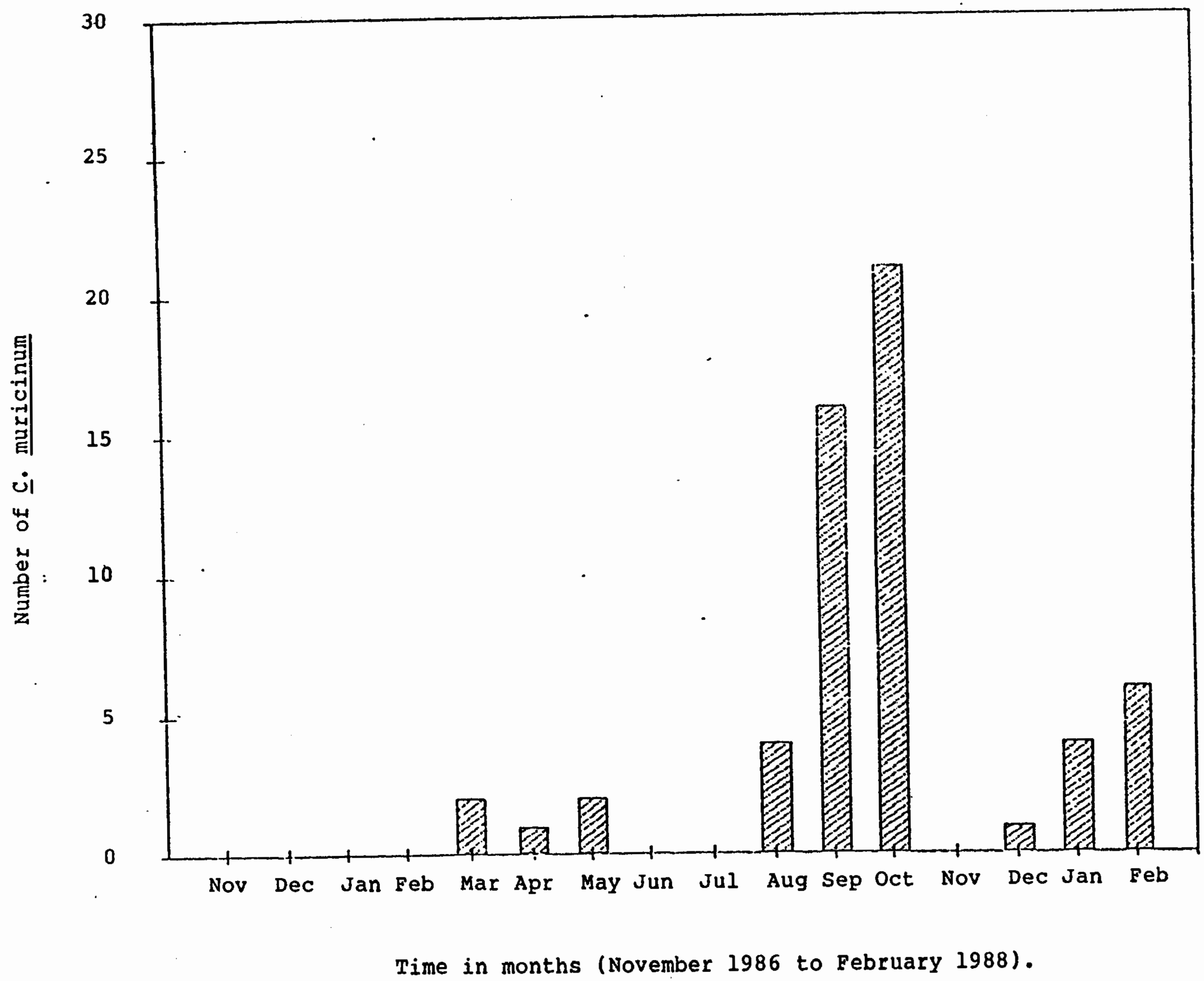

TABLE 3 : Number of C. muricinum collected each month by OMWR staff in the Alofau reef clam trays.

months in a row. Sample sizes were greater than ten percent. At Alofau, at least five trays of clams were measured and recorded to find the mean shell length of the sample. At the OMWR aquarium, at least two trays of clams were measured and recorded to find the mean shell length. Mortalities were not included in calculating the mean. Mean lengths for the clams transferred from the OMWR aquarium to the Alofau reefwere calculate separately.

Trays were examined during each visit and repairs were completed when necessary. Observations were recorded for anything unusual such as clams that had cracked shell margins but were still alive, the presence of Tridacna predators, or bite marks on the mesh covers.

RESULTS

MORTALITY

An unusually high mortality rate occurred during the shipment between Palau and Honolulu. From Palau to Honolulu, 94 clams perished from shipping stress. 894 clams arrived in Samoa and 22 mortalities were found the next morning leaving only 872 clams at the outset of the project.

During the first seven months, from November 26,1986 to June 26, 1987, samples were maintained at both the Alofau reef site and the OMWR aquarium. Mortalities at Alofau can be separated into four categories as follows; theft, C. muricinum, cracked shell and unknown. Mortalities at the OMWR aquarium can be separated into two categories as follows; accident and unknown. Monthly summaries and totals are found in Table 2.

CYMATIUM MURICINUM

C. muricinum were not found at the Alofau reef site until four months after the clams were introduced. The greatest number of snails appeared in September and October (Table 3) with high percentages of juveniles occurring. Appendix II shows the size distribution of the C. muricinum collected by month.

GROWTH

The growth rate for the T. derasa on the Alofau reef was much higher than for the clams held in the OMWR aquarium. During the first seven months, the clams in Alofau grew at a rate of 8.2 cm per year while the clams in the aquarium grew at a rate of 2.6 cm per year. After transfer to the Alofau reef site the clams from the aquarium increased their growth rate to 6.0 cm per year for the following eight months and the original Alofau reef clams decreased their growth rate to 4.5 cm per year for the same period. The original Alofau reef clams have grown from a mean length of 7.2 cm to 14.9 cm in fifteen months, exhibiting a growth rate of 6.2 cm per year (Table 4).

The values in centimeters for the sampled mean shell length of the T. derasa are as follows:

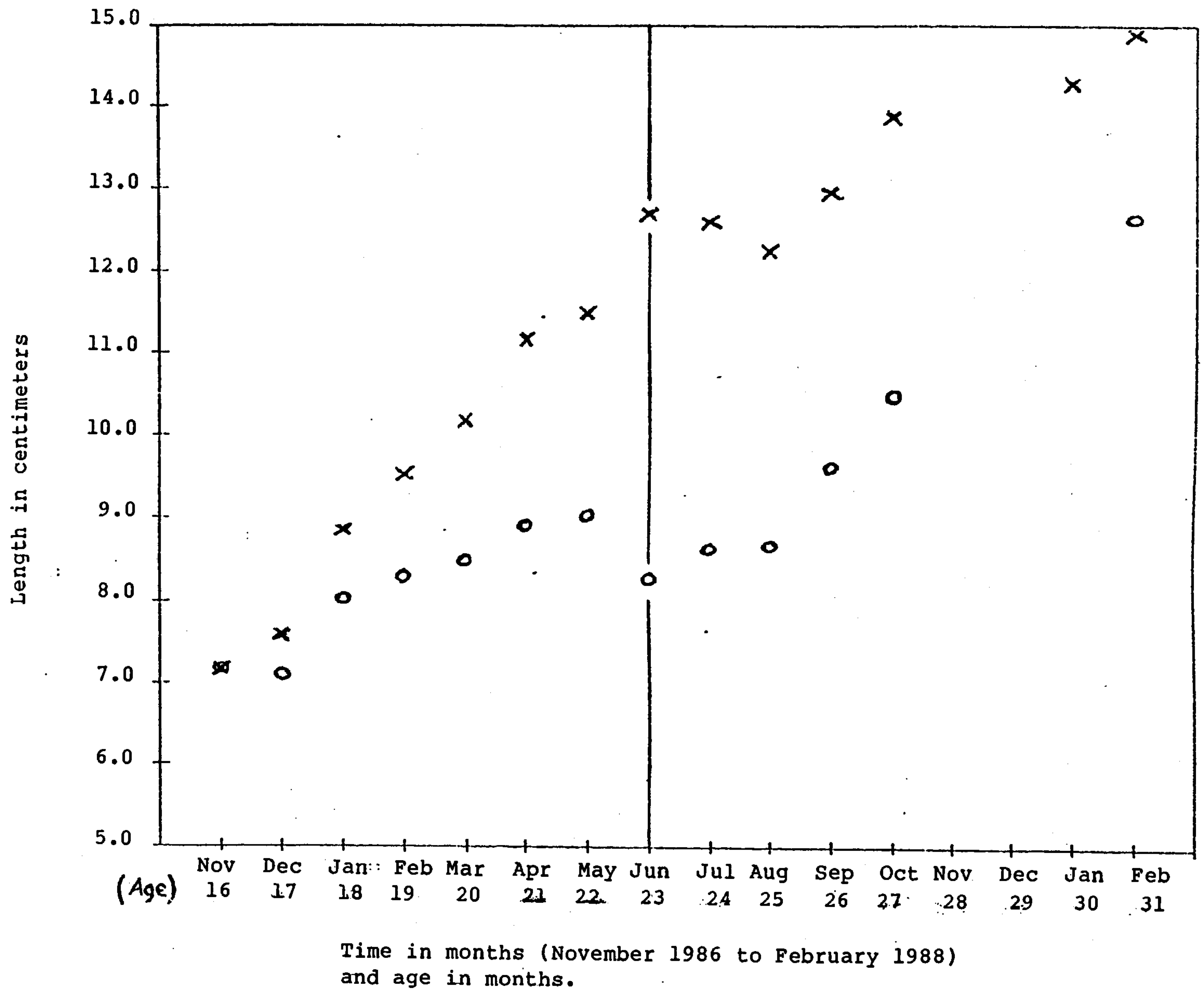

TABLE 4. : Growth of *T. derasa* at Alofau reef (x) and OMWR aquarium (o). Points express mean length of clams sampled. Vertical line marks the transfer of the OMWR clams to the Alofau reef flat.

MONTH	AGE	OMWR	ALOFAU
NOV	16	71.7	71.7
DEC	17	71.0	75.9
JAN	18	80.3	88.4
FEB	19	82.9	95.2
MAR	20	84.9	101.7
APR	21	89.2	111.6
MAY	22	90.3	114.9
JUN	23	82.7	126.7
JUL	24	86.2	125.8
AUG	25	86.6	122.3
SEP	26	96.0	129.4
OCT	27	104.7	138.6
NOV	28	-	-
DEC	29	-	-
JAN	30	-	142.9
FEB	31	126.2	149.0

DISCUSSION AND CONCLUSIONS

MORTALITY

The initial loss of 128 clams from shipping stress left 872 clams at the outset of the project. This loss of 12% of the shipment in transit has never been explained and is over 10 times the expected shipping mortality of 1% or less. It is possible that the clams experienced an unscheduled delay in Guam while in transit to Honolulu and that the shipment was delayed for a few hours in Honolulu before clearing customs. Longer shipments from the MMDC have been made with very low mortalities.

Theft was the greatest known cause of mortality for the 671 clams outplanted at Alofau. In June 1987, three trays of clams were taken, the trays were found about a half mile away, but the thief was never caught. This caused the village of Alofau to be more vigilant and no more thefts are believed to have occurred. In November 1987, a count of all the clams and a count of the mortalities recorded, revealed that 26 clams were missing. These clams were probably mortalities that the villagers collected and didn't turn over to OMWR. Several inquiries about missing clams produced plastic bags of clam shells and a sheepish grins.

During the first seven months, 63 clams from Alofau died and 17 clams from the 201 at OMWR died. The Alofau clams died at a rate of 16% per year and the OMWR clams died at a rate of 14% per year. Loss from theft was 62%, from cracked or broken shells was 32% and from C. muricinum was 5% for the Alofau clams. A majority of the mortalities at the OMWR are unexplained, but there are several probable causes related to being held in an aquarium.

It is interesting to note the similar percentage of mortality per year between the two groups. The gravel in the aquarium trays was searched thoroughly and the clams were inspected very closely for signs of the parasitic gastropod of the family Pyramidellidae. No sign of this parasite or of any predator was found. A combination of effects from the aquarium is probably responsible for the unexplained mortalities. Light penetration into the aquarium is retarded by three walls of the aquarium and a nearby building. There is a translucent plastic roof to prevent desalination from periods of heavy rain, and light penetration is further retarded by algal growth on the clear plexiglass viewing wall. Nutrient supplies were probably inadequate because drawing new water from the harbor was limited by a construction project that made the water muddy. Also, low level toxicity could have helped kill weakened clams.

During the eight months following the transfer of the clams from the OMWR to the Alofau reef, 56 of the transferred clams died and 59 of the original Alofau clams died. It appears that no more thefts took place but a C. muricinum pulse caused many mortalities during this period. The transferred clams had a mortality rate of 46% per year and the original Alofau clams died at a rate of 15% per year. A definitive cause of death was not known for 50% of the transferred clams. C. muricinum killed 39%, and 11% of the transferred clams had cracked shells. A definitive cause of death was not known for 54% of the original Alofau clams, but 46% were killed by C. muricinum. Nearly all the deaths by unknown causes are believed to be due to C. muricinum because they coincide with the pulse of the predatory snail, the shells are undamaged, and all the clams appeared to be very healthy before their deaths.

After transferring the clams from the OMWR to Alofau, mortalities from cracked shells were found for the transferred clams but not for the original Alofau clams. However, many of the original Alofau clams had cracked shell margins but survived, and the plastic mesh covers had bite marks in several places. The predators responsible (probably octopi) were still present and attacking both the larger original Alofau clams and the smaller transferred clams. Inside the plastic cages, the original Alofau clams could survive these attacks when they grew to about 12.0 cm. No mortalities from cracked shells have been recorded for the transferred clams after growing to 12.0 cm.

The 122 mortalities for the original Alofau clams during the entire fifteen months are due to theft (32%), unknown causes (27%), C. muricinum (25%), and cracked shells (16%). The mortality rate was 15% per year for this period.

A major portion of the mortalities by C. muricinum could have been prevented. Miscommunication with the villagers about what to do in particular situations can allow a snail to eat several clams before being detected. Twelve clams in one tray died because the dead clam shells were removed without removing the snails from the gravel. Without the dead clam shells to flag the condition to the OMWR staff after only a few mortalities, the snails continued their predation undetected. After re-explaining to the village leaders what to do when clams start to die, the problem did not repeat itself.

CYMATIUM MURICINUM

C. muricinum began appearing in the fourth month at Alofau.

Five months later, in August, there were a few more found than in the previous months. In September, the population at the nursery rose quickly because of a strong pulse of juveniles. This trend continued and peaked in October. In the following months, only a few larger specimens were found. It appears that heavy recruitment of juveniles occurs in September and October but adults may be present all year.

The pulse and size distribution of this predatory snail need to be carefully watched. Frequent inspections for C. muricinum will reduce the mortality rate dramatically. This may be the most important and most difficult concept to communicate to the village entrusted with the day to day care of a Tridacna mariculture project.

GROWTH

The calculations of the mean length each month did not include the mortalities discovered. The size of the clams that perished seemed to be smaller than the mean size calculated each month. This was not statistically tested, but intuitively it makes sense and we know that larger clams are more resistant to predation. The growth rate, calculated from the mean length of semi-random samples of clams, may be artificially high. If this is the case, the effect is considered negligible for the purposes of this study.

The growth of the clams held at the OMWR aquarium was very slow compared to the growth of the clams at Alofau. Light penetration into the aquarium is retarded by three walls of the aquarium and a nearby building. There is a translucent plastic roof to prevent desalination from periods of heavy rain, and light penetration is further retarded by algal growth on the clear glass viewing wall. The viewing wall was cleaned periodically but the filamentous green algae quickly regrew. The lack of direct sunlight for the OMWR clams is one reason for their slow growth compared to the clams at Alofau which received direct sunlight (dicounting clouds) every day.

Another explanation of the slower growth rate of the OMWR clams may be a lack of nutrients entering the aquarium system. Evidence for this is the general observation that the shells of the OMWR clams appeared thinner and much flatter. Also, a mortality from OMWR was less than half the weight of a mortality from Alofau of the same length found in the same month. The water was not changed frequently in the aquarium system because of road construction nearby that made the water at the system intake very muddy. The nutrients available to the growing clams may have been low enough to furhter stunt their growth.

The clear, shallow water on the Alofau reef flat and the long summer days helped the clams at the Alofau nursery to grow quickly for the first seven months. During the following eight months the growth rate seemed to slow. This could be due to the slowing of growth with the increase in size, seasonal influences or interference of growth by the protective covers. The data can be analyzed more thoroughly and experimental designs can be created to test this, but it is beyond the scope of this paper.

It is conclusive that the slowed growth of the OMWR clams was caused by being held in the aquarium. After the clams were transferred to the Alofau reef, the growth rate increased dramatically. The shells seem to be much thicker and robust and the clams look healthier than they did prior to the transfer.

RECOMMENDATIONS

Growout nurseries on the reef flat are more successful in terms of growth rate, and survivorship seems to be about the same as in the OMWR aquarium. An aquarium can be maintained for public viewing if the additional work and cost justify it. The plastic rearing trays remained cleaner when placed on coral rubble compared to sand in Alofau, and this practice should be followed in future nurseries.

The overall results from this pilot project have been encouraging. Care and monitoring of the growout nursery can be successful with an agency/village cooperative effort. Frequent communication needs to be maintained with the village leaders and the individuals inspecting the clams to be sure the proper procedures are followed to reduce the mortalities caused by predators, especially C. muricinum. Even lower mortality rates can result if theft can be eliminated. An atmosphere of cooperation needs to be maintained with the village by sharing results and thanking them for their work.

LITERATURE CITED

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APPENDIX I

Certificate of Origin and
Data Summary from the
Micronesian Mariculture Demonstration Center

MICRONESIAN MARICULTURE DEMONSTRATION CENTER
POST OFFICE BOX 350
KOROR STATE
REPUBLIC OF PALAU, 96940

CERTIFICATE OF ORIGIN

This shipment contains 1000 baby giant clams, Tridacna derasa, raised from eggs in tanks at the Micronesian Mariculture Demonstration Center in Palau. The export of these clams is part of an approved Government of Palau project and is in compliance with all of the laws and regulations of the Republic of Palau.

DISEASE FREE CERTIFICATION

These clams have been individually inspected by us and to the best of our knowledge are free of disease and parasites.

DATA SUMMARY

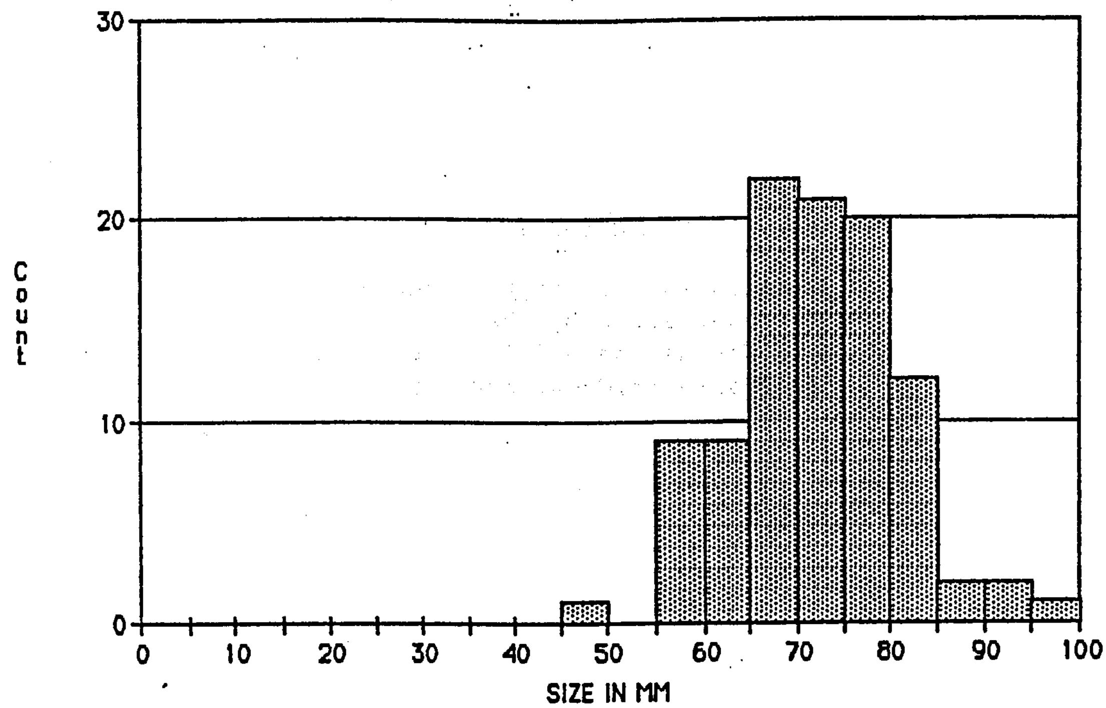
1.	Shipment number	86.22/39
2.	Shipment date	
3.	Species	TRIDACNA DERASA
4.	Destination	PAGO PAGO, A.SAMOA
5.	Number sent	1000
6.	Mean size	71.69 mm
7.	Std. Dev.	9 mm
8.	Measured sample size	100
9.	Spawn date	7/16/85
10.	Age in months	16 mos.
11.	Generation	F_1
12.	Broodstock I.D. number	WILD

APPROVED BY: Gerald Heslinga

GERALD HESLINGA, AQUACULTURE CONSULTANT
PACIFIC FISHERIES DEVELOPMENT FOUNDATION

T. Paulis

TOSHIRO PAULIS, CHIEF
MARINE RESOURCES DIVISION
REPUBLIC OF PALAU

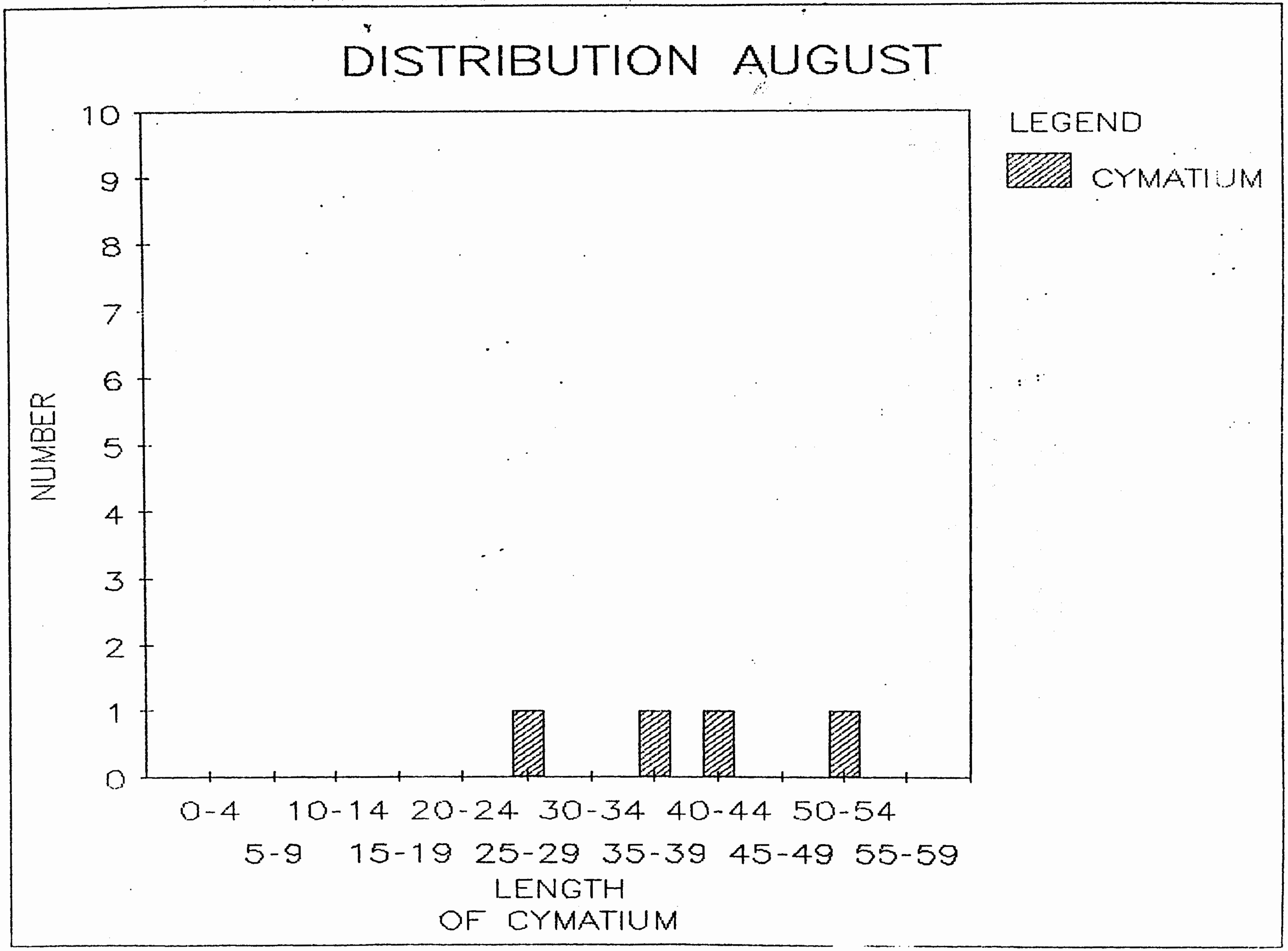


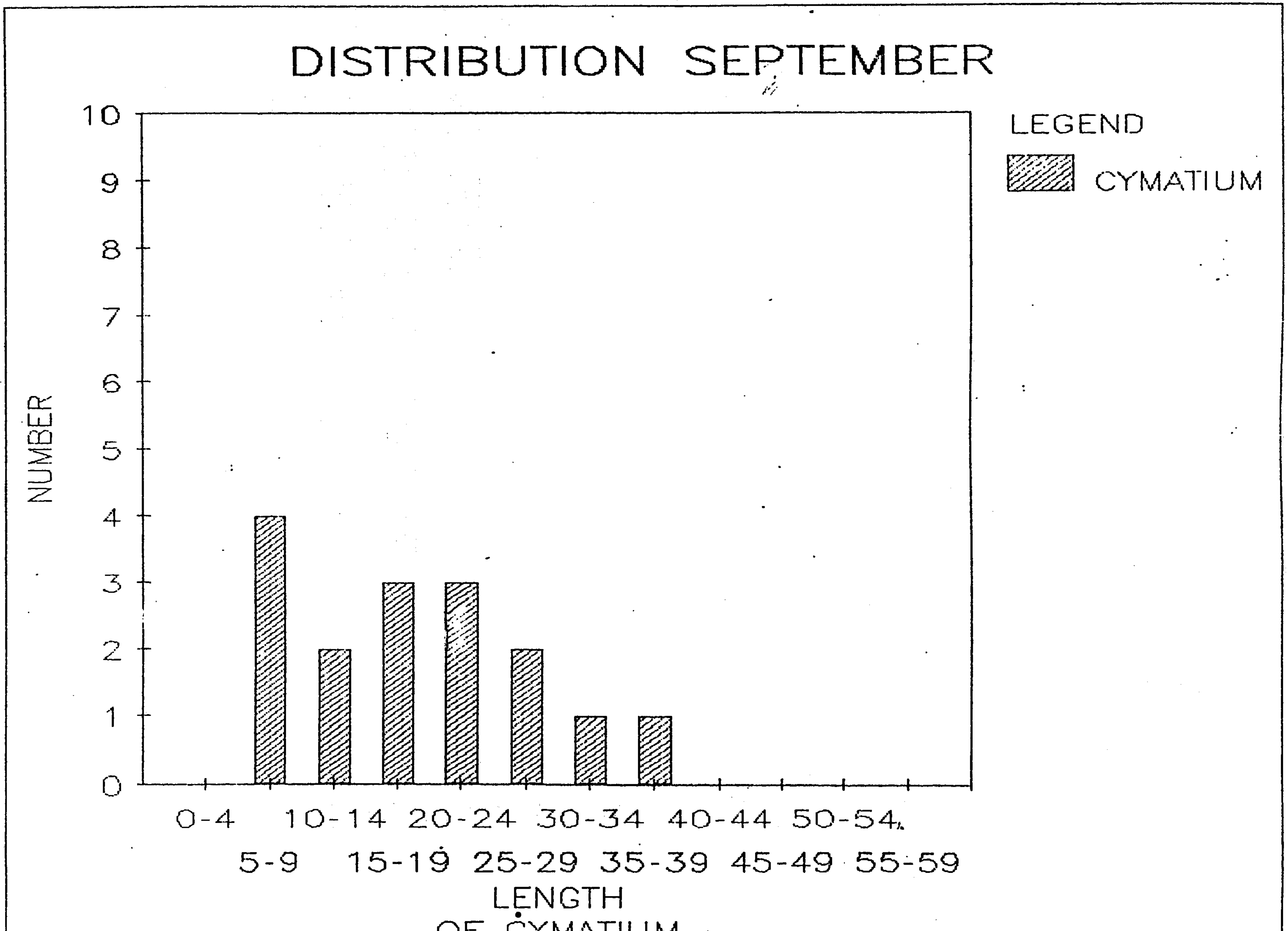
Data File: A. Samoa 11/19/86	
Variable: SIZE IN MM	Observations: 100
Minimum: 49.000	Maximum: 100.000
Range: 51.000	Median: 72.000
Mean: 71.690	Standard Error: 0.900
Variance:	81.004
Standard Deviation:	9.000
Coefficient of Variation:	12.554
Skewness: 0.255	Kurtosis: 0.356

APPENDIX II

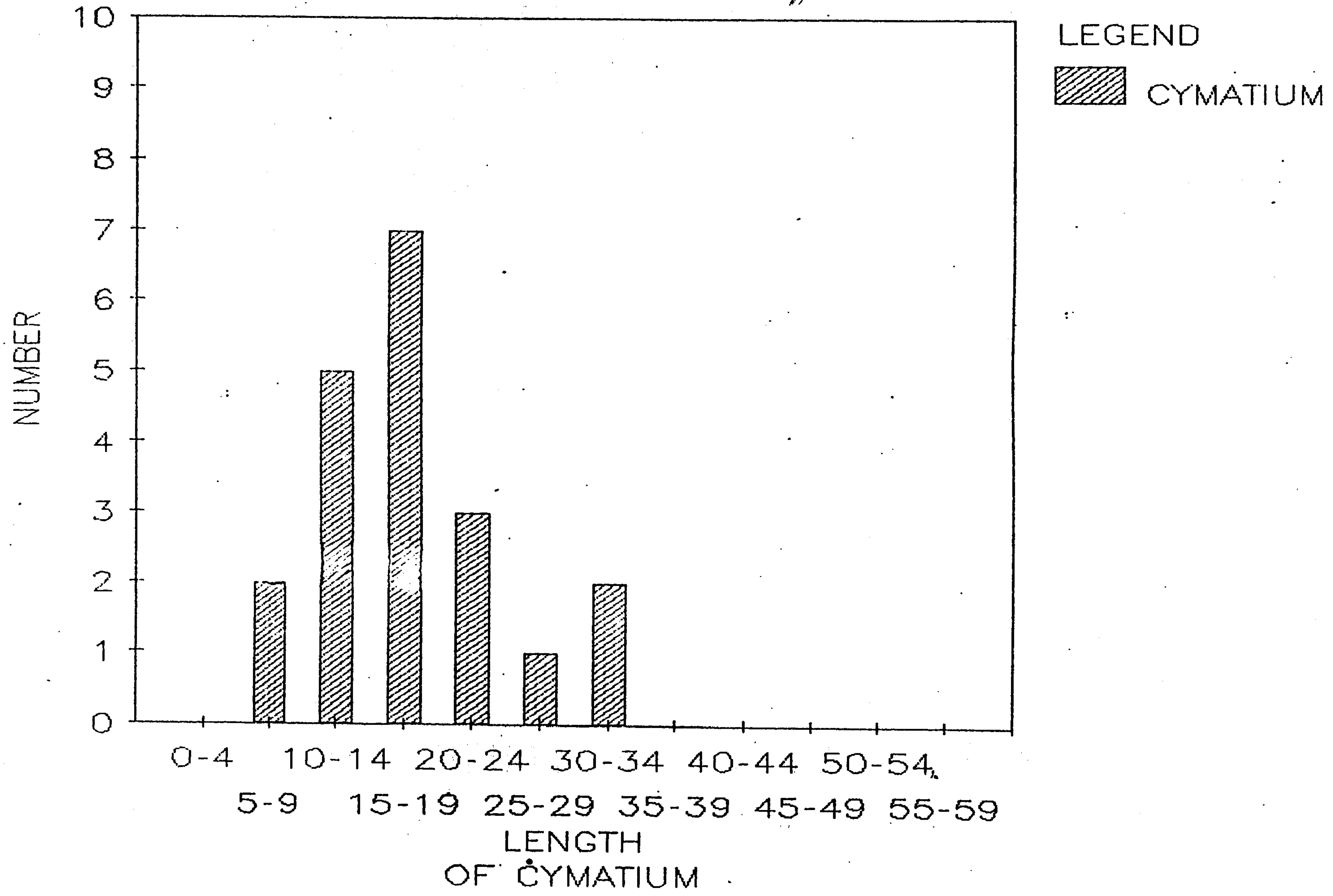
Size Distribution of *Cymatium muricinum*
Collected by the
Office of Marine and Wildlife Resources
at Alofau *Tridacna* Nursery

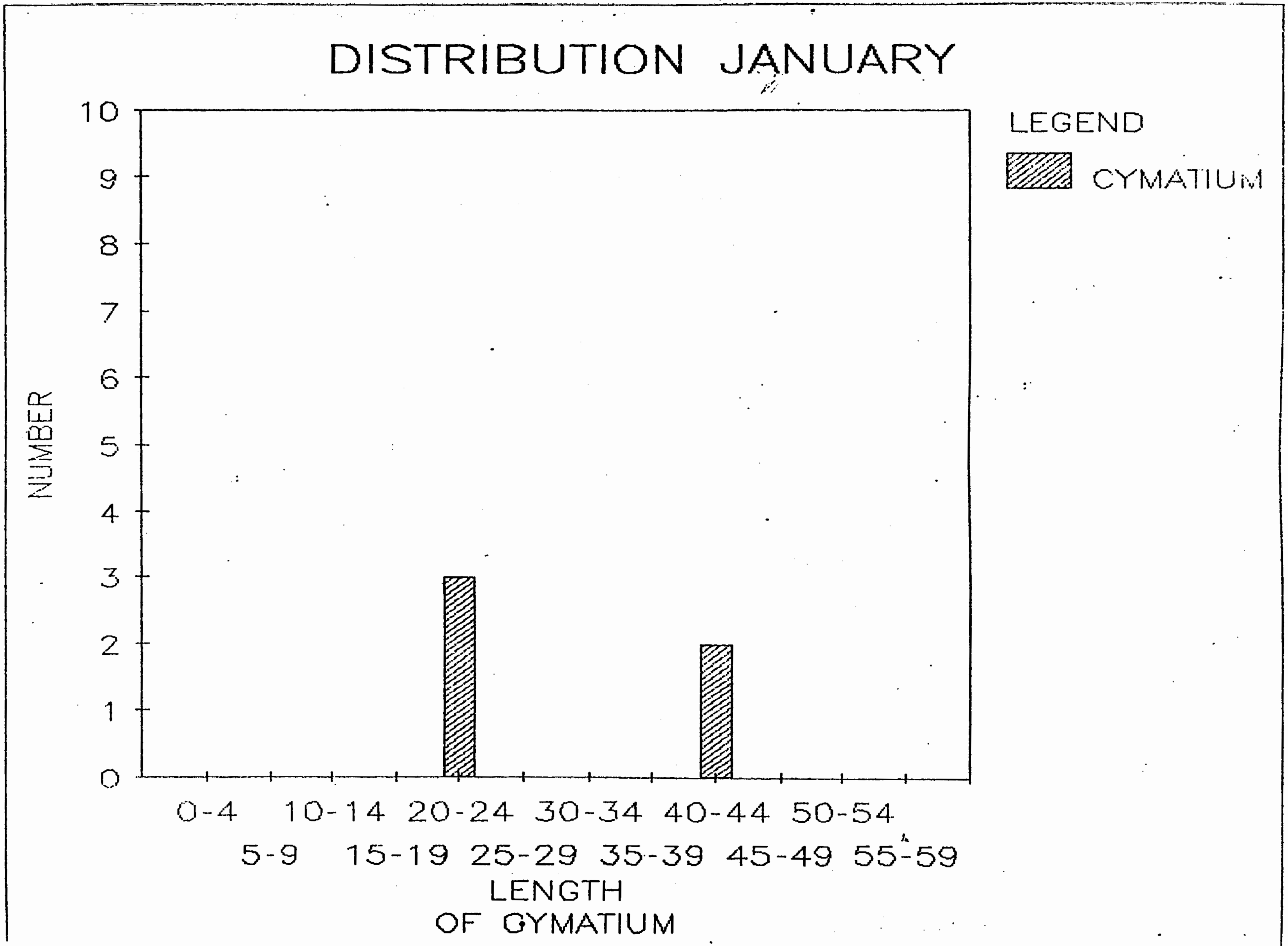
The five following graphs illustrate the size distribution of Cymatium muricinum collected by the Office of Marine and Wildlife Resources staff during visits to the Alofau clam nursery. The length categories along the horizontal axis are in millimeters. The size distribution of C. muricinum is not depicted for the months of November and December 1986; or January, February, March, April, May, June, July, November and December 1987 because too few snails were found for these months.


DISTRIBUTION AUGUST
LEGEND
CYMATIUM
NUMBER
0
1
2
3
4
5
6
7
8
9
10
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
LENGTH
OF CYMATIUM


DISTRIBUTION SEPTEMBER
NUMBER
10
9
8
7
6
5
4
3
2
1
0
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
LENGTH
OF CYMATIUM
LEGEND
CYMATIUM

DISTRIBUTION OCTOBER




DISTRIBUTION JANUARY
LEGEND
CYMATIUM
NUMBER
10
9
8
7
6
5
4
3
2
1
0
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
LENGTH
OF GYMATIUM

DISTRIBUTION FEBRUARY