MFR PAPER 1071

Valued for meat and shells, the giant clam faces an increased harvest.

A Survey of Giant Clams, Tridacnidae, on Helen Reef, a Western Pacific Atoll

FRANK J. HESTER and EVERET C. JONES

Frank J. Hester and Everet C. Jones were formerly members of the staff of the Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, HI 96812.

ABSTRACT

Transects and areal surveys by swimmers were used to estimate the standing stock of giant clams, Tridacnidae, at Helen Reef, Western Caroline Islands in March 1972. Estimates were Tridacna crocea *3.7* $\times$ 10^6, T. maxima *1.7* $\times$ 10^6, Hippopus hippopus *44.6* $\times$ 10^3, T. derasa *32.8* $\times$ 10^3, *and* T. gigas *49.8* $\times$ 10^3. Tridacna squamosa *was not abundant or was identified as* T. maxima. *Most* T. gigas *and* T. derasa *were large, suggesting low or erratic recruitment.*

INTRODUCTION

The Indo-Pacific family Tridacnidae comprises two genera, *Tridacna* Bruguiére with five species: *Tridacna gigas* (Linné), *T. derasa* (Roding), *T. squamosa* (Lamarck), *T. maxima* (Roding), and *T. crocea* (Lamarck); and the monotypic genus *Hippopus* represented by the species, *Hippopus hippopus* (Linné). Of these six species *T. gigas* is the largest, reaching a valve length in excess of 1,300 mm and a valve weight of over 150 kg. It is this species that is the giant clam, peril to divers and an occasional bird bath or holy water font. The other species are intermediate in size with *T. crocea* being the smallest, having a maximum valve length of about 200 mm. For a description of the family and its biology and distribution see Rosewater, 1965.

All of these clams, except possibly *T. crocea*, are of value both for their meat, which is consumed locally, and for their shells, which are of value as souvenirs and to collectors. *Tridacna gigas*, *T. derasa*, and *H. Hippopus*, the larger species, are particularly sought for their shells, which currently have an ex-vessel value in Koror, Palau Islands of approximately $0.02 per millimeter for specimens over 200 mm. The shells of *T. maxima* and *T. squamosa*, being smaller, are of lesser value but they are in demand for the meats. *Tridacna crocea* is seldom utilized for any purpose.

Because of the value of the shell, as well as the potential value of the meats, and because they occur in countries that are seeking foreign exchange, the larger Tridacnidae face increased fishing pressures that may result in a major reduction of the stocks. Already the size and abundance of *T. gigas* has declined in the central Pacific, parts of the Great Barrier Reef, Indonesia, and the Philippines, probably owing to fishing pressure. In some areas the clams are now protected by law. In others, where these animals are of some importance in trade, protective measures may be necessary; however, there are very limited biological and fishery data available to suggest how stringent or what these measures should be.

John J. Naughton, a fishery biologist, with specimens of Tridacnidae.

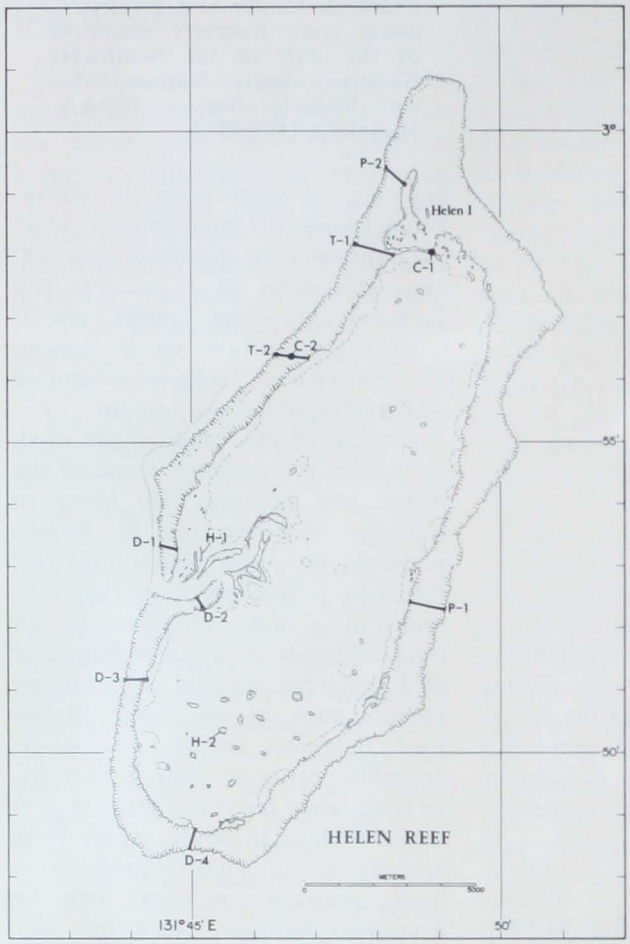

Figure 1.—Helen Reef showing location of transects.

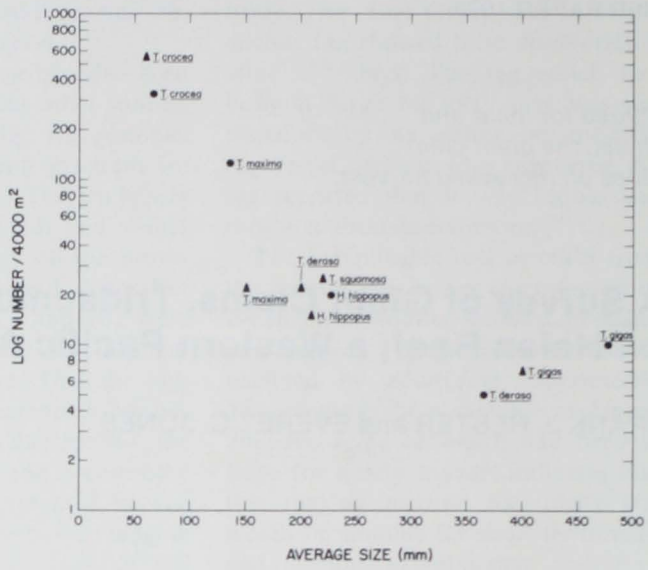

Figure 2.—Average length-frequency data of clams from Helen Reef (circles) and Palau Islands (triangles) (Hardy and Hardy, 1969).

One place that has been reasonably free from exploitation until recently is Helen Reef (Fig. 1), a small atoll to the south-southwest of the Palau Islands in the Palau District, Western Caroline Islands, of the Trust Territory of the Pacific Islands. Helen Reef lies at approximately lat.3°N, long. 131°E. It is about 24 km in its north-south dimension by 9 km in its east-west dimension and consists of reef, awash at high water, and a small sand island with coconut trees and low growth. Situated at the northern end of the reef, the island is about 1 ha (hectare) in area. The reef encloses a large lagoon with depths in excess of 60 m. The reef is about 1,200 m wide except in the north portion, which has an extended sandy area between the lagoon and the sea. A navigable passage on the western side permits access to the lagoon for vessels of moderate draft. Helen Reef lies in an area of variable winds and currents and there is no well-defined windward side although the coral growth is most luxuriant on the west side of the reef. Helen Reef is uninhabited and distant from most population centers and the reef and its associated flora and fauna are nearly untouched, being subject to only occasional visits by Trust Territory field trip ships and foreign fishing vessels. (There have been instances where the latter have been apprehended with *Tridacna* shell and turtles on board —communications from the Office of Marine Resources, Trust Territory of the Pacific Islands.)

In May 1971 and again in March 1972 the research vessel *Townsend Cromwell*, then operated by the Honolulu Laboratory of the National Marine Fisheries Service, Southwest Fisheries Center, called at Helen Reef as part of its marine resource survey of the Trust Territory of the Pacific Islands. On the latter visit of *Townsend Cromwell* a survey of Helen Reef was conducted for the Office of Marine Resources, Trust Territory of the Pacific Islands, in order to obtain a standing stock estimate of the giant clams. This had been requested because of poaching by foreign fishing boats and a growing interest on the part of the Palau District in the development of fisheries there. This report describes that survey and gives an estimate of the status of the stocks for the species found in abundance at the reef.

METHODS

Five types of surveys were used for assessing the *Tridacna* stocks: (1) Line transects: A line marked off at 100-m intervals was stretched normal to the reef from the lagoon to the seaward dropoff. The occurrence of clams within 2½ m on either side of the line was recorded, together with the

Table 1. — Helen Reef survey data.

Sta.	Type and location	Substrate notes	Distribution and abundance				Area surveyed (m^2)	Density clams per 100 m^2	Estimated area both sides of reef transect (ha)	Standing stock estimated numbers
T-1	Linear transect running 285° T from a pipe located at lat. 2°58′00″N, long. 131°48′16″E.	Transect ran from lagoon dropoff (5 m depth) to sea, a distance of 1,500 m. Inner 500 m sand and coral heads (water depth 1.5-2 m) turning to sand; coral and coral rubble 500-1,100 m algal flat and hard reef from 1,100 m to dropoff. The outer 7-800 m is exposed to low water.	*Inner 500 m*	*Mid-500 m*	*Outer 500 m*	*Total*				
			2 *T. gigas*		1 *T. gigas*	3	7,500	0.04	520	2,080
			5 T. derasa	2 T. derasa	1 *T. derasa*	8		0.107		5,500
				2 *H. hippopus*	5 *H. hippopus*	7		0.093		4,853
			T. crocea and *T. maxima* ubiquitous							
T-2	Linear transect running 277° T from a pipe located at lat. 2°56′20″N, long. 131°46′53″E.	Essentially the same as T-1 except transect ended at wrecked freighter 1,100 m from Lagoon across reef. From 300 to 800 m the reef was carpeted with living coral (*Acropora* sp.).	*Inner 300 m*	*Mid-300 m*	*Outer 300 m*	*Total*				
				11 *T. gigas*	5 *T. gigas*	16	5,500	0.29	800	23,273
			2 *T. derasa*	25 *T. Derasa*	6 *T. derasa*	33		0.60		48,000
				1 *H. hippopus*	7 *H. hippopus*	8		0.145		11,636
					1 *T. squamosa*	1				
			T. crocea and *T. maximus* ubiquitous							
C-1	Areal survey of circle 25 m radius around a pipe located at lat. 2°58′03″N, long. 131° 48′56″E.	On shallow finger (2 m depth) of reef extending into lagoon. Massive *Porites* sp. and sand and rubble.	*T. gigas*			4	2,000	0.20	520	10,400
			T. derasa			3		0.15		7,800
			H. hippopus			3		0.15		7,800
			T. maxima			62		3.10		
			T. crocea			200		10.0		
C-2	Areal survey of circle 25 m m radius around a pipe located at lat. 2°56′18″N, long. 131°46′36″E.	On coral carpet midway through T-2.	*T. gigas*			6	2,000	0.30	800	24,000
			T. derasa			2		0.10		8,000
			H. hippopus			13		0.65		52,000
			T. maxima			63		3.15		
			T. crocea			138		6.90		
D-1	Drift transect starting from lat. 2°53′15″N, long. 131°44′45″E. Course 282° T.	Transect ran 600 m across reef of mostly hard coral flat and large rubble.	*T. gigas*			3	3,000	0.10	175	1,750
			T. derasa			4		0.13		2,333
			H. hippopus			6		0.20		3,500
D-2	Drift transect starting from lat. 2°52′18″N, long. 131°45′14″E. Course 330°T.	Transect ran 440 m across sand and coral heads.	No large clams seen				2,200		140	
D-3	Drift transect starting from lat. 2°51′10″N, long. 131°44′16″E. Course 266° T.	Transect ran 700 m from sand and large coral heads to reef flat and rubble. Large T. *gigas* and *T. derasa* along lagoon in 2-3 m water. Power tows made between D-3 and D-4.	*T. gigas*			3	3,500	0.086	430	3,686
			T. derasa			3		0.086		3,686
			H. hippopus			4		0.114		4,914
D-4	Drift transect starting from lat. 2° 48′ 46″ N, long. 131° 45′ 06″ E. Course 200° T.	Transect ran through dirty water 820 m across sand and mostly dead coral. Large clams along lagoon and first 200 m of transect. Power tows made between D-4 and P-1.	*T. gigas*			2	4,100	0.049	550	2,683
			T. derasa			3		0.073		4,024
			H. hippopus			5		0.122		6,707
P-1	Transect under power from lat. 2°52′25″N, long. 131°48′30″E. Course 100° T.	Transect ran 1,200 m. Clams along lagoon in *Acropora* sp. rubble, some signs of *Acanthaster* at work. Few clams on reef except for sandy areas seen on power tows made between P-1 and P-2.	*T. gigas*			3	6,000	0.050	1,950	9,750
			T. derasa			2		0.033		6,470
			H. hippopus			4		0.066		13,000
P-2	Transect under power from lat. 2°59′05″N, long. 131°48′30″E. Course 311° T.	Transect ran 1,100 m across sand and scattered coral heads, 1-1.5 m depth. Only large *T. gigas* and *T. derasa*.	*T. gigas*			6	5,500	0.109	600	6,545
			T. derasa			7		0.127		7,636
H-1	Coral head at lat. 2°53′13″N, long. 131°45′14″E.	Lovely live coral, many clams, small and medium, 1-4 m depth.	*T. gigas*			13	900	1.44	175	25,270
			T. derasa			17		1.89		33,075
			H. hippopus			2		0.22		3,888
H-2	Coral head at lat. 2°50′24″N, long. 131°45′30″E.	Fine flat head, small and medium clams, live coral 2-3 m depth.	*T. gigas*			23	1,600	1.44	175	25,270
			T. derasa			19		1.19		20,781
			H. hippopus			6		0.38		6,562
				TOTAL	*T. gigas*	82	43,800 m^2		6,835 ha	
					T. derasa	101				
					H. hippopus	58				

Table 2.—Abundance of clams at Helen Reef and the Palau Islands. Numbers adjusted to 2,000 m^2.

Species	Circle No. 1	Circle No. 2	Transect No. 1	Transect No. 2	Hardy & Hardy
T. crocea	138	200	Not counted		275
T. maxima	63	62	Not counted		11
H. hippopus	13	4	3	3	8
T. squamosa	0	0	0	1	13
T. derasa	2	3	3	15	11
T. gigas	6	4	1	10	4

general bottom type and the water depth. Only the three largest species, *T. gigas*, *T. derasa*, and *H. hippopus*, were recorded, and *T. gigas* and some *T. derasa* were measured. (2) Areal: Two circles, each with a radius of 25 m (2,000 m^2), were laid out around reference stakes. All of the clams occurring within this circle were counted and measured. (3) Drift transects: A small boat was allowed to drift across the reef with the current while swimmers holding on to the side counted *H. hippopus* and *T. derasa* and counted and measured *T. gigas* and some *T. derasa*. (4) Towing: The boat under power towed swimmers slowly across the reef, and they counted the three largest species. (5) Power tows: Swimmers were towed along the reef between transects to estimate the densities of clams. Power towing provided an indication of the variability of the occurrence of clams in areas of the reef between transects.

The centers of the two circular surveys and the starting points of the two line transects were marked with bronze pipes imbedded in quick-hardening cement. The locations of these marks to the nearest second of arc are given in Table 1, together with the starting points and directions of the drift and tow transects. All positions are taken from the Navy Hydrographic Office chart of Helen Reef, No. 6072, 1st edition, April 1944. Areas not actually measured by transect were taken from the chart with a planimeter. All clam measurements are straight-line valve length made with meter stick calipers, a method that was unsatisfactory for the larger specimens owing to the shortness of the caliper jaws and the width (curvature) of the valves. The estimated error of measurement was ± 5 mm for clams up to 400-mm shell length. For clams larger than this, the error was probably on the order of ± 25 mm.

RESULTS

The abundance of clams at Helen Reef for the two transects and the two circle surveys is presented in Table 2 with abundance data from the Palau Islands (Hardy and Hardy, 1969) for comparison. For this table both our data and Hardy and Hardy's data have been adjusted to number of clams per 2,000 m^2 (the area of each circle survey).

Average shell size and log abundance adjusted to 4,000 m^2 (equivalent to the two circle surveys combined) for the six species are given in Figure 2. Average sizes for Hardy and Hardy's clams were estimated from their Figure 4 and are subject to interpretive error.

Length-frequency data for all *T. gigas* and *T. derasa* measured and for *T. crocea*, *T. maxima*, and *H. hippopus* from the two circle surveys combined are presented in Figure 3.

Measured by planimeter, the area of Helen Reef judged suitable habitat for clams is approximately 5,340 ha. Standing stock estimates for the three larger species were made in several ways. From the data in Table 1 the total numbers counted and the total area surveyed were converted to density per hectare which, when multiplied by total reef area, gave estimates of standing stock. Second, densities calculated for each transect were extrapolated to standing stock for adjacent sections of the reef to adjust for habitat variability. Because the data were available from both linear and areal surveys in two sections, estimates were made using each set independently. Third, estimates based on the two coral heads surveyed resulted in surprisingly high

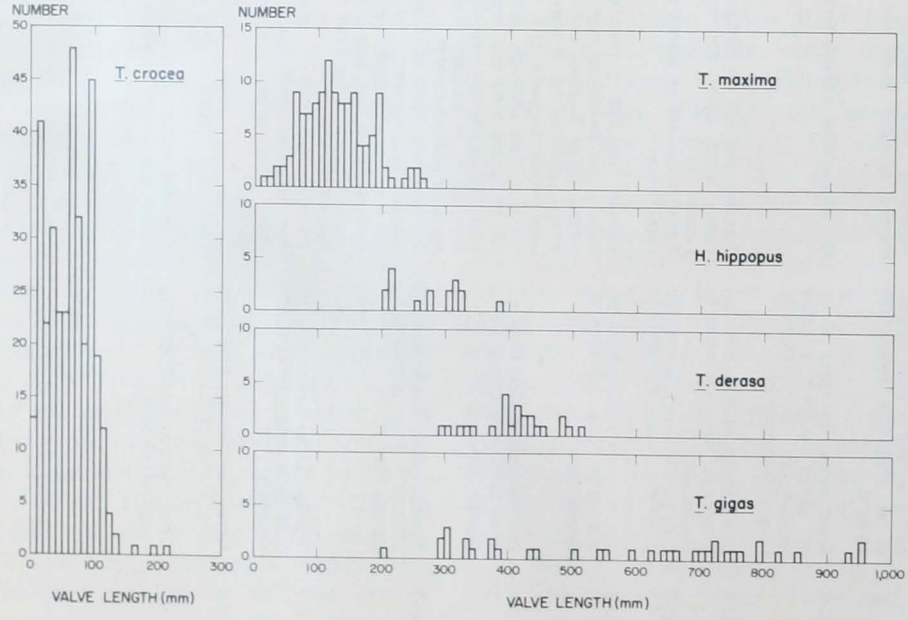

Figure 3.—Length frequency of Tridacnidae at Helen Reef.

standing stock estimates, so total standing stock was calculated with and without the coral head data. Fourth, for the two smaller species, *T. maxima* and *T. crocea*, estimates were made by extrapolating the areal survey data to total reef area resulting in a probable overestimate of abundance. From these estimates maximum and minimum standing stock are obtained (Table 3).

DISCUSSION

Tridacna squamosa was exceedingly rare at Helen Reef, only one specimen being found, whereas *T. maxima* was abundant. This differed from the pattern in the Palaus (Hardy and Hardy, 1969).

The smallest *T. gigas* found was a 200-mm specimen and only two specimens of *T. gigas* shorter than 300 mm were observed. We thought it might be possible to make some recruitment and growth rate estimates by looking for modal size groups with *T. gigas*. However, our measurements are too few to permit any inferences to be drawn.

The growth rates of giant clams are subject to debate in the literature, estimates ranging from a few millimeters per year to an excess of 50 mm per year (see Rosewater, 1965). Observations from Eniwetok based on radioautographs (Bonham, 1965) together with our observations that encrusting coral on the shells seldom is very large, suggest that the growth rates are relatively rapid and that large *T. gigas* probably are 10-20 years of age. Hardy and Hardy's data suggest that the Palaus' *T. gigas* and *T. derasa* are smaller on the average than our Helen Reef clams. For *T. gigas* this may be the result of our extrapolation and interpretation of their data, but in the case of *T. derasa* a size difference appears likely.

With regard to distribution our observations were very similar to Hardy and Hardy's and the rest of the literature. *Tridacna crocea* usually was imbedded in coral heads (*Porites* sp.). *Hippopus hippopus* was found on sandy areas and on occasion on the reef flat, and *T. maxima* was attached to suitable substrate out into the surf zone. *Tridacna derasa* and *T. gigas* occurred in various habitats. To the north of Helen Island, there is an extensive sand flat with occasional small coral patches. Here we found large *T. derasa* and *T. gigas*. Large

The giant clam, shown top and lower left in its natural habitat, is hoisted aboard ship, lower right.

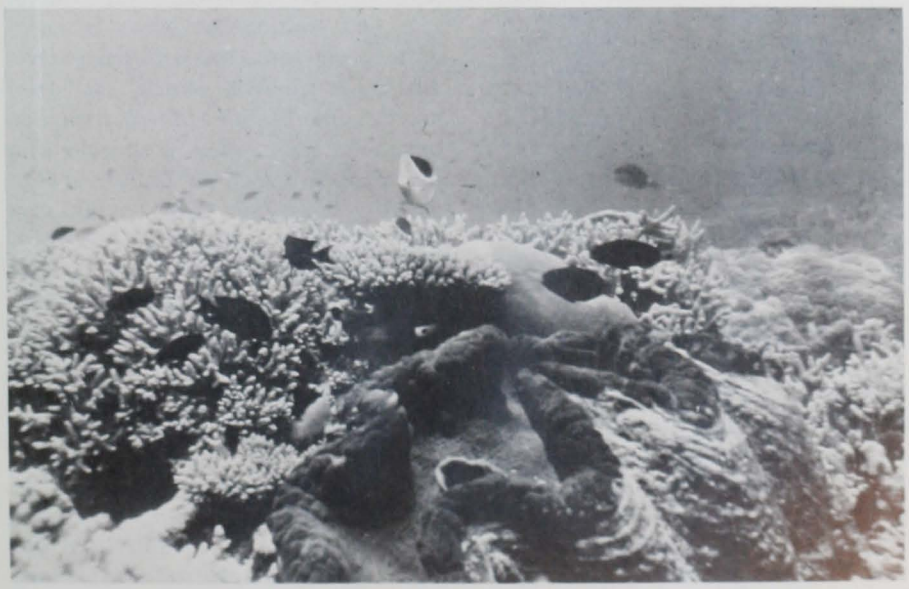

Table 3. — Standing stock estimate.

Species	Based on number per ha: Density no ha	Based on number per ha: Standing stock		Based on number per survey sector: T−1 + T−2	Based on number per survey sector: C−1 + C−2
T. gigas	18.72	99.97 × 10^3		49.77 × 10^3	58.81 × 10^3
T. derasa	26.94	143.86 × 10^3		77.65 × 10^3	32.75 × 10^3
H. hippopus	13.47	71.90 × 10^3		44.61 × 10^3	87.92 × 10^3
T. maxima	3.10 × 10^2	1.66 × 10^6			
T. crocea[1]	10.00 × 10^2	5.34 × 10^6			
				Plus H-1	Plus H-1
T. maxima	3.15 × 10^2	1.68 × 10^6	*T. gigas*	75.04 × 10^3	83.08 × 10^3
T. crocea[2]	6.90 × 10^2	3.68 × 10^6	*T. derasa*	110.73 × 10^3	65.83 × 10^3
			H. hippopus	48.49 × 10^3	91.80 × 10^3
	High estimate	Low estimate			
T. gigas	99.97 × 10^3	49.77 × 10^3			
T. derasa	143.86 × 10^3	32.75 × 10^3			
H. hippopus	94.48 × 10^3	44.61 × 10^3			
				Plus H-2	Plus H-2
T. maxima	1.68 × 10^6	1.66 × 10^6	*T. gigas*	75.04 × 10^3	83.06 × 10^3
T. crocea	5.34 × 10^6	3.68 × 10^6	*T. derasa*	97.93 × 10^3	58.53 × 10^3
			H. hippopus	51.17 × 10^3	94.48 × 10^3

[1]Estimates for *T. maxima* and *T. crocea* from survey C-1.
[2]Estimates for *T. maxima* and *T. crocea* from survey C-2.

T. gigas also occurred along the lagoon edge of the reef south of the pass. Small, medium, and large *T. gigas* and *T. derasa* were found on the coral heads in the lagoon and associated with *Acropora* sp. rubble along the east side of the lagoon. The east and south flats of the reef were hard and relatively bare compared with the west and north sections of the reef except for some sandy portions where *T. gigas* and *T. derasa* were found.

CONCLUSIONS

The clam populations at Helen Reef appeared to be large at the time of the survey. The lack of small *T. gigas* and *T. derasa* suggests that recruitment may be erratic or slow or both. Our lowest standing stock estimates of these two species, the most desirable for shell, are 49.8 × 10^3 *T. gigas* and 32.8 × 10^3 *T. derasa*, suggesting that a moderate fishery for these two species could be prosecuted. Uncertainties with regard to growth rates and recruitment advise caution.

SUMMARY

A standing stock estimate of giant clams, Tridacnidae, at Helen Reef, a small coral atoll in the western Pacific (lat.3°N, long.131°E), was made in March 1972. Eight transects of the reef were made together with two areal surveys 2,000 m^2 each. From these transects, high and low estimates of standing stock for five species of clams, *T. gigas*, *T. derasa*, *T. maxima*, *T. crocea*, and *H. hippopus* were made. Low estimates for the stocks were: *T. gigas* 49.8 × 10^3, *T. derasa* 32.8 × 10^3, *T. maxima* 1.7 × 10^6, *T. crocea* 3.7 × 10^6, and *H. hippopus* 44.6 × 10^3. Only one specimen of the sixth clam, *T. squamosa*, was encountered.

LITERATURE CITED

Bonham, K. 1965. Growth rate of giant clam *Tridacna gigas* at Bikini Atoll as revealed by radioautography. Science (Wash., D.C.) 149:300-302.

Hardy, J. T., and S. A. Hardy. 1969. Ecology of *Tridacna* in Palau. Pac. Sci. 23:467-472.

Rosewater, J. 1965. The family Tridacnidae in the Indo-Pacific. Indo-Pac. Mollusca (Smithson.) 1:347-408.

MFR Paper 1071. From Marine Fisheries Review, *Vol. 36, No. 7, July 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*