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Helen Reef's large tridacnid clams have declined sharply in recent years.

Status of Giant Clam Stocks (Tridacnidae) on Helen Reef, Palau, Western Caroline Islands, April 1975

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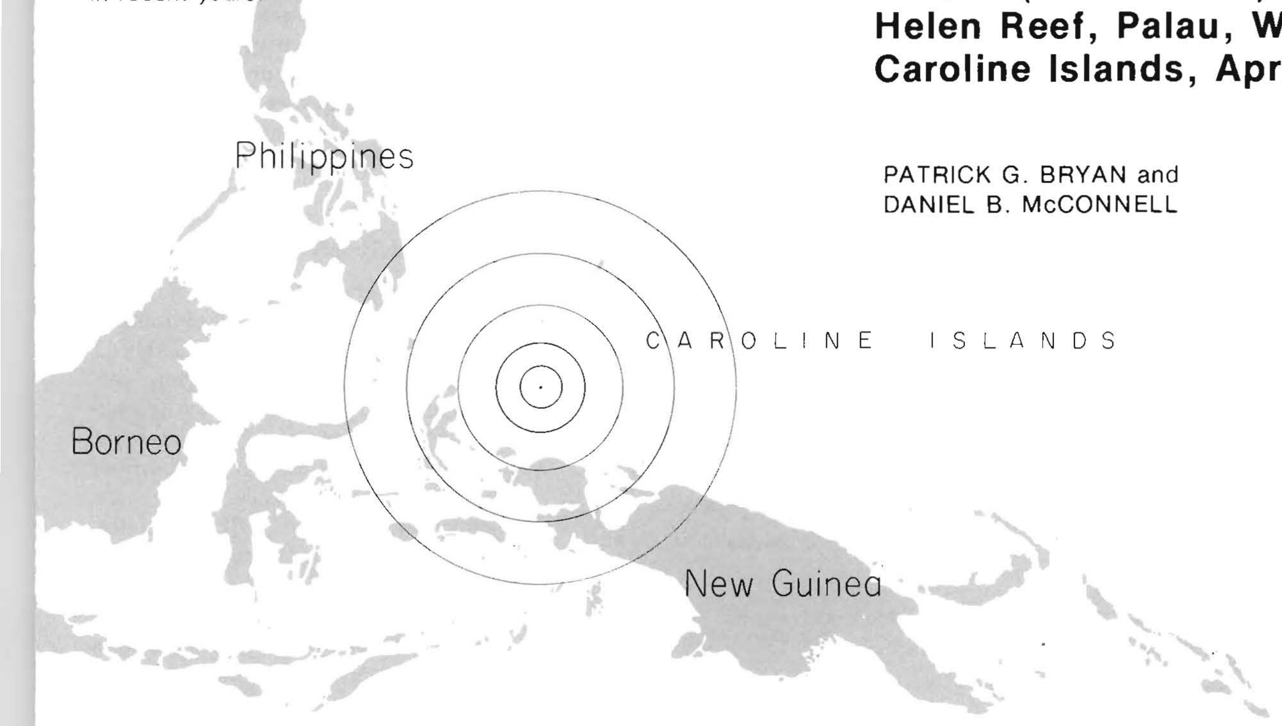

Abstract—A total of 24,800 m^2 *were covered in transects made on Helen Reef to assess population levels of Tridacnidae. Standing stock estimates were:* Tridacna gigas, *8.6 x* 10^3; T. derasa, *12.9 x* 10^3; T. maxima, *1.4 x* 10^6; *and* Hippopus hippopus, *47.4 x* 10^3. Tridacna crocea *was omnipresent.* Tridacna squamosa *was difficult to identify and only three were seen. A similar study conducted in 1972 gave the following estimates:* Tridacna gigas, *49.8 x* 10^3; T. derasa, *32.8 x* 10^3; T. maxima, *1.7 x* 10^6 *and* H. hippopus, *44.6 x* 10^3. *A large percentage of three species were dead z (empty shells):* Tridacna gigas*—4 live, 206 dead;* T. derasa*—6 live, 168 dead; and* H. hippopus*—22 live, 458 dead. The reduction in population numbers of these three species is attributed to human exploitation.* Tridacna maxima *and* T. crocea *did not appear to have been exploited.*

INTRODUCTION

Helen Reef is a small atoll lying on the southernmost border of Palau District, Trust Territory of the Pacific Islands, at approximately lat. 3°N and long. 131°E. The barrier reef and lagoon reefs (patch reefs) harbored, until recently, considerable populations of tridacnid clams (giant clams), of which several species are highly valued for their meats and shells. The family Tridacnidae includes six species, all of which are limited in distribution to the Indo-Pacific faunal region (Rosewater, 1965). They are: *Tridacna gigas* (Linné), *T. derasa* (Röding), *T. squamosa* Lamarck, *T. maxima* (Röding), *T. crocea* Lamarck, and *Hippopus hippopus* (Linné).

In March 1972 a group of biologists from the Honolulu Laboratory of the National Marine Fisheries Service were called upon by the Division of Marine Resources, Trust Territory of the Pacific Islands, to conduct a survey of Helen Reef and assess standing stocks of tridacnid clams. They concluded that population levels of tridacnids were high at the time of their survey (Hester and Jones, 1974). Since that time, foreign fishing vessels poaching on Helen Reef have been captured by the Trust Territory field trip vessel with alarming frequency. For this reason, the Palau Marine Resources Office chartered the Oceanic Society's flagship *New World* in April 1975 to carry a team of biologists to Helen Reef so that a resurvey could be made. The purpose of this survey was to assess population levels of important marine organisms which are being exploited by foreign fishing vessels and to some extent by the unauthorized

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Trust Territory flagship. Particular emphasis was placed on assessing tridacnid clam stocks.

METHODS

Straight line transects, 2 m in width, were used almost exclusively in this survey. Transects on the barrier reef were made by swimming with an inflatable boat from the lagoon slope normal to the reef as far into the surf zone as circumstances allowed. In some cases, because of currents, the transects began in the surf zone and ran to the lagoon slope. Tridacnid clams lying within the transect path of 2 m were counted and recorded on underwater writing boards. Patch reefs within the lagoon were transected from the lagoon slope on one side to the lagoon slope on the adjacent side. All transects ran true north, east, south, or west. The only deviation from the transect methods were two areal tows which were made along the lagoon terrace and which followed the contour of the lagoon slope. Counts, however, were limited in these tows to a 2-m path as in the transects. Strong winds and high seas prevented survey of the outer reef front and terrace. Positions and measurements were figured from the Navy Hydrographic Office chart of Helen Reef, No. 6072, 1st edition, April 1944.

Table 1.—Survey data of live tridacnid clams taken from transects and areal tows on Helen Reef. T = transect. A = areal tow. *Tridacna crocea* not included.

Station	Location and direction of transect or areal tow	Reef type	Length of transect or areal tow (m)	Area surveyed (m^2)	No. of live species counted	Clam density per 100 m^2
T_1	lat. 2° 51′ 10″N long. 131° 44′ 16″E 270° true	Barrier reef	650	1300	5-*T. maxima* 1-*H. hippopus*	0.4 0.1
T_2	lat. 2° 48′46″N long. 131° 45′06″E 180° true	Barrier reef	650	1300	3-*T. maxima*	0.2
T_3	lat. 2° 51′ 24″N long. 131° 48′23″E 90° true	Barrier reef	975	1950	60-*T. maxima* 1-*H. hippopus* 1-*T. squamosa*	3.1 0.1 0.1
T_4	lat. 2° 50′ 33″N long. 131° 45′48″E 270° true	Patch reef	475	950	27-*T. maxima*	2.8
T_5	lat. 2° 50′ 24″N long. 131° 45′ 30″E 180° true	Patch reef	325	650	51-*T. maxima* 1-*T. gigas*	7.9 0.2
T_6	lat. 2° 52′ 13″N long. 131° 45′03″E 180° true	Channel reef	475	950	49-*T. maxima* 1-*T. derasa*	5.2 0.1
T_7	lat. 2° 53′ 13″N long. 131° 44′ 56″E 270° true	Patch reef	325	650	53-*T. maxima* 1-*T. gigas* 1-*T. derasa*	8.2 0.2 0.2
T_8	lat. 2° 54′ 42″N long. 131° 45′ 14″E 270° true	Barrier reef	975	1950	61-*T. maxima* 1-*T. derasa* 2-*H. hippopus*	3.1 0.1 0.1
T_9	lat. 2° 56′ 20″N long. 131° 46′53″E 270° true	Barrier reef	975	1950	39-*T. maxima* 2-*T. derasa* 1-*T. squamosa*	2.0 0.1 0.1
T_{10}	lat. 2° 58′ 00″N long. 131° 48′ 16″E 270° true	Barrier reef	1125	2250	44-*T. maxima*	2.0
T_{11}	lat. 2° 59′05″N long. 131° 48′30″E 270° true	Barrier reef	800	1600	43-*T. maxima* 3-*H. hippopus*	2.7 0.2
T_{12}	lat. 3° 00′30″N long. 131° 48′55″E 0° true	Barrier reef	650	1300	2-*T. maxima*	0.2
T_{13}	lat. 2° 58′06″N long. 131° 49′24″E 90° true	Barrier reef	1600	3200	137-*T. maxima* 1-*T. derasa* 9-*H. hippopus*	4.3 0.03 0.3
T_{14}	lat. 2° 56′30″N long. 131° 49′51″E 90° true	Barrier reef	1125	2250	4-*T. maxima* 6-*H. hippopus*	0.2 0.3
T_{15}	lat. 2° 58′00″N long. 131° 49′00″E 180° true	Patch reef	325	650	37-*T. maxima*	5.7
A_1	lat. 2° 49′00″N long. 131° 44′30″E Direction variable	Lagoon terrace	475	950	2-*T. maxima*	0.2
A_2	lat. 2° 50′30″N long. 131° 47′30″E Direction variable	Lagoon terrace	475	950	12-*T. maxima* 2-*T. gigas*	1.3 0.2

RESULTS AND DISCUSSION

Figure 1 presents a map of Helen Reef showing the localities of stations made during this survey. Table 1 presents data calculated from live tridacnid clam counts according to each station. Standing stock estimates for tridacnid species found on Helen Reef are presented in Table 2 and are compared with the 1972 estimates made by Hester and Jones (1974).

Because of limited manpower and time, *T. crocea* (the smallest tridacnid species) was not counted. This species was extremely abundant and was usually omnipresent. *Tridacna squamosa* is either extremely rare on Helen Reef (Hester and Jones, 1974) or is so morphologically similar to *T. maxima* as to be almost indistinguishable. Only

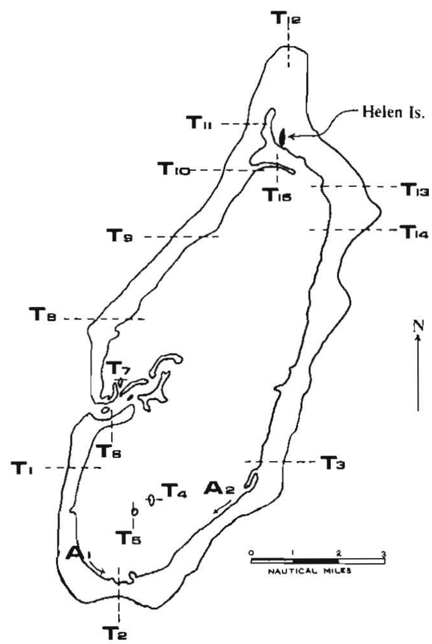


Figure 1.—Localities of survey stations made on Helen Reef. T = transect. A = areal tow.

three *T. squamosa* were identified (2 live, 1 dead) during this survey, and the authors are not absolutely positive of their proper identification. Hardy and Hardy (1969) apparently found no difficulty distinguishing between *T. squamosa* and *T. maxima* in Palau proper.

The results of this survey show that Helen Reef has been systematically harvested of at least two species of tridacnid clams, *T. gigas* and *T. derasa*. The graveyard appearance (empty shells) on the reef suggests that only the fleshy portions of these species have been harvested. Most of the captured foreign fishing vessels have had their holds filled only with tridacnid muscles. Many of the empty shells on the reef appeared to be several years old, i.e., they were encrusted with algae, sponges, corals, and other invertebrates. About 50 shells were unidentifiable because of weathering and deterioration. This suggests that the exploitation of tridacnid clams on Helen Reef has been proceeding for several years. By contrast, Hester and Jones (1974) made no mention of sighting empty shells in their 1972 survey and even suggested that a moderate fishery for *T. gigas* and *T. derasa* might be initiated with caution. It must be assumed from their report that the clam population on Helen Reef had not been exploited to a noticeable extent at the time of their survey (March 1972) and that methodical harvesting probably began sometime after March 1972.

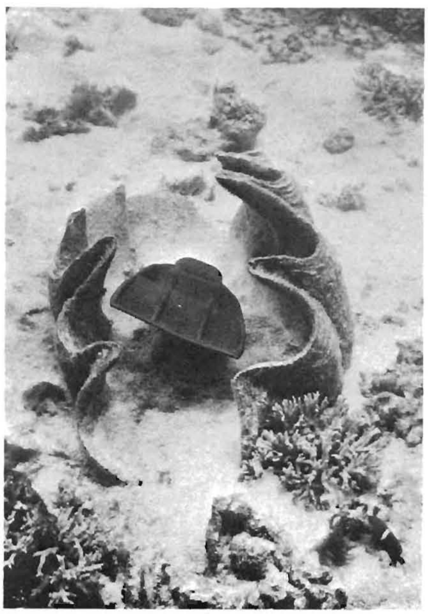
In January 1937, Motoda (1938) visually estimated the number of *T. gigas* around his ship's anchorage to be 5 to 6 per 13 m^2. He also reported seeing many empty *T. gigas* shells, which he attributed to harvesting by Nanyo-Boeki Co. several years earlier. A comparitive estimate of *T. gigas* from the 1972 survey of Hester and Jones (1974), derived from the station which gave the highest count (23 counted in 1,600 m^2), would be 0.187

Patrick G. Bryan with empty *T. gigas* shell.

Table 2—Summation of survey data for tridacnid clams found on Helen Reef. Standing stock estimates are based on Hester and Jones' (1974) figure of 5,340 hectares as suitable habitat for tridacnid clams on Helen Reef.

Species	Live	Dead	Percent live	Percent dead	1975 Estimate of standing stock	1972 Estimate of standing stock[1]
T. gigas	4	206	1.9	98.1	8.6×10^3	49.8×10^3
T. derasa	6	168	3.4	96.6	12.9×10^3	32.8×10^3
T. maxima	629	23	96.5	3.5	1.4×10^6	1.7×10^6
T. crocea	Omnipresent	—	—	—	—	3.7×10^6
T. squamosa	2	1	66.7	33.3	4.3×10^3	—
H. hippopus	22	458	4.6	95.4	47.4×10^3	44.6×10^3

[1] Data from Hester and Jones (1974).



Empty *T. gigas* containing swim fin for size comparison.

Survey party aboard *New World* at Helen Reef. Trust Territory field trip ship in background.

per 13 m^2. This survey's highest estimate of *T. gigas*, derived from station A_2 (2 counted in 950 m^2) is 0.027 per 13 m^2. These figures imply that *T. gigas* has declined rapidly since 1937, but further systematic harvesting after 1972 resulted in obvious overexploitation.

Standing stock estimates made by Hester and Jones (1974) for *T. gigas* (49.8×10^3) and *T. derasa* (32.8×10^3) contrast sharply with our figures of 8.6×10^3 and 12.9×10^3, respectively. We counted only four live *T. gigas* (206 dead, 98.1 percent) and six live *T. derasa* (168 dead, 96.6 percent). Our standing stock estimate for *H. hippopus* (47.4×10^3) is similar to the estimate of 44.6×10^3 made by Hester and Jones (1974). However, we counted only 22 live *H. hioppopus* versus 458 dead (95.4 percent). This survey indicated that *T. gigas, T. derasa*, and *H. hippopus* have been harvested at depths up to around 20 m, about the maximum depth tridacnids are found (Hardy and Hardy, 1969), and suggests that sophisticated diving gear, such as scuba (self contained underwater breathing apparatus) or hooka (surface supplied air), may have been used to harvest the deeper clams. The current authors consider any further fishing for tridacnid clams on Helen Reef to be unfeasible in terms of catch per unit effort. Live *T. gigas, T. derasa*, and *H. hippopus* are presently scarce and probably only those which were overlooked by fishing parties remain. *Tridacna crocea* and T. *maxima* apparently have not been exploited. Either these have no commercial value or it has been unfeasible to harvest them because of their relatively small size.

Motoda (1938) reported not finding any *T. gigas* smaller than 30 cm in valve length on Helen Reef. Hester and Jones (1974) reported similar observations. They found only two *T. gigas* smaller than 30 cm, the smallest being 20 cm, and concluded that recruitment may be erratic or low. In this survey, although actual measurements were not taken, the authors believe the smallest *T. gigas* seen, live or dead, was at least 20 cm in valve length and most were larger than 30 cm.

Life-span of tridacnids is said to range from eight to several hundred years (Hardy and Hardy, 1969) and several short term growth rate experiments have suggested that *T. gigas* may grow about 5 cm in valve length per year (Bonham, 1965; Rosewater, 1965). However, McMichael (1974) showed that in *T. maxima* growth is a function of size. His data indicated that growth is relatively rapid during the early years of life, slowing down with increasing size. If *T. gigas* has similar growth, about 20 years may be required for this species to reach a valve length of 1 m.

Tridacna gigas, T. derasa, and *H. Hippopus* populations have declined drastically, apparently through human exploitation, on Helen Reef in recent years. *Tridacna gigas* is probably the most sought after because its large size and abundance makes it easy to see and efficient to harvest. Assuming that recruitment is erratic or low and that growth is slow, many years may be required for *T. gigas* to substantially repopulate if no further human predation occurs. Continued harvesting may severely retard or endanger the survival of *T. gigas* on Helen Reef.

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