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GIANT CLAMS IN FIJI

by

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Introduction

To those with any interest in the wonders of nature, giant clams are remarkable creatures. All members of this group have undergone adaptation to act as symbiotic hosts to single- celled zooxanthellae. These algae have removed the giant clam's necessity to filter food from the water and instead, the clam can obtain almost all its nutritional requirement, via the algae, from sunlight. This also has a number of interesting consequences for the ecology of the animal: for example, giant clams probably do not need to compete for food, and because they spend so little energy collecting food they can afford to grow to large sizes. Light-levels will play a large part in defining their habitat.

Species

The World currently has seven species of giant clam (five in the genus *Tridacna*, and two in the genus *Hippopus*). Their geographical ranges vary but the family, as a whole, is confined to the Indo-Pacific. Two of the smaller species, *Tridacna maxima* and *T.squamosa*, appear to have the widest ranges, from the Red Sea to French Polynesia, whilst the newly-classified species, *Hippopus porcellanus*, is only found in the Philippines and lately, Indonesia.

Three of these species: *T.maxima*, *T.squamosa* and *T.derasa*, are presently found in Fiji. T.gigas has become extinct within living memory, and *H.hippopus* is only known from Pleistocene fossils. The Fijian "Tevoro", or devil, clam has not yet been classified but will probably be raised to the specific level, if enough specimens are ever found. The "Tevoro" appears to bear the same sort of affinity to *T.derasa* as *H.porcellanus* does to *H.hippopus*. One further matter, worthy of taxonomic investigation, is the marked average size-difference between western and eastern Pacific populations of *T.maxima*.

Exploitation

On the smaller Indo-Pacific islands, where land-based sources of protein are naturally scarce, inshore resources have played a large part in subsistence nutrition. Sedentary resources, particularly, have been an important fall-back in hard times and many Pacific peoples have "ranched" the larger giant clams. The larger species tend to be saved for traditional ceremonies, and the smaller species used for subsistence. This is not as unfair as it sounds: most people reckon the smaller species to be much tastier.

The erosion of traditional cultural values has tended to remove restraints on subsistence harvesting. For example, the availability of hurricane relief supplies in Fiji has removed the need to "ranch" *T.derasa* against times of hardship, and nobody does it now, unless a big provincial council meeting is coming up.

However the main drain on giant clam stocks, particularly in the Western Pacific, has been the Taiwanese import market. In the 1960's, Taiwanese clam poachers gradually worked their way down through the Pacific, literally decimating the population of *T.gigas* and *T.derasa* They usually concentrated on uninhabited islands and reefs, but would (and still will) approach settlements to request permission to harvest in return for a carton of corned beef or cigarettes. Only the muscle is valuable: the larger the muscle the higher the price, so only the larger species (*T.gigas* & *T.derasa*) are taken. After the muscle is chiselled out the rest of the animal is left to rot in the sea.

Little, originally, could be done about this by the smaller Pacific nations, but when the poachers reached Australia several boats were arrested, and the Taiwanese Government forced to take notice. Eventually, probably as an informal condition for the signing of a new fishing agreement with Australia, Taiwan banned landings by the poachers, and imposed a restrictive level of duty on imports, driving trade onto the black market.

Today, the Taiwanese demand for clam adductor muscle is still very much in existence and, in Fiji at least, there are always people willing to try and satisfy it, despite the grossly overfished nature of the stock. The place of the poachers has been taken by commercial operators who collect the clams using local labour, paying $1-$2 per kg piece-rate, and export the muscle to Taiwan, usually via Australian processing companies.

Catch rates

As an example of commercial catch-rates, the good ship "Vaea", which made a brief but significant blitz on Fijian clam stocks in 1985, used teams of two men on Hookah underwater breathing gear, with catch rates of between 50 and 250 clams per team-day, depending on the habitat. At one site, which we subsequently visited, the harvesters had taken roughly 80% of the standing stock; some 15,000 *T.derasa*, from an area of about 10 square miles using 5 teams working for 20 days at depths down to 60 feet.

In Fiji, *T.derasa* is the species of choice for commercial fishermen and, since licensed exports started in 1984, we estimate that catch rates have varied between 20 and 40 tonnes of flesh per year, of which approximately half is exported. Almost all of the muscle is exported, and a proportion of the mantle flesh. The pattern of harvesting is: wipe out one reef and then move to another. Catch rates average 70% of the total living stock at each reef (less for scattered stocks, more for denser), and it does not take any sophisticated statistical analysis to show that this is way above the sustainable annual yield.

T.maxima and *T.squamosa* are collected for subsistence purposes and market sale from around the coasts of the larger islands, and particularly close to villages. About 10 tonnes goes through the municipal markets per annum, and this figure has remained fairly constant over the past few years.

Habitat

T.squamosa (Fijian: Cega) is most common close to the larger islands and is generally found in cracks and gullies of fringing reefs, often in quite turbid water. We have never found it in great concentrations. It appears to be less hardy than the other Fiji species, and when we relocate clams for experimental purposes we usually expect the first mortality to be *T.squamosa*

T.derasa (Fijian: Vasua dina) is generally confined to clearer, full salinity waters. A certain percentage of the population is usually found on the outer reef slopes, particularly on the leeward side, but this species reaches its greatest concentrations in shallow enclosed lagoons, generally clustered near coral walls or outcrops. At good sites, up to 100 individuals can be found on, or around, a single 50-foot diameter bommie. Exposure appears to play a large part in the habitat preference of *T.derasa*, but for what reason we have yet to determine. The best sites appear to be the lagoons of small, enclosed ring-reefs, or the foot of high coral walls (if present) on the inner reef-slopes of larger barrier reefs. Good *T.squamosa* and *T.derasa* habitats appear to be mutually exclusive, although there is some overlap in marginal habitats.

T.maxima (Fijian: Katavatu), on the other hand, blankets the range of both *T.squamosa* and *T.derasa*, and has similar stock- densities to both the larger species in their respective habitats. Because *T.maxima* is not commercially harvested, some dense concentrations remain on the uninhabited ring-reefs of the Lau group.

Susceptibility to overfishing.

As with most sedentary marine organisms which rely on the release of eggs and sperm into the water to effect fertilization, stock- densities must play a large part in determining reproductive success. Giant clams release a pheromone into the water which stimulates simultaneous spawning once environmental conditions are right, but this will only increase reproductive success if the clams are sufficiently densely aggregated to feel the effects of the pheromone. At the moment, we have no idea of the diffusibility, or the sensitivity of clams, to this substance, so we cannot say what the minimum stocking density is likely to be. However, when talking about management measures, it would make sense to stress those which will increase, or retain, high densities of clams in small areas.

Additionally, giant clams are restricted in depth by ambient average light-levels at the lower limit, and (probably) by turbulence at the upper limit. Clams found in shallow water tend to be either juveniles of the larger species or individuals of the smaller species, all of which are byssally attached to withstand wave action. Thus juveniles are more available to casual harvesters which, in a taxon with low and erratic recruitment rates, is potentially disastrous were it not for the the more cryptic nature of small clams and their lower acceptability to commercial harvesters. Hopefully these factors would offset the vulnerability of juveniles, as size-limits are virtually unenforceable when harvesting does not include the shell, and when account has to be taken of different species.

The lower depth-limit depends on turbidity, but in clear lagoons and outer reef-slopes the maximum is generally 80 feet. A restriction on the use of underwater breathing gear would clearly be effective in helping to conserve a proportion of the mature stock in deeper water, particularly in the Melanesian islands, where free-divers are not so skilled as the Polynesians.

Unfortunately, *T.derasa* is a high-value, high-return commodity, particularly in Fiji, where prices are geared to the local market for *T.maxima*, and where there is little idea of the export value by the people actually doing the fishing. Consequently, harvesting is economic even at low stock-densities, particularly when multipurpose collection trips to the outer islands are subsidised by the Government. Past experience has shown that stock-management cannot be left to the prevailing economics of the situation, but that active management is necessary if stocks are not to fall below critical levels (we must assume that these sedentary organisms do have such a "critical level" of abundance or dispersion, below which they will gradually become extinct, but what this level is remains to be determined).

In one respect, the publicity surrounding the International Giant Clam Project has had a negative impact, in that many people think that mariculture will solve the natural stock-depletion problem, or that the market will soon be swamped by maricultured clams, and they feel that this is a license to continue the present rate of exploitation or even to step it up.

It will be interesting to see if the recent opening-up of trade with the Chinese mainland will lead to the same sort of dramatic increase in demand as has been observed in the beche-de-mer trade.

Surveys.

Stock assessment of *T.derasa* in Fiji has aimed at a general overview of the whole of Fiji waters (Fiji has around 3000 nautical miles, in length, of reef) and so our estimates of abundance have been based on timed transits by a number of surface-towed, or free-swimming, snorkellers, rather than by measured transects. This gives us a rough idea of the present stock, and level of harvesting in those habitats that are considered to be suitable for *T.derasa*. When populations of clams are dense, the abundance estimates are supplemented by length- frequency measurements of a sample. Unfortunately, dense populations are all too rare, and most reefs can be classified as "low abundance" (less than 6 giant clams seen per man-hour). A table of reefs surveyed so far is appended.

A number of difficulties are attached to the accurate quantification of stock densities:

- The patchy nature of the resource. *T.derasa* tends to cluster around coral outcrops. This, and the generally low density mean that an inordinate number of transects would be needed to define a statistically significant number of clams.
- The difficulty of defining "suitable habitat". As previously mentioned, "exposure" seems to play a major role, but defining this in quantitative terms is difficult.
- When doing tows, the difficulty of quantifying "track width", where the area covered depends very much on the depth, the visibility and the visual background, and where all of these conditions may vary drastically during the course of a single tow.

All in all, we are satisfied with the index of abundance and exploitation that we obtain from experienced teams, particularly in relation to the coverage of large areas for the formulation of management plans. We can also calibrate this estimate on known catch returns from a particular area to give a rough estimate of stock density. For example, at Naqelelevu, a large ring-reef in Northern Lau, with a moderate to good stock of *T.derasa*, we know that 15,000 clams were harvested from an area of approximately 10 square nautical miles at a harvesting rate of 80%. This gives a rough figure of 1,875 clams per square mile, or 5.5 clams per hectare (this area includes a lot of bare sand). A subsequent visit by our survey team estimated the index of abundance at 145 clams (both alive and dead - dead shells were left in situ by the harvesters) per man-hour. Depending on the towing speed and assumed track width, extrapolations can then be made (very roughly) to other reefs surveyed, if necessary.

From the few length-frequency samplings made, the main point to emerge is that juveniles are under-represented. Obviously, mature clams are more visible, and juveniles are likely to be missed by broad surveys, especially if they are disguised, or hidden in crevices. However, intensive searches for juveniles have not turned up the missing age-classes, and they are not particularly difficult to spot when they are present (usually, several juveniles are found close together). It must be assumed that recruitment is erratic, and low-level, and that clustering may cause many to be overlooked entirely by anything short of a complete survey. The general length-frequency distribution is as expected from a long-lived, slow-growing organism. Age-class modes are not clear and tend to "pile up" once maturity is reached, so analysis is limited.

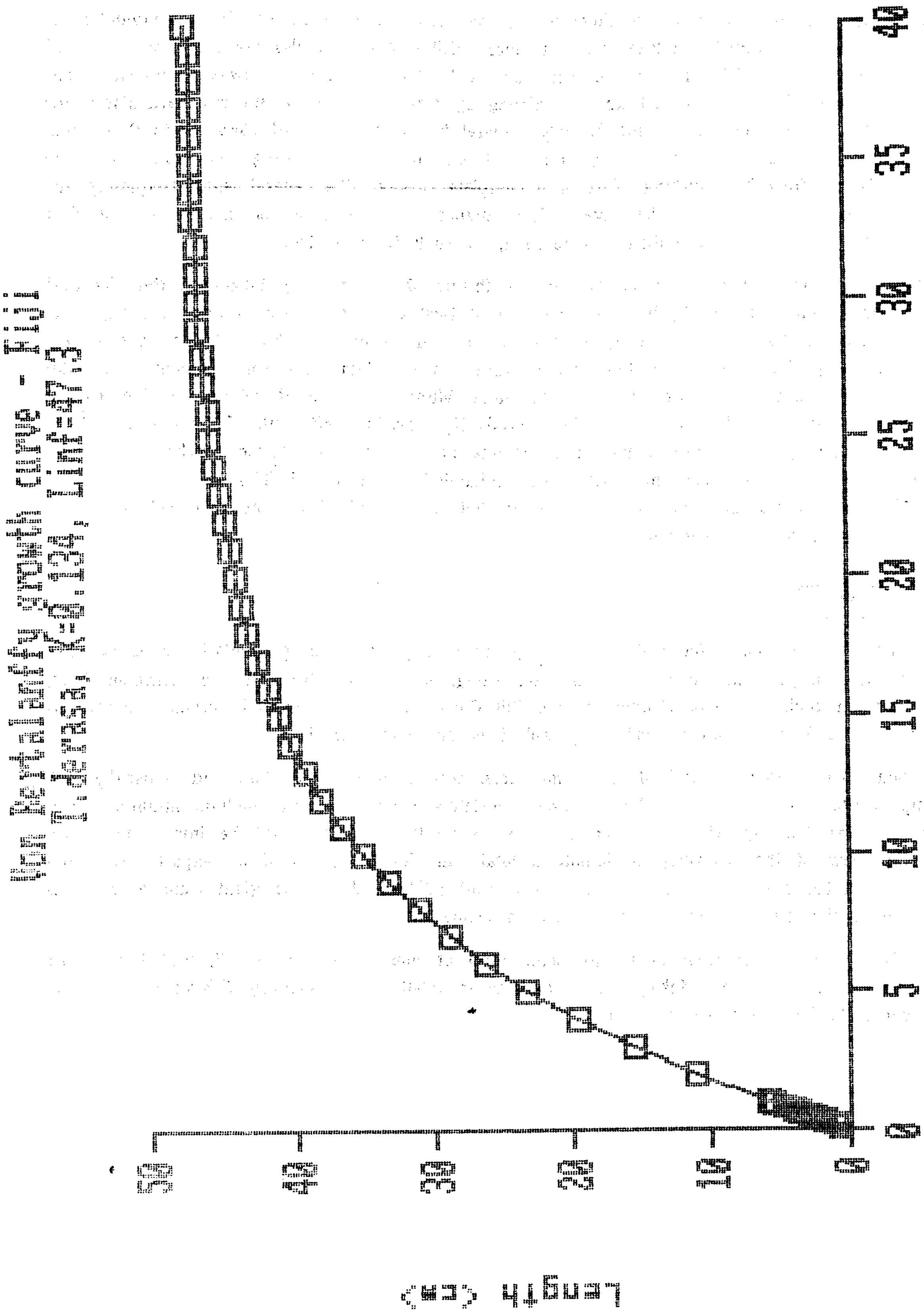
Attempts have been made to quantify the growth-rate of *T.derasa* by tagging. After the first year's remeasurement it quickly became clear that at least 2 years growth would be required to make any statistically significant analysis, due to the scarcity of juveniles and the slow growth of the larger age-classes. Applying the Fabens routine to the data from approximately 150 T.derasa, after the various cleanups suggested by John Munro, a value of 47.3cm for the asymptotic length, and 0.134 for the yearly Von Bertalanffy growth coefficient, K, was estimated. A Von Bertalanffy growth curve using these parameters is appended. These results are from a tagged population at Ono-i-Lau, the southernmost inhabited island in Fiji. The third year's growth increment will be measured in June, presuming that the tagged clams have escaped the attention of recent harvesting operations.

The Future

In summary, the prospects for Fiji's natural population of giant clams, particularly *T.derasa* looks fairly bleak, First poaching, then commercial harvesting, and lately subsidised fish- collection trips, have all taken their toll. The Cabinet of the Fiji Government recommended certain management measures in 1984, and, before 1987, they looked to be taking effect.

Legislation, incorporating several of these measures, was draughted in 1986 and hopefully will be implemented in the future. The proposed legislative measures might include minimum size-limits, and the banning of underwater breathing apparatus, but it would be interesting to see what the view of the workshop is. Ideally a total ban should be placed on exports, as is the case in Australia, but that is unlikely in the present political climate as giant clam harvesting is tied in with the drive to develop outer-island economies.

It has been our earnest wish to set up some form of marine reserve in Fiji, probably at our budding research station on Makogai, but problems in relation to customary fishing-rights ownership remain to be accommodated first.


Von Bertalanffy growth curve - Fiji
K=0.134, Linf=47.3
Length (cm)
0
10
20
30
40
50
Years
0
5
10
15
20
25
30
35
40