Trochus Studies In U.S. Trust Territory

Grading trochus shell in Palau, 1956.

Mainly in the 1930's, an extensive trochus transplantation-programme was carried out by the Japanese in what is now the Trust Territory of the Pacific Islands, under United States administration. A main objective of the current Trust Territory Trochus Research Project is to determine whether or not the islands planted now have trochus in commercial quantities. Another objective is to introduce trochus to new areas. Below is a report on progress made with the project to date, by the officer in charge . . .

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AS an export item the trochus industry of the Trust Territory of the Pacific Islands is second only to copra in value. It has been harvested ever since German times (1898-1914) in the Palau and Yap Islands, but its development as an industry is fairly recent in the rest of the Trust Territory. At present there is an annual catch from Palau, Yap, Truk, Ponape, Saipan and occasionally small amounts from Majuro, Jaluit, Ailinglaplap and Arno.

The reason for this extension of range (about 2,500 miles) is that during the Japanese era (1914-1945) an extensive transplantation programme was carried out. Although detailed records are not at present available it appears that most of this work was done during the 1930's, and that trochus were introduced to many islands and atolls. The stock for these introductions came from Palau, where *Trochus niloticus* is indigenous. The animals were transported in the live bait wells of Skipjack boats and placed either in the passes of barrier reefs or merely scattered on the outside of these reefs in about 10 feet of water.

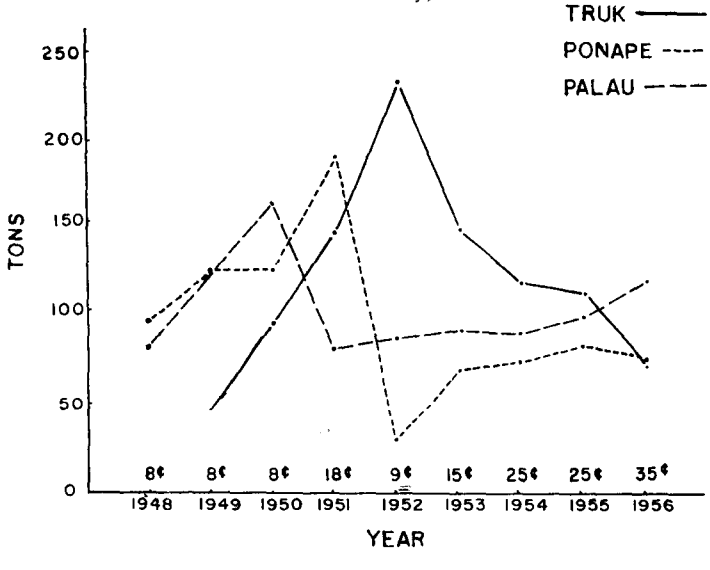
Islands known to be planted are: Truk, Ponape, Saipan, Majuro, Jaluit, Arno, Ebon, Mokil, Ngatik, Ailinglaplap, Pulawat, Ulithi, Ngulu, Nukuoro, Kapingmarangi and Pingelap. Some of these introductions were supervised by a professional biologist working for the Japanese Government, but others were not.

It is said that various companies as well as private individuals also introduced shell to many of the smaller, more isolated islands of the Territory. Several of these introductions were unsuccessful, according to the natives. One such attempt was made at Nukuoro where the adult trochus which were brought in managed to survive but the juveniles all died as soon as they reached a certain size.

There are other rumours from other islands that while the introduced trochus did manage to establish themselves, the population density is quite low. However, observations that trochus is either rare or abundant depend to a great extent on the observers' experience, and since the people from these islands have had no previous experience diving for shell, this statement must be open to question.

In order to resolve this difficulty, a survey technique has been developed by the current Trust Territory Trochus Research Project that will enable us to determine whether or not these islands have trochus in commercial quantities. It is one of the objectives of the Trochus Research Project to survey these islands, and if the results are favourable, to assist the inhabitants in developing this resource.

Another objective of the project is to introduce trochus to new areas. This aspect of the work is being delayed until we have a better understanding of the ecology of the larvae, juveniles and adults. It would also be desirable to have a knowledge of the growth rate of in-



Production curves for the main trochus-producing islands of the Trust Territory. The prices per pound paid to the diver is shown on the abscissa.

dividuals and of populations. This would help us to predict at what point we could expect to begin harvesting the new population and at what level to harvest them, i.e., what percentage of the adult population could we safely remove every year.

The results of the Japanese work can give us some indication of what to expect when we introduce trochus. For instance, a total of 6,724 shells were planted at Truk in 1927, 1928, 1929, 1930 and 1931. According to Japanese reports there was no harvest until 1939, when 7 tons were taken. The following year a little more was taken, and then the war interfered and little shell was produced for commercial purposes until 1948.

The production curve for the years subsequent to 1948 indicates an extremely rapid rise in production, followed by an equally abrupt drop and then a tendency towards levelling off. Production curves such as this one are difficult to interpret because they are affected by both biological and economic factors. The price of a fisheries product often has a great influence on the intensity with which it is fished, and therefore the size of the catch does not necessarily reflect the size of the population available to the fishermen. However, in the case of the Truk trochus catch curve, the peaks and troughs seem to have little relationship to the market price, and we must assume that at least part of the curve indicates, in a general way, what is really happening to the Truk trochus population.

The trends indicated by these curves are similar to many of the world's great fisheries, and although much of the information necessary to interpret them is lacking it is probable that they are similar for similar reasons.

Such curves are often explained in the following manner; at the beginning of the exploitation of a new fishery the catch is of course low, but as more and more fishermen become familiar with the most suitable techniques for catching their prey, as more and more of them enter the fishery, and as they discover the best fishing grounds, production shoots up.

Trochus divers at Helen Reef, 1956.

This expansion is generally short-lived in the case of organisms whose population size is rather limited, as is the case with trochus. For up until this point (the peak of the curve) the fishery has depended on stocks of organisms that have been accumulating for many generations. From this point on, the growth rate of the animal and the rate of recruitment of new individuals to the population cannot keep pace with the rate at which the old ones are being removed from the population by the fishermen, and the real production, which is measured in catch per unit of effort, begins to fall.

It is from this point on that we may assume that our curves show what is happening to the population size. If sound conservation measures have been instituted, production does not continue to fall, but will level off at some equilibrium point. An equilibrium point is a level at which recruitment will balance the rate of removal. The yearly catch will now be fairly stable, although environmental fluctuations can cause ups and downs in the population size, which are usually relatively minor, but in some cases may be rather severe. There is reason to believe that the trochus catch at Palau and Ponape is now at, or approaching, equilibrium. Thus it seems that in areas where trochus is newly introduced we might expect the same sort of production curves if conditions are similar to those described above.

The problem of the equilibrium catch has intrigued fisheries biologists for years, and it has gradually become evident that much can be done by man to adjust this equilibrium to the most profitable level. He can, by manipulating the fishing regulations, drive the equilibrium level either up or down.

The size of a population of trochus depends on the rate of fishing, and this as a mortality factor determines to a great extent the age distribution of the stock. This in turn affects the total number of eggs spawned, since a large trochus (4½ to 5½ inches) produces many more eggs than a smaller one (3 to 4½ inches). If we have more eggs produced we will have a better chance of getting more larvae, juveniles and adults.

This process cannot go upward indefinitely, however. Sooner or later we

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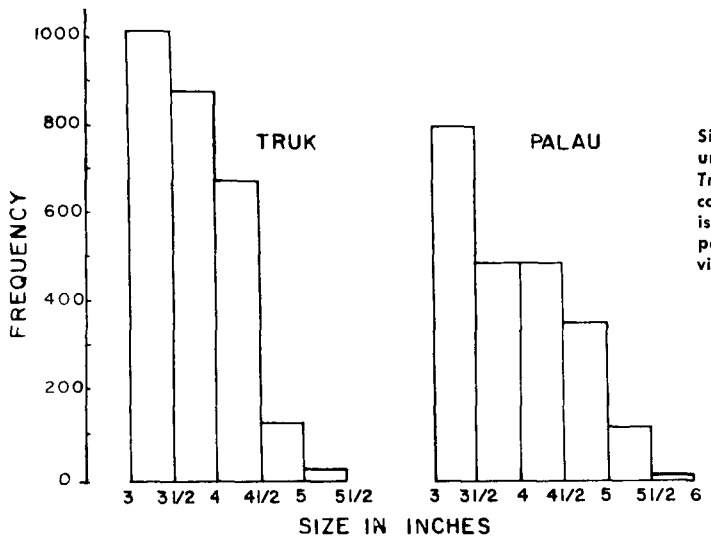
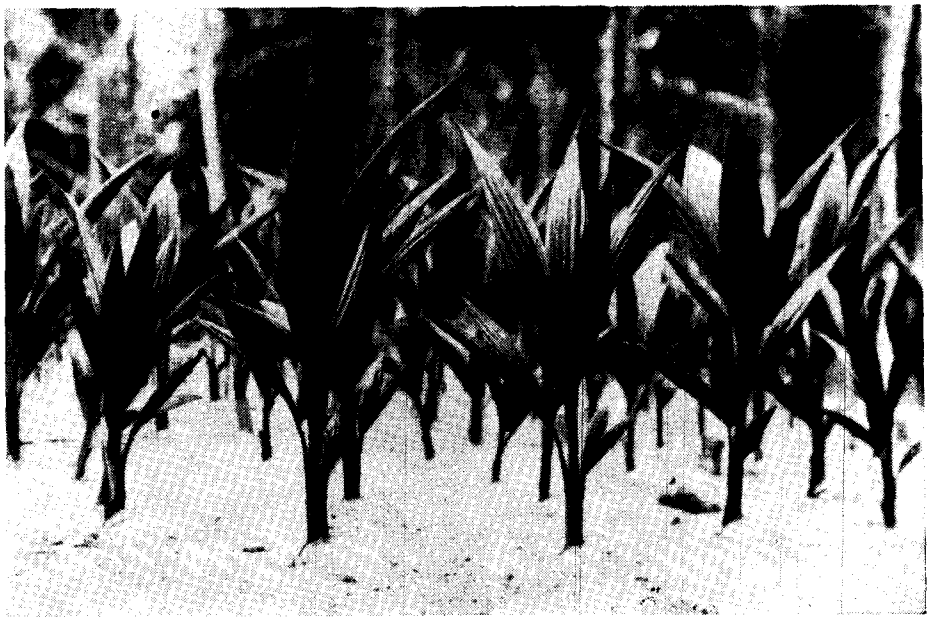


Size/frequency measurements made on the *Truk and Palau* trochus catch show that there is a much higher proportion of older individuals in the Palau population.



Correct planting of seed coconuts. These seedlings are in the right stage for transplanting. The two in the foreground, second and third from the left, are the robust types to be selected for the purpose.

rapidly and yield more than those which sprout late; further, a young, healthy, robust specimen has a good chance, under normal conditions, of retaining these qualities in the adult stage. Such correlations have an undeniably practical character.

Selection of seedlings, which has the effect of reducing the possibility of unproductive palms in the plantation, thus increases the average production by roughly 12%.

Palms produced from mass selection, like those from genealogical selection, are always liable, according to the occurrence of disjunction, to be unstable, and it is therefore indispensable to submit the plant material to rigorous selection before setting out. According to the variations of the nursery population, this selection, which takes place at least nine months after sowing, eliminates from 20 to 60% of the seedlings for planting.

Regeneration

Before undertaking regeneration of a plantation, a soil survey is indispensable in order to discover whether its composition and fertility are suitable for restoration as such, or for change of methods of cultivation with a view to improved productivity, or whether the plantation site should be merely abandoned and transferred to more favourable land.

It is always inadvisable to regenerate a plantation without improving soil fertility. In fact, without mineral and humic fertilizers, the first fruit is formed from the tenth to fifteenth year, whereas if they are used, the bearing period commences between the sixth and eighth year.

A necessary preliminary to restoration of any sort is a study of spacing and the use of selected seedlings. It should be accompanied by mechanical or chemical weed control, and methods should be perfected for elimination of old palms by felling or poisoning the tree with sodium arsenite.

Current Methods for Restoring Plantations

Three methods for restoring coconut plantations are at present in use:

1: Planting after removal of all old palms;
2: planting, followed by gradual removal of old palms, 20% the first year and 10% the other years;
3: planting, followed by removal of old palms at the time when the young coconuts, substituted for the old, start to bloom, i.e., eight years after their planting.

The first method produces the most vigorous palms but it is not yet known whether this vigour subsequently compensates for the loss of the old palms which have been removed.

Fertilization of old palms is often profitable since quite often their apparent senility is merely the effect of undernourishment. When this has been eliminated, yield increases and the land, enriched in its turn, offers suitable ground for further regeneration.

Clearing of natural stands, which is also an important aspect of regeneration, is a field of investigation from which the South Pacific in particular might obtain a substantial rise in its present copra production.

(To be concluded)

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will reach a point where the number of eggs produced is so great that the proportion of them that find room to grow becomes smaller and smaller. At this point, in spite of all our efforts, nothing can be done to increase the size of the population. Until we reach this point the population will either increase, decrease or stabilize at certain levels, depending on the number of eggs spawned and the rate of survival of these eggs.

The problem of equilibrium catch then is not merely one of allowing trochus to grow to size large enough to allow a super-abundance of eggs to be spawned, because in this way we may be robbing ourselves of many pounds of trochus each year due to the fact that the growth rate slows down as trochus gets larger. The problem is rather one of striking a mean balance between egg production, survival, growth rate and catch. In other words, what is the highest level at which we can fish and still leave enough organisms to re-populate the stock so that this high fishing level may be maintained?

Of course, it is necessary to have a great deal of biological and statistical information to predict the level at which we can achieve this. In many cases it is perhaps an ideal which we can only hope to approximate, but, since the advantages in raising your equilibrium 10, 15 or even 20 per cent. are great, it is obviously an ideal worth striving for. It is with this purpose in mind that a rather complex series of catch statistics are now being recorded in the Trust Territory. This data, in combination with certain biological information which it is hoped will be forthcoming from this study and that being made in New Caledonia, should give us a much better understanding of what will happen in the future should we decide to manipulate our fishing regulations in an attempt to increase our productivity.

At present the Trust Territory Code limits the taking of trochus to any 14-day period during the months of May, June or July. No trochus may be taken that are less than 3 inches in diameter. These regulations are a hold-over from Japanese times, and have apparently served to maintain the Palau and Ponape populations at fairly constant levels. However, as was pointed out earlier, the Palau population is an indigenous one, while the Saipan, Truk, Ponape and Marshall Islands populations are not; therefore they may be subject to environmental pressures which are new to them as a species and to which they have not had time to adapt themselves. Conservation measures which may serve very well to protect a natural population may not be at all satisfactory for an introduced one. The persistent downward trend of the Truk population curve is an indication that this may be true.

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