Journal of the
Marine Biological Association of India

ABBREVIATION : *J. mar. biol. Ass. India*

VOL. 13 June 1971 No. 1

THE RECOVERY OF CORAL REEFS DEVASTATED BY CATASTROPHIC EVENTS WITH PARTICULAR REFERENCE TO CURRENT *ACANTHASTER PLANCI* PLAGUES IN THE TROPICAL INDO-WEST PACIFIC REGION

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ABSTRACT

Catastrophic mortality of corals due to severe tropical storms, emersion at low tide, salinity changes, excessive siltation, earth movements and by other agencies is discussed. Destruction on a scale unprecedented in recent times of the corals of coral reefs of the Great Barrier Reef and at Guam and Palau due to the feeding activities of the starfish *Acanthaster planci* is described. Wholesale destruction of corals of coral reefs at numerous other localities in the Indo-West Pacific region due to population explosions of this coral predator appears to have recently occurred or to be occurring. The possibility is raised that unless effective measures to control the starfish plagues are rapidly adopted coral growths on reefs of many areas of the Indo-West Pacific region will be impoverished for prolonged periods.

INTRODUCTION

DURING the last decade massive destruction of hard corals on reefs of the Great Barrier Reef (Barnes, 1966 ; Endean, 1969 ; Pearson and Endean, 1969) and at other localities in the tropical West Pacific region (Chesher, 1969a) due to the feeding activities of the multi-armed starfish *Acanthaster planci* has been observed. The starfish appears to be undergoing a population explosion on an unprecedented scale. Chesher has raised the possibility that as a result of the starfish plagues, the destruction of coral ' may continue to the point where the coral fauna cannot recover ' (Chesher, 1969a, p. 283).

Wholesale destruction of the corals of recent coral reefs due to causes other than the feeding activities of *A. planci* has been recorded in the literature. Information is also available on the recolonization of devastated reefs by hermatypic corals. It is proposed to review briefly the literature on these aspects and in the light of available information to examine the current destruction of corals by *A. planci* and to assess the likelihood of recovery of affected reefs.

FACTORS RESPONSIBLE FOR THE CATASTROPHIC MORTALITY OF CORALS

Stoddart (1969a) has provided a recent summary of recorded instances of the catastrophic mortality of corals. He noted that severe tropical storms are a major cause of large-scale mortality of corals on reefs and described the devastation caused to British Honduras reefs by a hurricane in 1961. Moorhouse (1936) described the destruction caused to corals at Low Isles, Great Barrier Reef by a cyclone in 1934. The destruction caused at the same locality by a cyclone in 1950 was described by Stephenson, Endean and Bennett (1958). Likewise, Glynn *et al.* (1965) have described the coral destruction caused by a hurricane in Puerto Rico in 1963. It is apparent that coral destruction caused by tropical storms can be extensive, branching corals in particular being severely affected. However, colonies belonging to species of massive corals usually survive. Also corals in sheltered situations usually survive the immediate effects of the storms.

On the other hand, both branching and massive corals in shallow water habitats can be killed by a marked reduction in salinity caused by a local influx of large volumes of fresh water. Hedley (1924) and Rainford (1925) have described the destruction of coral on certain fringing reefs in the Whitsunday area caused by heavy rain associated with a cyclone in 1918. Slack-Smith (1959) and Cooper (1966) have described coral destruction due to a similar cause at Moreton Bay (Queensland) and at Fiji respectively.

Earth movements are believed responsible for the mass mortality of corals on coral reefs noted at some localities (Stoddart, 1969a) and excessive siltation appears to have been at least partially responsible for the deaths of some corals at other localities (Mayor 1924 ; Stephenson *et al.*, 1958). Emersion at low tide can result in the deaths of those polyps exposed to the atmosphere. Deaths, which could be attributed basically to this cause, of a large number of *Acropora* colonies were observed on the reef flat at Heron Island in 1970 (Endean, unpublished).

So-called ' dark water ' was reported to have destroyed a large area of coral in the lagoon at Cocos-Keeling in 1876 (Guppy, 1889 ; Wood Jones, 1910) and Bass-Beking (1951) has described coral deaths stemming from contact with masses of a planktonic alga *Trichodesmium* which had been washed onto reefs by wind-borne waves.

A variety of animals (see Robertson, 1970) including fish (representatives of at least 12 families), polychaetes, a cyclopoid copepod, a barnacle, species belonging to 3 genera of crabs, several species of gastropods (eolid nudibranchs and species belonging to the families Epitoniidae, Architectonidae, Ovulidae, Coralliophilidae and Muricidae) and the asteroids *Acanthaster planci* and *Culcita novaeguineae* feed on living coral polyps. However, as far as the Great Barrier Reef is concerned only two species of gastropods and the asteroids *C. novaeguineae* and *A. planci* have been observed to kill entire coral colonies. The colonies observed to have been killed by the gastropods and *C. novaeguineae* were relatively few in number. On the other hand, the mass mortality of corals on numerous reefs of the Great Barrier Reef (Endean, 1969 ; Pearson and Endean, 1969 ; Talbot and Talbot, 1970) and of certain reefs in American Trust Territories in the Pacific Ocean (Chesher, 1969a, 1969b), which has occurred during the last decade as a result of population explosions of the starfish *A. planci* has been on a scale which appears to be without precedent at least in recent times.

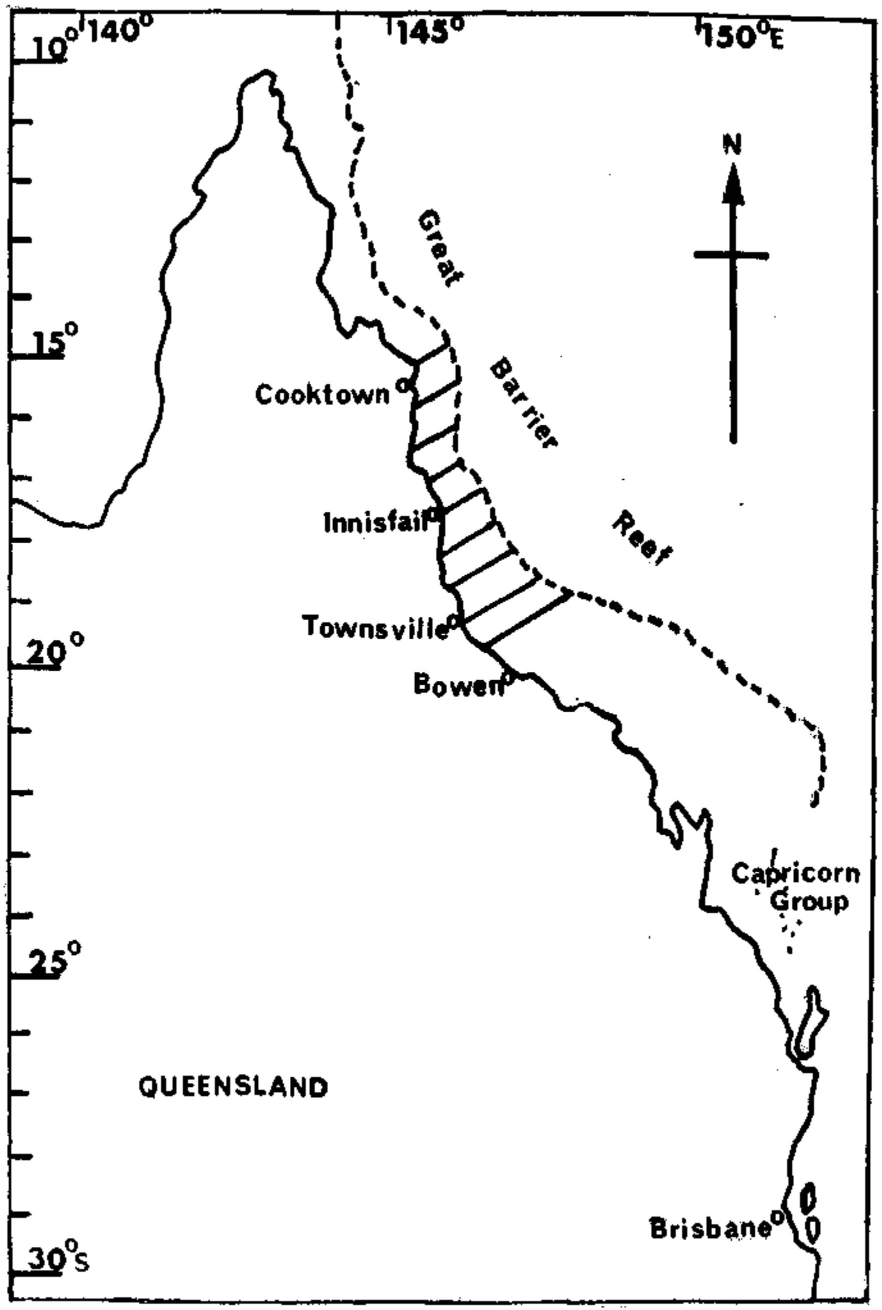

FIG. 1. Map of the coast of Queensland, Australia, showing the position of the Great Barrier Reef and Queensland localities mentioned in the text. The shaded area indicates the region of the Great Barrier Reef known to have been affected by *Acanthaster planci* population explosions during the 1960's.

POPULATION EXPLOSION OF *Acanthaster planci* ON THE GREAT BARRIER REEF

During the 1960's *Acanthaster planci* appeared in plague proportions (Plate I & II) on many of the reefs of the Great Barrier Reef (Barnes, 1966 ; Endean, 1969 ; Pearson and Endean, 1969). The region of the Great Barrier Reef (Fig. 1) now known to have been affected by the *A. planci* plague (Endean and Stablum, unpublished) extends from the vicinity of Lizard Island (Lat. 14° 40′ S) near Cooktown to reefs lying between Lat. 19° S and Lat. 20° S (off the Queensland coast between Townsville and Bowen). The distance involved is approximately 300 miles—*i.e.* about a quarter of the total length of the Great Barrier Reef. The area affected by the starfish plague embraces about 270 reefs—about a quarter of the total number of reefs appearing on recent charts of the Barrier Reef. However, only about half these reefs have been visited by the author and co-workers in recent years. Approximately 70% of the reefs visited were found to carry *A. planci* in numbers sufficiently large to be capable of causing extensive damage to the corals of the reefs visited. Almost all the reefs lying between the latitudes of 17° S and 18° S have probably been devastated by the starfish. For example, of the 42 recognised reefs lying on the Barrier Reef between these latitudes 25 were visited (some on more than one occasion) during the 1960's. Of these reefs 23 were found to be infested with starfish at some stage during this period. It appears likely that a similar situation prevails on reefs between 16° S and 17° S and between 18° S and 19° S. There is no evidence that the starfish plague is attenuating, at least as far as the southern region of starfish infestation is concerned. During 1970 most of the reefs off Townsville carried starfish in plague proportions and the plague appears to be spreading slowly southwards. It is to be expected that most of the reefs of the Great Barrier Reef between 19° S and 20° S will come under attack during the next five years if the plague continues to move southwards.

POPULATION EXPLOSIONS OF *A. planci* IN THE INDO-WEST PACIFIC REGION GENERALLY

Chesher (1969a) reported that *A. planci* became abundant on reefs at Guam in early 1967. Subsequently, Palau and Truk became infested. Investigations in 1969 by teams of scientists of *A. planci* populations on reefs at other localities in the U.S. Trust Territories in the Central Pacific revealed that Saipan, Tinian, Truk, Ponape, Rota, Palau, Ant, Guam, Majuro and Arno were infested (Chesher, 1969b). A ' normal ' population of *A. planci* was considered to have fewer than 20 specimens per 20 minutes of search. On an infested reef population densities increased to more than 100 per 20 minutes of search and frequently to several hundred.

Unfortunately precise data for densities of *A. planci* populations on reefs in other parts of the Indo-West Pacific region are lacking but reports of plagues of *A. planci* and massive destruction of coral on reefs at the following localities (Fig. 2) have been received :

Reefs off the east coast of Malaysia, reefs in the Gulf of Siam, reefs off Borneo, the Philippines, New Guinea, Papua, New Ireland, New Britain, Okinawa, the Solomons, New Caledonia, Fiji, Samoa, Cook Islands, Tonga, Society Islands, Tuamotu Archipelago and Hawaiian Islands.

Unconfirmed reports relating to increases in *A. planci* populations in the Seychelles and Maldives have been received.

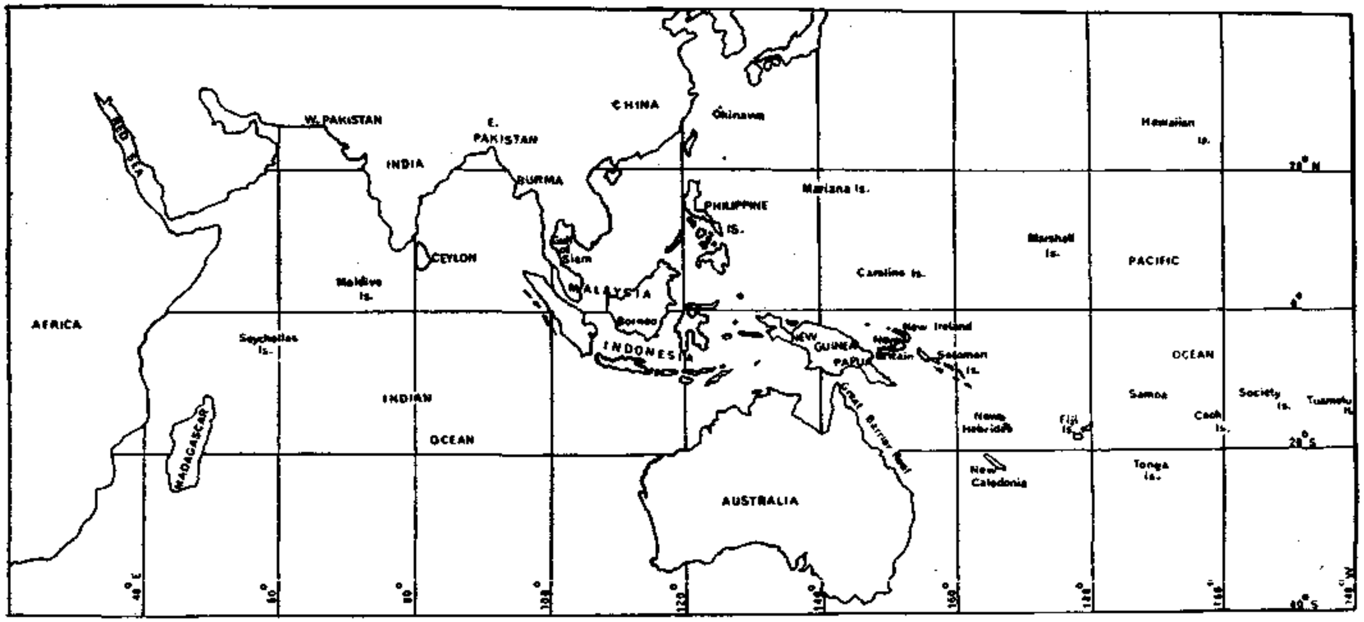

FIG. 2. Map of Indian Ocean and West Pacific Ocean showing positions of localities mentioned in the text.

THE RECOVERY OF REEFS DEVASTATED BY CATASTROPHIC EVENTS

Theoretical considerations

Recovery of coral reefs devastated by catastrophic events depends primarily on recolonization of devastated areas by coral colonies and on the continued growth and reproduction of surviving coral colonies. Regeneration of coral colonies from surviving portions of coral colonies would also be involved. However, full recovery would involve the return of most of those species characteristically associated with corals and coral reefs in the particular geographical region concerned. The reestablishment of the complex relationships normally existing between the numerous species comprising the biota of a reef will also be involved.

Many factors could affect the rate at which recolonization by corals of devastated reefs occurs. Recolonization of such areas is dependent upon the settlement of coral planulae and on the steady growth of colonies which these planulae initiate. If the destruction of coral colonies on a particular reef has been restricted to relatively small areas, or if substantial numbers of coral colonies (representative of a large number of species) survive in numerous patches, then recolonization should be relatively rapid compared with the situation which would arise if destruction of coral colonies had been uniformly extensive over the reef. In the latter event the planulae involved in recolonization might have to be transported by currents over distances of perhaps several kilometres from reefs where corals had escaped destruction. Alternatively, an extended period of time would be required for adequate numbers of recolonizing planulae to be produced by sparsely scattered survivors of the destruction.

Apart from the availability of coral planulae the rate of recolonization will also depend on the degree of success attending the settlement of planulae. One factor which would obviously affect settlement would be the availability of suitable substratum on which the planulae could settle. If the coral colonies present in an area of reef had been effectively removed by wave action at the time of a catastrophic event, or shortly afterwards, then suitable substratum should be immediately available for recolonization by planulae. On the other hand, if dead coral colonies remained *in situ* then the amount of suitable substratum available for recolonization would be restricted. Planulae could, of course, settle on the dead skeletons of the colonies remaining *in situ*. However, such recolonizers might subsequently be lost as a result of the coral colonies upon which they have settled being detached from the substratum. Mechanical effects due to heavy wave action could fragment the skeletons of branching corals. Biogenic erosion could also be involved since a number of organisms bore into or abrade coral skeletons. Among the borers are filamentous algae, sponges, molluscs, polychaetes, sipunculids and barnacles. Among the abraders molluscs and fish are well represented. Certain types of bacteria are apparently responsible for weakening the attachment to the substratum of coral skeletons (DiSalvo, 1969a ; 1969b). Then too, in exposed and semi-exposed situations coral rubble arising from the mechanical effects of wave action and biogenic erosion could roll about and hamper the settlement of planulae.

Another factor which would affect the rate and extent of recolonization by hermatypic corals of devastated areas would be the rate at which organisms other than corals settle on and/or encroach on such areas.

After settlement of planulae the rate of growth of the coral colonies initiated must next be considered. Growth rates vary from species to species and are affected by several environmental factors. However, it is well known that colonies of branching corals (e.g. species of *Acropora* and *Pocillopora*) increase in linear dimensions more quickly than colonies of massive forms such as *Porites* or *Favia* but the total weight attained is much less than in the massive forms. It has been found (Goreau, 1957 ; 1961) that the rate of growth in branching forms is greatest at the tips of the branches whereas it is fairly uniform over the surface of a colony belonging to a massive species. It has also been found that the initial rapid growth rate of a coral colony is followed by a slowing down leading to an almost complete cessation of growth (Manton, 1932 ; Motoda, 1940 ; Abe, 1940 ; Goreau and Goreau, 1960). In view of this latter finding, extrapolation from available data for the growth rates of corals would be unwise. Studies of the growth rates of coral colonies over many years, preferably decades, are required. However, if one was to accept the figures quoted by Stoddart (1969a)—annual increments of 5-10 cm. in diameter and 2-5 cm. in height for branching colonies and 0.5-2 cm. in diameter for the hemispherical colonies of massive species—then it could be estimated that colonies of branching corals might attain a significant size (50-100 cm. in diameter) in ten years and colonies of massive species might attain a substantial size (10-40 cm. in diameter) in 20 years from the time when the colonies were initiated.

However, while it is difficult to envisage any marked increase in the growth rates given as a result of the operation of normal environmental factors it is not difficult to conceive of the operation of factors which would slow growth rates considerably and hence lengthen markedly the time required for corals to attain substantial sizes. Rubble, for example, could roll about in shallow water under the influence of wave action and smash branches of small branching colonies growing there. Then too, coral colonies growing in shallow water could be subjected to excessive dessication if an exceptionally low tide coincided with a hot sun and negligible wave action or coincided with heavy rainfall. Long periods of cloudy weather might occur resulting in a slowing of coral growth. Goreau (1961) found that the normal growth rates of corals can be cut by half on a cloudy day. Parts of some of the growing colonies could be killed by animals which prey on coral polyps.

More subtle ecological factors could well play important roles in slowing the growth rates of corals. Interspecific and intraspecific competition for space on which to grow could be involved. In this respect evidence is accumulating to suggest that many sedentary organisms found on coral reefs produce antibiotics which inhibit the growth of other organisms in their immediate vicinity (Nigrelli, 1958 ; Burkholder and Burkholder, 1958 ; Endean, 1966 ; Burkholder and Ruetzler, 1969). It is also possible that a distinct succession of species will occur during the re-establishment of a cover of hard coral colonies on an area of devastated coral reef and that pioneer species of corals will subsequently be replaced by corals belonging to other species.

In summary, it would appear that the rate of recolonization of a particular reef by hard corals after a catastrophic event will depend on the initial magnitude and extent of coral destruction caused by the event, on the proximity of other reefs carrying undamaged corals which could supply adequate numbers of coral planulae belonging to a diversity of species to the devastated areas, on the presence of favourable water currents for conveying planulae to the devastated reef, on the availability of suitable substrate for settlement of planulae, on the existence of environmental conditions favourable for settlement and on the net result of the interactions of the numerous factors which influence the growth rate and disposition of coral colonies. If known growth rates of corals are used as criteria it would appear that under optimal conditions the recovery of a coral reef which had been heavily damaged by a catastrophic event would require a minimal period of 10-20 years.

Recorded instances of recovery or lack of recovery of devastated reefs

It is instructive to review the meagre amount of information on the recovery of coral reefs from catastrophic events which is available in the literature. The recovery of coral reefs following catastrophic damage caused by severe tropical storms certainly requires a number of years. Stoddart (1969a, p. 451) states that ' three years after the British Honduras hurricane ' (of 1961) ' the only corals living in any quantity were those which survived the storm itself and wide areas were blanketed by the algae *Padina* and *Halimeda*.' He also states (1969b, p. 5) that ' the slow rate of reef recovery requires explanation, in view of the known rapidity of growth of coral colonies, especially of branching forms such as *Acropora cervicornis*.'

Low Isles, on the Great Barrier Reef, was struck by a cyclone in 1934 and again in 1950. Moorhouse (1936) studied the effects of the first cyclone and noted that destruction of branching *Acropora* species had been extensive but that massive corals had suffered less damage. By 1945 (eleven years after the cyclone) damage was largely repaired (Fairbridge and Teichert 1947 ; 1948 ; Fairbridge, 1950). Stephenson, Endean and Bennett (1958) visited Low Isles in August, 1954, approximately four years after the reef there was lashed by storm waves accompanying a cyclone. Again it was found that the cyclone had caused great destruction to branching corals but that massive corals had survived in most cases. However, coral rubble resulting from the fragmenting of branching corals was being rolled about by waves on the seaward slopes of the reef and was hampering recolonization. It was estimated that 10 to 20 years would elapse before recovery occurred but Stoddart (1969a, p. 452) regards this estimate as ' probably minimal '. It should be noted that Low Isles is an inner platform reef and is sheltered by the reefs of the outer Barrier from the full force of wind blown waves from the Coral Sea. Also, it should be noted that the cyclones of 1934 and 1950 which affected Low Isles were much less intense than the British Honduras hurricane of 1961.

In January, 1967 a cyclone of relatively low intensity struck the northern side of Heron Island reef (Capricorn Group, Great Barrier Reef). Some coral colonies were stripped from the reef edge and upper seaward slopes and others were damaged apparently by rubble hurled about by the wind-borne waves. However, within twelve months small coral colonies were noted in the relatively small sections of the reef which had been denuded of living coral and by August, 1970 recolonization of these areas was well under way (Endean, unpublished). It would appear from the above studies that the rate of recolonization of coral reefs damaged by tropical storms depends primarily on the actual extent of the damage to hard corals caused by the storms. If this damage is localised recovery can probably occur within five to ten years. If the damage is moderately heavy and extensive then a recovery period of ten to twenty years might be involved. If the damage is exceptionally severe and widespread then a still longer period of time will probably be required.

Rainford (1925) reported on the effects of a flood which occurred in 1918 on coral growing on fringing reefs in the Whitsunday Group region of the Great Barrier Reef. Widespread destruction of corals occurred and only slight recovery was observed six years after the flood. Corals on the fringing reef at Stone Island, near Bowen, Queensland, were killed by the flood and Dr. F. Whitehouse has reported that in 1953, 35 years after the event, negligible recolonization of the reef by hard corals was in evidence (Stephenson *et al.*, 1958).

The classic case of man-induced change to a coral reef is provided by Palmyra Atoll in the Line Islands. During the 1939-1945 war causeways were built around the perimeter of the atoll. Renewal of water in the lagoon was thereby prevented. The flourishing coral reefs in the lagoon died and were replaced by algal communities dominated by *Lyngbya* (Dawson, 1959).

The recovery of reefs devastated by Acanthaster planci

Quantitative data (Endean and Stablum, unpublished) relating to the extent of coral damage caused by *A. planci* are now available for some reefs of the Great Barrier Reef affected by the starfish plague during the 1960's. It is apparent that when present in plague proportions in an area the starfish are capable of killing over 95% of the hard corals in the area. Although there is some variation from reef to reef in the extent of coral destruction caused by the starfish it is estimated that at least 60% of the hard corals on most reefs affected by *A. planci* have been killed by the starfish and that frequently over 80% destruction of hard corals (from sea floor to reef flat) has occurred. On some reefs coral destruction has been almost total. Normally coral on all parts of the reef except regions of the reef crest and reef edge exposed to strong wave action (generally the south-east sector of the reef) is attacked by the starfish. Massive as well as branching corals are attacked. Thus the devastation of hard corals on reefs in Queensland waters caused by *A. planci* in recent years has been much more extensive and severe than any devastation known to have been caused by tropical storms.

The skeletons of corals killed by the starfish remain *in situ* until subsequently broken off by wave action or as a result of biogenic erosion. Skeletons of some corals have been marked and observed to be still *in situ* after the lapse of almost three years. The situation contrasts with the extensive removal of coral skeletons from regions exposed to waves generated by destructive tropical storms which has already been noted.

After the deaths of the corals a marked change in the specific composition of the fish fauna normally associated with corals is apparent and it is probable that most animals and plants normally associated with live corals are affected. Within a few days after a coral colony has been killed (Chesher, 1969a ; Endean, 1969) a coating of filamentous algae appears on the skeletons remaining *in situ*. After several weeks calcareous algae appear among the filamentous forms. Subsequently, either filamentous algae or calcareous algae may predominate. It remains to be seen whether the presence of algae (of either general type) hampers or facilitates the settlement of coral planulae. However, it can scarcely be doubted that the development of extensive blanket-like formations of alcyonarians would hamper recolonization by the planulae of hermatypic corals. It has been noted (Endean, 1969 ; Endean and Stablum, unpublished) that on many Queensland reefs where the bulk of the living coral has been killed by *A. planci*, alcyonarians have spread over many of the coral skeletons which remained *in situ*. For example, approximately 24% of the available substratum at the northern end of Feather Reef (off Innisfail) is now covered by alcyonarians and examination has revealed that many of these colonies of soft corals have grown over the skeletons of recently killed corals.

Coral recolonization of reefs of the Great Barrier Reef devastated by *A. planci* has been studied on only two reefs, Green Island Reef and Feather Reef. Pearson and Endean (1969) found that coral recolonization had occurred at all areas examined at Green Island but that in most areas the recolonizers covered only about 1% of the available substratum. Only at one station (Station 'a') was recolonization judged to be significant. However, there is some doubt as to respective proportion of recolonizers and survivors among the corals studied. Also, there is doubt as to the exact dates when the regions at Green Island studied were devastated by the starfish. Reference to the map of Green Island reef appearing in Barnes (1966) shows that Station 'a' of Pearson and Endean (1969) is in the area designated Sector A by Barnes where starfish were active as early as 1961.

The data obtained for two areas of Feather Ree examined in August, 1969 is more instructive since it is known that both areas definitely supported very large numbers of starfish in October, 1966 and that destruction of hard coral in both areas was almost total (Pearson and Endean, 1969). It was found that new growths of hard corals were present in both areas in August, 1969 but that these new growths were not abundant (approximately 1% cover) and measured less than 5 cm. in diameter in each case. Fresh data were obtained for one of these areas (the northernmost area) in late 1969 and early 1970 by Endean and Stablum (unpublished). It was found that the percentage of live coral cover (new colonies plus survivors) ranged from approximately 0.4% on the lagoon edge to approximately 2.5% on the seaward reef edge with a mean of approximately 1%. However, many of the recolonizers had settled on coral skeletons which had remained *in situ* and it is expected that these unconsolidated skeletons will break away from the substratum in due course and the new coral colonies which they currently bear will be lost.

After destroying the bulk of corals on a reef in Barrier Reef waters, starfish appear to migrate en masse to adjacent reefs carrying flourishing coral growths. However, on some devastated reefs (e.g. Taylor Reef) there are residual populations of starfish. It remains to be seen whether these residual populations will increase in size as recolonization of devastated reefs by hard corals proceeds.

Chesher (1969a) reported that since 1967 *A. planci* has killed well over 90 per cent of the living coral along 38 km. of the coastline of Guam. During the 1969 survey of reefs in the U.S. Trust Territory in the Central Pacific recent extensive destruction by *A. planci* of coral reefs was observed and large portions of coral reefs were being attacked by the starfish (Chesher, 1969b). Data relating to recolonization of coral reefs at Guam and at other localities in the Marianas and Caroline Islands are not available as yet.

CONCLUSIONS

It would appear that recent destruction of corals on many of the reefs of the Great Barrier Reef lying between Lat. 14 S and Lat. 20° S and recent destruction of corals on the reefs of Guam and Palau due to the feeding activities of *A. planci* has been on unprecedented scale. Certainly this destruction has been more widespread and severe at the localities mentioned than recorded instances of recent coral destruction attributable to other natural causes. Moreover, judging from reports so far received it is probable that massive destruction of corals on numerous other reefs in the tropical Indo-West Pacific region by *A. planci* has occurred recently or is currently occurring. However, the extent and magnitude of the destruction have still to be recorded and the reasons for the current population explosions of *A. planci* determined.

Consideration of coral growth rates and of the various factors likely to affect recolonization by hard corals of reefs devastated by catastrophic events would indicate that, under optimal conditions, the recovery of a coral reef which had been heavily damaged by a catastrophic event such as a severe tropical storm would require a minimal period of 10-20 years. However, because destruction of coral on reefs affected by the current *A. planci* plagues has been more widespread and severe than destruction of corals caused by other recorded catastrophic events in recent times it is possible that a period in excess of 20 years, possibly a period between 20-40 years, would be a realistic estimate of the time required for recovery to occur. On the other hand, the factors which have caused the current *A. planci* plagues may be still operative. If so, then starfish may reinvade reefs as these are recolonized by hermatypic corals and complete recovery may be postponed idefinitely. While, on theoretical grounds, it is difficult to entertain the possibility raised by Chesher (1969a, p. 283) that '*we are witnessing the initial phases of extinction of madreporian corals in the Pacific*' it is perfectly possible that the *A. planci* plagues are recent phenomena—possibly man-induced—and that we are entering a period when coral growths over most areas of the tropical Indo-West Pacific region will be impoverished. Goreau (1963) has already suggested that impoverished coral growth in areas of the Red Sea is due to predation by *A. planci*.

Additional research to determine the extent of the *A. planci* plagues, their causes and their probable consequences, is required. However, it would seem wise to take steps similar to those already taken by the authorities in the U. S. Trust Territories to control the starfish plagues pending the outcome of research on these aspects. As pointed out by Chesher (1969b) if research subsequently reveals that the starfish plagues are definitely undesirable then reefs will have been protected. On the other hand, if research subsequently reveals that *A. planci* plagues are a normal part of coral reef ecology no harm will have been done by the institution of control measures for a limited period. Certainly some reefs (e.g. Heron Island on the Great Barrier Reef) are known to have been free of starfish plagues for decades without the biota of these reefs suffering any apparent ill effects. Even if it were found that *A. planci* plagues are in the long term beneficial rather than harmful to coral reefs no permanent damage will have been caused as a result of instituting control measures now. Those control measures currently in use (e.g. injection of ammonia into starfish by divers) would not endanger survival of the species. *A. planci* is normally sparsely represented on coral reefs and lowering of *A. planci* population levels below those normally found on coral reefs would be extremely difficult to achieve.

The time appears opportune for concerted action on the *A. planci* problem to be taken by all nations interested in the conservation of coral reefs in the tropical Indian and West Pacific Oceans.

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PLATE I. A specimen of *Acanthaster planci* attacking a branching acropore on Taylor Reef, Great Barrier Reef, in January, 1970. The white, freshly exposed skeletons of some branches already denuded of their covering of coral polyps are visible.

PLATE II. Part of an aggregation of *Acanthaster planci* observed in August, 1970 on the reef flat at the Slasher Reef complex (part of the Great Barrier Reef lying off Townsville, Queensland).

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