MISSION TO THE TOKELAU ISLANDS TO EVALUATE CYCLONE DAMAGE TO CORAL REEFS

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PURPOSE

This mission was carried out on behalf of the South Pacific Regional Environment Programme (SPREP) following a request received from the Tokelau government. The purpose of the visit was to evaluate damage by cyclone "Tusi" to coral formations in the lagoons and on the outer reef slope of the Tokelau Islands (figures 1, 2, 3).

ORGANISATION

The visit took place from 23 April 1987 (departure from Noumea) to 9 May 1987 (return to Noumea). Travel was by plane (Noumea-Auckland-Apia, and return) and by ship (Apia-Tokelau, and return). The visit was organised as follows:

- 23 April : Noumea - Auckland
- 23-24 April : Auckland - Apia (change of date). Met at airport by Mr Foua Toloa, Director of Agriculture in Tokelau.
- 24 April : Preparatory meeting with Mr Foua Toloa who is responsible for all material arrangements.
- 25 April : Boarded the M.V. "Wairua" (a 40 m ship registered in Fiji) with all our equipment. Left Apia at 11 p.m.

- 27 April : Arrived at Fakaofo (main island of the Tokelau group) at 7 a.m. Passengers disembark, and freight is unloaded. First contact between the traditional authorities of the island and the New Zealand administrative officials who were on the ship. In fact, a large meeting is to be held in Fakaofo with the traditional authorities of the three islands, and the "Wairua" will therefore have to set out again to fetch these authorities from the two other islands (Nukunonu in the middle and Atafu in the north). Despite the ship's movements to and from Fakaofo, we are able to dive on two occasions on the western outer reef slope of this atoll.

  At 1.30 p.m. we leave for Nukunonu.
  At 4.30 p.m. we arrive at Nokunonu and a launch is immediately put at our disposal for a third dive.

  During the night, the "Wairua" leaves for Atafu.

- 28 April : Arrival at Atafu at 6.30 a.m. Many shuttle trips are made between the ship and the island. The fourth dive is carried out at the beginning of the morning and the fifth dive at the end of the morning.

  At 12.30 p.m. the ship leaves for Nukunonu.
  At 6.25 p.m. the ship arrives at Nukunonu.

- 29 April : At dawn, a launch is ready for the sixth dive.
  At 11 a.m. the ship leaves for Fakaofo.
  At 1.30 p.m. the ship arrives off the coast of Fakaofo. Nearly all passengers disembark.

  In the evening, the ship leaves Fakaofo for Atafu.

- 30 April : The ship arrives off the coast of Atafu around 5 a.m. We are able to make two dives during the day.

In the evening, the ship leaves Atafu for Nukunonu.

- 1 May : Arrival off the coast of Nukunonu at 4.30 a.m.

9.30 a.m. departure for Fakaofo.
1.30 p.m. arrival at Fakaofo where I disembark with all the equipment.

From 2 p.m. to 5 p.m., inspection of the west reef flat.

- 2 May : A dive is done on the outer reef slope in the north of the island.

In the afternoon, the tenth and last dive is carried out in the lagoon.

- 3 May : The "Wairua", having returned from Atafu and Nukunonu, leaves at 2 p.m. for Apia.

- 4 May : Arrival at Apia at 8 p.m.
Disembarkment at 10.30 p.m. (the ship leaves again immediately for Fiji).

- 5 May : Oral report on my visit to the Office of the Tokelau Affairs.

- 6 May : Visit to the Tokelau islanders' taro plantation established on a piece of land leased from the Western Samoa government.

- 7 May : Apia - Auckland (change of date).

- 9 May : Auckland - Noumea.

GENERAL COMMENTS ON THE DIVES*

Mr Foua Toloa possesses a diving certificate and accompanied me on seven of the ten diving inspections made. Mr Foua is not authorised to go deeper than 25 to 30 m, so when it was necessary to go down deeper I went alone. The air bottles we used had a capacity of only about two cubic metres and it was therefore impossible to stay for very long at each depth described. For this reason the descriptions given hereafter are very rough and the percentages only approximate.

OBSERVATIONS MADE DURING DIVES*

Dive No. 1 - Fakaofo Island, outer slope, about 600 m north of the pass that leads to the village. Depths: 2 to 55 m.

Depths: 2 to 10 m. Massive destruction (80 to 90%) due first to the action of the very heavy swells generated by the cyclone, secondly to the abrasion of those species that managed to withstand the action of the swell (round and plate corals) by large lumps of hard broken coral. The main species destroyed are: Porites lobata, Pocillopora eydouxi, Millepora Platyphylla, Montipora sp., Pavona sp., Favia stelligera, Favia rotumana.

Depths: 10 to 15 m. Heavy damage (60 to 80% destroyed) affecting branching corals and other fragile species (Pocillopora, Acropora, Pavona). Damage is more serious in depressed areas (80 to 90%) than on the ridges (30%).

Depths: 15 to 20 m. This is the level where reef drop off occurs. The most representative coral species measure up to two metres in diameter (Porites lobata). These colonies jut out from the 50 or 60 degrees slope and appear very vulnerable because of their "overhanging" position, but paradoxically there is little damage in this area (about 20% destruction).

Depths: 20 to 30 m. On this part of the slope, damage is very considerable: about 50% on the average and up to 80% in the depressions. Porites lobata is still by far the dominant species.

(* Areas of damage are shown on figures 1, 2 and 3.)

Depth: 55 m. Destruction here is about 80%. Porites lobata is markedly dominant although the first few Pachyseris speciosa appear. The coral masses are broken into large blocks. Most of these blocks are still precariously balanced on the slope while the rest has already rolled downward like an avalanche.

Dive No. 2 - Island of Fakaofo, Western tip (Fenua Fala) 2 to 60 m.

Depths: 2 to 10 m. Damage ranges from 30 to 40% and again there is both direct damage and damage by abrasion. The main branching species, Favia stelligera, Pocillopora eydouxi and Pavona sp. are broken. Porites lobata, the dominant massive species is usually still found in its normal place but shows many necrotic areas on which red filament algae have developed.

Depths: 10 to 15 m. There is heavy damage here (70%). The species present are, in decreasing order of abundance: Porites lobata, Favia stelligera, Pavona sp., Montipora sp., Lobophyllia corymbosa, Stylophora mordax, Acropora robusta. There is always far more damage in the depressions or valleys than on the ridges (70 to 100%).

Depths: 30 to 50 m. Damage is in the vicinity of 70%. Porites lobata is still the dominant species although a few fine colonies of Porites (Synarea) convexa are also present. Many broken blocks remain in unstable balance on the slope.

Depths: 50 to 60 m. Below 50 to 55 m the dominant species is Pachyseris speciosa which does not require much light. Damage is only 30 to 40% despite the relative vulnerability of these thin-plate coral forms, which can be explained by the fact that the broken heavy blocks in the area above them have largely remained in place.

Dive No. 3 - Island of Nukunonu, western outer reef slope (Ahaga-Lahi) 2 to 70 m.

Depths: 2 to 10 m. Only about 10 to 15% damage, which can moreover be accounted for by natural mortality. The only evidence of recent abrasive action is some necroses caused by impact on the tops of Porites lobata. The main coral species in decreasing order of abundance are: Porities lobata, Montipora sp., Pocillopora eydouxi, Pocillopora verrucosa, Acropora sp., Favia stelligera.

Depth: 20 m. Here too there was limited damage (10%). The main species present are: Pavona sp., Porites lobata, Acropora robusta and Lobophyllia corumbosa.

Depths: 20 to 60 m. On the steep slope (about 50 degrees), Porites lobata is markedly dominant. Damage is a little more evident (about 20%).

Depths: 60 to 70 m. Damage to Pachyseris speciosa, which here replace Porites lobata, is estimated at 15%.

Dive No. 4 - Island of Atafu. North-west tip. 2 to 70 m.

Depths: 2 to 10 m. Coral mortality here is about 90%, but dates back to before the last cyclone. The coral colonies are not broken; they are simply dead, still in position and covered with algae. Only a few patches of Millepora platyphylla and Porites lobata appear to have survived whatever caused the death. A few very young colonies of Pocillopora, Porites and Montipora can be seen in places. The largest living colonies respectively measure about 46 cm for Porites lobata, 18 to 25 cm for Pocillopora eydouxi and 9 to 13 cm for Montipora sp.

Depths: 18 to 50 m. Mortality is 95% all along this part of the slope. The coral colonies are in position, dead and covered with algae. Here too, a few rare young colonies of Porites, Montipora and Pocillopora emerge from this coral cemetary, particularly between 18 and 25 m.

Depths: 55 to 70 m. At these depths, just about everything is dead (95 to 100%). The Pachyseris speciosa seem to be still in position, but the sediment and the algae which cover them make it fairly difficult to form an overall image of their structure.

Dive No. 5 - Island of Atafu, about 600 m south of Dive No. 4. 2 to 50 m. This dive was carried out in the area where a Korean ship had run aground on the reef in 1979 and was subsequently blown up in 1981. It confirmed the result of the previous dive. The presence of the wrecked ship may possibly account for the huge mortality in the area.

Dive No. 6 - Island of Nukunonu, south western outer reef slope (Te Puka i Mua). 2 to 70 m.

Depths: 2 to 10 m. No cyclone damage because here all the coral species are embedded in the depressions as a result of their adaptation to the strong swells.

Depths: 12 to 18 m. This is the level where the reef drop off occurs. Just before the drop off, on a narrow strip, 2 to 3 m wide, all the corals are dead. On either side of this strip destruction is about 40%. The coral species present are: Pocillopora eydouxi, Pavona sp., Montipora sp., Favia sp., Acropora sp. and Porites lobata.

Depths: 20 to 40 m. Here damage is about 40% to the Porites lobata and Pocillopora corals which are dominant.

Depths: 50 to 70 m. Strangely, damage here is greater (60%) than at the previous level. The species found here are: Porites lobata to 55 m and Pachyseris speciosa deeper down.

Dive No. 7 - Island of Atafu, western outer reef slope, 600 m north of Te Alofi. 2 to 60 m.

Depths: 2 to 10 m. No more than 10% damage, probably because the coral species are particularly well embedded. However, many Porites lobata colonies show damage on the edges in the form of clean breaks, probably caused by the impact of large lumps of dead coral. The main species present are, in decreasing order of abundance: Favia stelligera, Pocillopora eydouxi, Pocillopora verrucosa, Pavona sp., Montipora sp., Stylophora mordax, Gardinoseris planulata, Lobophyllia corymbosa, Favia sp.

Depths: 15 to 20 m. This is where the reef drop-off occurs; damage is very great (90% in the depressions or valleys and 40 to 50% on the ridges). Red filament algae have invaded all the necrotic parts.

Depths: 20 to 40 m. On this part of the slope which is always deeper than 45 degrees, the Porites lobata which constitute most of the coral formations, are about 50% destroyed.

Depths: 40 to 60 m. Damage is estimated at 70%. The affected species are mainly Porites lobata as far as 55 m and Pachyseris speciosa deeper down. Numerous heaps of large dead coral lumps are still precariously balanced on the slope.

Dive No. 8 - Island of Atafu, external outer reef slope; 1.2 miles north of Edgar Island. 2 to 60 m. This area, lying leeward of the cyclone winds did not suffer any damage. It therefore gives a good idea of the composition and distribution of the coral species present in the damaged areas before the cyclone occurred.

Depths: 2 to 10 m. Pocillopora markedly dominate, with two species: P. eydouxi and P. verrucosa which account for 50% of the coral colonies, followed by Montipora sp. (30%), Acropora sp. (5 to 10%). The remainder includes a few Pavona colonies (1 species), Hydnophora (1 species) and Millepora platyphylla. The reef drop-off is here located between 10 and 12 m. The coral platform is therefore very narrow, only about 15 m wide. An alga of the Halimeda genus is fairly abundant and occupies all cracks and crevices between 4 and 15 m.

Depths: 18 m. Pocillopora (two species), Montipora sp., Pavona sp., and Porites lobata are the main coral species at this level.

Depths: 18 to 50 m. On this very steep slope (60 degrees), Porites lobata alone accounts for 60% of the coral covering. Because of its very flat morphology, this species forms many umbrella-like projections under which large numbers of pink Stylasterides have developed, from a depth of 30 to 40 m. These marine organisms whose colours do not fade are used in making jewellery.

Depths: 55 to 60 m. Pachyseris speciosa here replaces Porites lobata. Its covering rate is rather low (20%) compared with what can be seen in French Polynesia where covering rate is close to 100%. A few other species are found but in small colonies only. They are: Leptoseris sp., Mycedium elephantotus, Pavona sp., and at least two species of Favia.

Dive No. 9 - Island of Fakaofo, north western outer reef slope, 3 miles north of Fenua Fala. Limited damage (10 to 20%) between 15 and 60 m.

Depths: 2 to 10 m. Pocillopora eydouxi, Pocillopora verrucosa, Millepora platyphylla, Porites lobata, Favia stelligera, Pavona sp., Montipora sp., Acropora robusta, are the main species present. The damage observed is not significant and where it exists is comparable to natural mortality.

Depths: 10 to 25 m. In decreasing order of abundance, the coral species present are: Pavona sp., Porites lobata, Acropora sp., Pocillopora eydouxi, Montipora sp., Lobophyllia corymbosa, Favia stelligera, Favia rotumana.

Depths: 30 to 50 m. As is nearly always the case, Porites lobata has the highest covering rate (60 to 70%) and the species of Acropora is fairly well represented (55%).

Depths: 55 to 60 m. Pachyseris speciosa here has a covering rate of about 40%. Leptoseris sp. and two species of Favia are sparsely represented by very small colonies.

Dive No. 10 - Island of Fakaofo, western part of lagoon. 0 to 50 m. No coral damage appears to have occurred within the lagoon. The coral pinnacles scattered over the lagoon are usually large in size, with very jagged edges and steep slopes, sometimes in tiers from which portions of coral slabs emerge. The lagoon sediment is very fine and light coloured (beige to grey). On the very deep bottoms (which are estimated to go down to 100 m or more) the sediment is probably muddy, as it is already at 40 to 50 m.

It is mostly on these coral pinnacles that the bivalve molluscs such as Aca (aff. ventricosa), Tridacna maxima, Chama (aff. imbricata) are found in for the first ten metres. The remarkable abundance of Spondylus (aff. varius), present from 5 m to more than 50 m deep, is surprising. Even more surprising is the absence of Pinctada margaritifera (the pearl oyster) and Pinctada maculata, which are remarkably prolific in French Polynesia in lagoons of the same type. A yellow-orange sponge (Axinellida) is also abundant on the hard ground. Algae are scarce except a Halimeda species. Coral growth is diversified but not very luxuriant. On the edges of the lagoon, Holothuria (Halodeima) atra is present with a density of 8 to 12 individuals to the square metre. Near the village, heaps of plant, metal and plastic materials have been deposited in the lagoon by the cyclone.

Western outer reef flat: Island of Fakaofo.

Numerous dead coral boulders have been shifted or turned over in places without significantly disturbing the species living in this environment, which are: the Holothurians (beches de mer), Actinopyga mauritiana (surf red fish), Holothuria (Halodeima) atra (lolly fish), Stichopus chloronotus, Bohadschia argus (lapod fish), Microthele nobilis (pit fish); the sea urchins Heterocentrotus mamiliatus, Echinothrix calamaris; and the starfish, Linckia multifora, as well as some completely flattened down coral formations.

CONCLUSIONS

There is heavy damage on the western outer reef slopes of the Tokelau Islands. Unfortunately there is nothing much that man can do to improve the situation. The damage caused by this natural disaster will have to be repaired by nature itself. A few recent examples do however give us cause not to be overly pessimistic. Indeed, the atolls of the Tuamotu group in French Polynesia which were hard hit by cyclones in 1982 and 1983 and where damage to the coral formation was often as bad, or even worse, now have a fishery that is just as productive as before the cyclone, and furthermore, what is most encouraging, no recurrence of fish-poisoning has been observed since. It will take about fifty years however before the coral environment regenerates completely. The first fifteen to twenty metres of the reef slope, which have the most favourable conditions (light), will recover first, but even here, recovery will take at least five years. As regards the northern and north-western outer reef slopes of Atafu, where almost all the coral has died, we can only guess at the reason for a mortality of such magnitude. The previous cyclones, which occurred in 1924 and 1966, are probably not to blame for the coral colonies are neither broken nor shifted. The establishment of US Army troops in the Tokelau Islands for two years (1944-1946) and the pollution that may have been caused by the works done during that time, seem to go back too far in time to be regarded as a cause; in the past thirty years, recolonisation of at least part of the area by coral species should have occurred. The one remaining hypothesis is that the Korean ship that ran aground on the reef at the north western tip of the island in 1979 and was two years later blown up with dynamite, was in some way responsible for the destruction of coral life in this area.

RECOMMENDATIONS:

New sea bottom growth is in theory conducive to the development of the algae responsible for ciguatera. Consequently, monitoring for ciguatera fish poisoning could be started by taking a few samples of alga every quarter during a period of eighteen months. In this connection Dr R. Bagnis of the Louis Malarde Institute in French Polynesia might be asked whether he would be willing to analyse the samples.

For the same reason, it would be advisable to organise removal of all organic and man made waste material that have accumulated in the Fakaofo lagoon south of the village (and probably also at Nukunonu).

The Fakaofo lagoon (and probably the Nukunonu and Atafu lagoons as well) should be suitable for trials to establish Pinctada margaritifera (pearl oyster). Temperature and salinity data should however be obtained beforehand, so as to compare them with those of pearl-shell producing atolls such as Takapoto or Scilly in French Polynesia.

ACKNOWLEDGEMENTS:

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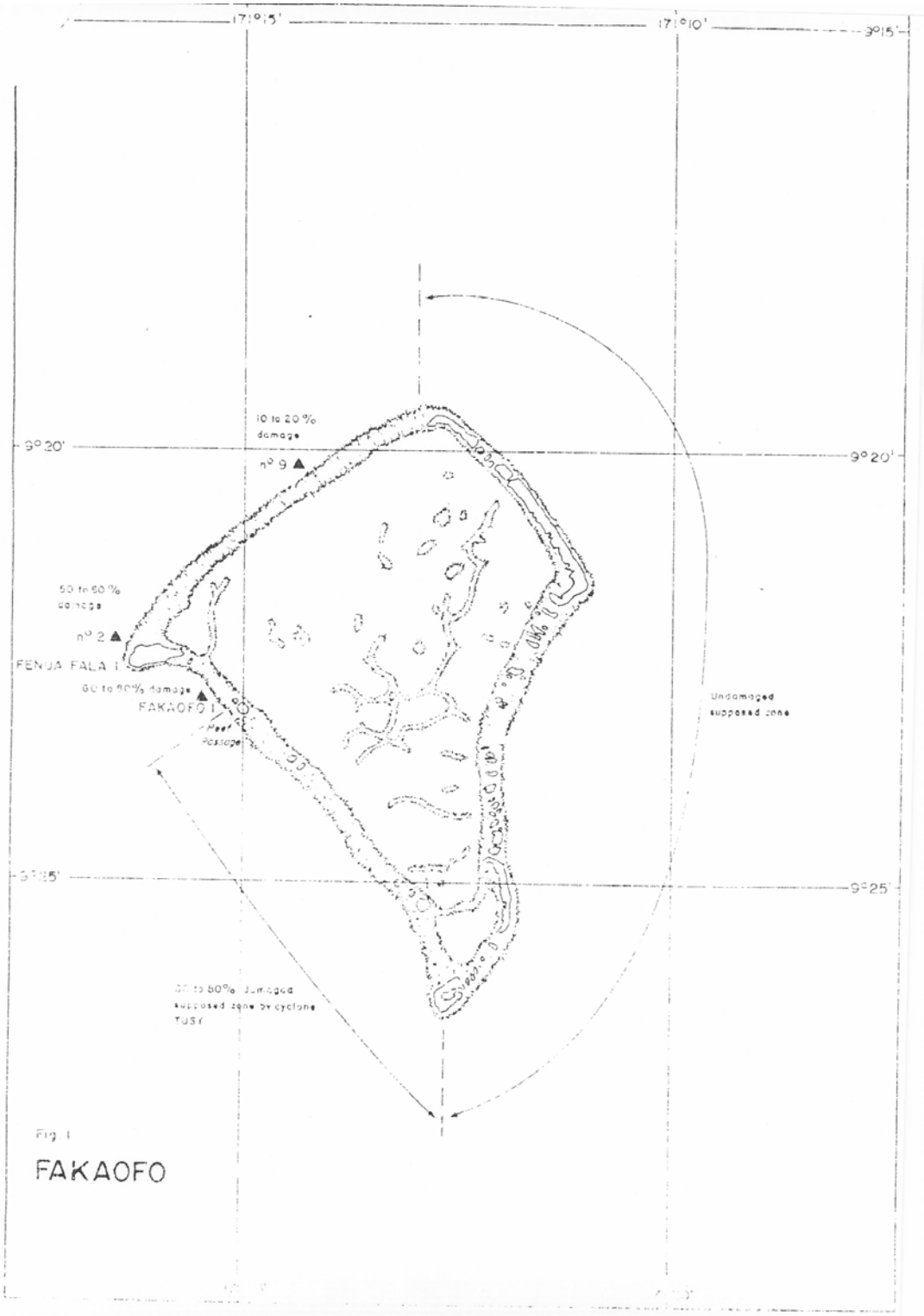

Fig. 1

FAKAOFO

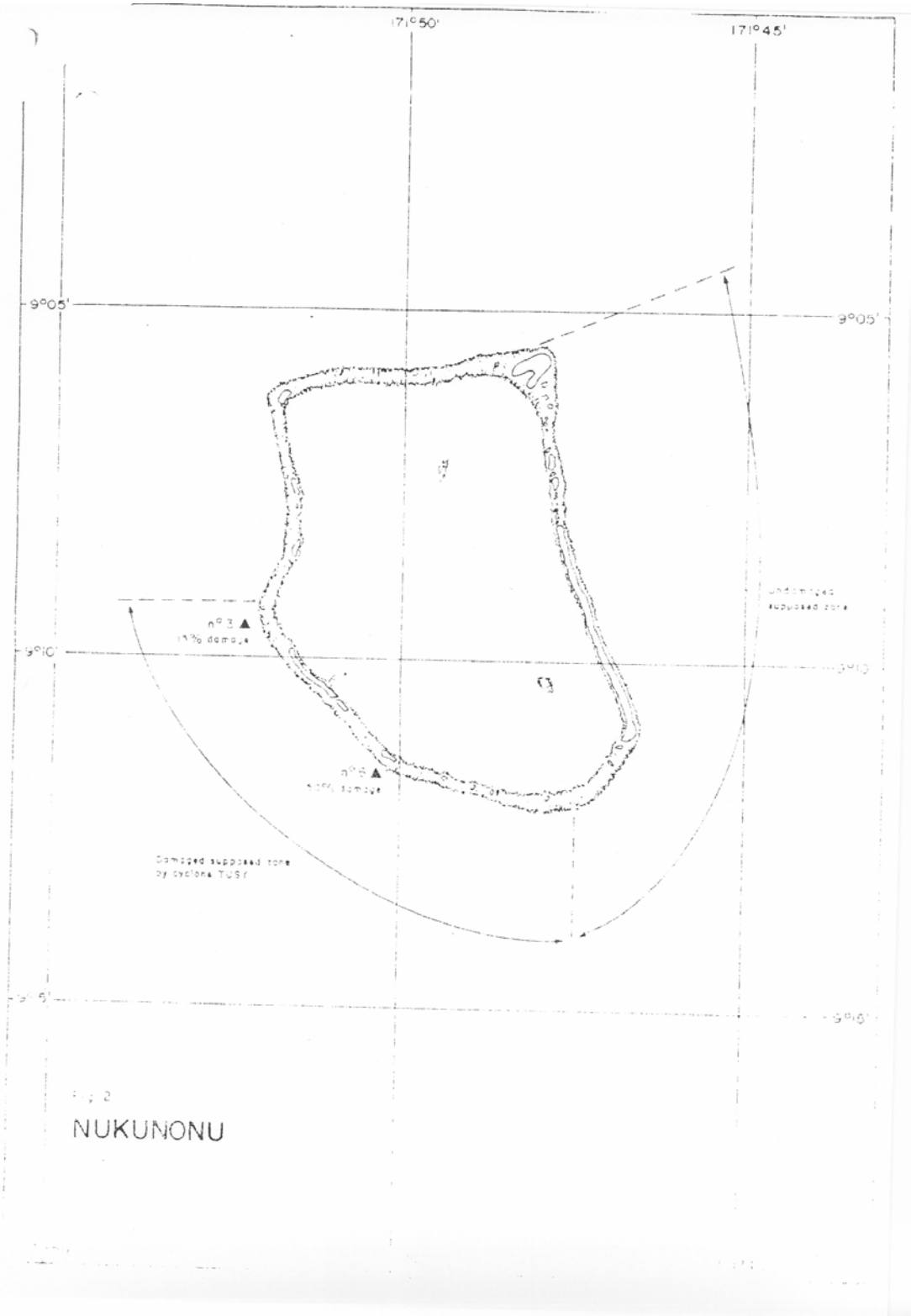

Fig. 2

NUKUNONU

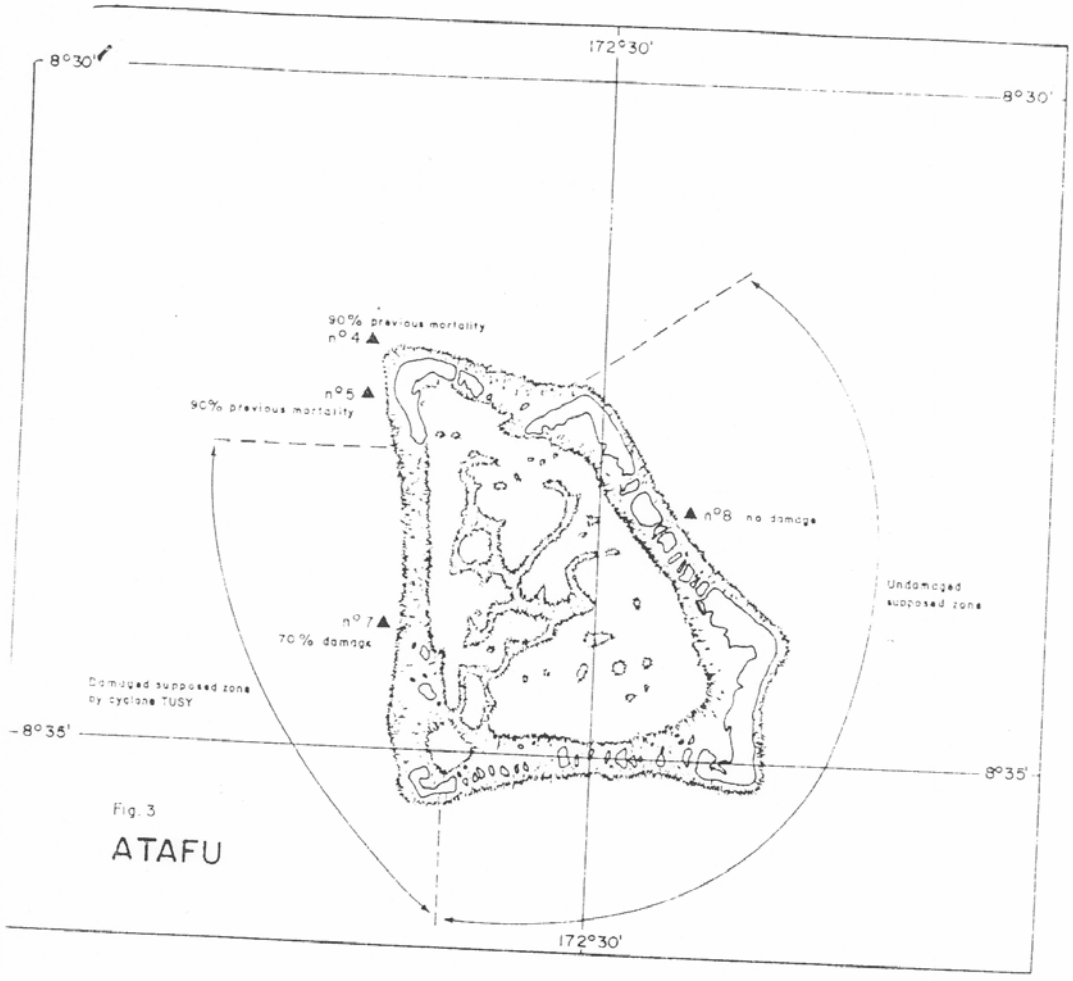
8°30'
172°30'
8°30'
90% previous mortality
n°4
n°5
90% previous mortality
n°8 no damage
Undamaged
supposed zone
n°7
70 % damage
Damaged supposed zone
by cyclone TUSY
8°35'
8°35'
172°30'

Fig. 3

ATAFU