

B. Preliminary account of the land and marine vegetation of Addu Atoll

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There are few studies of the vegetation of the Maldives, and even less attention has been paid to that of Addu Atoll. Earlier papers were mostly systematic lists of plants. In addition to such a list, Willis and Gardiner (1901) include much information on plant distribution, economic uses and vegetation of the Maldivian Islands. Gardiner (1903, p. 25) noted that the luxuriance of the vegetation of the Maldives tended to increase with rainfall from North to South. Both Agassiz (1903, p. 146) and Sewell (1936a) comment on Addu vegetation.

During the 1964 expedition, collections of land and marine flora and notes on the vegetation were made at Gan and Hitaddu Islands. The other islands could not be visited, but Midu and Maradu are described in some detail by Willis and Gardiner (1901, p. 78-80). Gan was described as "well-wooded" by Sewell (1936a, p. 80), and remained so at least until 1940 (West coast of India Pilot, 1961, p. 58). During World War II, much of the vegetation was removed when an airstrip and installations were built, and a second major phase of clearing took place in 1957, when the present staging post was established. There is little undisturbed vegetation left at Gan therefore, but in recent years there has been considerable opportunity for additions to the flora of imported species, both weeds and cultivated plants. Similar, though less extensive, clearing has taken place on the southern part of Hittadu. Conditions are therefore comparable with those of other airstrip atolls in the Pacific, such as Midway and Wake. About 142 species of land plants were collected at Addu Atoll in 1964, and these are reported in Chapter V, part C. About 100 species of algae were collected and were identified by R. Tsuda and J. Newhouse (Chapter V, part D).

Land vegetation of Gan Island

Much of the original woodland vegetation of Gan has disappeared with recent clearing, and most of the island is now covered with open grassland, with a little open woodland in the centre of the island, and some coastal shrubs and trees. The water table is high over the whole island surface, resulting in the formation of a zone of marshland at the southeast end (Figure 29).

The open grassland is continually cleared of bushes and tall herbs by hand and mechanical activity, and is continually sprayed with tar sprays to reduce the breeding of mosquitoes. Where the water table is highest, sedges form the sward completely, Cyperus rotundus, C. polystachyos and Fimbristylis cymosa being very common. Grasses are commoner in the drier regions, comprising largely Panicum repens, Digitaria timorensis and Dactyloctenium aegyptium. In some parts, where the ground is very dry, with bare patches of earth, Sida humilis, Tridax procumbens, Corchorus aestuans and Thuarea involuta are typical.

A variety of weeds occur in this open grassland. Celosia argentea, Cassia occidentalis, Cyperus melanosperma, Physalis angulata and Cleome viscosa seem particularly characteristic of this habitat.

Areas near roads and buildings are also kept clear of tall herbs and shrubs. A few trees have been left standing near the staging Post buildings at the northwest point: these include various coconut palms 30-67 ft. tall, Terminalia catappa 50 ft tall, Artocarpus altilis 35 ft tall, and Delonix regia. In the northern part of the island, at the site of the former Maldivian village, is an old graveyard. This contains a single specimen of Moringa oleifera, and adjacent to a nearby Mosque a single large tree of Erythrina variegata.

In the centre of the island is a zone of woodland. Part of this is fairly dense and is probably regenerating after clearance. The woodland has well developed tree, bush, and herb layers. The tallest tree was Eugenia cumini averaging 44 ft in height but reaching 50 ft. Hibiscus tiliaceus is very common, the mature trees reaching 14-16 ft. Other trees include Morinda citrifolia up to 9 ft tall and Pandanus up to 26 ft. The shrub layer consists mainly of juvenile Hibiscus tiliaceus, Morinda citrifolia and Pandanus. There is little light penetration to the herb layer, where the ferns Thelypteris goggilodus and Nephrolepis hirsutula cover the ground in a dense layer. Cyanotis axillaris is found at the edge of the woodland, and in sunny clearings. South of the main woodland is an area of younger woodland largely consisting of juveniles reaching a height of 9 ft. Hibiscus tiliaceus is widespread, with Morinda citrifolia and Eugenia also occurring. Ixora coccinea is common. The fern layer is well developed, with the grass Apluda mutica occurring in the more open conditions of regenerating woodland.

In the southern part of the island, in the marshland and open scrub, clearing is not as rigorous as in the northern end. The grass Apluda mutica occurs extensively over the whole area, with many bushes. Many plants are found here that do not occur in the open grassland, including Ricinus communis, Hedyotis brachiata, Ammania baccifera, Passiflora foetida, Ipomoea tuba, Gloriosa superba.

Much of the marshland consists of sedges, Cladium jamaicense, Cyperus ligularis, and C. javanicus, to a height of 2-3 ft. Other sedges present are Cyperus rotundus and C. polystachyos and the two species of Fimbristylis. In the wetter areas, Lippia nodiflora, Eclipta alba and Bacopa monnieri are plentiful, the latter two species being found only in this region. Apluda mutica occurred over the whole marshland, and patches of Thelypteris goggilodus in the drier areas.

Around the edge of the marshland, and scattered sparsely throughout, are small shrubs of Scaevola taccada, Hibiscus tiliaceus, Pandanus and a few specimens of Morinda citrifolia and Tournefortia argentea. The first three are characteristically found under fairly open conditions in a successional stage to forest.

It is convenient to consider the vegetation at the periphery of the island as comprising a shoreline community, reached by the tide and directly exposed to sea winds, and a coastal scrub community immediately behind this.

The most common shoreline shrubs at Gan are Scaevola taccada, and Tournefortia argentea. On the lagoon side, these are frequently covered with the vines of Canavalia cathartica and Vigna marina. Where the shoreline has been cleared, Launaea pinnatifida and Ipomoea pes-caprae cover the ground around the hightide line. Cocos nucifera occurs at the shoreline near the staging post, and single specimens of Cordia subcordata and Hernandia sonora on the lagoon shore. Behind the shoreline, Hibiscus tiliaceus, Pandanus and Wedelia biflora characteristically form a dense coastal scrub. This also includes bushes of Morinda citrifolia, Carica papaya, Scaevola taccada and Tournefortia argentea, and a variety of herbs, including Ipomoea pes-caprae, Apluda mutica, Boerhavia diffusa. A few specimens of Pemphis acidula and a single specimen of Suriana maritima were found on the south shore.

Land vegetation of Hitaddu Island

The area occupied by the staging post at Hitaddu is extensively cleared of vegetation. Many of the herbs seen at Gan are also found here, with a few additions, such as Stachytarpheta indica.

Immediately surrounding the buildings is an area of open grassland which is completely free of shrubs. Tridax procumbens covers the ground extensively, with much Cassytha filiformis and patches of Launaea pinnatifida and Apluda mutica.

North of this area, clearance is not so vigorously maintained, and there is open scrubland. Apluda mutica is very common, and a variety of bushes occur; Scaevola taccada, Dodonaea viscosa occur in the drier areas. The scrub is densest on the seaward side with Tournefortia argentea, Pandanus juvenile shrubs and tall stands of Wedelia biflora. In the centre of the open scrub, much of the ground is open and covered with trailing plants, Cucumis melo, Jacquemontia paniculata, Passiflora suberosa, Cassytha filiformis and Boerhavia diffusa being common. Other common herbs are Cleome viscosa, Corchorus aestuans, Nothosaerva brachiata. In the extreme northern part of the scrub is a small area of open marshland. At the edge of the water, Scaevola taccada, Morinda citrifolia and Muntingia calabura are typical. Where the water table is at ground level an extensive carpet of Lippia nodiflora occurs. Large tussocks of Cyperus javanicus form islands, with Cyperus polystachyos. Blumea sinuata occurs here in shallow water and was not found elsewhere.

Woodland is found to the north and south of the cleared area. To the south, the undergrowth had been cleared beneath the coconuts on the lagoon side, and Apluda mutica and Wedelia biflora were especially common. To the north, pathways have been cut through the coconuts, and plants such as Apluda mutica and Vernonia cinerea introduced.

In the midst of the northern forest, parts have been cleared for banana plantation, with a number of original trees such as Artocarpus altilis, Terminalia catappa and small groves of Pandanus left standing. With the opening up of the forest, Apluda mutica, Vernonia cinerea and Euphorbia cyathophora occur as common weeds. Kalanchoe pinnata and Turnera

ulmifolia were common in this area of cultivation, but not seen anywhere else at Gan or Southern Hitaddu.

A transect was taken through the woodland at the northern boundary of the staging post area. Seven zones may be distinguished: (1) on the eastern lagoon side, the soil is dry and under woodland. The main pathway along the island runs along this shore, and there is probably periodic clearing of shrubs. The main trees are Cocos, with Hibiscus tiliaceus and Guettarda speciosa as both trees and shrubs. The herb layer includes Apluda mutica, Launaea pinnatifida, Striga asiatica, and Tacca leontopetaloides. Scaevola taccada is occasionally found on bare ground in clearings.

(2) About 245 metres from the shore, the bush layer becomes much denser, with Guettarda speciosa and Morinda citrifolia more frequent.

(3) About 260 metres from the shore, the ground surface is lower and covered with a mosaic of pools. These are surrounded with bushes of Hibiscus tiliaceus and Guettarda speciosa, and with palm trees separated from each other by distances of 9-12 metres. The ground surface lies 2.4-3 ft. below the crest of the lagoon beach ridge. On the bases of the palm trunks, which are usually surrounded by water, Asplenium pellucidum and Psilotum nudum are found. Moss is also found on the bases of the trunks and in the pools. The pools contain several inches of water, with decaying palm leaves and other debris forming a soft layer a foot or more thick. Two species of sedge grow in the centre of the pools, Fimbristylis sp. projecting 6 inches or more above the surface, and Eleocharis geniculata 2-3 inches. No clearing of vegetation takes place in this marshland, and there is no obvious sign of human interference.

(4) Between 280 and 425 metres from the shore of the lagoon, this marshland vegetation changes into one with Pandanus as the dominant tree, and Cladium jamaicense forming a tall stand below it. The forest is still fairly open. The Pandanus at Hitaddu is of different growth-form from that at Gan. At Gan, mature Pandanus has an erect main stem, with stilt roots leading from the lower part and branches from the upper, to form a fairly compact dense canopy. The Pandanus at Hitaddu in the mature state has thinner, decumbent stems with foliage not in a dense canopy but produced at all levels. At Hitaddu, the Pandanus foliage seems lighter in color and more yellow. Where Cladium jamaicense occurs in a dense stand, no other herbs are seen, and open water is restricted to narrow channels.

(5) At 450 metres from the lagoon shore, the marsh disappears and the ground is covered with dense Pandanus woodland. This was the densest and most impenetrable woodland encountered. It is almost entirely Pandanus, with a little Hibiscus tiliaceus included. The Pandanus trees grow with stems spreading out in groves, and when a certain age is reached a clearing forms in the centre, and Scaevola taccada invades as temporary coloniser. The Pandanus regenerates from the fruit and several seedlings were seen where fruit had fallen to the ground. The ground is covered with a dense mat of dead Pandanus leaves, and there is no herb or shrub layer. There is no evidence of human interference. The small number of species in the mature undisturbed woodland is of interest.

(6) Toward the shore on the seaward side, a dense coastal scrub of Hibiscus tiliaceus, Scaevola taccada, Morinda citrifolia, and Pandanus is found. Scaevola taccada occurs in woodland clearings and margins, together with Wedelia biflora and Pemphis acidula. Terminalia catappa is also found in this zone.

(7) On the seaward shore itself, Pemphis acidula is common all along the crest of the shingle ridge, with Scaevola taccada and Tournefortia argentea immediately behind. Scaevola frequently shows leaf stripping along the shore, and many nearest the sea are dead. Suriana maritima is also frequent, particularly in exposed conditions. Ipomoea pes-caprae and Launaea pinnatifida are not seen on the beach itself, growing only well back from the shoreline, but the grass Lepturus repens does occur in these exposed situations and was not seen elsewhere.

In the central part of North Hitaddu there is a large area of open marshland. This appeared from the edge to be largely Cladium jamaicense, traversed by frequent channels.

On the lagoon shore at Hitaddu, the vegetation is similar to that at Gan. Scaevola taccada is the commonest shoreline shrub together with some Tournefortia argentea and Hibiscus tiliaceus. To the south, where the island narrows towards Abuhera, both Pemphis acidula and Suriana maritima are common on the lagoon shore. Behind the shore occurs an open scrubland of Wedelia biflora, Apluda mutica, Scaevola, Guettarda speciosa, Tournefortia argentea and others.

Coastal scrub on the lagoon side is much less dense than on the seaward--presumably due to the establishment of a major pathway, a few houses and general clearance of vegetation on this side.

Comment: Human activity has thus considerable effects on the vegetation of Gan and Hitaddu. The result of clearing, if only partially, of the mature woodland, is to allow the introduction of many new species, including pantropic weeds, and to increase the number of species per unit area, which probably accounts for the large number of species collected at Gan and Hitaddu. In this connection, comparison with the vegetation of an uncleared Maldivian island would be valuable.

At both Gan and Hitaddu many of the plants are diseased or damaged. This is particularly the case along the shore. Chlorosis was often seen in Ipomoea pes-caprae and other herbs. The most serious damage, however, was inflicted on foliage by insects. This is seen in nearly all the shrub and ground-level foliage along the shore, but is especially severe on Scaevola taccada and Ipomoea pes-caprae. Grasshoppers particularly occur in vast numbers in the Ipomoea. Many trees, shrubs and herbs are also overgrown by creepers, particularly by Cassytha filiformis. Several specimens of Scaevola are completely smothered by Cassytha, with much dead foliage where the Cassytha is most abundant.

Marine algae of Gan and Hitaddu Islands

Collection of marine algae at Gan and Hitaddu was carried out either along line or quadrat transects, or by traversing on the reef flats, fixing location with horizontal sextant angles. The latter method was useful in covering large areas rapidly; the transect method gave detailed observations in smaller areas, and was useful in studying zonation. Under difficult conditions no record of precise location was made. The algae were collected in polythene bags, examined fresh, and then transferred to alcohol-formaldehyde preservative, to which metaldehyde had been added as a neutralising agent. Species distribution along transects, Figs. 30-32.

Out of 61 marine species and varieties, 18 were most common in or restricted to the seaward reef, 31 to the lagoon reef, and 15 occurred equally on both. Three species were found only on Hitaddu.

Lagoon reef, Gan

Charts of algal distribution show that for most algae, there was no strict zonation across the reef, but considerable variation along the reef, so that distribution over most of the reef flat was mosaic.

On the basis of algal distribution, it was possible to divide the lagoon reef from the shore to the base of the reef slope, into three major zones. Distance on the lagoon reef were measured from a sand ridge which was presumably high tide line.

(1) An inshore zone (20-60 ft). Algae found here were specific to this zone, characterised by a loose sand substratum, continuous water motion, and high turbidity. Chaetomorpha brachygona, C. crassa and Enteromorpha sp. occurred very close inshore, attached to stones and pieces of coral lying in the sand. Just beyond this, Padina commersonii formed a very characteristic zone.

(2) An inshore zone (60-150 ft) between the zone of turbulence and the beginning of the large dead coral masses. The substrate was mainly sand patches with much dead coral litter.

Beyond the Padina zone, Dictyota sp. and Jania capillacea covered the ground in large patches. Intergrading with, and beyond this, Halimeda incrassata was common on sand and coral fragments. Halimeda discoidea and Boergenesia forskii were also common in this zone along parts of the reef. Caulerpa lentillifera and C. racemosa var. macrophysa were especially luxuriant here.

(3) From about 150 ft to bottom of the reef slope. The whole of this zone is characterised by an abundance of dead and living corals. Both the completely dead corals, and the dead parts of living ones were covered by epiphytic algae. The epiphytic habit was thus the predominating one in this part of the reef.

Common epiphytic algae included Hypnea sp., Jania capillacea and Lophosiphonia villum which formed a mat-like covering over the coral. Lyngbya majuscula occurred as a mass of threads attached to the coral. Most of the algae seen in zone 3 on the reef flat also occurred on the

reef slope, e.g. Dictyota sp., Caulerpa lentillifera, Gelidium divaricatum. Exceptions to this were few, and included Lyngbya majuscula and Polysiphonia ferrulacea which were rare on the reef slope, and Symploca hydroides and Pocockiella variegata which were common on the reef slope but not on the flat. Pocockiella was a very common epiphyte on dead coral on the reef slope and represented the most significant difference between it and the reef flat.

Seaward reef, Gan

The seaward reef profile was divided into two major areas, separated by the rubble or boulder zone.

(1) Shore-boulder zone, a shallow zone of little water movement and exposed to sun and rain. Algae were not plentiful in this zone. Much of the reef was covered by Thalassia and Cymodocea, with patches of sand and marine grass forming a mosaic. Cladophora sp. was common over the whole of the reef as free floating or loosely attached to the marine grass. Jania capillacea and Boergeresia forskii were common in the sand between and within patches of marine grass.

(2) Boulder zone to surge channels. Between the boulder zone and the surge channels there were 3 main zones:

a. In the region of the surge channels, towards the edge of the reef, the coral rock was almost entirely covered by encrusting red algae.

b. At the ends of the surge channels, and for a distance up to 30 ft, the growth of algae was luxuriant. A few algae were restricted to this zone, Caulerpa racemosa var. peltata, Codium arabicum and Valonia utricularis. Algae which were particularly common included Codium edule, Halimeda opuntia and Jania capillacea which formed compact bunches, with strong attachment to the coral rock. Pocockiella variegata was luxuriant on rock surfaces between algal clumps.

c. Between zone b and the boulder zone, algal growth was not so luxuriant. This was a zone of algal pavement with clumps of Halimeda opuntia, H. discoidea and Jania capillacea distributed over it. Turbinaria ornata occurred towards the sea end, as small rosettes covering much of the ground. Pocockiella variegata, Schizothrix calcicola and Cladophoropsis sp. occurred on rock surfaces.

Seaward reef, Hitaddu

The seaward reef at Hitaddu was narrow compared with Gan, a width of about 250 yards as against 900, distances measured to beginning of surge channels. The physical appearance of the reef is very like the outer part of the seaward reef at Gan, consisting over nearly the whole surface of hard coral pavement, with a boulder ridge on the shore in places. The transect taken across the reef at Hitaddu was divisible into 2 distinct algal regions:

(1) An outer zone, about 60 ft offshore to the surge channels. The number of algae was large over the whole of this zone comparable with the outer reef zone at Gan. The force of wave action seemed less at the edge of the reef at Hitaddu than at Gan, and there was no zone of marked algal abundance as at Gan close to the surge channels.

The algae over the whole zone were comparable to those seen at Gan, Caulerpa racemosa var. peltata and Valonia utricularis occurred in the outer zone. Halimeda opuntia, H. discoidea, Jania capillacea, Pocockiella

variegata, Turbinaria ornata, Boodlea composita, Cladophoropsis sp., and Dictyosphaeria intermedia var. intermedia were recorded as occurring over most of the reef. Neomeris mucosa occurred mid-reef at Hitaddu, and was only seen elsewhere in strong current on the far seaward side of the Gan-Fedu gap.

(2) An inshore zone within about 60 ft from the shore. This was a zone of continual water motion, and was closely similar to the inshore zone at Gan lagoon reef. Two algae were recorded, Padina commersonii forming a distinct zone, and inshore to this, Chaetomorpha gracilis growing on stones and loose coral rock.

Notes on occurrence of algae collected*/

Myxophyceae

Anacystis montana

Gan, seaward reef. Covered the surface of low lying beachrock in the Gan-Fedu gap. Periodically submerged and exposed by the tide.

Calothrix pilosa

Gan, seaward reef. Found in association with A. montana on beach rock.

Hormothamnion enteromorphoides

Gan, lagoon reef: found in inshore zone, within 100 ft from shore. Seaward reef: fairly common over most of the reef flat between the shore and the boulder ridge, appearing as a brown-golden covering on stones and dead coral.

Lyngbya aestuarii

Appeared as a greenish felt of projecting filaments on dead coral. Gan, lagoon reef: fairly rare on dead coral from about 100 ft to the reef edge.

Lyngbya majuscula

Gan, lagoon reef: common, especially from about 100 ft to reef edge. Uncommon in the inshore zone, and a few specimens were found on the reef slope. Seaward reef: quite rare between the shore and boulder ridge, becoming slightly more frequent between the ridge and the surge channels.

Schizothrix calcicola

Gan, seaward reef: very common as a covering on stones and rocks, between the shore and boulder zone.

Symploca hydroides

Wide variation in external appearance, collected as 7 different forms. Gan, lagoon reef: uncommon over the whole of the reef flat, but becoming fairly common near the reef edge, and common on the reef slope. Seaward reef: uncommon, occurring in the shoreward half of the reef flat, between shore and boulder zone.

*/ The data on occurrence were received too late to be of use to the algologists who identified the collection, and even to be incorporated in their systematic list below (Tsuda and Newhouse, Chapter IV, Part D). Their identifications, however, are utilized in the present enumeration, but see last paragraph on p. 93 [ARB Eds.]

Chlorophyceae

Boergesenia forbesii

Gan, lagoon reef: occurring at the western end of the island, on the reef between about 100-150 ft from shore, where it was common on a substratum of sand and dead coral fragments. Seaward reef: seen over a wide area of reef flat, between shore and boulder zone, where it was locally common. It was not common between the boulder zone and surge channels.

Boodlea composita

Gan, lagoon reef: common and restricted to outer zone of the reef, from about 200 ft to the reef edge. Seaward reef: not common, occurring between the boulder zone and the surge channels.

Boodlea sp.

Gan, lagoon reef. A few specimens were found on the reef slope, at a depth of about 60 ft.

Bryopsis pennata

Gan, lagoon reef: common in mid-reef zone, between 100-200 ft, found occasionally over most parts of the reef. Seaward reef: generally uncommon, occurring occasionally over the greater part of the reef.

Caulerpa lentillifera

Gan, lagoon reef, western end. Common in the middle of the reef, from 100-200 ft, uncommon on the lagoon edge and on the reef slope.

C. racemosa var. macrophysa

Habitat closely similar to that of C. lentillifera.

C. racemosa var. peltata

Gan, lagoon reef: uncommon, occurring locally in the mid-reef zone, 100-200 ft from shore, with a few specimens occurring either side of this. Seaward reef: uncommon, between the boulder ridge and the surge channels. Hitaddu, seaward reef: not common, occurring toward the seaward edge of the reef.

C. serrulata var. typica

Gan, Gan-Fedu Gap: common and restricted to this area, on the seaward side between islands. Occurred on sand substratum, as small colonies, with a distinctly yellowish appearance.

C. taxifolia

Gan, lagoon reef: uncommon, occurring at the western end of the island, 40 to 250 ft from shore.

Chaetomorpha brachygona

Gan, lagoon reef: uncommon, occurring locally along the reef. A filamentous green alga living on dead coral fragments, it occurred close inshore, 20-50 ft from high tide line.

C. crassa

Gan, lagoon reef: uncommon, restricted to a zone 20-100 ft from shore.

C. gracilis

Hitaddu, seaward reef: common and restricted to close inshore zone, 0-20 ft from tideline.

Cladophora sp.

Gan, lagoon reef: uncommon, attached to rocks and dead coral, occurring between 20-250 ft from shore. Seaward reef: common between shore and boulder zone.

Cladophora sp.

Gan, lagoon reef: uncommon, attached to stones and coral, inshore zone 20-250 ft.

Cladophoropsis sp.

Gan, seaward reef: uncommon, occurring between the boulder ridge and the surge channels, where it was attached to coral pavement and loose rocks. Hitaddu: common over the whole of the seaward reef from 60 ft to edge.

Codium arabicum

Gan, seaward reef: not common, but found several times in the dense algal growth near to the surge channels.

C. edule

Gan, lagoon reef: a few specimens only were found in one locality, attached to dead coral about 250 ft from shoreline. Seaward reef: fairly common, between the boulder zone and the surge channels, attached to the underside of rocks near the boulder zone and to the surface and cavities of the porous rock at the surge channels.

Dictyosphaeria intermedia var. intermedia

Gan, seaward reef: occurring only very occasionally between shore and boulder zone, but fairly common between boulder zone and surge channels. Hitaddu, seaward reef: fairly common over a wide area of reef from about 50 ft from shore to the reef edge.

Enteromorpha sp.

Gan, lagoon reef: strictly an inshore alga on the reef flat, where it occurred 20-50 ft from high tide line. It was attached to stones and dead coral lying loose in the sand. A few specimens were also found on the reef slope on dead coral at about 50 ft depth.

Halimeda discoidea

Gan, lagoon reef: uncommon, locally common along the reef. It occurred between 50 and 200 ft from shore, attached to sand or loose lying rocks. Seaward reef: common in the boulder zone to surge channels. Hitaddu, seaward reef: quite common within 130 ft from the surge channels at the edge of the reef.

H. incrassata

Gan, lagoon reef: common inshore, the inner limit being fairly sharp at 60 ft from high tide line, the range extending lagoonwards to about 150 ft; beyond this the alga was uncommon. Seaward reef: found occasionally attached to rubble and coral pavement in the boulder zone and up to halfway between this and the surge channels. A few specimens were also found between the shore and the boulder zone.

Halimeda opuntia

Gan, lagoon reef: as with H. incrassata, common between 60 and 150 ft from shore. Seaward reef: very common between the boulder zone and the surge channels. It was the species of Halimeda extending farthest seaward, almost up to the channels, where it had a very compact growth form. Hitaddu, seaward reef: fairly common in the mid part of the reef.

Neomeris mucosa

This had the appearance of small bunches of bright green fingers, and occurred in conditions of good water flow. Gan, seaward reef: uncommon, between boulder zone and surge channels, and found only at the Gan-Fedu Gap. Hitaddu, seaward reef: a few specimens were found in the mid part of the reef, attached to the coral pavement.

Tydemania expeditionis

Gan, lagoon reef: very characteristic of the outer reef zone, 200 ft to edge, where it was sparsely distributed. Common also on the reef slope to depths of 60 ft. A few specimens were attached to coral brought up from a knoll in the lagoon, depth 30 ft.

Udotea orientalis

Gan, lagoon reef: occurrence very sporadic, specimens were collected from inshore, mid reef and outer reef. Seaward reef: a single specimen was collected during traverses between the shore and the boulder zone. The species was quite common between the boulder zone and surge channels opposite the Gan-Fedu Gap. Hitaddu, seaward reef: fairly common in the middle part of the reef.

Valonia utricularis

Occurred as a dense mat of green vesicles, well attached to the rocky substratum. Gan, seaward reef: uncommon, between the boulder ridge and the surge channels. Hitaddu, seaward reef: common at the edge of the reef, within 150 ft of the surge channels.

V. ventricosa

Solitary, olive green vesicles, concealed within coral masses, or in crevices in rocks. Gan, lagoon reef: fairly common on reef slope, to depth of about 30 ft, less common over most of the reef flat. Seaward reef: a few specimens were found in the porous coral near the surge channels.

Phaeophyceae

Dictyota friabilis

Gan, lagoon reef: not common, found mainly on the inshore part of the reef in patches at about 40-60 ft.

Dictyota sp.

Gan, lagoon reef: common over the whole of the reef. Especially common in an inshore zone at about 50-150 ft, where it formed a carpet on the sand. Common in other parts of the reef on dead coral, occurring on the reef slope to a depth of 70 ft. Seaward reef: uncommon on the reef flat between shore and boulder zone, common between boulder zone and surge channels. Hitaddu, seaward reef: common over the whole of the reef except the inshore 50 ft, and the surge channel zone.

Hydroclathrus clathratus

Gan, seaward reef: not common, seen on the coral pavement midway between the boulder zone and the surge channels, and in the boulder zone itself. Gan-Fedu Gap: quite common in the sand on the seaward side of the channel between the two islands.

Padina commersonii

Gan, lagoon reef: very characteristic as an inshore alga, between 30 and 50 ft from shore. Gan, seaward reef: rare, a few specimens were found between the shore and the boulder ridge. Hitaddu, seaward reef: very characteristic inshore plant, occurring within 60 ft of the shore.

Pocockiella variegata

Gan, lagoon reef: common on the reef slope, where it formed a common covering over dead coral to a depth of 70 ft. Uncommon on the reef flat, occurring as occasional specimens. Seaward reef: abundant covering on rocks and coral pavement between the boulder zone and the surge channels. Hitaddu, seaward reef: abundant over most of the outer zone of the reef, especially so within 100 ft of the surge channels.

Sphacelaria sp.

Gan, lagoon reef: uncommon in the mid part of the reef.

Turbinaria ornata

Gan, lagoon reef: occurred very infrequently in the middle of the reef flat, attached to coral. Seaward reef: common between the boulder ridge and the surge channels, as small, rosette-like plants attached to the coral pavement. It occurred between the shore and the boulder zone as an occasional find, and was of moderate size (3 inches long). In the area shore to boulder zone at the eastern end of Gan, the Turbinaria was of large size, and attached to coral microatolls in the swiftly flowing current. Gan-Fedu Gap: large well developed specimens attached to microatolls in the strong current. Hitaddu, seaward reef: abundant over the whole of the reef flat except the close inshore zone, as small compact rosettes.

Rhodophyceae

Antithamnion sp.

Gan, an epiphytic pink alga, occurring on Caulerpa and associated algae and on dead coral. Lagoon reef: fairly common on the reef flat in the mid and outer zones of the reef.

Botrycladia skottsbergii

Gan, lagoon reef: generally uncommon over the reef flat, most frequent in the mid zone of the reef, occurring on the underside of dead coral rock. Seaward reef: a few specimens were found in cavities in the porous coral rock in the surge channel region.

Ceramium fimbriatum

Hitaddu, seaward reef: restricted to the close inshore zone (0-60 ft), where it was common.

Ceratodictyon spongiosum

Gan-Fedu Gap: occurred as a spongy, olive brown thallus on the seaward side of the gap, on a sand substratum.

Champia parvula

Gan, lagoon reef: fairly common in close inshore zone, on sand.

C. salicornoides

Habitat closely similar to that of C. parvula

Dasya sp.

Hitaddu, seaward reef: common in the mid region of the reef, attached to the coral pavement and to coral rocks.

Dictyurus purpureus

Gan, lagoon reef: a pink alga, which occurred only in the mid region of the reef flat as a few specimens along one of the transects (200-250 ft from shore).

Galaxaura marginata

Gan, a massive pink alga. Lagoon reef: rare, only a few specimens found, attached to coral heads in the mid-outer region of the reef flat.

G. rudis

Gan, lagoon reef: not common, occurring locally along the reef; most frequent in the mid reef zone; specimens also found inshore, and on the reef slope.

Gelidium divaricatum

Gan, lagoon reef: occurred on the surface of stones, dead coral and living Halimeda. Occasional over the whole of the reef flat, and on the reef slope to a depth of 40 ft. Seaward reef: single specimen seen near reef edge. Lagoon knoll: specimens brought up on dead coral from surface of knoll, 30 ft below surface.

Griffithsia sp.

Gan, lagoon reef: rare, occurring from about 250 ft to edge.

Herposiphonia sp.

Commonly occurred as an epiphyte on Halimeda. Gan, lagoon reef: uncommon, occurring mid reef at 200-270 ft, also infrequently found on reef slope, depth 30 ft. Hitaddu, seaward reef: a few specimens occurred at mid reef.

Hypnea sp.

Gan, seaward reef: rare, occurring between boulder zone and reef edge. Another form occurred as thick brown filaments twining through cavities in the coral rock. Gan, seaward reef: fairly common near the surge channels, uncommon between boulder zone and shore. Hitaddu, seaward reef: common over middle part of reef. Gan, lagoon reef: another form common on dead coral, 40 to 250 ft from shore. Seaward reef: common between shore-boulder zone. Gan, lagoon reef: still another form common on dead coral from 30 ft to reef edge, and on upper part of reef slope (to depth 40 ft).

Jania capillacea

This was the most common alga observed at Addu atoll in marine habitats. Gan, lagoon reef: common over the whole reef flat except the close inshore zone, from 40 ft to near the bottom of the reef slope at 80 ft depth. It was especially common in the midreef zone, where it formed clumps on the sand and rock substrate, and was also common attached to dead coral. Seaward reef: locally common between the shore and the boulder zone, having a patchlike distribution over the whole area. Abundant between the boulder zone and the surge channels, occurring near the channels as especially compact masses with high calcification. Hitaddu, seaward reef: common over the whole of the reef except the inshore 150 ft, occurring in masses on the coral pavement.

Lophosiphonia villum

Occurred as a reddish, velvet-like covering on stones and dead coral. Gan, lagoon reef: common on dead coral in the midreef zone, between 150 to 300 ft, less common to the reef edge, and rare on the reef slope. Gan, seaward reef: rare, a few specimens were found near the surge channels. Hitaddu, seaward reef: rare, a few specimens about 30 ft offshore. Lagoon knoll: fairly common on dead coral brought up from the summit of the knoll, depth 30 ft.

Polysiphonia ferrulacea

Gan, lagoon reef: common on outer part of reef, from 140 ft to reef edge, where it occurred on sand and rock substratum. Seaward reef: rare, between shore and boulder ridge. Gan-Fedu Gap: common, on sand, midway between islands.

Spyridea filamentosa

Gan, seaward reef: occurred as a mass of pinkish filaments, close to the shore at the eastern end. Very local.

Tolypiocladia glomerulata

Gan, lagoon reef: quite common, and local, at the western end of the island, forming dark red clumps on dead coral masses. Most frequent from 100 to 200 ft from shore.

Viadlia serrata

Gan, lagoon reef: locally fairly common, 150 to 200 ft from shore.

Freshwater and terrestrial algae

Nostoc commune

Gan, locally common on open waste ground with grassland, where the water table was high. Formed olive green masses, which under wet conditions, as just after a rain shower, became swollen and apparent.

Pithophora oedogonia

Gan, found floating on the surface of fresh water in an old well at the centre of the island.

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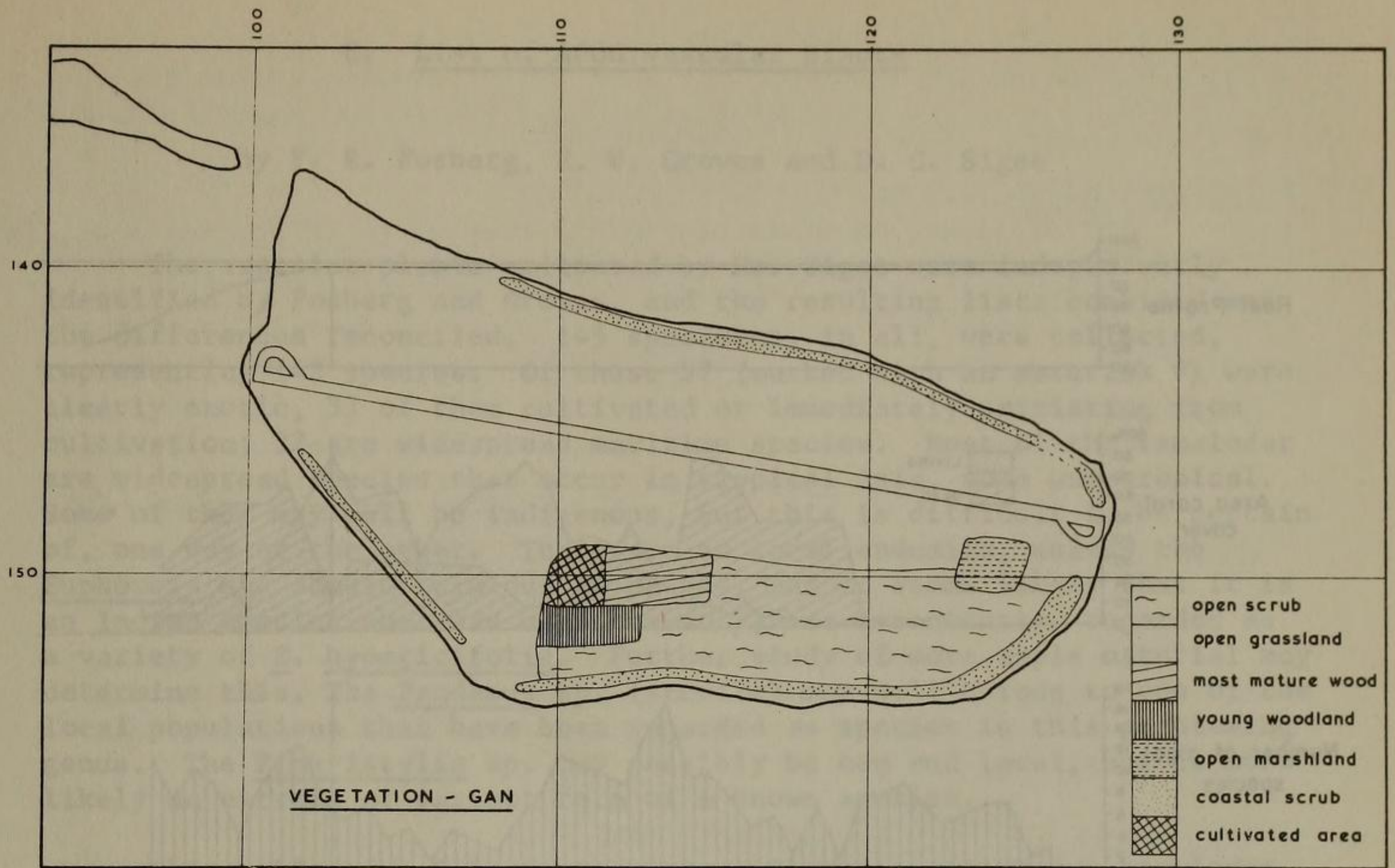


Fig. 29. Vegetation of Gan Island, 1964.

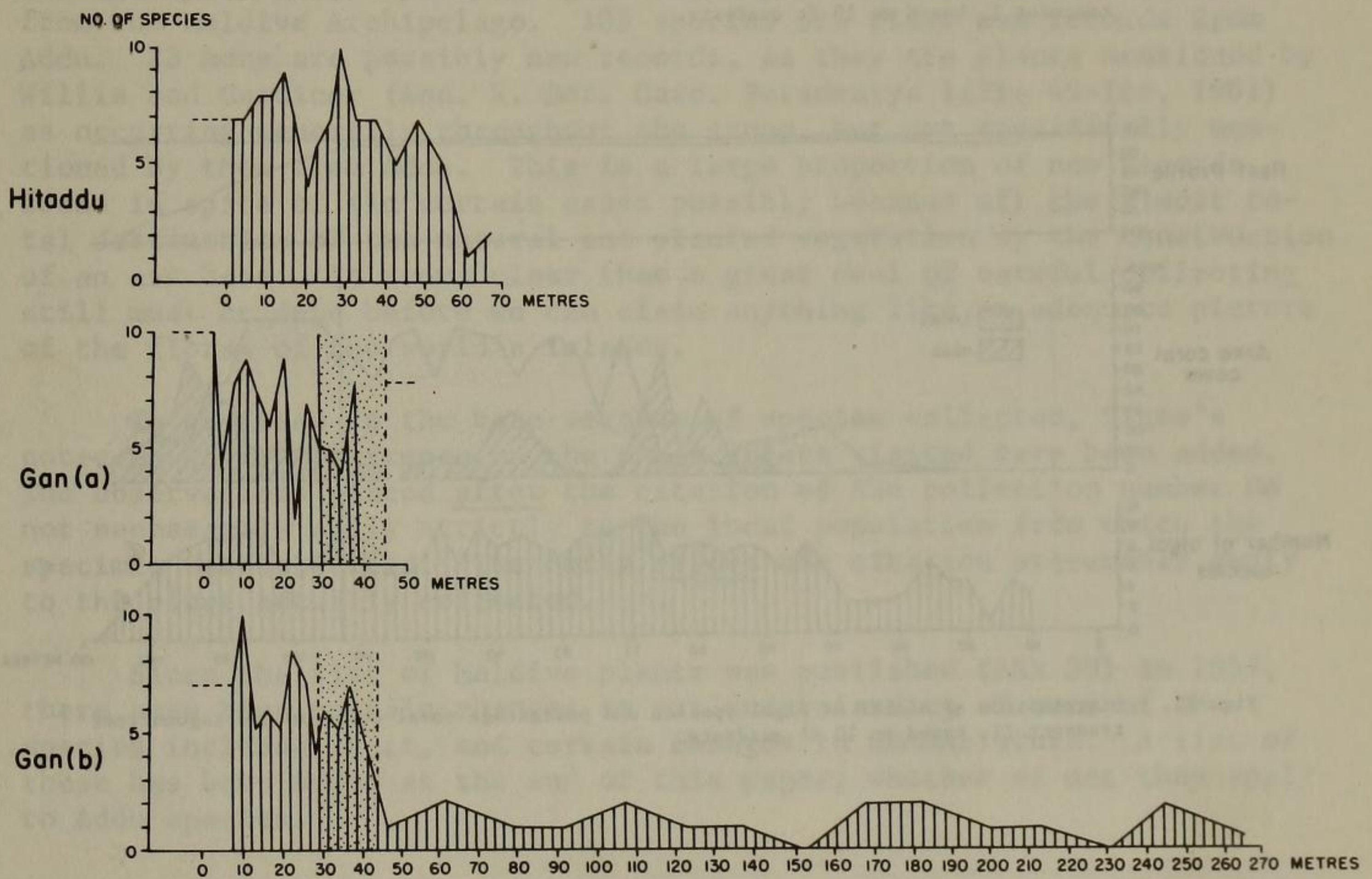


Fig. 30. Distribution of number of algal species collected in 10 ft quadrats on the seaward reef flat in transects at Hitaddu and Gan Islands. Transect Gan (a) is incomplete.

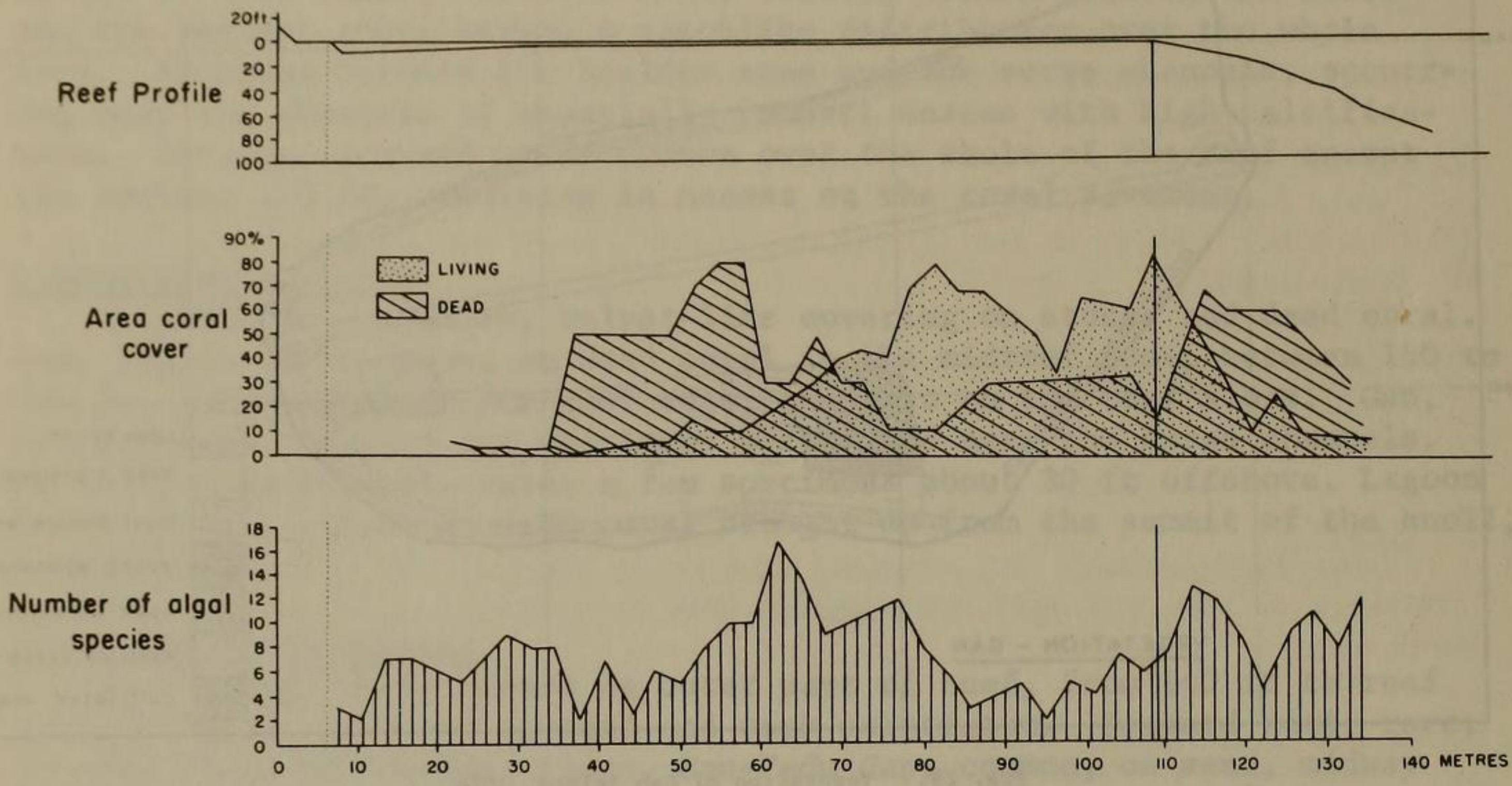


Fig. 31. Distribution of number of algal species and percentage coral cover in Gan lagoon reef transect I, based on 10 ft quadrats.

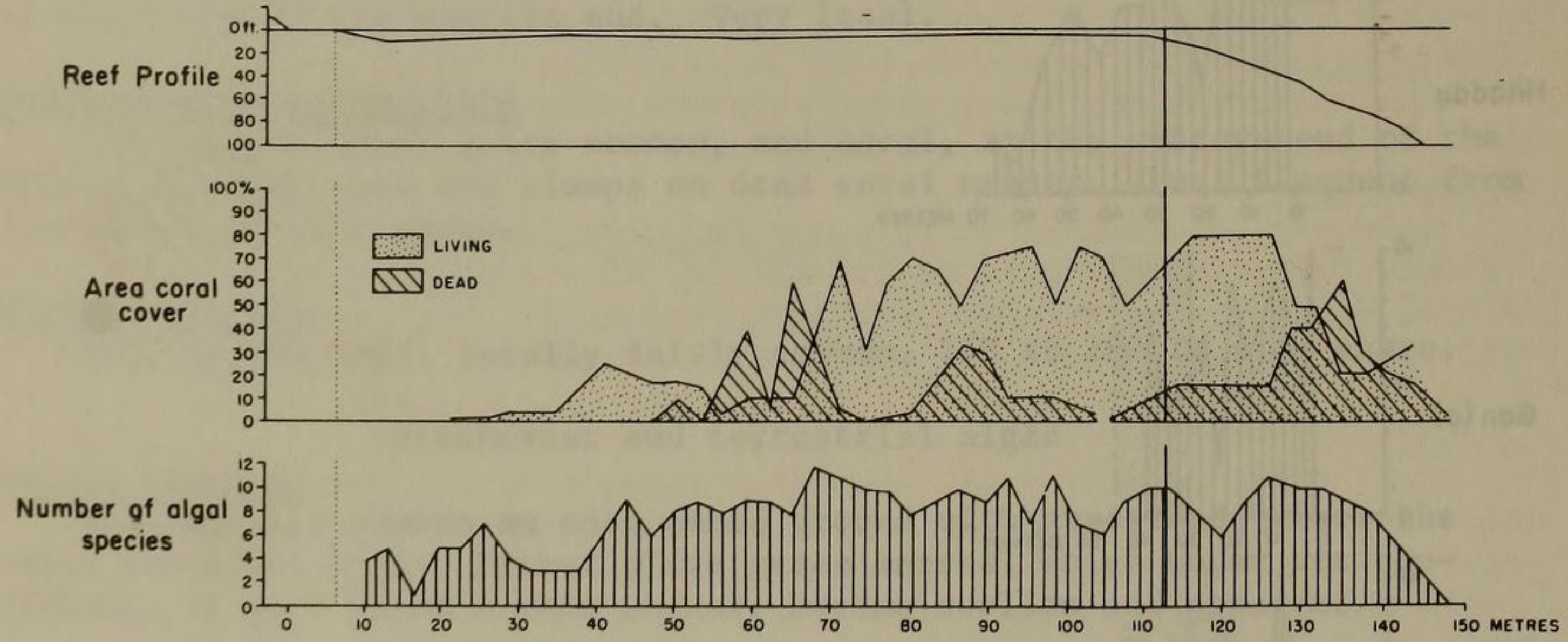


Fig. 32. Distribution of number of algal species and percentage coral cover in Gan lagoon reef transect II, based on 10 ft quadrats.