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A PHOTOGRAPHIC SURVEY DOWN THE SEAWARD REEF-FRONT OF ALDABRA ATOLL

by Edward A. Drew

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by Edward A. Drew[1/]

SUMMARY

A simple photographic transect method, using aqualung diving techniques, is described, together with an assessment of its limitations and possible improvements.

Data obtained from analysis of a 250 metre long transect (0 - 40 metres depth) photographed on the seaward reef-front of Aldabra Atoll are presented. Results are discussed in the context of previous reef zonation data and the possible environmental factors controlling such zonation.

INTRODUCTION

The upper 20 metres of the seaward reef-front of any barrier, fringing or atoll coral reef has until recently been impossible to investigate thoroughly due to prevailing sea conditions so close to the reef ridge.

However, in recent years the introduction of self-contained diving equipment, and care in selection of the season for field work to coincide with moderately calm conditions, have allowed a considerable amount of direct observational data to be acquired in this environment.

Nevertheless, such investigations tend to use a variety of ecological methods, mostly qualitative, and still "much of the difficulty in comparing reefs stems from the lack of uniformity in surveying methods" (Stoddart, 1969a).

In this paper a simple method of photographic recording down a reef transect is described and the results from its use on the most luxuriant section of the Aldabra reef-front are presented. The field work can easily be carried out by divers with no training in coral taxonomy and could be applied to any reef system, giving a standard basis for valid comparisons.

[1/] Gatty Marine Laboratory, St. Andrews, Fife, Scotland.

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METHODS

Establishment of the transect

This was marked by a string, knotted with a loop at one metre intervals. It was laid down in 50 metre sections from the reef ridge (mean low water springs - MLWS) to the beginning of the basal sand plain at 40 metres depth. The string totalled 253 metres in length and was orientated approximately perpendicular to the shore-line although some meandering occurred in the extensive shallow parts. Each end was marked with a small buoy and these were triangulated from the shore; bearings are shown on the inset of the map in Figure 1.

Depth was recorded at 10 metre intervals using an 'SOS' totally enclosed bourdon tube gauge, and corrected to depth below MLWS according to the state of the tide.

An attempt to assist diver orientation on the very long transect by placing numbered polystyrene floats on short strings at 10 metre intervals proved unsuccessful. The film of algae (diatoms?) which rapidly developed on these floats was attractive to the browsing fish population which rapidly consumed most of the floats completely.

Photography

Standard 'Calypsophot' and 'Nikonos' underwater cameras with 35mm wide angle lenses were used to photograph the transect every metre from a distance of approximately 2 metres from the bottom. The open frame viewfinder of the cameras was used to align the camera as shown in Figure 2. Considerable overlap was achieved in all frames.

Monochrome 35mm film was used - Kodak Plus X (125 ASA) for most of the transect photographs, replaced by Ilford HP3 (400 ASA) in the deeper sections. No artificial lighting was used. The wide aperture setting required in the 30 - 40 metre section resulted in considerable loss of resolution in many of those frames.

Films were developed in the field, using a daylight-loading developing tank and cooling solutions in the refrigerator to about 20°C before use. In this way it was possible to ensure complete coverage of the transect with usable negatives.

Although several photographic dives were carried out on the transect, a large proportion of the usable exposures were made on a single dive of two hours duration. Three cameras were used, and each was reloaded twice in the boat, giving a total of over 300 frames.

The best negative for each metre section was printed to 12.5 x 20 cm (5" x 8") in the laboratory in the United Kingdom, using 'Ilfoprint' materials followed by hypo fixation and high gloss finishing.

Analysis of photographs

Sequential prints were oriented and cut to produce complete but unduplicated coverage down the transect; strips of five prints were each analysed as follows.

Code numbers were allocated to a total of 26 different coral growth forms and other recognisable organisms. Some of these were later lumped together and final analysis involved the following groups:

Cymodocea (marine angiosperm)	Alcyonacean (soft coral)
Branching coral	Gorgonian
Columnar coral	Halimeda algae (+ traces Caulerpa)
Brain coral	Sponges
Foliaceous/encrusting coral	Tridacna clams
'Pioneer' coral	Anemones
Fungia coral	Uncolonised bare areas

Encrusting calcareous red algae could not be distinguished on the photographs although they represented a significant part of the living cover in some sections. The organisms and coral types involved are illustrated in a representative selection of frames in Plates 1 and 2.

The outlines of the various colonies in each set of five contiguous prints were traced onto high quality tracing paper (uniform density) and the appropriate shapes were cut out and weighed. In this way the area of each 5 metre transect section covered by a particular growth type was determined. No attempt was made to allow for differing colony morphology and therefore actual surface area of living coral which in some instances would be several times greater than the area photographed. In view of the great importance of the symbiotic algae present in the coral organisms, it seems probable that the area exposed to direct solar illumination will be of major importance in their growth.

RESULTS

The topography of the transect studied is shown in Figure 3, together with an analysis of the percentage cover of living organisms on both a horizontal and a vertical basis.

This particular transect, the longest of a total of 12 accurately surveyed around the atoll (see Figure 1), provided two contrasting environments. Firstly there was an extensive shallow region where the major variable factor appeared to be proximity to the reef ridge surf zone, followed by a region of moderately rapid increase in depth until the growth of hermatypic corals ceased at the start of the basal sand plain. This last appeared to slope away indefinitely at an angle of about 20° from horizontal.

Analysis according to depth has been carried out by averaging the various series of prints included in each 2 metre increment of depth. Percentage living cover remains remarkably constant until below 30 metres, when it drops rapidly to a much lower value.

The regular alternation between high and low cover values shown in the horizontal analysis is due mainly to a series of completely bare areas, on a scale several times greater than the size of a photographic frame. These were either bare coral rock or depressions filled with coral debris (mainly branching types) in shallow water but sandy in deeper parts.

The distribution of the various growth types with depth is illustrated in Figure 4, again averaged for the series of 5 metre strips included in each 2 metre depth increment. Uncolonised bare areas have been disregarded in this analysis which shows the percentage of the living cover represented by each type. There is a marked zonation, with the branched and less massive types in shallow water and the massive brains much deeper. Alcyonacean soft corals were intermediate in distribution whilst only the foliaceous and encrusting types occurred in the deepest parts. The significance of this zonation will be discussed later; representative strips from the major zones are shown in Plate 3.

Additional information about the response of the shallow water types to surf action has been obtained by analysis of the first 60 metres of the transect horizontally, this being restricted to the upper 2 metres of the depth range. Heavy surf is unlikely to occur far seaward of low water mark. Figure 5 shows such a horizontal analysis which indicates restriction of the millipore corals to the maximum surf zone whereas branching corals formed a small part of the total cover until some 25 metres from MLWS. Columnar corals were relatively unimportant and showed little correlation with distance from MLWS, but the restriction of the Alcyonaceans to the most distant part suggests that they are relatively sensitive to severe water movement.

OTHER TRANSECTS

In order to put this transect into perspective compared with other areas of the Aldabra reef-front, the 14 transects surveyed around the atoll are shown in Figure 1. Only transect topography and the approximate coral cover were determined on all but transect 1, the photographic transect. The submarine contours shown are greatly exaggerated compared with the scale of the atoll outline. Also shown is the vertical extent of reef-front rocky substrate before the beginning of the basal sand plain.

The north-west part of the reef-front was the only region with luxuriant coral growth, that along the north shore was generally poor, and that on the south had apparently recently suffered a major catastrophe with the dead remains of apparently good growth evident in several places. The eastern end of the atoll had no coral reef front, but rather a very gently sloping sand plain from MLWS.

DISCUSSION

Initial structural considerations would suggest that branching corals of the millepore and acropore types are less well suited to the rigours of shallow water reef-front environments than are the more massive brain corals. Indeed, Stoddart (1969a) cites numerous references to the occurrence of fragile-branching types on lagoon reefs and in sheltered pools, whilst stout-branching and more massive types are concentrated on reef flats and upper seaward slopes.

The data presented in this paper suggest the opposite for the luxuriant section of Aldabra reef-front, a situation also noted by Stoddart (1966, 1969b) in the Maldives and the Solomons where "reefs consist largely of foliaceous and fine branching forms even in exposed situations". This feature of reef zonation may be due to the rarity of severe storms in these three regions. The north-west tip of Aldabra is nevetheless completely exposed to oceanic swell and receives a considerable pounding by waves for much of the year. Taylor (1968) also reports dominance of millepore/acropore types in exposed situations on Seychelles reefs, but with massive species dominant in sheltered areas.

The restriction of millepore corals to the heavy surf region of the reef-front may be associated with the same factor which allows their predominance in the fast-flowing channels leading into Aldabra's extensive but very shallow lagoon, perhaps a requirement for constantly moving water or an ability to withstand the relatively warm water which flows both off the reef flat and out of the lagoon. Taylor (1968) suggests that the vertical inter-connected plates which comprise the surf-zone millepore colonies are well adapted to absorb the energy of breaking waves, but it is also necessary to explain their virtual absence in stiller water.

Foliaceous forms of coral are well suited to intercept a maximal amount of available light with a minimum volume of colony, and are thus well suited to the deep dim waters where they predominated on this transect. It is however surprising that the total living cover of the reef remained reasonably constant until the very rapid reduction below 30 metres. There was even a noticeable increase between 15 and 25 metres. Thus, living cover does not appear to be correlated directly with ambient light energy - the two are compared in Figure 6 - although the interrelations between growth type, efficiency of light utilisation, rate of primary organic production and rate of calcification are as yet only known in the barest outline. Important too may be the preferences of coral browsers such as parrot fish, and their ability to feed in turbulent shallow water.

The simple photographic transect method described here could provide a basis for rapid accurate assessment of various types of reef and allow valid quantitative comparisons. The method has certain limitations in accuracy, such as the edge distortion produced by uncorrected wide angle lenses, although most of this is eliminated by cutting off the extremities of each print for overlap. The expense of using the 28mm corrected underwater lens available for the Nikonos camera is probably unwarranted, especially as several separate cameras are required for long transects (see later).

Recognition of various growth forms proved moderately easy with the monochrome prints used, although artificial illumination would have allowed increased definition in deep sections whilst the use of colour print film should in future allow positive identification of most species, including the encrusting calcareous red algae, as well as a further increase in definition. Unfortunately the prints from colour transparencies usually lack the sharpness required for this work.

Phototransect methods could also be used in the rapid topographic survey method used on the majority of transects studied in Aldabra. This involved two divers, separated by a 10 metre length of string, leap-frogging each other in a straight line down the reef and recording depth every 10 metres. A third diver could photograph the ten metre strip in 1 metre sections whilst the surveyors recorded their own data. This would require six cameras for a long transect - say 200 metres - and may double the survey time. However, the vast increase in data obtained, and the saving in time required to establish semi-permanent transects and relocate them on each dive, would certainly justify this.

Finally, a note on diver safety. Coral reefs are frequently inhabited by potentially aggressive animals, mainly sharks. Fortunately these were virtually absent from the Aldabra reef-front at the time this survey was carried out (December, 1968 to February, 1969), so that divers could concentrate on their scientific tasks. It would, however, be essential for a survey team working in more dangerous waters to be accompanied by 'look-outs', perhaps involved in more random photography or collection of reef flora and fauna, but primarily there to allow the team to concentrate on their complex tasks knowing they will be warned of impending danger.

ACKNOWLEDGEMENTS

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I would also like to thank all the other members of that phase of the Expedition, and especially Dr. J. Lythgoe, Mr. D. Jones and Mr. J. Barnes who accompanied me on most of the photographic and survey dives, for their help in the field.

The Court of St. Andrews University generously granted me leave of absence for this expedition.

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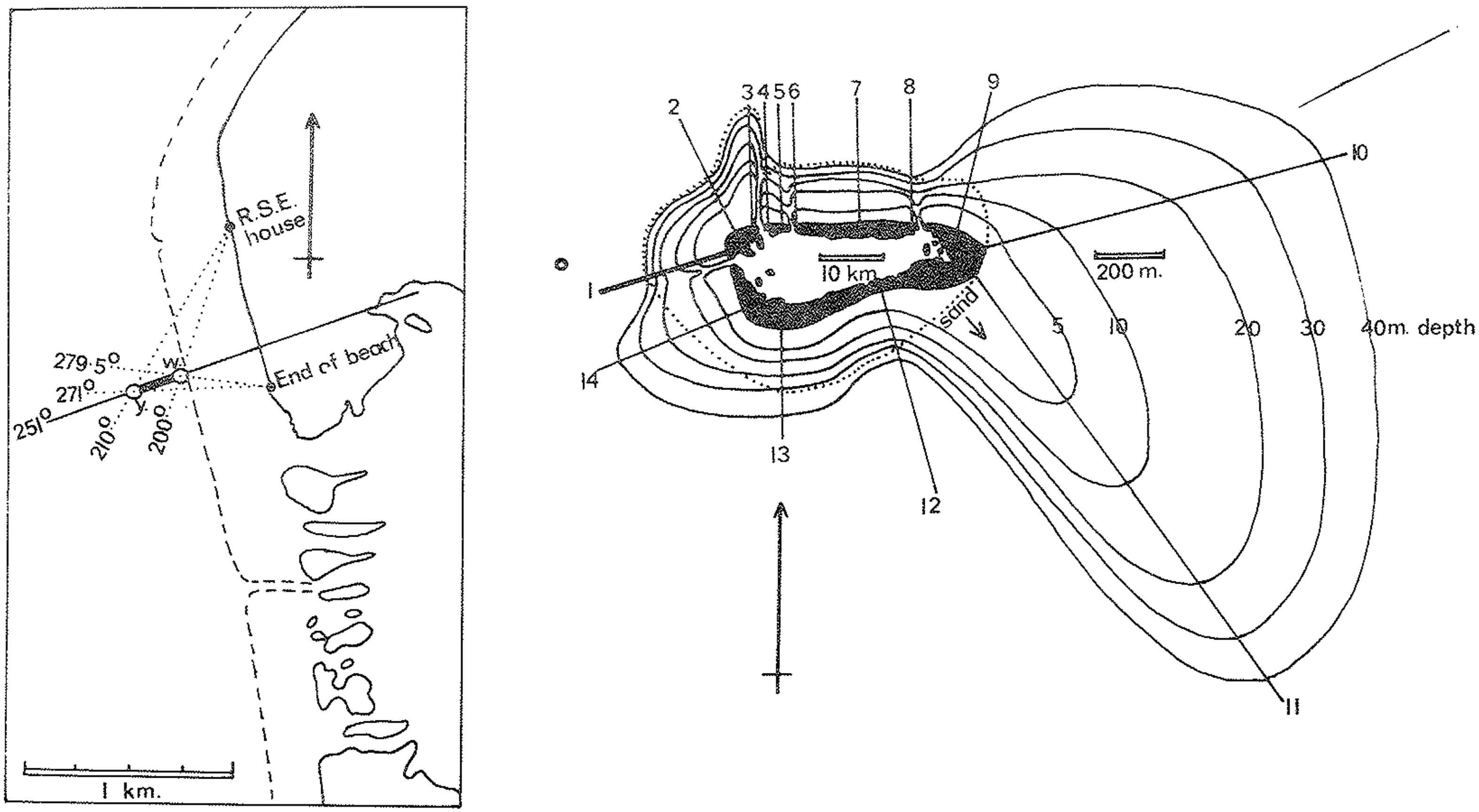
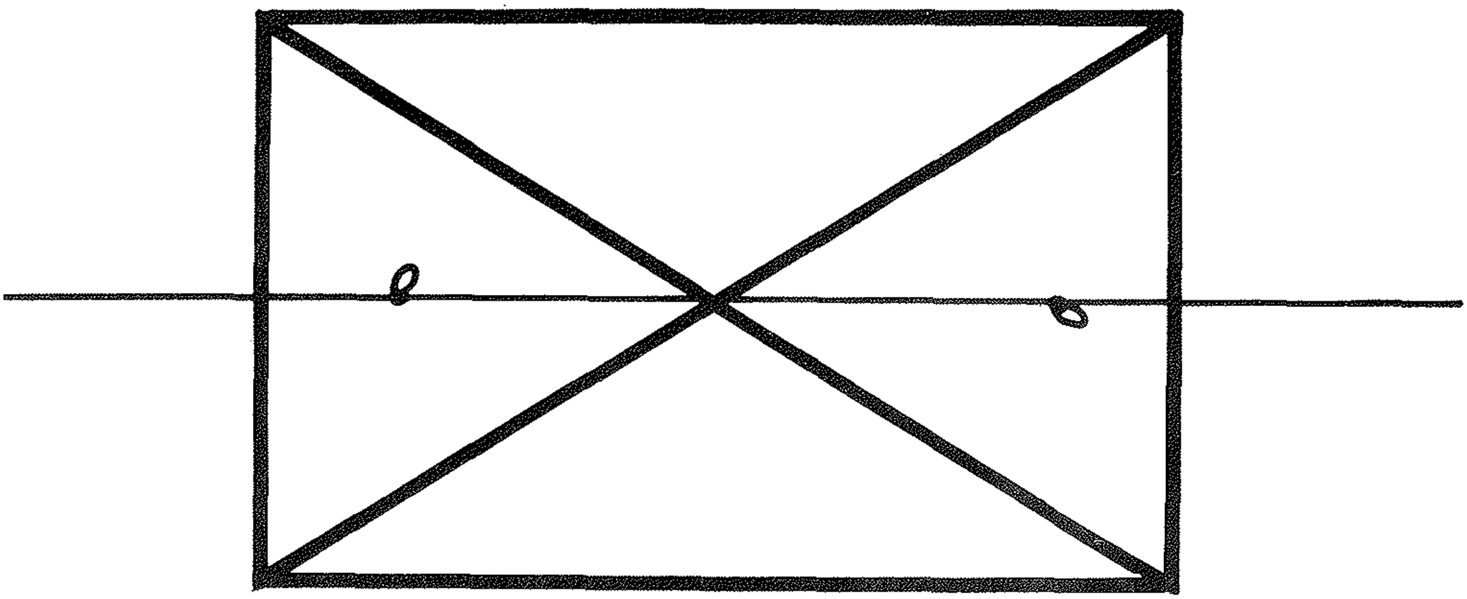
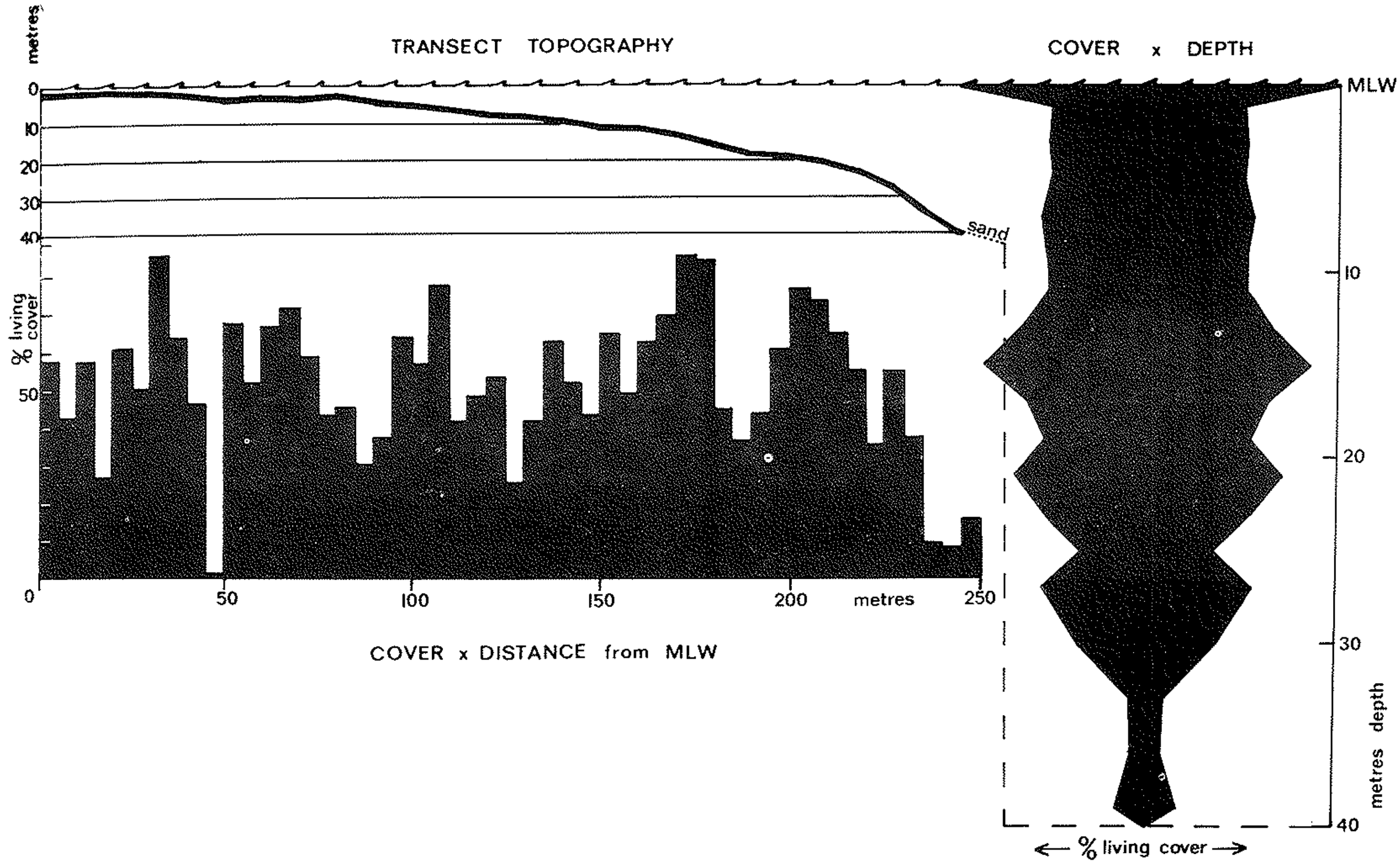
Taylor, J. 1968. Coral reef and associated invertebrate communities around Mahé, Seychelles. Phil. Trans. Roy. Soc. B. 254: 129-206.



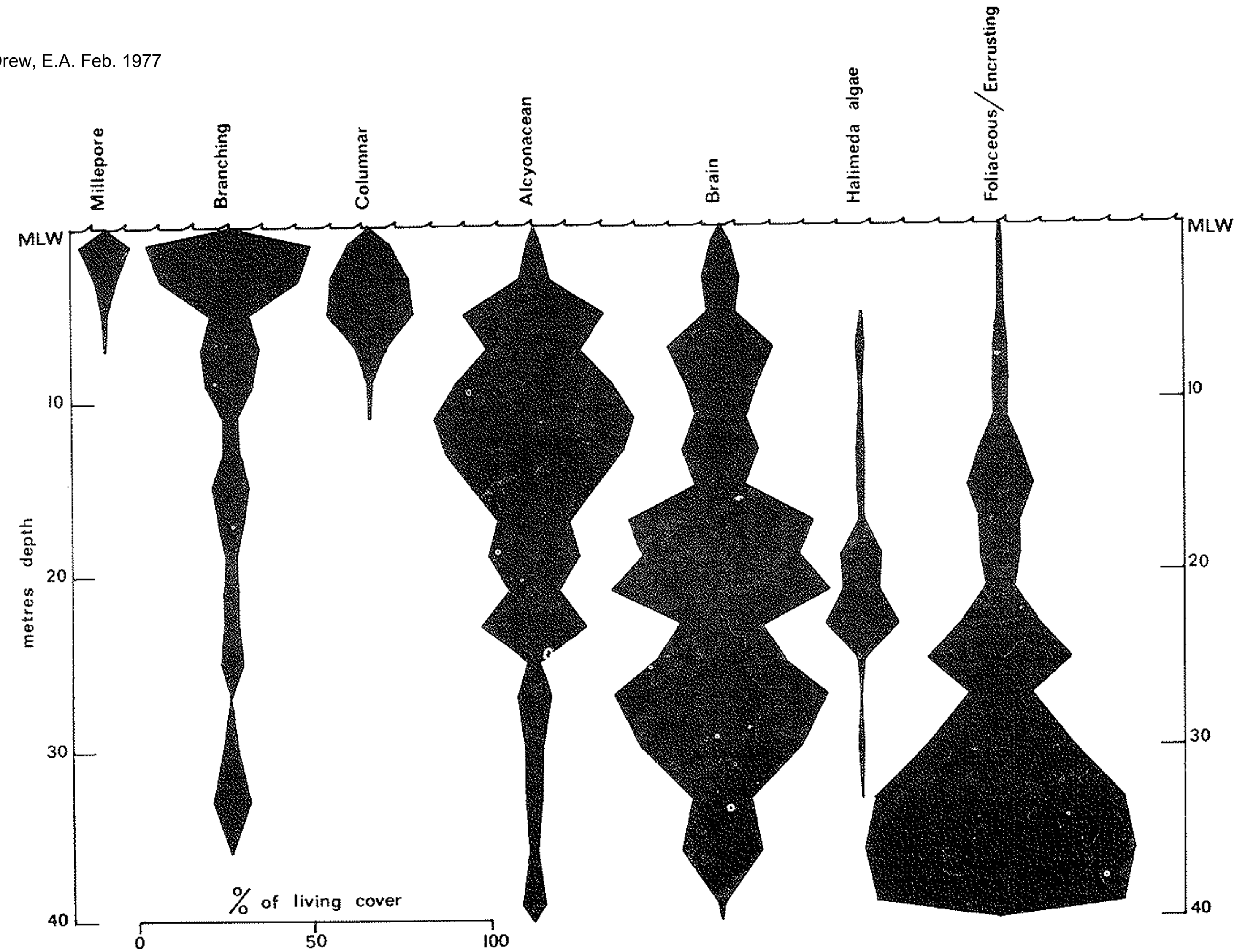
1 Aldabra Atoll, showing location of all transects and implied submarine contours (modified from Bellamy et al, 1970)



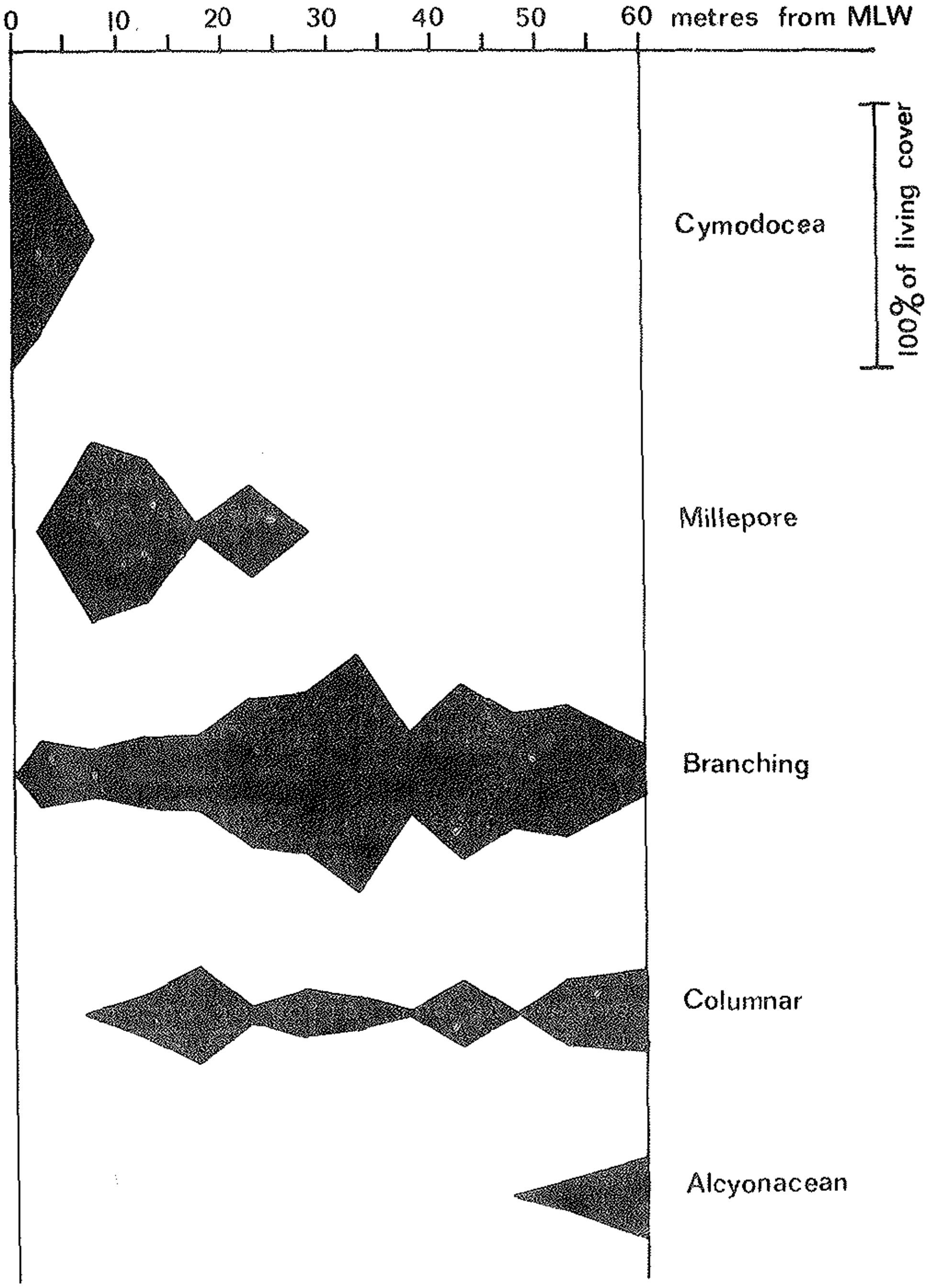
2 Camera orientation on photographic transect



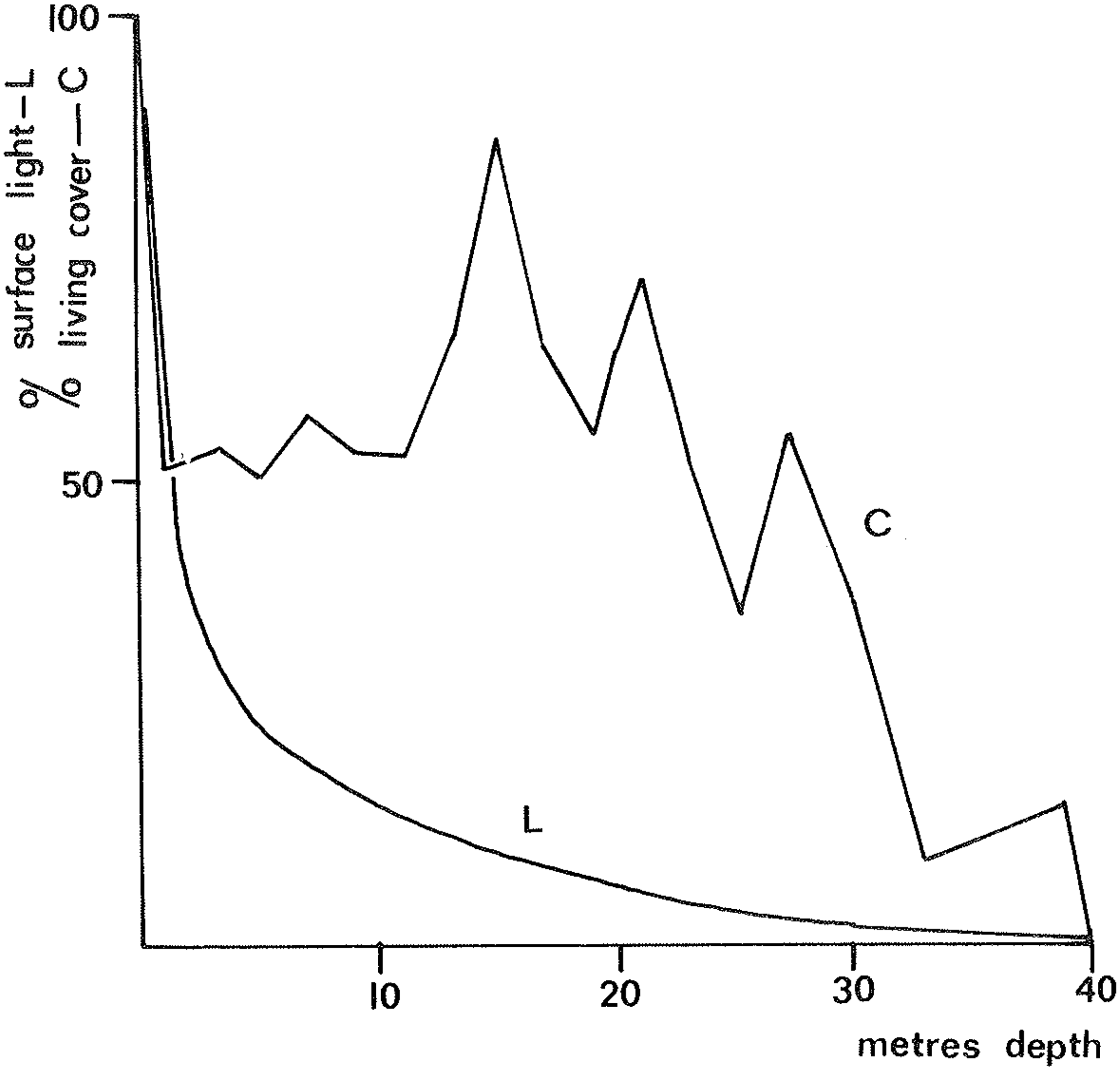
3 Transect topography and percentage living cover



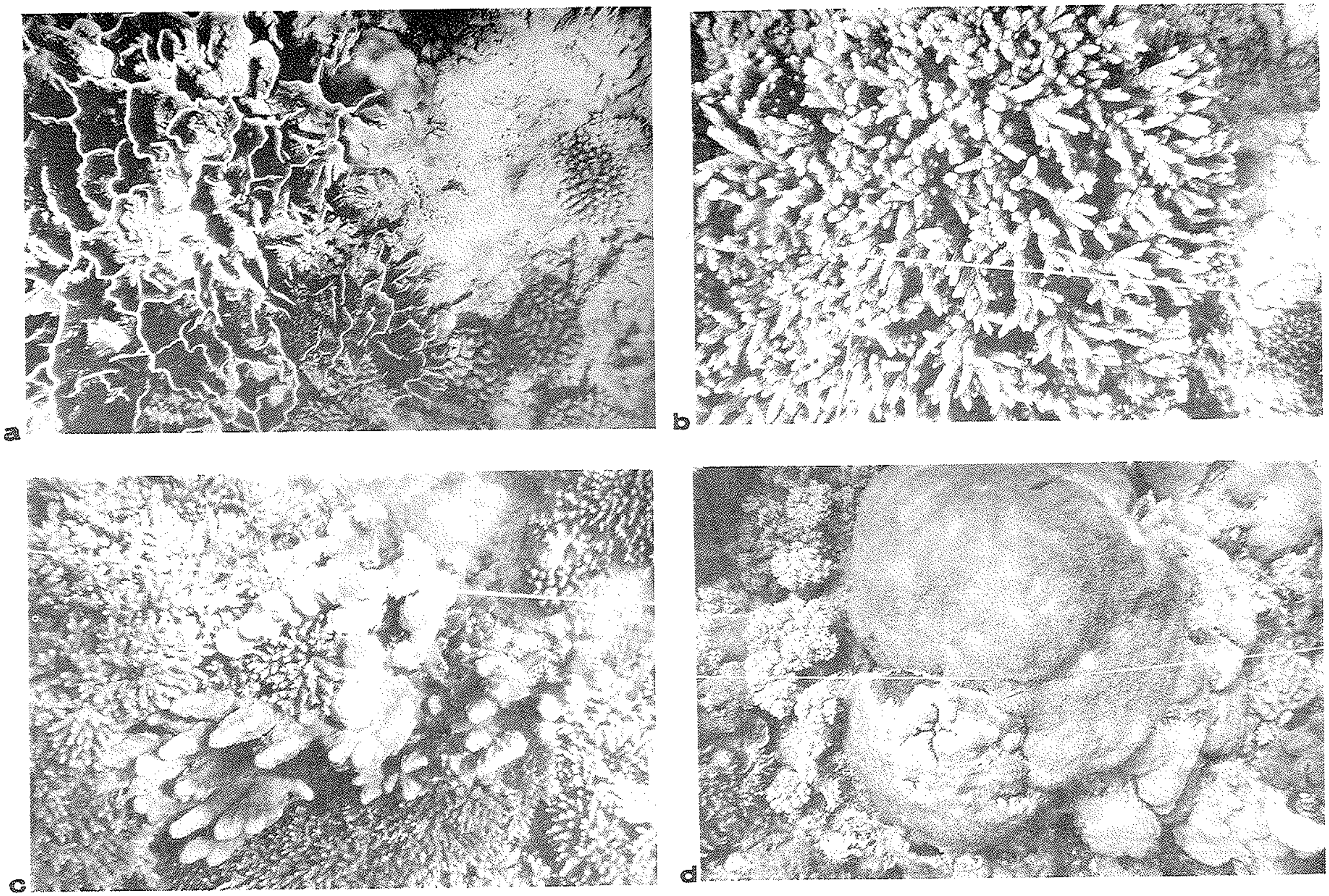
4 Depth distribution of various growth types



5 Horizontal distribution of growth types away from surf zone

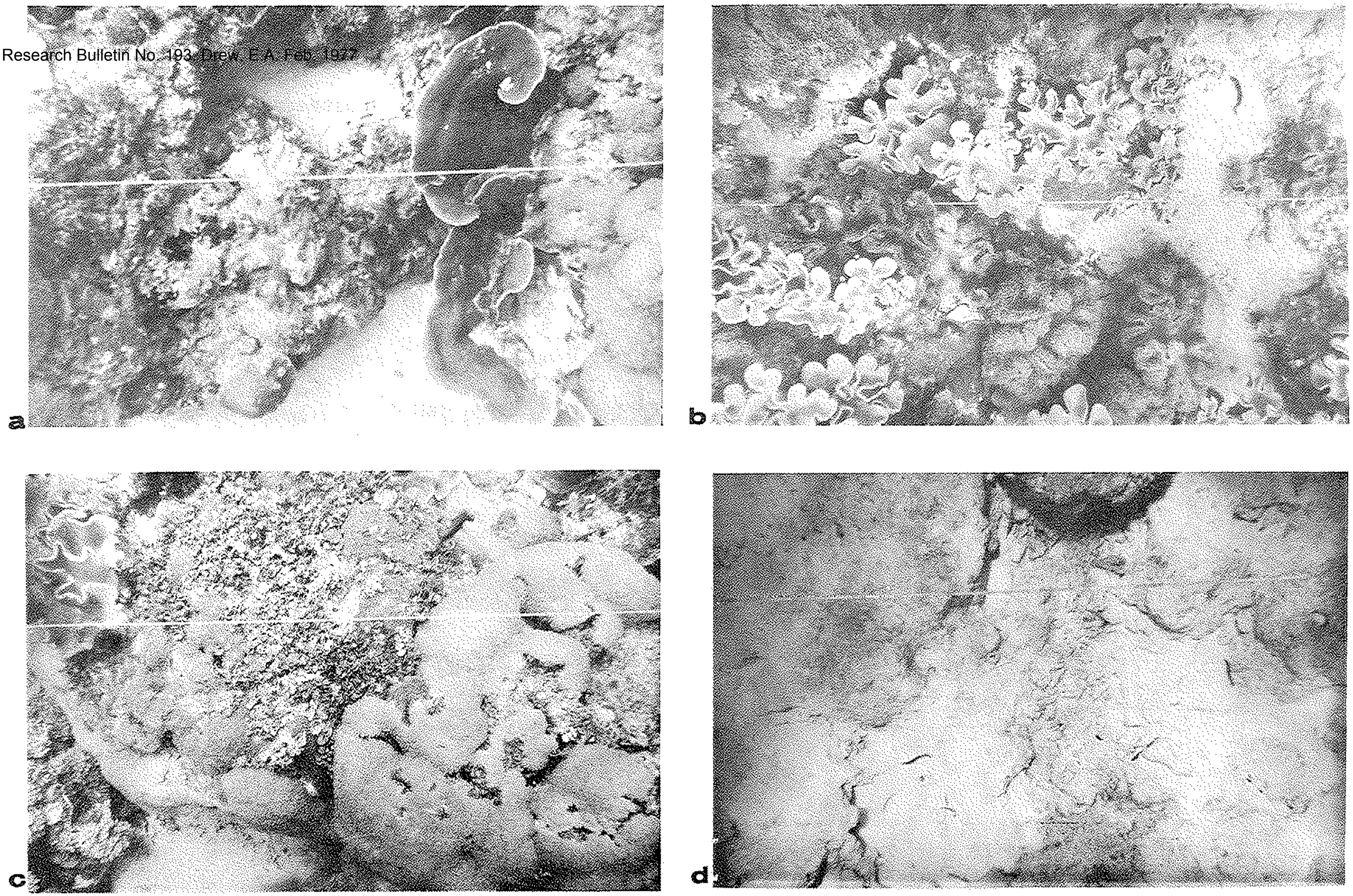


6 Submarine light intensity and percentage living cover



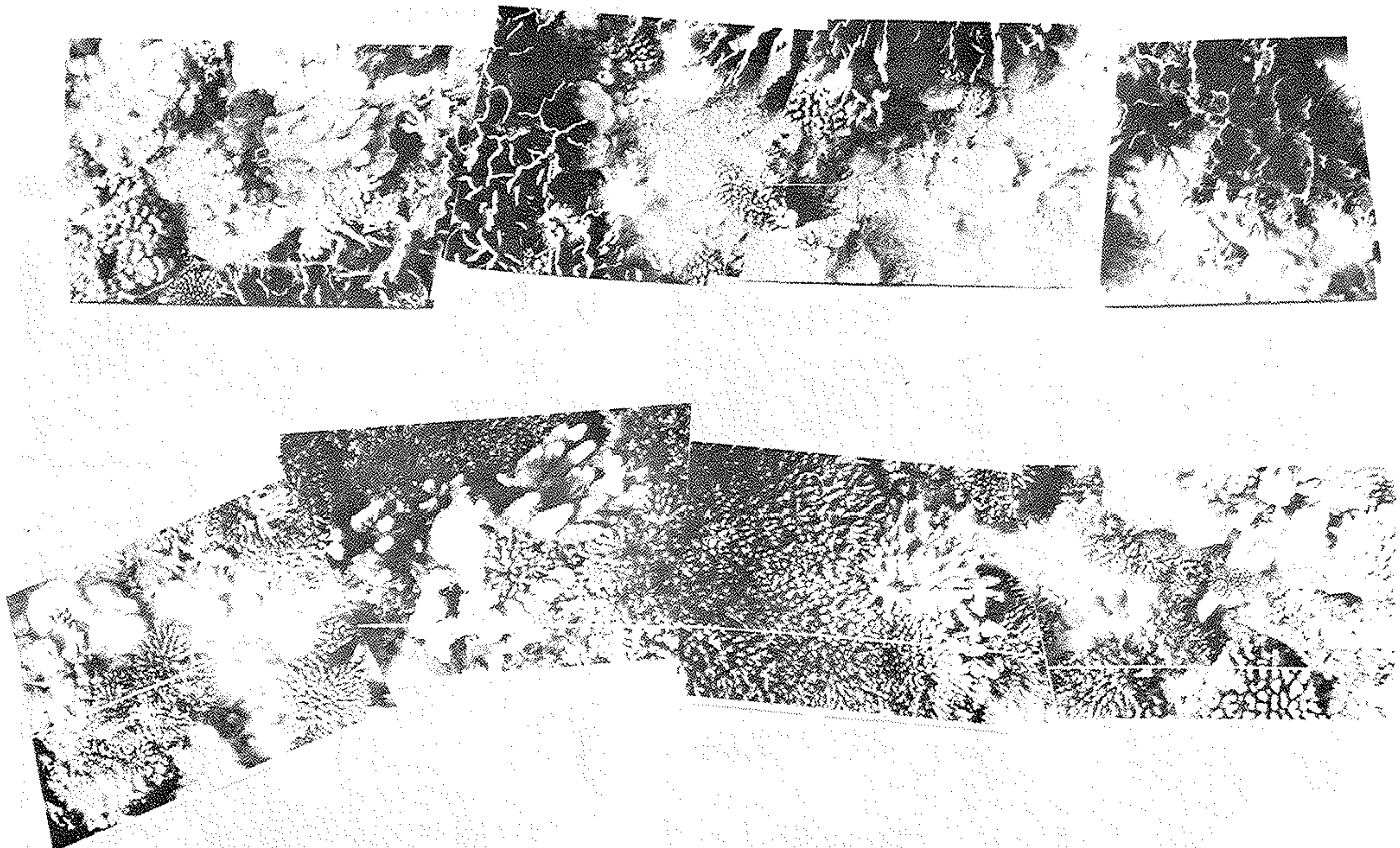
1 Phototransect frames illustrating growth types discussed

a. Millepore
b. Branching coral
c. Columnar coral
d. Brain coral



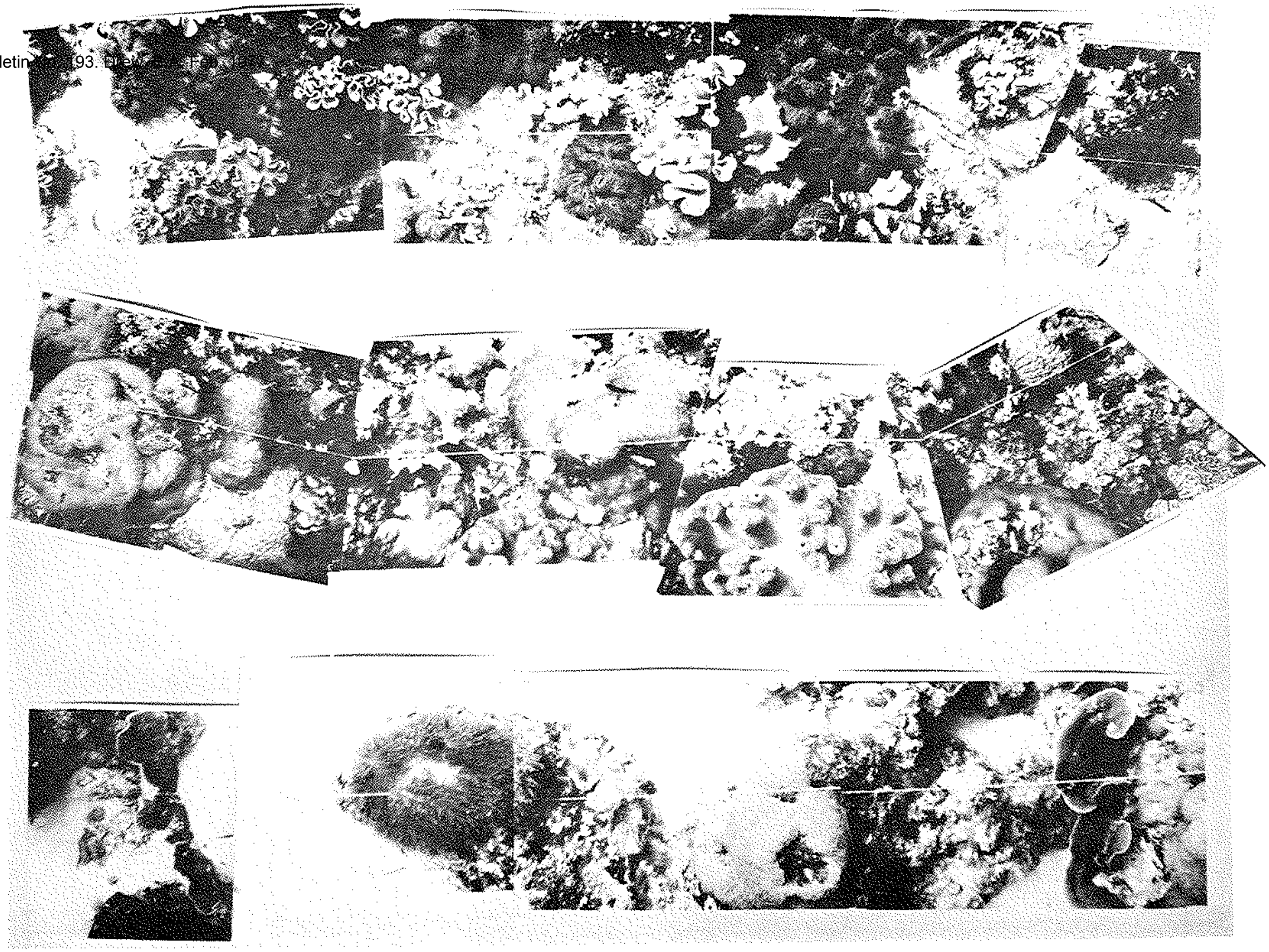
2 Phototransect frames illustrating growth types discussed

a. Foliaceous coral
b. Alcyonacean soft coral
c. *Halimeda* algae
d. Uncolonized bare areas



3 Representative strips from various important zones

a. Millepore coral zone
b. Branching coral zone



c. Alcyonacean soft-coral zone
d. Brain coral zone
e. Foliaceous coral zone