NOTE ON THE GROWTH OF CORAL REEFS (*)

by

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In coralline regions, charts must be frequently revised. Recent research has shown that the growth of coral can occur at a far from negligible pace and cause appreciable alterations to the bottom. The coral grows, decays or dies — a biological factor; the ledge of the reef gets higher or lower — a morphological factor. In every case it is possible to recognise and dissociate the influence of the two factors; it is even of considerable utility to do so in order to gain information concerning evolution and to make predictions; but in practice they are closely associated, either augmenting or neutralising each other, in the sense of superelevation (negative movements) or of subsidence (positive movements).

Attempts have been made to determine precisely the process of growth of the coral, at any rate for a determined region. The research work of J. Stanley GARDINER in 1903, in the Laccadives and the Maldives, must be mentioned. He attributed to the corals of these archipelagos rates of growth varying between 0.16 and 3 cms. per annum.

More recently, research work and attempts at estimation of the same nature but of greater accuracy have been made in the Netherlands East Indies and in Australia — two regions of great interest with respect to work of this nature: the first, on account of the relative rapidity and great complexity of the positive and negative movements which take place; the second, on account of the imposing phenomenon of the Great Barrier Reef which follows the coast of Queensland for a thousand miles. The work in the Netherlands East Indies is of a purely hydrographic nature; it is based on comparisons between two successive precise surveys at a few years' interval. It has been dealt with by VERSTELLE in the Dutch review, *De Zee*, in May 1931 and March 1932, and in the Buitenzorg review, *Treubia*, in December 1932; Captain LUYMES discussed it in the review *De Zee*. In Queensland the research was carried out from a strictly scientific, and particularly biological, point of view, by the Great Barrier Reef Expedition of 1928-9; it has been dealt with in a series of volumes of Scientific Results; questions regarding the superelevation or subsidence of the polyps were dealt with principally by T. A. and Anne STEPHENSON.

The problem of the positive or negative movements of coral reefs is often stated in too simple or summary a way. It is actually an extremely complex one.

As we have already stated, it is necessary to distinguish between movement of a biological order, resulting from the vital evolution of the polyps, and changes of a morphological nature which are changes in the reefs raised by these polyps.

Every living polyp has its annual rate of increase; but this quantity is not always the same in the course of the life of the coral colony. Sometimes the increase is rapid, sometimes slow. It differs as between one species and another. The branching forms (e. g. *Pocillopora* and *Acropora*) grow quickly. The massive forms (*Astraeidae*) grow slowly.

Next comes the position of the coral colonies with respect to surf and to the meteorological happenings which determine the roughness of the sea. Coral conglomerates in curved forms which tend to become circular or ovoid. The convex part of the curve most exposed to agitation grows quicker than the other parts. This applies in the South Pacific to the coral formations exposed to the full effects of the S. E. Trade.

But, with regard to the branched forms, the exposed parts of the polyps are also

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(*) Note by the I. H. B. *See also: International Hydrographic Bulletin, Monaco,*
1932, *No. XI, page* 258
1933, *No. I, page* 9
No. IV, page 81
No. VI, page 110.

those which experience the most considerable destruction as a result of storms. It is true that the broken branches can agglomerate with the reef and contribute to raising it. It also happens that they are ground into such tenuous particles that the latter are carried far afield and float for a long time before being deposited.

Such are the principal *biological* phases of the growth and decay of corals. The *morphological* phases of the evolution of the reefs are no less complex.

The reefs grow, in depths or at the surface, as a result either of the multiplication of the living or the accumulation of dead coral, or of negative movements of the ground which forms their infra-structure — very localised movements, when they are of eruptive origin, and often of wider extent when they are of tectonic origin.

The reefs decrease, either on account of dispersion, from the effect of surf, breakage of coral branches or fragmentation of the coral, or as a result of positive movements of the infra-structure; these movements being determined, like the negative ones, by causes of eruptive or tectonic origin.

The interplay of these various forces may determine movements in opposite senses in the same coral mass, at very short distances apart: apparent superelevation at one point, apparent subsidence and recession at another. The periodicity of these movements and their unforeseen alternation are of a complexity which often defies any attempt at accurate prediction.

The numerous forces causing variation in the reefs are nowhere as active as in the western part of the Pacific. This is what makes the research undertaken in Australia and in the Netherlands East Indies so interesting.

Between July 1928 and June 1929, the Great Barrier Reef Commission undertook genuine experiments, at the Low Isles, on the growth and regeneration of coral. In the first and most interesting of the four series of experiments, 169 corals were placed in normal vital conditions, and observed for more than six months. The branched forms (*Psammocora*, *Pocillopora*, *Acropora* and *Montipora*) increased their original diameter from 33 to 95 % during this period. The massive forms of the *Porites* only increased by 17 % and the *Astraeidae* had an even smaller amount of growth (10 %). Even during the rather short period of the experiments, the amounts of growth were not uniform for any species. In general, the small colonies grew quicker than the large ones which had already reached a certain stage of development. The growth on the open side, exposed to the surf, took place quicker than on the sheltered side.

In the Netherlands East Indies, the observations are based on a comparison between old hydrographic surveys and recent determinations of shoal depths and coralline shores. They thus refer to the reefs as a whole, and not to the biological conditions peculiar to the different species of polyps.

Some results have been given by VERSTELLE in the Buitenzorg journal *Treubia*. They may be summarised as follows:

1. Reef of less than 3 metres depth at the time of the first survey;
2. Reef of 3 to 5 metres depth at that time;
3. Reef of more than 5 metres depth at that time.

Togian Islands, Gulf of Tomini :

	Mean annual superelevation in cms.	*Mean annual subsidence in cms*
1	4.7	3.1
2	10.3	6.3
3	14.6	5.0
Gulf of Tomini, E. Coast of Celebes (Part I) :		
1	4.2	5.4
2	5.8	3.2
3	9.0	3.6
Gulf of Tomini (Part II) :		
1	3.5	2.3
2	7.0	no subsidence observed.
3	10.5	2.7

Kei Islands :

1	1.7	3.7
2	1.4	4.1
3	5.5	2.7

In discussing these results, VERWEY remarks that the superelevations and subsidences very often occur in the immediate neighbourhood of one another. This will not surprise those readers who have borne in mind the considerations which we have stated above.

VERWEY also observes that nearly everywhere the growth of the reefs outweighs their decay, particularly in the case of categories 2 and 3 which are not subjected to the influence of the surf which destroys the branched coral.

We must nevertheless make a reservation in the case of the Kei Islands, where the forces of subsidence seem at least to balance the forces of superelevation.

In connection with these figures and some others, Captain LUYMES, lately Hydrographer of the Netherlands, advanced a suggestion that the extreme limit of growth of the reefs could not be at a greater rate than 1 metre in 15 years. This figure has been found to be excessive. Captain LUYMES has replied that he gave it from the navigational point of view, to "put the navigator on the safe side".

In any case, it is nearly certain that if this figure is excessive in the Netherlands East Indies, it is even more so in French Oceania, where everything shows us that the forces in play act at a much slower periodicity either from the point of view of biology or from that of morphology : none the less, it would be very desirable that our hydrographers and scientists should be able to undertake research work on our coralline coasts, as instructive as that which has recently been carried out in the Netherlands East Indies and in Queensland.