GROWTH-RATE OF A DEVONIAN REEF-CORAL (*PRISMATOPHYLLUM*).

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ABSTRACT. The periodic variation in growth-rate is discussed as a basis for measuring the annual increase of the *Prismatophyllum* skeleton, and the possibility of using the phenomenon for measurements of short intervals of time in the Paleozoic is outlined.

INTRODUCTION.

DURING field work, in the spring of 1942, in the northern part of Michigan's Lower Peninsula, the writer has observed peculiar markings on the skeletons of the very common tetracoral, *Prismatophyllum*. These markings, shown well even by weathered specimens (Plate 1, Fig. 1), apparently correspond to the rings found in transverse sections of trees, on fish-scales, and other organic structures with a variable growth-rate. Besides arousing purely academic interest, these "timed" corals may be of great use as an accurate scale for actual measurement of comparatively short periods of time in the long-past Paleozoic.

Ting Ying H. Ma of the Chinese Geological Survey has compiled a great amount of data on rates of growth of Devonian corals as well as recent anthozoa of the Western Pacific. The writer is indebted to Dr. T. Wayland Vaughan of the U. S. National Museum for bringing Ma's work to his attention. Dr. Carl O. Dunbar of Yale University and Dr. William A. Kelly of Michigan State College have made valuable suggestions. The writer is also grateful to Dr. Hervey W. Shimer of the Massachusetts Institute of Technology for criticism of the manuscript.

RATE OF GROWTH.

The growth rings appear in longitudinal sections of corallites. In thin section a periodic decrease in the size of dissepiments[1] is observed, occurring in all corallites at the same level of growth. The dwarfing of these skeletal elements is accompanied by a general thickening of the skeleton at that point, a high development of carinae, and a bunching of tabulae. The constricted dissepiments and bunched tabulae follow exactly the outline of the calicinal surface, as if the corallites

[1] The current coral terminology as summarized by Sanford (1936) is used throughout this paper.

had gradually decreased their rate of growth to almost a total stagnation, then recovered their original high degree of metabolism only to stagnate again a few millimeters higher (distally). (See Plate 1, Figs. 2-5.) The decrease in growth-rate is periodic, but the distance between the "growth-rings" may vary slightly from ring to ring. This second order variation is apparently quite irregular and shows no discernible periodicity.

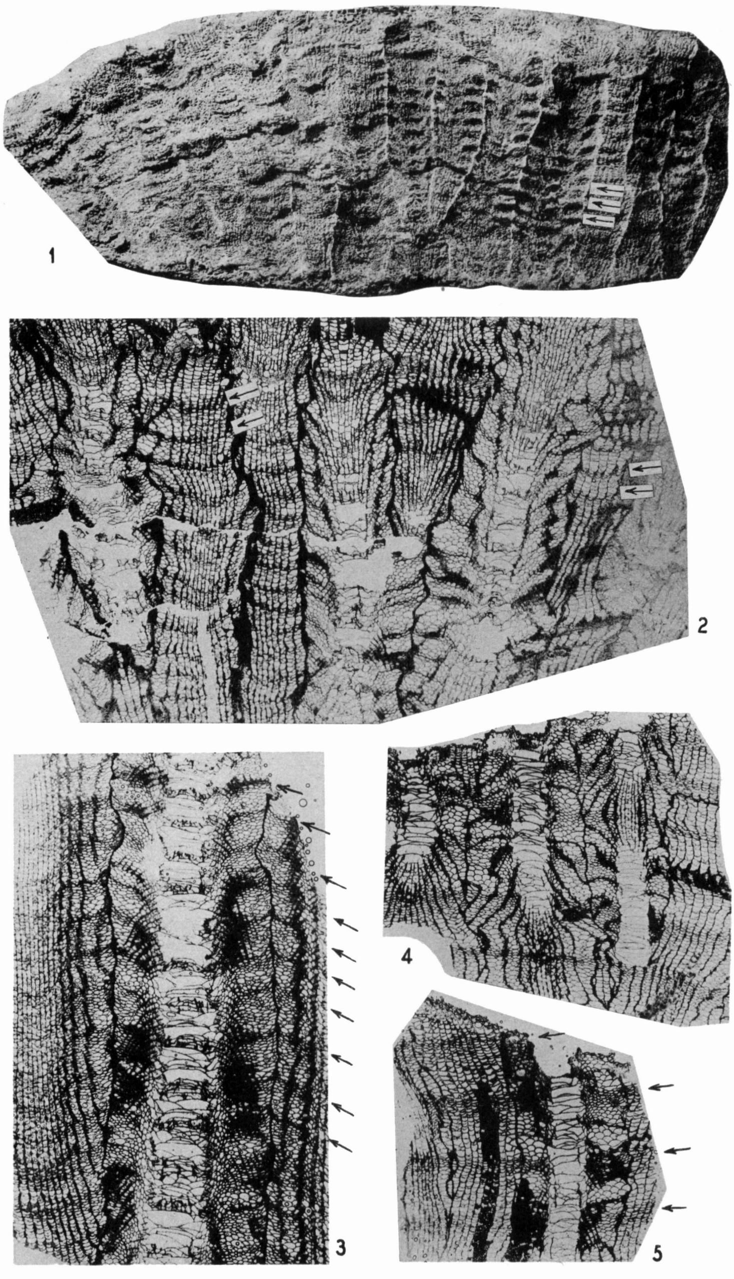
For measuring the growth rate of the coral in length-units per year, however, it is necessary first to determine whether the "slow downs" of metabolism in corals are seasonal or whether they occur irregularly. Vaughan (1917) has reported experiments with Florida reef corals and their sensitivity to heat and light. He reports that reef corals that thrive at a certain temperature will barely survive if this temperature is lowered only a few degrees. He also has shown experimentally (*ibid.*) that reef corals seek such environments that will give them a maximum of sunshine. If they are placed in dark surroundings artificially, they perish or become abnormal.

It is known that the temperature of shallow seas varies annually. In the Pacific of the northern hemisphere, the average temperature is highest in August and lowest in February, and may show a variation of tens of degrees Centigrade (Ma, T. Y. H., 1934). The variation is obviously seasonal in character.

The intensity of light-rays at a given depth of water is proportional to the inclination of the rays, other things being equal. The inclination, in turn, depends on the height of the sun above the horizon, which is a strictly seasonal variable. Obviously, the light intensity will be highest when the inclination of the rays is steepest (summer), and it will be at a minimum when the sun is lowest (winter). Furthermore, the average atmospheric cloudiness is higher in winter than in summer.

Therefore, since reef corals need and seek both warmth and light for their growth, and since the temperature and light intensity are both highest in summer and lowest in winter, it appears safe to postulate that reef corals will grow faster in summer and slower in winter.

The "growth-rings" on coral skeletons may thus be interpreted very much like the rings in soft wood where the denser part represents winter growth and the more porous part cor-



FIGS. 1 AND 2

Prismatophyllum C, from the "Marvin" Quarry, near Afton, Cheboygan County, Michigan. 1, View of a weathered longitudinal section (actual size) of a small corallum. 2, Longitudinal thin-section (X2) of the same specimen.

FIG. 3

Prismatophyllum percarinatum, H var. 2, from near the Bunker Farm, near Afton, Cheboygan County, Michigan. Longitudinal thin-section (X2) of a fragment of a large corallum.

FIGS. 4 AND 5

Prismatophyllum D, from near the Bunker Farm. Longitudinal thin-sections (X2) of parts of a large corallum.

Note: Arrows point to constrictions representing the retarded winter growth.

responds to spring and summer growth. Both in wood and in corals the transition from summer to winter growth is generally gradual, but the rapid growth acceleration in spring usually results in a rather sharp boundary between winter and spring tissue.

Variable water temperature and radiation intensity are not the only factors affecting the growth of corals. Variations in pressure, salinity, and turbidity of seawater are all known to influence them (Vaughan, 1917), but far off shore these factors are probably constant. In very shallow seas, or in river estuaries, etc., they may become variable, but it is difficult to imagine this variation to be other than seasonal.

TIME MEASUREMENT.

We are thus served with an accurate method of time measurement, not only for determining the age of individual corals but also for the measurement of rates of sedimentation, rates of growth of coral reefs, speed of volcanic activities, etc. The average growth rate of a Prismatophyllum is about ½ to 1 centimeter per year, and some single corals more than one hundred years of age have been found in the Middle Devonian of Michigan.

A detailed set of measurements is given in Table I.

TABLE I.

Growth Rate Measurements of *Prismatophyllum*

Prismatophyllum	Locality[3]	Formation	No. of Measurements	Growth Rate (mm.) Max.	Min.	Average
Species A[2]	Black Lake Quarry	Lower Genshaw	3	6.2	5.6	6.0
Species B	Tower dam site	Lower Genshaw	3	4.2	3.8	4.0
Species C, var. 1	Draper School	Lower Gravel Point	1	—	—	4.0
Species C	Afton Quarry	Gravel Point	7	2.2	1.75	2.0
Species C	Marvin Quarry	Gravel Point	1	—	—	2.
percarinatum, var. 2	Gorbut School	Gravel Point	10	5.5	4.5	4.9
percarinatum, var. 2	Bunker Farm	Gravel Point	4	3.	2.5	2.8
percarinatum, var. 2	Petoskey P. C. Quarry	Gravel Point	4	4.15	3.6	3.8

[2] All species are described in a forthcoming paper.
[3] Faul (1942), Kelly and Smith (1943).

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