# DISCUSSION

## A SUBMERGED BEACH OFF BERMUDA

WORK has been continuous this summer on the Third Bermuda Oceanographic Expedition. This is carried on as before, under the directorship of the writer, by the Department of Tropical Research of the New York Zoological Society.

In the course of the researches on the limited deep-sea area under intensive study, some interesting new discoveries have come to light and one in particular. The area covered in the season of 1931 was, as before, roughly a circle eight miles in diameter, with its center 32° 12′ North Latitude and 64° 36′ West Longitude, which point is 160 degrees by the compass, or south-south-east of Nonsuch Island, Bermuda. This brings the center of the circle 6.75 miles from the nearest one hundred fathom line and 9.25 miles from the laboratory on Nonsuch.

In addition to the regular trawling, attention has been given this season to temperatures and water samples, and work on the bottom. Accidental touching of the bottom from time to time by the silk nets has shown that this lies within the small area of pteropod ooze which was discovered many years ago south of and close to Bermuda. These nets were usually torn, and a large otter trawl which I lowered one thousand fathoms to the bottom was ripped half across.

Four-foot iron dredges were used this year with unexpected results. About two hauls were made with each dredge before it was lost, and at each successful haul the dredge was bent almost double. One-half square-inch mesh netting was used on the dredge, which allowed most of the pteropod ooze to slip through. What remained was of great interest, since it consisted almost entirely of water-worn pebbles, shells and bits of coral. Several hauls were made at nine miles distance from shore, and later others at twelve miles yielded the same general material.

The lowest levels of oceanic water at the glacial periods have permitted to geologists estimates of an increased Bermudian land area from almost twenty square miles of the present dry land, to 230 square miles, including all the shallow waters to the outermost reefs. An actual rise and subsidence of the land itself is admitted, a change in altitude, however, not exceeding 150 feet.

The gradient of the sea bottom south and south-east of Nonsuch, out to nine miles, is, to judge by my soundings and those marked on admiralty charts, about one in six.

The depths at which my dredge hauls were made, where absolute evidence of submerged sea beaches was brought up, were 1,450 to 1,550 fathoms, over one and a half miles deep. This was in perfect conformity with the proven roughness of the bottom over almost all the area in the eight-mile circle. The sea-floor at 1,000 to 1,500 fathoms is usually comparatively smooth and flat. But here my nets and dredges have encountered obstacles at every trawl, obstacles similar in hardness, and in the bits of broken rocks which came up, to the water and air-worn reef rocks in shallow water near the shore.

I have submitted my shells to Mr. Arthur Haycock, who has kindly identified them; and Dr. C. M. Yonge, of the Marine Biological Association, while on a recent visit to Nonsuch, was good enough to look over the alcyonarians and corals.

I have had no opportunity to extend the dredgings beyond my eight-mile circle, but, at the most conservative estimate, the addition to a former Bermudian land mass is more than sixty times. In other words, the present dry land of Bermuda is slightly less than the area of Manhattan Island (19.3, as compared with 22 square miles), while the area added by the inclusion seaward of these submerged beaches would increase this to 576 square miles. This is only an estimate, but, based on these preliminary facts, it is probably far under the truth.

A complete report will be forthcoming. Here it will suffice to say that the majority of the waterworn bivalves are *Glycimeris* and *Pectunculus,* nearly fifty of which were taken in Dredge No. 1224, at 1,500 fathoms. With these were *Arca imbricata,* a *Cardium, Cryptodon chrisostoma, Ostrea frons, Chione latilirata,* etc. Also bits of limestone affected by volcanic action. The pteropods remaining in the coarse dredge nets were chiefly *Cavolinia* and *Cuvierina.*

Some of these shells have been found fossil in Bermuda by Mr. Haycock, together with similar water-worn pebbles in old raised beaches thirty feet above high water, and most of them are West Indian species.

The bottom of my trawling area appears to alternate tall, exposed, reef-like, sharp-edged, water-worn limestone, with stretches of water-worn shells, coral fragments, rounded limestone pebbles, covered several inches deep with an almost pure culture of pteropod shells of five or six species, unusually deep for this type of ooze: This at a distance of five to thirteen miles from the outer reefs off Nonsuch. The bottom has so slight a gradient and is of so rough a nature that any gradual rolling or washing down from higher levels is unthinkable.

The discovery of a submerged sea-beach of great

extent, *in situ*, at a depth of 1,500 fathoms, was quite unexpected in this part of the Atlantic.

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## POSITION OF WOOD IN BEAVER DAMS

A TYPICAL beaver dam is a bank of earth reinforced with brush, in vertical sections approaching an equilateral triangle with a rounded apex. The reinforcing branches do not show on the upstream side of the dam; the slope in that direction is covered with a thick layer of solid earth. But on the downstream side the branches continue outward as a bed of brush a foot or so thick, covering the face of the dam from crest to foot, their very important function being to prevent erosion by the water flowing over the dam.

Every writer known to me who goes into details of beaver dam construction, says that these branches are placed with their butts upstream. Thus Morgan[1] writes in his monograph: "In general the large ends of the poles and of the limbs with their branches attached were upstream, which itself would tend to strengthen their hold on the bottom."

Mills[2] says: "The majority of dams are made of slender green poles. . . . With these are used occasionally small limby trees. The large end of the trees is placed upstream and the bushy end downstream."

Equally definite is Dugmore:[3] "As a matter of fact the building of an ordinary dam consists originally of a number of sticks and brush being laid (no stakes are driven) in the water with butts upstream."

Johnson[4] makes some qualifications: "Boughs are generally found with the butt end upstream, but numerous examples occur where they lie across the current, diagonally and in every intermediate position."

And lastly Warren,[5] in the best book yet written on the beaver: "Branches of willow, alder or whatever brush is most available . . . are cut and placed on the bottom with the butt ends upstream, and often forced into the bottom."

Now for twelve years I have been observing the work of a beaver family established on a small stream tributary to the Ottawa River near Arnprior, Ontario. There is nothing out of the ordinary in the situation. The stream rises in a group of springs, and with a moderate current flows a distance of two miles through a shallow thickly-wooded valley. Before the beavers came it had a fairly uniform width throughout its whole length of four to six feet, and a depth varying from six inches in its upper part to three or four feet in its lower reaches. The beavers occupy the last half-mile of the stream, where there is, or rather was a good supply of poplar and other favorite woods, and their dams have expanded this section of the stream into a pond four or five feet deep and about 300 feet wide.

At one time and another these beavers have built nine dams, and have rebuilt or repaired five or six dams that broke. In every case, both in new work and repairs, the great majority of the branches used in construction were laid with butts *downstream*, in direct opposition to the beaver practice unanimously alleged by the writers quoted. As mentioned by Johnson,[4] some of the branches were placed in every possible position, but at least 90 per cent. with butts downstream. To venture on an *a priori* argument, it may be said that this disposition of the branches is what might be expected. In general, beavers float their wood downstream: naturally it is towed butt-end first to prevent twigs and branches from catching, and it is likely to be laid in position without change of direction, that is, butts downstream.

Certainly such is the habitual and uniform procedure of my beavers, both in new construction and repairs. There is no reason to suppose that they differ in any way from other beavers, and there does not appear to be anything in their environment that might cause a reversal of habit.

I have had no opportunity of examining critically beaver dams elsewhere, but perhaps some field naturalist who is familiar with dams in different parts of the country will say if the wood in other dams really is laid with butts upstream.

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[1] Lewis H. Morgan, "The American Beaver and its Works," p. 103, 1868.

[2] Enos A. Mills, "In Beaver World," p. 66, 1913.

[3] A. R. Dugmore, "The Romance of the Beaver," p. 34, n. d. (ca. 1914).

[4] C. E. Johnson, "The Beaver in the Adirondacks," *Roosevelt Wild Life Bulletin*, p. 632, July, 1927.

[5] E. R. Warren, "The Beaver," p. 28, 1927.

## VIRGINIA GEOLOGICAL SURVEY FIELD WORK

DURING 1931 the Virginia Geological Survey has conducted an extensive program of field work, under the supervision of the State Commission on Conservation and Development, Mr. William E. Carson, chairman, and Dr. Arthur Bevan, state geologist. The results of each of these projects will probably be published as survey bulletins.

This field work consists of the following projects:

The survey of the geology and mineral resources of the Hot Springs district in the central-western part of the state is being continued by the state geologist. He has been assisted at times by Mr. C. R. L. Oder, of the University of Illinois, Mr. Paul Averitt, of the University of Kentucky, and Mr. R. L. Laurence, of the University of Cincinnati. This area is also being topographically mapped, in cooperation with the