ing spectroheliographs of solar prominences; visits to the University of Buffalo, the Spencer Lens Company, the Cyanamid Plant, the Queenstown Power House, the Whirlpool, the Welland Ship Canal and the Locks at Thorold. The meeting will be open to non-members as well as members of the society. Non-members, who desire to receive the advance program, final notices or other information in regard to the meeting, should address their requests to the secretary not later than October 10.

DISCUSSION

AN ALGONKIAN JELLYFISH FROM THE GRAND CANYON OF THE COLORADO

DURING the field study of the Algonkian formations in the Grand Canyon of the Colorado River, one of my field assistants, Mr. C. E. Van Gundy, then a graduate student at the University of California, discovered a well-preserved imprint of a jellyfish in the red sandstones above the great lava sequence which forms the top of the Unkar (lower) division of the Algonkian Grand Canyon series. The jellyfish is above 18 centimeters in major diameter. The specimen was submitted to Dr. R. S. Bassler, of the United States National Museum, who identified it. Later a detailed description will be published. The specimen was exhibited at the annual meeting of the Carnegie Institution in Washington in December, 1937, and will be deposited permanently in the National Museum.

Our studies indicate that the Grand Canyon region was under ocean water at least during a part of early Algonkian (Unkar) time when the lower limestones and some of the clastic sediments were laid down. Toward the close of this epoch, emergence took place, and, upon a land surface which probably stood close to sea level, fluvial sediments were deposited as broad flood plains. The latest event of the Unkar was the opening of fissures, the intrusion of diabasic dikes and sills, and the eruption of about a thousand feet of basalt flows. At the top of the lavas is an erosion surface, which sank below sea level and was buried beneath about 400 feet of red sands and clays; between two of the sand layers, the jellyfish was buried. This sequence has a disconformity above and below, and consequently has been set apart as a new group of Van Gundy[1]; to it the name Nankoweap has been applied. After deposition of these strata, elevation above sea level again occurred, and erosion developed a very even surface plain. Later depression below sea level for a long period was marked by deposition of the Upper Algonkian (Chuar) beds, more than 5,000 feet thick. Algonkian history in the Grand Canyon region was closed by folding and faulting, which built the Grand Canyon Mountains. Erosion accompanying and following this orogeny evolved the Ep-Algonkian peneplain, which remained above the ocean until late Lower or early Middle Cambrian time. During this erosion interval, great volumes of Algonkian strata were removed and, over considerable areas, the whole thickness of more than 12,000 feet was swept away, and the Archean basement below suffered some denudation.

The jellyfish is the only authenticated animal fossil which has been found in the Grand Canyon Algonkian. Walcott[2] in 1886 reported the finding of certain fossils "midway of the lower portion of the shales and limestones" of the Chuar group—"a minute Discinoid or Patelloid shell, a small, Lingula-like shell, a species of Hyolithes, and a fragment of what appears to have been the pleural lobe of the segment of a trilobite belonging to a genus allied to the genera Olenellus, Olenoides or Paradoxides. There is also an obscure Stromatopora-like form that may or may not be organic." In 1899, Walcott[3] described and figured these forms. The discinoid shell was named *Chuaria circularis*, nov. g., and sp. The obscure remnant of a brachiopod shell resembles the Cambrian genus Acrothele. The identification of the Hyolithes was questioned, since the specimen possibly may be an inorganic marking. Doubt also was expressed regarding the identification of the trilobite fragment. The Stromatopora-like form was submitted to Sir William Dawson, who was not certain of its organic origin; none the less he gave it the name "Cryptozooan"? occidentale. I have not examined the specimens figured by Walcott, but the illustrations strongly suggest the multitude of inorganic markings to be found throughout the Grand Canyon series. Re-examination of these specimens must be made to prove their organic origin; certainly the existing descriptions do not prove it. My assistants and I have carefully searched the various zones in this great sequence without making other finds. This scantiness of fossils has long been known and is in keeping with that characteristic of Algonkian beds elsewhere in the world. The explanation of this of course has been debated by geologists and paleontologists. Some have accepted Walcott's opinion that the continents stood above sea level during the great length

[1] C. E. Van Gundy, *Proceedings Geol. Soc. America*, 1936, p. 304, 1937.

[2] C. D. Walcott, Second contribution to the studies of the Cambrian of North America, *U. S. Geol. Surv. Bull.*, 30, p. 43, 1886.

[3] C. D. Walcott, *Bull. Geol. Soc. America*, 10: 232–235, 1899.

of Algonkian time and that the sediments were accumulated in fresh-water lakes of huge size situated at a considerable distance from the margins of the continents. In these lakes was relatively little animal life. This view is not in accordance with the testimony of the sediments, for Barrell[4] has shown that many horizons of the Belt series of northern United States and southern Canada and of the Grand Canyon series strongly indicate deposition below sea level. My detailed studies at the Grand Canyon and some acquaintance with the Belt series, the Apache group of southern Arizona and the unnamed Algonkian series of southeastern California support Barrell's findings. The hypothesis originally advanced by Brooks[5] and recently modified and expanded by Raymond[6] seems a much more reasonable explanation of the paucity of fossils. These authorities and others hold that animals developed a lime- or silica-secreting mechanism for the generation of resistant parts relatively late in their evolution and that this had not taken place in most forms by Algonkian time. Even in the early and middle Cambrian, the secretions were mostly of chitin, but by the late Cambrian many forms developed structures of calcium carbonate and silica. Raymond holds that most pre-Cambrian animals were motile, swimming or crawling forms, lacking in hard parts. Predaceous carnivores apparently were scarce, hence, "the swimming and floating organisms must have increased rapidly until there came a time when the upper, sunlit part of the oceans was over-populated. This would force some individuals to the bottom. . . . Those animals which reached the bottom near the shore, where the waters were shallow, found abundant food, and survived. . . . Active animals reaching the bottom continued to swim, or learned to crawl after food. The more passive forms adhered to the substratum, became relatively inactive, and began the secretion of skeletons because they were no longer able to get rid of the calcium carbonate. . . . Animals had only commenced to discover the bottom in early Cambrian times." Thus it is probable that the Algonkian oceans were teeming with life when they spread over northern Arizona, but most of the animals, being composed only of soft tissue, left no record. Strange it is that a jelly-fish, one of the most perishable of animals, should have left the only imprint so far discovered. Many fossils doubtless are present in the great mass of sediments deposited in the Grand Canyon region, but so widely scattered are they that great masses of rock may be examined without finding any. Search in the Algonkian Apache beds of southern Arizona, probably correlative with the Unkar strata at Grand Canyon, so far has not yielded any animal fossils.

In the lower Unkar and especially in the Chuar group, are many limestones which exhibit the structures commonly described as of algal origin. Some of these probably are inorganic, but many of them seem without question to represent algal secretions. The number of such horizons indicates that, at various times at least, the seas were heavily populated with these primitive plants. Most of the limestones probably are marine, but there is the possibility that some may have been accumulated in fresh-water lakes existing on the flood-plains when the land was above sea level. A detailed study of the considerable variety of these structures in the Grand Canyon Algonkian would be a material contribution to pre-Cambrian paleontology. There is no record of any higher types of plants.

Another indication of the abundance of life during Chuar (later Algonkian) time is the great volume of carbonaceous shale and the smaller quantity of carbonaceous and bituminous limestone. Examination of much of this material which I collected has not yielded any actual fossils. Some of the limestones are so strongly bituminous as to emit a very distinct fetid odor when broken.

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[4] J. Barrell, *Jour. Geol.*, 14: 553–560, 1906.
[5] W. K. Brooks, *Jour. Geol.*, 2: 455–479, 1894.
[6] P. E. Raymond, *Bull. Geol. Soc. America*, 46: 375–391, 1935.

A RAINBOW AT NIGHT

I WOULD hesitate to record so trifling an observation as I recently made, were it not for the fact that none of my scientific friends with whom I have spoken seem to be aware of the phenomenon. On the night of June 16, 1938, I observed a rainbow caused by the moon, then only three or four days beyond its full stage. I was crossing from Nassau to Miami on the *Ena-K*, a small motor launch, and was obliged to remain on deck all night. The moon rose about 9 o'clock out of a beautiful calm sea. There was no land in sight. Tumultuous trade wind clouds towered to gigantic heights and there were occasional squalls of rain. About 11 o'clock, when the moon was well up in the southeast sky, the rainbow appeared in the northwest, where a thunderstorm was in progress. The prismatic colors were fairly distinguishable. The arc was complete, the two ends dipping into the sea. At no time was there the least doubt as to the cause of the phenomenon. The conditions were unusually favorable, but probably no more so than at every occurrence of full moon in the trade wind belt, where thunder squalls are common. June is their so-called rainy season for this reason.

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