

In none of the areas in which these bombs occur is there any indication of either active or extinct volcanoes, and the question of their distribution is a problem which the author does not attempt to solve.

The specimens all consist of a black compact and homogeneous glass, with a very few small and isolated gas inclusions, but no crystals of any kind. The specific gravity varies between 2.41 and 2.52. There is no doubt that the bombs are really of Obsidian, and that they are volcanic in origin. One specimen is polyhedral in form, others are rounded or ellipsoidal, with the peculiarity that they appear as if built up of two distinct halves, one somewhat flattened and larger, the other more convex and smaller. In two instances the form is that of a button-shaped mushroom; as if the smaller of two rounded thick-walled shells had been pressed into the concavity of the larger. One specimen is a hollow sphere, which may have been simply a large bubble enclosed by glassy walls. In this hollow bomb and in the mushroom-like forms there are on the larger and flatter hemisphere, and on this only, from four to six ring-like elevations parallel with the equatorial margin, as well as fine straight or wavy lines, having a meridional direction; and further, this flatter half has a distinctly varnished appearance in contrast with a dull aspect on the other more convex half of the bomb.

The peculiar form of these bombs, and the pittings and other markings on their surfaces, are attributed to the resistance which they encounter in their flight through the atmosphere, and their individual differences probably depend on the greater or lesser plasticity of the lava when the explosion takes place, and the varying rapidity of the projectile and the consequent varying force of the resistance of the atmosphere. The bombs examined range from 15 mm. to 55 mm. in their greatest diameter.

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III.—1. PRESIDENTIAL ADDRESS: THE CRETACEOUS SYSTEM IN CANADA. By J. F. WHITEAVES. (Transactions of the Royal Society of Canada, Section IV. 1893, pp. 3–19.)

2. NOTE ON THE RECENT DISCOVERY OF LARGE UNIO-LIKE SHELLS IN THE COAL-MEASURES AT THE SOUTH JOGGINS, NOVA SCOTIA. By J. F. WHITEAVES. (Transactions of the Royal Society of Canada, Section IV. 1893, pp. 21–24.)

1. THE first of these papers contains an interesting summary of the Cretaceous system of Canada from the palæontologist's standpoint, and as it proceeds from the pen of one of the best authorities on the American Mesozoics the views put forth in it carry weight.

The literature of the subject dates from the year 1857, at which time F. B. Meek, that most accomplished of American palæontologists, described some fossils from the Cretaceous rocks of Vancouver Island (Trans. Albany Institute), and in the same year Dr. J. S. Newberry discussed the age of the rocks associated

with the Coal on Vancouver Island, and concluded upon palæontological evidence that they were Cretaceous. In the following year, Dr. B. F. Shumard (Trans. St. Louis Academy of Sciences) described some fossils from the Cretaceous rocks of the Nanaimo River. He was followed, in 1859, by Prof. Leo Lesquereux, who, in the 27th volume of the American Journal of Science and Art, described some fossil plants from the same rocks belonging to the genera *Populus*, *Quercus*, and *Cinnamomum*, which, however, he regarded as of Miocene age. Captain Palliser's explorations in British North America were fruitful in palæontological results, worked out by Dr. (now Sir James) Hector. In the same year (1859) fossils collected in the country between Lake Superior and the Red River Settlement, and between the latter and the Assiniboine and Saskatchewan rivers, were sent to Mr. E. Billings, then palæontologist to the Geological Survey of Canada, who found that the specimens supplied "almost indisputable evidence that a considerable part of the territory belongs to the Cretaceous period, or the great Chalk formation so largely developed in the Old World." In 1861 Dr. Hector, in a paper on the geology of the country between Lake Superior and the Pacific Ocean (Palliser's Expedition, 1857-60), compared the Cretaceous rocks east of the Rocky Mountains with those of Vancouver Island, and published an ideal vertical section of the Cretaceous system in British North America, which agrees in part with Meek and Hayden's Upper Missouri section. Lists of the Cretaceous fossils were contributed by Mr. Etheridge; but most of the fossils were only determined generically. Nineteen species were recorded, all marine mollusca. Eleven of these were from various localities now called Manitoba and the districts of Assiniboia, Saskatchewan and Alberta, and eight from Nanaimo, Comox or Valdez Inlet. No less than thirteen of the species are identified with Texan or Mexican species. Again, in 1861, Meek described the following Cretaceous fossils from Vancouver and Sucia Islands, viz.: *Dosinia tenuis*, from Nanaimo; *Inoceramus subundatus*, *Baculites occidentalis*, *Ammonites Vancouverensis* and *Nautilus Campbelli*, from Comox; *Ammonites complexus*, var. *Suciensis*, from Comox and the Sucia Islands; and *Baculites inornatus* from the Sucia Islands. A few plants were described in 1863 by Dr. Newberry (Boston Journ. Nat. Hist. vol. vii.), viz. *Aspidium Kennerlyi* and *Taxodium cuneatum*, from Nanaimo; also *Populus rhomboidea* of Lesquereux and a *Sabal*, afterwards described by Sir J. W. Dawson under the name of *Sabal imperialis* (Trans. Royal Soc. Canada, sec. 1). The first volume of the Palæontology of California (1864) contains descriptions, by W. M. Gabb, of two new species from Nanaimo, viz. *Hamites Vancouverensis* and *Pecten Traskii*. Since the confederation of the provinces of Canada in 1867, much work has been done upon the Cretaceous rocks of Manitoba and the North-West Territories and in the Rocky Mountains and British Columbia by Sir J. W. Dawson, Doctors Selwyn, G. M. Dawson, R. Bell, and J. W. Spencer, and by Messrs. J. Richardson, R. G. McConnell, and J. B. Tyrrell. In summarizing

the results of the work of these geologists Mr. Whiteaves follows the Cretaceous rocks in a direction from east to west geographically, and in a descending order geologically, thus: (1) Manitoba and the North-West Provinces; (2) the Rocky Mountain region; (3) British Columbia, inclusive of the islands off the Pacific Coast; (4) the Yukon district.

In Canada, as in the United States, it is found convenient to adopt a single division of the Cretaceous system and to draw the line between the Upper or Later and the Lower or Earlier North American Cretaceous, as nearly as possible at the base of the Dakota Group, or of that of its local representative.

*Manitoba and the North-West Territories.*—In these regions all the Cretaceous rocks, as yet examined, appear to be referable to the Upper or Later North American Cretaceous, as defined above. "It is still doubtful," observes Mr. Whiteaves, "whether the Laramie formation of Canada should be regarded as forming the summit of the Cretaceous or the base of the Tertiary system, though, at present, the consensus of opinion among geologists would seem to favour the former view. In mapping the northern part of the district of Alberta, Mr. Tyrrell found that the Laramie there is divided into two series, and has expressed the opinion that its upper portion, which he proposes to call the Pascapoo series, is of Eocene age, and that its lower portion, which he calls the Edmonton series, and which is equivalent to Dr. Dawson's 'St. Mary River series,' of Southern Alberta, is Cretaceous. This division is based mainly upon palæontological evidence, and more especially upon the circumstance that the Edmonton series is now known to contain numerous remains of Dinosaurs (*Lælaps*, etc.), and that it is the highest horizon in Canada at which Dinosaurs are known to occur." The divisions adopted for the rocks of Manitoba and the North-West Territories are: (1) The Laramie, in whole or in part; (2) The Pierre-Fox Hills or Montana formation; (3) The Belly River series; (4) The Niobrara-Benton, or Colorado formation; (5) The Dakota. It was found that in this region it was no longer practicable to separate the Fox Hills group from the Fort Pierre group, nor the Niobrara from the Benton.

*The Rocky Mountain Region (inclusive of the Foot Hills).*—In this region the Cretaceous rocks occupy the bases of narrow troughs in the Palæozoic rocks. The fossils consist of the remains of plants or of marine invertebrata. By means of the plants Sir J. W. Dawson recognized three horizons in this region, viz. (1) The Mill Creek series; (2) The Intermediate series; (3) The Kootanie series. The following estuarine or purely marine divisions of the distorted Cretaceous rocks of this region have been recognized: (1) The Laramie; (2) The Pierre-Fox Hills, or Montana formation; (3) The Niobrara-Benton, or Colorado formation; (4) The Devil's Lake Deposit.

*British Columbia and the Islands off the Pacific Coast.*—The Cretaceous rocks of this region are taken in the following order: (1) The Nanaimo group of Vancouver and the adjacent islands; (2) The

Queen Charlotte Island series; (3) The Cretaceous at other localities in the province. It is judged from palæontological evidence that the lower and middle, or most fossiliferous, subdivisions of the Nanaimo group are referable to the Upper or Later rather than to the Lower or Earlier North American Cretaceous. The Queen Charlotte Island Cretaceous has been thoroughly investigated, first by Mr. James Richardson, and later by Dr. G. M. Dawson. Numerous fossils have been collected by both these explorers, and they have been described by Mr. Whiteaves in his "Mesozoic Fossils," published by the Geological Survey of Canada. Cretaceous rocks occur also at Tatlayoco Lake, Jackass Mountain, Sigutlat Lake, and the Iltasyouco River, all on the mainland.

*The Yukon District.*—This district, though included in the North-West Territories, is geologically more nearly related to British Columbia, and it is therefore considered here. Fossil plant remains (reported upon by Sir William Dawson) were found by the members of Dr. G. M. Dawson's exploring expedition of 1887-1888 (Geol. Surv. Canada, 1889). Some new species of marine invertebrates were also obtained by Dr. Dawson at Rink Rapids, viz. *Discina pileolus* (afterwards changed to *D. Dawsoni*), *Cyprina Yukonensis*, *Schlenbachia borealis*, and *Estheria bellula* (Contributions to Canadian Palæontology). Finally, in 1888, Mr. R. G. McConnell discovered rocks holding *Scaphites*, resembling one of the Benton species, on the Porcupine River, fourteen miles below the mouth of the Bell River, and further down the Porcupine he found sandstones full of one of the varieties of *Aucella Mosquensis*.

No less than 108 species of fossil plants have been recorded or described, up to the present time, from the Canadian Cretaceous, exclusive of the Laramie, or 179 species including the Laramie; and 358 species of animal remains from the undoubted Cretaceous rocks of the Dominion are now known, or 394 if the Laramie be included. Mr. Whiteaves concludes his Address by saying that "a comparatively small portion of the Cretaceous rocks of Canada has been examined in any detail, and more or less isolated areas of these rocks are known to exist in parts of the Canadian North-West, about which scarcely any other information has been obtained. Still, the facts, as summarized in this Address, are sufficient to show that substantial additions to our knowledge of the geographical distribution, of the economic products, and of the fossil flora and fauna of the Cretaceous rocks of Canada, have been made within the quarter of a century that has elapsed since the confederation of the Provinces."

2. In the second paper before us an account is given of the discovery of two very large *Unio-like* shells, for which the author proposes the new generic name *Asthenodonta* (*ἀσθενής*, weak, in the sense of feebly developed; and *ὄδους*, a tooth). In passing in review the literature of the subject of the ancient representatives of *Unio*, *Margaritana* and *Anodonta*, it is remarked that fresh-water shells belonging to these genera have not yet been satisfactorily recognized in rocks older than the Trias. In justification of the rejection of

these names for fossil genera, Mr. Whiteaves quotes the late Dr. S. P. Woodward (Manual of the Mollusca, p. 414) that the molluscan genera of the older rocks "are believed to be nearly all extinct, for although the names of many recent forms appear in the catalogues of Palæozoic fossils, it must be understood that they are only employed in default of more exact information." Thus the *Anodonta Jukesii* of Forbes, from the Upper Old Red Sandstone of Ireland, is the type of the recently proposed genus *Archanolodonta*; and, similarly, the species described as *Unio* by Sowerby, Phillips and others, from the Coal-measures of Great Britain, are now referred to *Anthracosia* or *Anthracomya*. "But although there is at present no satisfactory evidence of the existence of any of the recent genera of Unionidæ in rocks of Palæozoic age, the family seems to have been then represented by extinct genera, such as *Amnigenia* (and possibly *Archanolodonta* in the Devonian), by *Naiadites* or *Anthracomya* in the Carboniferous, and by *Palæomutela* and *Palæopleidon* in the Permian." The specimens of *Asthenodonta Westoni* (the subject of the paper) were found associated with large fragments of *Sigillaria* and *Lepidodendron*, leaves of *Cordaites*, and a piece of the lower jaw of a reptile. The stratigraphical position of the sandstones in which the remains occurred is believed to be between Coal Groups 31 and 32 of Sir J. W. Dawson's South Joggins section, as described in the Accadian Geology. The external contour of *Asthenodonta Westoni* is not unlike that of large specimens of the freshwater pearl mussel (*Margaritana margaritifera*, Linn.), but the beaks are more nearly terminal and the posterior termination of the valves more pointed below. The test is very thick, and shows nacreous structure under the microscope. There are no traces of lateral teeth in either valve, and the hinge dentition as a whole, so far as it can be ascertained, is in some respects comparable with that of *Anthracosia*. Until, however, the hinge dentition of both of its valves is more perfectly known, the exact systematic position of *Asthenodonta* will be uncertain; but it is considered by its describer to represent an aberrant and extinct type of Unionidæ. The length of the most perfect specimen collected was 200 mm.; height in the centre 90 mm.; maximum breadth or thickness of the two closed valves, about 42 mm.; thickness of the anterior end of the test of one valve, 9 mm. ARTHUR H. FOORD.

IV.—THE PROTOCONCH OF *ORTHOCERAS*. By J. M. CLARKE. (The American Geologist, Vol. XII. August, 1893, pp. 112–115.)

THE fortunate discovery of a perfect specimen of the extreme apex of an *Orthoceras* has enabled Mr. J. M. Clarke to supply information, hitherto wanting, as to the nature of the protoconch or initial chamber of that genus. Specimens showing the penultimate chamber, with external cicatrix, have long been known, both from the Carboniferous limestone of Belgium and from the Triassic beds of St. Cassian. De Koninck has figured the Belgian examples (Ann. Mus. Roy. d'Hist. Nat. Belg.), Hyatt those of St. Cassian