DISCUSSIONS.

OZARKIAN AND CANADIAN BRACHIOPODS.

For many years we have been waiting for Ulrich to place in final form his detailed knowledge of the Ozarkian and Canadian brachiopods of North America, and now we rejoice with him and his associate, G. Arthur Cooper, to see this information appearing in the printed record, and in the best possible dress.[1] We have long needed these results in our genetic studies of this class of invertebrates, because it is in the late Cambrian and early Ordovician that the articulate brachiopods begin actively to evolve into suborders, superfamilies, and families. As is well known, the Lower and Middle Cambrian are characterized by the orders Atremata and Neotremata, and now we learn that the Upper Cambrian is marked by the first decided evolution of the suborder Orthoidea, while the Canadian has the beginnings of the Strophomenoidea and outbursts of the Clitambonoidea and especially of the Syntrophioidea. We congratulate the authors, and the Geological Society of America as well, on the publication of this epochal memoir, the joint work of the stratigrapher who has the widest knowledge of the rocks containing the fossils described, and of the most discerning brachiopod morphologist of our time.

This classic describes 4 suborders, 8 superfamilies, 27 families, 70 genera, and 345 named species. This vast amount of material was "taken from rocks equal to more than 11,000 feet of limestone" (p. 5). Ulrich is wholly responsible "for all age and formation assignments," while Cooper "assumes major responsibility for the family and subordinal arrangements of the genera."

Part I presents the general and morphologic discussion (pp. 1-22), Part II gives in tabular form the formations and the range of the genera and species (pp. 23-45), with a handy correlation table of the formations of the eastern half of the United States and Canada (Pl. 58), and Part III has the systematic descriptions (pp. 47-323).

Even though the authors have looked deeply into the morphology of the inarticulate brachiopods of the Cambrian and Canadian formations, and here list or describe 65 species of Atremata and 28

[1] Ulrich, E. O., and Cooper, G. Arthur: Ozarkian and Canadian Brachiopods. Geol. Soc. America, Special Papers, No. 13, 1938.

of Neotremata, yet they say that there is not much possibility of revising these forms generically. This is partly on account of the usual inadequate preservation, but more especially because the interior shell characters are so simple or so faintly impressed on the valves. They conclude that the material for a revision of the early inarticulate brachiopods is not yet at hand.

In the classification of the articulate brachiopods it is well known that the presence or absence of a deltidium and a chilidium plays a great rôle. Nevertheless, among the ancestral Orthoidea of the late Cambrian, Ozarkian, and Canadian these covers are found only in five groups of genera: (1) the Billingsellidae, (2) aberrant orthoids, (3) pro-strophomenids (developed out of the Orthidae, "perhaps by way of *Hesperonomia*"), (4) Clitambonacea, and (5) *Leptella-Leptellina* (p. 12).

In discussing parallel development, the authors say that "Among the Ozarkian and Canadian brachiopods homoeomorphy is one of the most troublesome factors in the determination of genera. It makes the preparation of internal characters absolutely necessary for all species and all lots of shells." Further, that homoeomorphy makes for "a notable rise in the number of brachiopod genera" (pp. 7-8). Because of this fact the old genera *Syntrophia, Syntrophina,* and *Clarkella* have grown in the present work into the new suborder Syntrophioidea with 5 new families and 15 genera.

In this connection it should be said that many of the most important results of the book are due to the skilful preparation of the material, and the plates illustrating brachiopod interiors show that a great deal of time must have gone into the removal of the adhering rock by tooling and by chemical means.

The Ozarkian and Canadian articulate brachiopods show the first marked differentiation into the suborders Orthoidea (20 genera with 112 named species), Clitambonoidea (3 and 27), Strophomenoidea (8 and 13), and Syntrophioidea (8 and 89). The genus *Syntrophia* "is the possible ancestor of the camerellids . . . and possibly the rhynchonellids" (p. 21).

The authors emphasize that even among these early brachiopods there is some specialization. "The failure to realize that even primitive stocks have the ability to become specialized is one of the factors that has retarded the study of evolution" and classification (p. 9).

In the Upper Cambrian, articulate brachiopods begin to be common, and yet *Eoorthis* and *Billingsella* do not continue into Ozarkian time; the same appears to be true of *Orusia* and *Palaeostrophia.* Among orthoid shells, *Finkelnburgia* has the greatest number of species and the longest time range, beginning with 2 forms in the Upper Cambrian, deploying into greatest variation in the

Ozarkian with 13 species, and attaining largest size and final representation in the Canadian, with 7 forms.

The Upper Canadian has a great development of the Clitambonoidea in the family Tritoechiidae; *Tritoechia* begins in the late Ozarkian with 2 species, and has 12 in the late Canadian; *Pomatotrema* and *Polytoechia* of the late Canadian have 7 and 5 forms, respectively.

As said above, the genera described by Ulrich and Cooper number 70, and of these one does not occur in North America; of 22 genera neither the geological range nor the genus is firmly established, and 5 are restricted to the Upper Cambrian as Ulrich defines it (*Billingsella, Eoorthis, Huenella, Orusia,* and *Finkelnburgia*). This leaves 42 other genera in the Ozarkian and Canadian of which the genus and age relations are established for stratigraphical discussion. Of these 42 genera, 5 are inherited from the Upper Cambrian (3 die out with the Ozarkian—*Apheoorthis, Lingulepis, Mesonomia*—and 2 continue into the Canadian—*Archaeorthis* and *Finkelnburgia*). These genera show a curious stratigraphic localization, namely, that the great bulk of the well ascertained articulate brachiopods occur in the late Ozarkian (17 genera with 70 species) and in the late Canadian (at least 23 genera, with 95 species).

A significant omission is the lack of any discussion in Part II to show that the brachiopods prove the existence of two periods of time between the Cambrian and the Ordovician. On the basis of brachiopods, a good case can be made out for a Canadian system, but that the Ozarkian formations as given on Plate 58 represent a natural system is not proved by these fossils.

Of brachiopod genera in the Ozarkian there are, all told, 23. Of these, 10 have no stratigraphic value and can be eliminated from further discussion: *Acrotreta, Conodiscus* (occurs only in West), *Elkania, Lingulella, Lingulepis, Linnarssonella, Obolus, Punctolira* (only in West), *Schizambon,* and *Westonia.* It is not known that *Palaeostrophia,* of wide distribution in the Upper Cambrian, surely passes into the Ozarkian. This leaves 12 genera in the Ozarkian of *eastern* North America, with 40 species (9 in the Lower, none in the Middle, and 31 in the Upper Ozarkian); those of the western Cordilleran region are not surely known stratigraphically. Of these 12 genera which are most useful in chronology, 4 have come up from the Upper Cambrian, 7 pass up into the Canadian, and 3 widely distributed genera are restricted to the Ozarkian. Accordingly, it does not seem to the reviewer that the brachiopods give strong support to Ulrich's opinion that the Ozarkian is a period of time between the Upper Cambrian (= Croixian) and the Canadian periods. For more detail, see the following table.

In the Canadian, there are at least 31 genera and 8 of these have come up from older formations, leaving 23 genera restricted to this system.

Table of Ozarkian Genera and Named Species in Eastern North America.

C = Cambrian, Cn = Canadian, * = restricted, WD = wide distribution		Low.	Mid.	Up.	
C	Apheoorthis	2	0	2	4 in Up. C, WD
C, Cn	Archaeorthis	4	1	3	2 in Up. C, 4 in Cn in Nevada
*	Clarkella	5	0	5	WD
C	Diaphelasma	2	0	2	2 WD
C, Cn	Finkelnburgia	8	3	5	2 in Up. C, 6 in Cn, WD
*	Glyptotrophia	1	0	1	WD
C	Mesonomia	1	1	0	4 in Up. C., WD
Cn	Nanorthis	1	0	1	WD
Cn	Syntrophia	1	0	1	2 in Cn
*	Syntrophina	7	1	6	WD
Cn	Tetralobula	6	3	3	1 in Cn
Cn	Tritoechia	2	0	2	7 in Cn
		40	9	31	

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KARAKORUM GLACIOLOGY.

Wissentschaftliche Ergebnisse der Niederländischen Expeditionen in den Karakorum und die Angrenzenden Gebiete in den Jahren 1922, 1925, 1929/30 und 1935: Band II, Glaziologie; by Ph. C. Visser, pp. 216, 98 figs., 3 tables, 3 maps. Leiden 1938 (E. J. Brill).

INTRODUCTION.

During four expeditions to the Karakorum, Doctor Visser has made several important glaciological observations. Some of them have already appeared in other publications, but in the present report they are all gathered together and presented as a whole. Probably not all geologists will agree with some of Doctor Visser's views, but their interest and the little-known character of the region upon which they are based seem to warrant a rather lengthy review of Doctor Visser's work.