NEW PALEONTOLOGIC EVIDENCE ON THE AGE OF THE METAMORPHIC SERIES OF NORTHEASTERN WASHINGTON

THE three northeastern counties of the state of Washington—Ferry, Stevens and Pend Oreille—are covered in the main by outcrops of metamorphosed sedimentary rocks. The outcrops are in isolated fault block hills, and stratigraphic relationships are obscure. Weaver, in his report on the mineral resources of Stevens County,[1] divides the sediments into twenty-one formations, all included in the Stevens series. This is a thick series of alternating argillites and quartzites with lenticular beds of limestone. Weaver states that "the several divisions or stratigraphic members which have been grouped under the Stevens series are entirely nonfossiliferous."[2] On the basis of possible lateral continuity with the Pend Oreille series of British Columbia he states that the upper members of the Stevens series are of the same age, possibly upper Paleozoic, and that the lower members of the Stevens series may represent the lower and middle Paleozoic.

Very little has been added since to this statement of age. Previously, Shedd had stated that the only locality in the limestones of eastern Washington where he knew of fossils being found was in the undifferentiated limestones north and east of Springdale.[3] The fossils appeared to be corals. Some crinoid stem segments have been found near Republic, Ferry County. From the coral and crinoid remains and from the apparent relationships of the Stevens series with beds in British Columbia, the age of the Stevens series has been given as Carboniferous, at least in part.

Dr. Culver and Dr. Jones, of the State College of Washington, have brought in some additional fossils from the Stevens series, and these give definite evidence of the age of the deposits. One collection was blasted from the undifferentiated limestone six miles north of Chewelah, Stevens County. The limestone is reddish in color, dense, sandy, and bears thin lenses of impure argillite. Specimens of *Kutorgina cingulata* (Billings) are abundant and a few fragments of free cheeks of trilobites occur. *K. cingulata* is confined to the Lower Cambrian in its numerous occurrences, so it is certain that this portion of the Stevens series is Lower Cambrian in age.

The Mission argillite occurs two miles east of Daisy, Stevens County. Two specimens of a pelecypod were found there. These appear to belong to the genus *Paleoneilo*, which is most common in Devonian rocks, but which ranges to Triassic. Some graptolites of the *Monograptus* type were found in the Mission argillite north of Colville, Stevens County. *Monograptus* is confined to Silurian and Devonian rocks, and this occurrence, together with the occurrence of *Paleoneilo*, indicates Devonian age of the Mission argillite. A coral from the undifferentiated limestone north of Colville appears to be a *Favosites*. Some *Fusulina*-like foraminifera were found in the same area.

It seems quite possible that the metamorphic series of northeastern Washington represents most of the Paleozoic periods, and that careful search in the area will disclose definitive fossils in most of the members of the Stevens series.

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[1] C. E. Weaver, Washington Geol. Surv., *Bull.* No. 20, 1920.

[2] *Idem*, p. 52.

[3] Solon Shedd, Washington Geol. Surv., *Bull.* No. 4, p. 123, 1914.

THE BASAL-METABOLIC RATES OF VEGETARIANS

THE work of Benedict and Roth[1] published in 1913 indicated that there is little, if any, difference between the basal-metabolic rates of vegetarians and non-vegetarians.

Consistent sub-normal results for the basal-metabolic rates of long-time vegetarians led the writers of this paper to present the following data:

The group chosen for intensive study consisted of girls—nurses in training at a vegetarian sanitarium—between the ages of eighteen and twenty-five, and living under uniform conditions of diet, work and general environment. No subjects who were more than 10 per cent. over or under weight, or who showed symptoms of poor health or other abnormality, were included in the group. The determinations were all made with the same apparatus and at the same time of day, before the girls left their beds in the morning. The Du Bois standards of normality were used as the basis of comparison.

Five girls were classed as life-long vegetarians, having never eaten meat of any kind in their lives. Their average basal-metabolic rate was 14 per cent. below the normal of Du Bois. Ten girls were classed as long-time vegetarians, having been non-meat-eaters for five years or more. Their average basal-metabolic rate was 12 per cent. below normal.

As a check on this work, the basal-metabolic rates of twenty-six non-vegetarian girls were determined, with the same apparatus and under conditions as nearly parallel as possible. Their average basal-metabolic rate was 4 per cent. below normal.

Comparison of these results with the basal-metabolic rates of short-time vegetarians seems to show that

[1] *Jour. Biol. Chem.*, 20: 231, 1913.

a long period of vegetarianism is necessary if the rate is to be noticeably reduced.

A fuller account of this work will appear elsewhere.

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REACTION OF THE CONTENTS OF TRICHINELLA SPIRALIS CYSTS

THE late Dr. Allen J. Smith, former professor of pathology in the University of Pennsylvania, added crushed *Trichinella spiralis* (Owen) cysts from a human muscle to ordinary agar medium tinted blue with litmus indicator. The cysts were found in a portion of the pectoral muscles of a badly infested human cadaver (U. of P. Path. Mus. 37) in the dissecting room. There resulted a pink color indicating an acid reaction. He suggested to the writer, in 1925, to carry on this unpublished work and endeavor to determine the reaction of the contents of such cysts in rats.

Feeding rats with trichinosed meat, secured through the late Dr. B. H. Ransom, of the Bureau of Animal Industry, Washington, heavy infestation was secured in one month. It was deemed advisable to allow three months to pass before beginning work on them. Numerous cysts were found after lapse of that period, the regions of highest infestation being the diaphragm and intercostal muscles. The nematode larvae were found singly in the cysts, which measured 0.33 x 0.16 mm. The rats became fat and exhibited all the signs of general well-being.

Upon ordinary agar medium, having phenolphthalein indicator over the surface, were placed twelve capsules. They were then crushed between two needle scalpels and it was observed that the indicator turned pink—showing the presence of an alkali. This was repeated with the same result.

To the contents of other cysts crushed on agar Rosolic acid indicator was added. This resulted in a pink color, after a half-day well protected from the air. This acid indicator has a pH range of 6.9–8.

A series of Clark and Lub's sulfonphthalein dibasic acids were employed as a comparator set to determine the pH. This resulted in failure. The indicators are too delicate to enable one to note color changes under the microscope. Crushed cysts on a white china dissecting plate and on plaster of Paris impregnated with phenolphthalein indicator gave a pink color in four out of fourteen. Allowing cysts to dry, crushing them, and then adding indicator, resulted in no change.

It is evident that in order to determine the contents of *Trichinella spiralis* cysts it is not feasible to use the colorimetric method. Dr. Smith noted an acid reaction. However, these results seem to point to the presence of an alkalin substance. To check this one would need to determine if the contents would form a definite crystal that has a polarizing color reaction distinctive for some base. Some investigator with apparatus available could employ Barber's pipettes on a micro-dissecting apparatus to draw out the fluid to test. Or, better to employ an electrometric potentiometer with glass needle electrodes as has been done in entering single cells. Electrometrically one can show the exact pH, one characteristic, and a step further in determining the contents of Trichinella cysts. Its importance lies in the fact that it is not known what enables larvae to remain viable in this infective stage up to twelve years.

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SEX IN THE LOUISIANA OYSTER, OSTREA VIRGINICA

As far as the writer is aware, it has been stated by every worker in the field that the Eastern American oyster, *Ostrea virginica* Gmelin, is a dioecious species. The oyster of the Gulf Coast is considered to be identical with the Atlantic Coast form. A study of sex in the common oyster of the Louisiana coast made during 1929 and 1930 indicates, however, that although the sexes of this animal are usually morphologically separate, the oyster is regularly a protandrous hermaphrodite.

Approximately 1,000 individuals were carefully examined during the spawning season with reference to sex, size and position in relation to other oysters. Smears of the gonad of each, stained with eosin and iodine, were used in determining sex. Oysters whose gonads were destroyed by bucephalus or which contained no typical ripe sexual products were discarded, together with other oysters growing in the same cluster.

The sexes were found to be present in almost equal numbers, 371 ♂ to 373 ♀. When the ratio of the sexes was examined in relation to size, however, a striking fluctuation appeared. Of oysters 40 mm or less in body length, there were 220 ♂ to 58 ♀, while of oysters over 40 mm in length there were 151 ♂ to 315 ♀. As an even clearer illustration of this reversal, of oysters 20 mm or less in length, there were 50 ♂ to 5 ♀, while of oysters over 80 mm in length there were 7 ♂ to 48 ♀. These figures would seem to the writer to indicate that individuals of *O. virginica* first become sexually mature as males, and that with increase in size there may be a change of sex to female. This sex-metamorphosis would seem usually to occur at a body length of about 40 mm.

Further data, as given below, indicate that under certain conditions this sex-metamorphosis does not occur, and incidentally show that we are not here