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E. B. BRANSON

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Three Plates

STRATIGRAPHY

The Ohio shales in the vicinity of Oberlin, Ohio, are about 610 feet thick and are quite uniform in color and texture from top to bottom. Within the area discussed in this paper, which extends from east of Elyria to west of Norwalk, the shales are brown to black, with occassional greenish layers, and in a few places one or two layers of fine grained sandstone one to six inches in thickness are present. In well records the designations "blue shale," "black shale" and "brown shale" are frequently used but without consistency and in the field it is impossible to distinguish different formations by colors. The thickness of the shales is determined from well records. More than fifty wells that pass through them to the Delaware limestone have been drilled in the vicinity of Oberlin. Unfortunately the data for most of the wells were not kept and the depth, which gives roughly the thickness, is the only thing known. Detailed data for only five wells are known to the writer.

The argillaceous and arenaceous shales and calcareous layers that distinguish the Chagrin formation farther east are absent here excepting as mentioned above. They cannot be considered as marking a formation at any place. Near Birmingham where Newberry mentions the presence of the Erie the only distinguishing feature is a thin bed of greenish shale.

Conditions of sedimentation were almost uniform while the Ohio shales were being deposited west of Norwalk, but east of this place the Chagrin enters as a wedge with the thin edge to the west. Its calcareous and arenaceous nature indicates shore conditions to the east.

The Olentangy shale varies in the well data from 110 feet to 147 feet in thickness. The Prout limestone member is absent in the vicinity of Oberlin but is present just west of Huron.

In the upper two or three hundred feet of the shales cone in cone concretions are abundant and in the lower hundred feet large concretions made up, for the most part, of the shale itself are common. The fish remains from the lower shales usually come from the concretions and those from the upper shales frequently do. Invertebrate fossils rarely occur in concretions except at the contact of the Ohio shales with the overlying Bedford where the concretions are of clay ironstone.

FOSSIL HORIZONS

The writer has collected fossils from twelve horizons in the Ohio shales and they probably occur at many other levels. The lowest horizon is at the contact of the shales with the Prout limestone and most of the fossils are in the limestone. Collections have been made from only one locality, about two miles west of Huron, Ohio, along the Lake Shore tracks. Several species of typical Olentangy invertebrates, two or three species of dinichthyids, an *Aspidichthys* plate, and teeth of two species of shark came from this place. The rock is highly pyritized and the fossils come out with great difficulty.

The dinichthyids are the oldest from Ohio except *D. precursor* from the Corniferous. The remains consist of part of a small dorsal plate, fragments of plates and fin rays, and the mandible described in this paper as *Dinichthys subgracilis*. All of the remains had been washed about by the waves before fossilisation and are more or less worn.

About twenty feet from the bottom there is a thin bed of shale that contains numerous specimens of *Lingula spatulatus*.

The bed is two or three feet thick and the fossils have been found in only one locality, about one mile west of Huron, Ohio, No other fossils have been found at this horizon.

About fifty feet from the bottom of the shales there is a bed that has yielded fish remains from one locality. They consist of many *Rhadinichthys* scales and teeth, several small plates, probably belonging to *Rhadinichthys* or *Stenosteus*, and two mandibles of a species named here *Stenosteus pertenuis*.

Fifty or sixty feet from the bottom, along the shore of Lake Erie, about two miles west of Huron, Ohio, Mr. H. E. Wilson found remains that probably belong to a new species of *Rhadinichthys*. The parts found consist of a large number of articulated scales, two mandibles, two maxillæ, one fin and a number of head plates. From the published descriptions of species of this genus it is impossible to determine whether or not this form belongs with described species.

From the bottom of the shales to at least one hundred feet from the bottom there are large concretions, in some places in great abundance, and the nucleus of perhaps one in every hundred of these is a dinichthyid bone. The first time that the writer worked along the Huron River he found four or five fossiliferous concretions in five hours. About the same results have been obtained by working along the river once a year. Seven or eight species have been found but the remains are too incomplete to justify descriptions of new species. *Dinichthys hertzeri* and *Dinichthys intermedius* are the only described species that have been recognized.

The next horizon from which the writer has collected is about 150 feet below the contact of the Ohio shales and the Bedford shale. The remains are dinichthyid plates that have not been specifically determined. Above this, fish remains may be expected at any horizon. Near the top occurs a species of *Rhadinichthys* distinct from those lower. It is represented in the Oberlin collections by scales only.

Seventy-five feet from the Ohio-Bedford contact a thin layer of green shale has yielded two specimens of an undescribed

species of cephalopod. One specimen was complete but it was pyritized and was found to be entirely ruined within six months of the time that it was collected.

About sixty-five feet below the Bedford large specimens of *Lingula spatulatus* occur in abundance. They often reach a length of 19 mm., while those from near the bottom of the Ohio shales are rarely more than 9 mm. long. Though this species is so abundant, no remains of other species have been noted in the same beds.

Invertebrate fossils are most abundant in the upper four feet of the shales. Twenty-five or thirty species occur here, mostly of brachiopods, pelecypods, and gastropods. This horizon is fossiliferous in every locality where the writer has observed it and the only invertebrates from below are lingulas and one cephalopod.

A fact of some significance is that the remains preserved in the Ohio shales to within a few feet of the top are of animals whose hard parts were originally phosphatic. Fishes and the brachiopod *Lingula* make up nearly all of the fossils, but it seems improbable that they constituted the only life of the sea of the area where the Ohio shales occur. In the Romney shales of northern Virginia phosphatic shells are almost the only ones preserved. The explanation seems to be that the carbonate shells were redissolved and the phosphatic remains fossilized, rather than the usual supposition that the other forms were absent from the seas. A rather superficial examination of literature on the chemistry of the process has failed to show that conditions likely to have existed at that time were peculiarily favorable for the solution of carbonates and not of phosphates, but the investigations were not applied to a problem of this kind and are not conclusive.

CORRELATION

The question of the correlation of the Ohio shales has long been a mooted one and little or no light has appeared on the subject in the last decade. In 1897 Williams* included the upper part of the black shales at Irvine, Kentucky, under the Mississippian and in 1909 Morse and Foerste† correlated the lower part of these with the Ohio shales and the upper part with the Bedford, Berea and Sunbury. In some recent articles all of the Ohio shales are referred to the Mississippian.

The species listed below are from within five feet of the top of the shales.

**Spirifer audaculus* Conrad, **Camarotoechia sappho* Hall, *Chonetes* two sp. undet., *Lingula* cf. *ligea*, *Coleolus* cf. *gracilis*, *Loxonema* cf. *delphicola*, *Euomphalus*, *Pleurotomaria*, *Nucula* cf. *corbuliformis*, *Palaeoneilo constricta*, *Leda* cf. *diversa*, *Cypricardinia* sp. undet., *Macrodon hamiltonæ*, *Orthoceras* cf. *sicinus*, *Goniatites* two species undet., **Palaeosolen* two species undet., *Spathiocarais* (Identifications by Dr. R. S. Bassler excepting those marked *).

There are no Mississippian elements in the faunas as far as they have been investigated and this fauna from the very top is characteristically Devonian. As this region had free communication with the east and probably with the west in early Mississippian time the faunas would have had a strong Mississippian element if they had been of that age.

The Hamilton age of the Olentangy shales seems to be established, and as the top of the Ohio shales bears a distinctly Devonian fauna, and as fish remains that are found no place outside of the Devonian are pre erved throughout their thickness, it seems that the shales must be classed as Devonian and younger than the Hamilton. That the overlying Bedford shales are Devonian cannot be so positively affirmed. As there is no break in sedimentation from Ohio to Bedford and evidence

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*Amer. Jour. Sci., Ser. 4, III, 398.

†Jour. Geol., XVII, 176.

from the fossils is negative, there seems to be no good reason for placing the dividing line at this contact. In as far as stratigraphic relations are concerned, the line would be drawn more appropriately at the contact of the Bedford and overlying Berea. Newberry's reference of the Bedford to the Mississippian on the basis of fossils lacks corroborative evidence. Herrick failed to find the Mississippian forms and in five years collecting the writer has failed to find a fossil of any kind above the Bedford-Ohio contact. The faunas collected by Herrick are of Devonian aspect.

CONCLUSIONS

West of Elyria, Ohio, the Ohio shales do not show distinct three-fold division.

West of Elyria the Ohio shales have a distinctly Devonian fauna at the top and must be classed as Upper Devonian.

The Bedford shale has its closest relationship with the Devonian and should probably be classed as Devonian.

VERTEBRATE REMAINS

Stenosteus pertenuis, sp. nov. (Plate I, figs. 8, 10, 11)

Types—one almost perfect mandible and one fragmentary mandible. Mandible 65 mm. in length, 11 mm. wide near the posterior end, 6 mm. wide at the narrowest part which is near the anterior end, 8 mm. wide at the symphysis. The posterior part is a little more than one millimeter thick and the thickest part which is near the anterior end is not more than two millimeters. Denticles are crowded on the top for two centimeters beginning one centimeter back of the symphysis. Back of this they decrease in size, are irregular in distribution, and merge so gradually with the bone that it is difficult to determine where they disappear. They extend for at least two-fifths the length of the mandible. For one centimeter from the symphysis no denticles can be determined. Lines indicating the bony lamellæ

converge toward a point about one centimeter behind the symphysis and near the top of the mandible.

The mandible of this species differs from that of *Stenosteus glaber* Dean in the anterior end curving strongly upward, in the teeth decreasing in size posteriorly, and in the greater comparative width at the posterior end.

Formation and locality: Fifty feet from the bottom of the Ohio shales, one-eighth mile south of Monroeville, Ohio.

Number 1496, Geological Museum of Oberlin College.

Dinichthys subgracilis, sp. nov. (Plate II)

Type—an incomplete mandible. Portion anterior to the main cusp missing, posterior third missing. Impression of the posterior third preserved in the rock and reproduced in outline in the figure. Length of mandible about 35 cm., length behind cutting blade about 19 cm., width at posterior end of cutting blade 62 mm., greatest width posterior to cutting blade 65 mm., thickness immediately behind cutting blade 13 mm., gradually thinning to 9 mm. twelve centimeters behind the cutting blade. The cutting blade shows one tubercle just behind the main cusp. The posterior end of the mandible curves strongly upward for the last ten centimeters but maintains a nearly uniform width.

Comparing this mandible with one of *Dinichthys intermedius* of the same length the latter is found to be nearly twice as wide in the widest part behind the cutting blade, the cutting blade is one-half wider, and the entire mandible is much thicker and stronger. As the mandible has one minute tubercle on the cutting blade it may be ancestral to the stronger non-tuberculate forms of the upper part of the Ohio shales.

Formation and locality: Top of Olentangy shale, two miles west of Huron, Ohio.

Rhadinichthyids (Plate I, figs. 1-6)

At least three species of *Rhadinichthys* from the Ohio shales are in the Oberlin College collection. Two species, the scales of which are shown in figs. 3 and 5, are from the lower fifty feet, and one species occurs in the top five feet. Several hundred scales of the specimen shown in plate I, figs. 1-4, are preserved and they are all of the same type. This indicates that scales that are distinctly different represent different species. The remains shown in plate I seem to be complete enough for specific description but such description should await a study of the types.

Ostracoderm, gen. et sp. undet. (Plate I, fig. 14)

About fifty feet from the top of the Ohio shales on French Creek near Lorain, Ohio, the writer collected a p'ate which seems to be an antero-dorso-median of an ostracoderm. The impression of the plate in the rock is complete but parts of the bone have been lost. The bone is smooth on both sides and is thin and fragile. If a dorso-median may be considered diagnostic this belongs to an undescribed genus.

A Unique External Occipital (Plate I, fig. 9)

About four feet from the top of the Ohio shales a unique external occipital was collected. It is about 40 mm. by 25 mm. in size and at the outer edge has an emargination one centimeter deep. The socket into which the ball of the antero-dorso-lateral fits is rough and little used. The plate probably belongs to a young ind.vidual of an undescribed form.

Dinichthys Terrelli Newberry (Plate III)

The photograph of *Dinichthys terrelli* is of the specimen that furnished data for the writer's restoration of that species published in the Ohio Naturalist in 1908. The skull is flattened and the suborbital, clavicular, and dorso-laterals lie in the

same plane as the top of the skull. The left clavicular lies on the right side on top of the right clavicular which has lost its lower end. They are fitted together in such a way that the left occupies the exact position that the right would occupy if present. The photograph shows the correctness of the writer's statement in the Ohio Naturalist where he said: "Every bone is represented, though in some of the paired bones one of the pair may be missing and the one preserved not be perfect. The bones missing are the right mandible, the right postero-supero-gnathal, the left antero-supero-gnathal, and the left postero-lateral." The left antero-lateral is not shown in the photograph on account of its being greatly distorted. The left mandible is shown on the right side in order to compare it with the length of the skull. The antero-supero-gnathal was omitted from the composition.

The main fault with Dean's restoration* is the size and position of the clavicular. As shown in the photograph of the Oberlin College specimen the clavicular comes against the posterior part of the suborbital probably fitting against it, though the imperfection of the posterior edge of the latter prevents a positive determination of that point. The inner arm of the clavicular must have come inside the suborbital and prevented the mandible resting against it as shown by Dean. As compared with the Oberlin College specimen the clavicular figured by Dean is almost two diameters too large for the specimen that it accompanies. On that account the lower end of the bone is thrown too far back and its relationships to suborbital and supero-laterals are incorrectly shown. Such a restoration also makes the animal much thicker dorso-ventrally than it should be.

The Oberlin specimen shows a distinct overlap of the clavicular on the marginal of the skull and Dean's restoration shows no such overlap. In Dean's restoration the anterior part of the suborbital is not shown. In an earlier paper I called

*Mem. Amer. Mus. Nat. Hist., IX, Part V, Plate XXXVIII.

attention to this part never having been figured or described and accounted for its usually being lost in specimens because of the slime canal crossing the anterior end, as shown in the figure.

EXPLANATION OF PLATES

Plate I

Figs. 1-4, *Rhadinichthys* sp. nov.

Fig. 1, Maxilla showing sculpturing.

Fig. 2, Mandible showing sculpturing.

Fig. 3, Scale showing markings (15).

Fig. 4, Head plates showing sculpturing.

Fig. 5, Scale of *Rhadinichthys* sp. ? from near bottom of Ohio shales (15).

Fig. 6, Scale of *Rhadinichthys* sp. ? from three feet from the top of the Ohio shales (15).

Fig. 7, *Lingula spatulata* Vanuxem (2) from Huron shale.

Fig. 8, Mandible of *Stenosteus pertenuis* Dean.

Fig. 9, External occipital of *Dinichthys* sp. ?

Fig. 10, Section of mandible of *Stenosteus pertenuis* near proximal end.

Fig. 11, Section of mandible of *Stenosteus pertenuis* near distal end.

Fig. 12, Section of tooth of Elasmobranch from top of Olentangy shale.

Fig. 13, Anterior view of same tooth.

Fig. 14, Antero-dorso-median of an ostracoderm.

Plate II

Mandible of *Dinichthys subgracilis* sp. nov. (Holotype)

Plate III

Dinichthys terrelli Newberry. Photograph of almost complete specimen. Left mandible placed on right side to show its length compared with the length of the suborbital.


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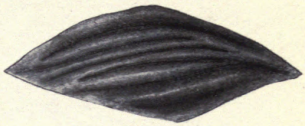
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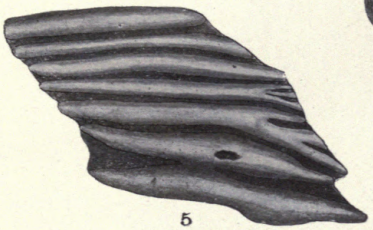
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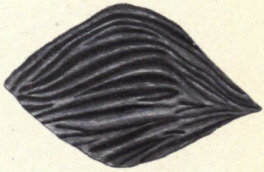
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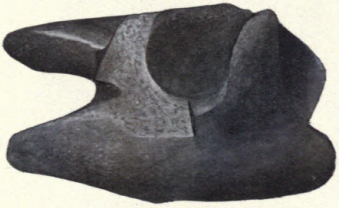
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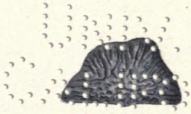
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