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AN EMBOLOMERE JAW FROM THE MID-CARBONIFEROUS OF NOVA SCOTIA

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It is not always realized that our knowledge of Carboniferous tetrapods is almost entirely confined to forms of relatively late age. Apart from a meager fauna from Scotland (cf. Watson 1929) and a single specimen from England, all described Carboniferous amphibians are of Westphalian or later date — i.e., from Middle to Upper Pennsylvanian strata (Romer 1947, p. 322). The jaw here figured is the first specimen to be described from any American pre-Westphalian formation.[1]

In 1956 the Museum of Comparative Zoology undertook a summer's exploration of the Carboniferous deposits of Nova Scotia in search of vertebrate fossils. Some excellent material of Westphalian amphibians was obtained, and will be described later. The present specimen is the only pre-Westphalian amphibian identified in our collections.

It was derived from the Point Edwards formation (Hyde 1913, p. 252), considered by Bell (1938; 1944, pp. 11–12, 16) to belong to the Canso group. It is definitely earlier than the Riversdale series, with a flora of Westphalian A type, and younger than the Windsor series of the Mississippian. It thus appears to be equivalent to some horizon in the Namurian of European nomenclature and is currently considered as late Mississippian (Weller *et al.* 1948, p. 173, chart 6).

Exposures of the Point Edwards formation occur only in limited areas adjacent to Sydney Harbor in Cape Breton. They are well shown in the series of maps illustrating the geology of

[1] I hope to describe at a later time remains from the Mississippian of West Virginia (cf. Romer 1941).

the Sydney Coalfield which were published by the Canadian Bureau of Geology and Topography in 1938. The best exposures are along the shores of Point Edward. A *Gyracanthus* spine was collected there many years ago. Our group in 1956 discovered a beach exposure containing dipnoan and other fish bones about one-half mile southwest of the point. The present specimen was found on the shore about 100 yards southeast of the tip of the point, on a detached slab of rock. An incomplete *Gyracanthus* spine and fragmentary fish remains were found nearby in the ledge from which the jaw slab was derived. On another loose slab was a crushed bone, about 50 mm. long and 29 mm. broad at one end, probably a *Sagenodus* quadrate. Intensive search of the area failed to produce further amphibian material.

The specimen consists of a slab of calciferous siltstone which, with its missing counterpart, had contained the greater part of the right lower jaw of a large labyrinthodont amphibian. Wave action had removed all the bone, leaving, however, an almost perfect mold of the outer surface, from which excellent casts have been made. The portion preserved extends from the symphysis to a diagonal line running down and forward from a point a short distance behind the termination of the tooth row; the greatest length as preserved, measured in a direct line, from the symphysis dorsally is 235 mm; the length of the tooth row is 191 mm. The shape of the jaw, as preserved, is that common to many early labyrinthodonts, particularly embolomeres; superposition of our fragment on an outline of such embolomeres as *Archeria* and *Pteroplax* suggests a total length of jaw — and hence, approximately, of skull — of about 365 mm. This indicates an animal of considerable size, this measurement being within 10–15 per cent of that of typical skulls of the familiar Permian labyrinthodont *Eryops*. If outlines of the jaws of such familiar embolomeres as *Pteroplax* and *Archeria* be superposed on that of our specimen by using as a common measurement the length of the tooth row, it will be found that the jaw ramus is intermediate in proportions between the long and slender *Archeria* jaw and the relatively deep and short ramus of *Pteroplax*. There are few non-embolomere jaws of Carboniferous age with which comparison can be made, and little reliance can be placed on proportions of the jaw ramus in attempts to determine

relationships. If, however, a series of representative jaws of labyrinthodonts be examined (cf., for example, Romer 1947, figs. 9, 10), it will be seen that in general there is little tendency for the development of an "ascending ramus" in the surangular region in temnospondyls, but some trend in this direction in seymouriamorphs, and in embolomeres a strong development of depth posteriorly, with a notable up-swing of the dorsal margin of the jaw posteriorly. This last trend is obvious in the specimen as preserved, and the edge of the jaw back of the end of the tooth row shows a thin broken margin, indicating that in life the jaw curved upward posteriorly still more strongly. This posterior depth strongly suggests that the jaw is that of an anthracosaurian (as I have used that term) and probably an embolomere. It is regrettable that the inner surface, where positive embolomere features are to be found is not available.

When the cast is viewed dorsally, it is seen that although the mold is slightly incomplete in the symphysial region, the jaw was not widely bowed outward as in such a broad-snouted type as *Eryops*, but turns sharply backward to run a straight course for almost the entire length of the portion preserved.

The surface has an ornamentation of pits anteriorly and extending back along dorsal and ventral margins; dorsally, the pits give way posteriorly to deeply incised striations. Between dorsal and ventral margins the surface shows a lighter series of antero-posterior striations. At the posterior end of the ventral margin there is part of a deep groove carrying the mandibular lateral-line canal; farther forward the mold does not extend quite to the ventromedial line of the ramus and hence the anterior prolongation of the canal is not visible on the cast.

The jaw was crushed before fossilization. As is frequently the case in labyrinthodont specimens (and well shown in an *Archeria* jaw before me at the moment), the outer surface was crushed downward (i.e. medially) in the area between the thickened dorsal part of the jaw carrying the tooth sockets and the stout ventral margin. Sutures are, for the most part, not apparent and since we are dealing with a mold only, further development is impossible. It seems certain that the uncrushed upper margin is entirely, or almost entirely, included in the dentary, and it may be that the longitudinal line of breakage below this

region is on or close to the suture between the dentary and the infra-dentary series. An area below this line of breakage, in which parallel striae extend forward and slightly downward, appears to be part of the surangular, which thus extends remarkably far forward (as in *Kotlassia*). Below this region, posteriorly, is one in which the striae extend diagonally anterodorsally; this seems surely part of the angular. The rugose ventral margin was surely occupied by postsplenial and splenial. The pertinence of the wedge-shaped anterior part of the finely striated area is uncertain.

A symphysial tooth pair is present, with both members developed and striated in labyrinthodont fashion. Much of the lateral tooth row is preserved. The most anterior teeth seen on the cast, lying close to the symphysis, appear to be somewhat crowded and irregularly placed. These are conical teeth of modest size, striated basally and slightly recurved at the tips. One complete tooth extends 8 mm. above the jaw margins; an adjacent incomplete tooth appears to have been several millimeters higher. For 5 cm. back of this region the teeth are broken off, but the alveolar surface of the dentary bone is preserved. Here there is seen a typical labyrinthodont arrangement of alternate teeth (broken) and empty alveoli; the interval between successive elements of the row is about 4 mm. The tooth bases suggest that the teeth are comparable in size to those seen at the anterior end, without the development of any large "fangs." For the next 10 cm. the mold does not extend inward beyond the outer rim of the dentary, so that the alveolar region is not visible and there are impressions of only 5 teeth in all, some of them obviously loose from their sockets. The most anterior of these teeth appears to be comparable to those seen near the symphysis; the others give the impression of greater slenderness, although this may be due to incompleteness of the mold. For the last 3 cm. of the series the alveolar surface is again visible, and 5 of the 6 most posterior teeth are present, although none is complete. Naturally these are smaller than the more anterior teeth, and the interval between successive elements is reduced to about 3 mm. There is little indication that the teeth were markedly recurved or had the chisel-like tips seen in *Archeria*. Calculation suggests that the total marginal row consisted of about 50 teeth, which were rather closely spaced and of modest size.

What are the relationships of this specimen? There are no described American pre-Westphalian amphibians with which comparison can be made. It was at one time believed that the older tetrapod faunas of Europe and North America were as radically distinct as are the reptile and amphibian faunas today, and that trans-Atlantic comparisons were invalid. However, such recent work as my study of the Kounova fauna (1945) and Baird's current (unpublished) studies of the Linton fauna indicate that eastern North America and western Europe were extremely similar in faunas in the Carboniferous, and that the supposed contrasts in genera present in the two areas are due in great measure to false assumptions as to faunal contrasts and lack of comparison of American and European materials.

But even so, the number of pre-Westphalian specimens from Europe, with which this jaw can be legitimately compared, are few (Watson 1929). There are several loxommids from the late Mississippian and early Pennsylvanian of Scotland, but this jaw is quite different from that of known loxommids, in which the jaw is shallow posteriorly, and in which the dentition consists of a smaller number of much more robust teeth. The straight ramus of the jaw indicates an animal with a more or less pointed snout (although the skull may have broadened posteriorly, with a triangular shape). This appears to eliminate from consideration *Otocratia* and *Palaeogyrinus* and perhaps *Crassigyrinus*. The massive upper teeth of *Anthracosaurus* (in the proper sense) make it improbable that our jaw is pertinent. Two Scottish forms remain — *Pholidogaster* from the Mississippian (Gilmerton Ironstone), and a skull attributed by Watson to *Pholiderpeton* from the Lanarkian of Airdrie. Both have a pointed snout and, appropriately, a marginal dentition including a long series of small teeth. Of *Pholidogaster*, the type skeleton (Huxley 1862; Watson 1929, pp. 230–233, figs. 7–9) is that of an animal much smaller than the present one; a skull from the same beds as the type, and which may be a specimen of the same form, is of somewhat larger size, with a length, measured to the quadrate of about 156 mm. The lower jaws are present of the type specimen; they do not appear to show the increasing depth posteriorly which is characteristic of this jaw, as of embolomeres (which *Pholidogaster* is not). Of *Pholiderpeton*, the

type (Huxley 1869) is of Westphalian age, but Watson (1929, 223–224, pl. I, fig. 2) assigned to this form a skull of earlier date. The latter skull appears to have had a length of approximately 405 mm., a length comparable to that estimated for our specimen. I have not seen the Manchester Museum slab containing part of this specimen but from Watson's description and the Museum of Practical Geology specimen it would appear that the jaw (definitely of embolomere type) is comparable to that described here. Hence, although the matter lies at two removes from certainty, our specimen may be provisionally assigned to *Pholiderpeton*. It may be reasonably questioned whether a fragment of this sort should receive a specific name. Since, however, it is of considerable interest from stratigraphic and topographic points of view, I will, nevertheless, describe it as *Pholiderpeton*(?) *bretonensis*, sp. nov. A specific diagnosis is, of course, valueless, but since this is required by the "règles," I will mention as a supposed specific character the observable gently striated nature of the external jaw sculpture between the coarser sculpture bands of dorsal and ventral borders. The holotype is M.C.Z. No. 2772.

Although it now seems probable that many of the Carboniferous labyrinthodonts once thought to be embolomeres are members of other groups — rhachitomes, ichthyostegalians, or pre-seymouriamorph anthracosaurians — there nevertheless remains a "hard core" of typical embolomeres which carry the story of the group downward through much of the Carboniferous. *Archeria* is the last survivor; *Pteroplax* ("*Eogyrinus*") is a typical Westphalian representative; the skull assigned to *Pholiderpeton* by Watson and the present jaw carry the story down to or across the Pennsylvanian-Mississippian boundary, and undescribed materials from West Virginia show the presence of a true embolomere in Upper Mississippian times. The trend within the group appears to be the development of persistently aquatic fish-eating amphibians with an elongated body and tail and short limbs, and, as in piscivorous vertebrates of many groups, a trend toward development of a long slender snout and a long row of relatively small marginal teeth.

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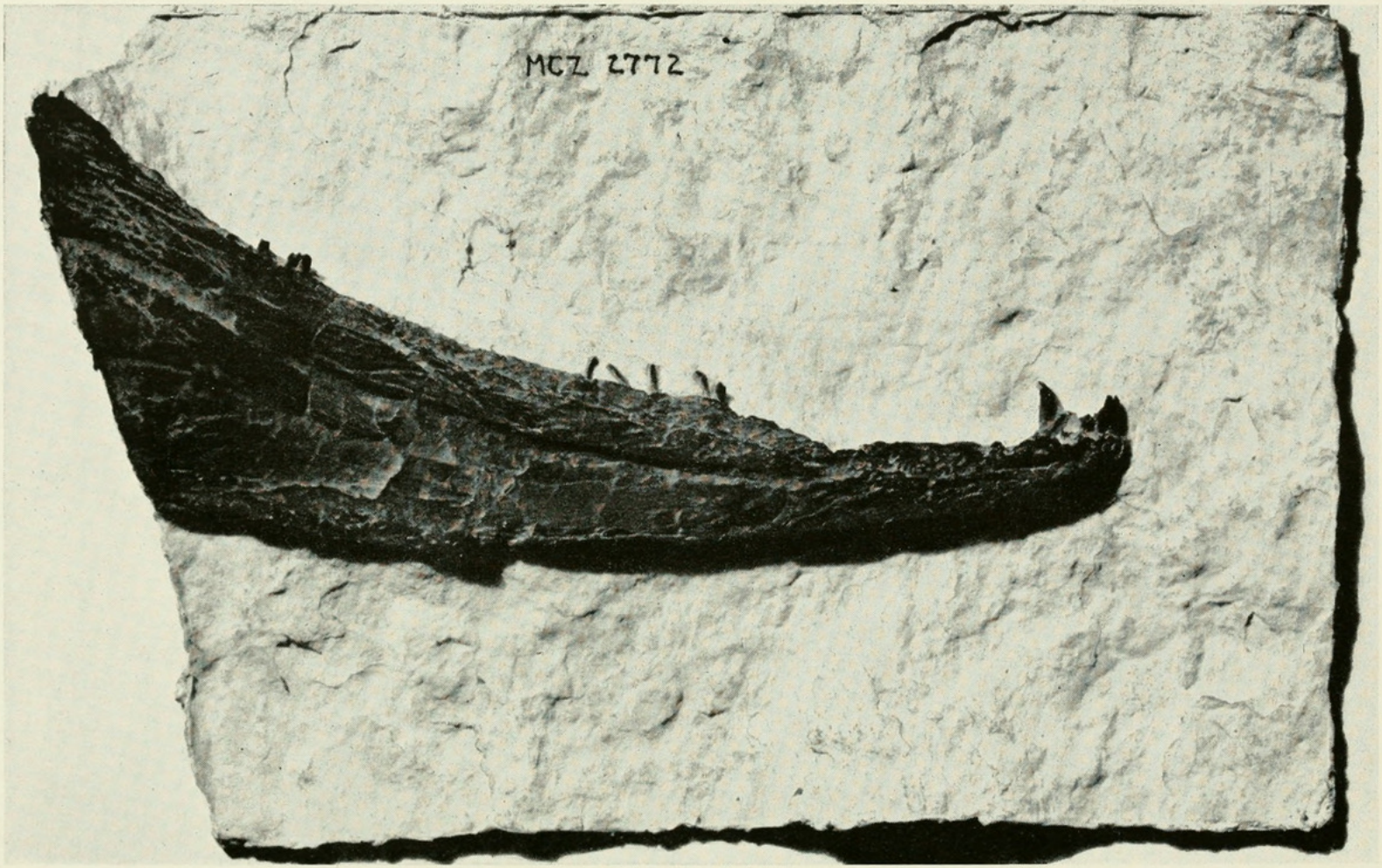

A cast from the type mold of *Pholiderpeton*(?) *bretonensis*, sp. nov.