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Jaws and dentition in an Early Triassic, 3-dimensionally preserved eugeneodontid skull (Chondrichthyes)

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ABSTRACT:

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Neutron scans of a concretion with a 3-dimensionally preserved partial skull from the Lower Triassic Vega Phroso Siltstone Member of the Sulphur Mountain Formation (western Canada), previously assigned to *Caseodus*, reveal that upper jaws were absent in this eugeneodontid. Large, anteriorly deep lower jaws housed relatively few and large tooth files and enclosed a narrow anterior mouth cavity together with the symphysial tooth whorl, which is situated on the mandibular rostrum. The symphysial teeth are slender-conical in antero-occlusal view and do not appear to possess a transversal crest. The taxonomic significance of tooth morphology and absence of upper jaws is discussed. This eugeneodontid yields evidence of another group of rather primitive fishes surviving the end-Permian extinction event. The architecture of oral cavity and dentition suggests these chondrichthyans were specialized on preying on disc-shaped or flat, presumably shelled organisms.

Key words: Neutron scan, Oral dentition, Skull, Jaws, Eugeneodontid, Early Triassic.

INTRODUCTION

Jaws and dentition of a partial, 3-dimensional caseodontid skull preserved in a concretion from the Lower Triassic Vega-Phroso Siltstone Member of the Sulphur Mountain Formation (Wapiti Lake, British Columbia) are examined and tentatively restored. The lower jaws with several tooth files, the rostral portion of the neurocranium and the symphysial tooth whorl represent the most complete eugeneodontid dentition known and are preserved *in situ* (MUTTER & NEUMAN 2008). Neutron scanning and re-assembly at variable angles provides insight into jaw architecture of this taxon, originally described as a new species of *Caseodus*, and a novel view of the position of the tooth whorl and tooth file arrangement.

EXTERNALLY VISIBLE FEATURES

The rostral portion of the neurocranium, the skull roof, the lower jaws and dozens of teeth are partly enclosed and partly sticking out of a pyritized, calcareous siltstone concretion (Text-figs 1, 2). The lower jaws are slender and relatively short, anteriorly deeper than posteriorly and apparently fused with a short symphysial cartilage (mandibular rostrum), which apparently contains symphysial teeth (Text-fig. 2F). Although the anterior tip of the mandibular rostrum is missing, it does not seem to have extended considerably beyond the tip of the snout (see below). There is no evidence of upper jaws, although there is one mesial tooth file containing at least four larger teeth preserved *in situ* in the right upper rostral region of the

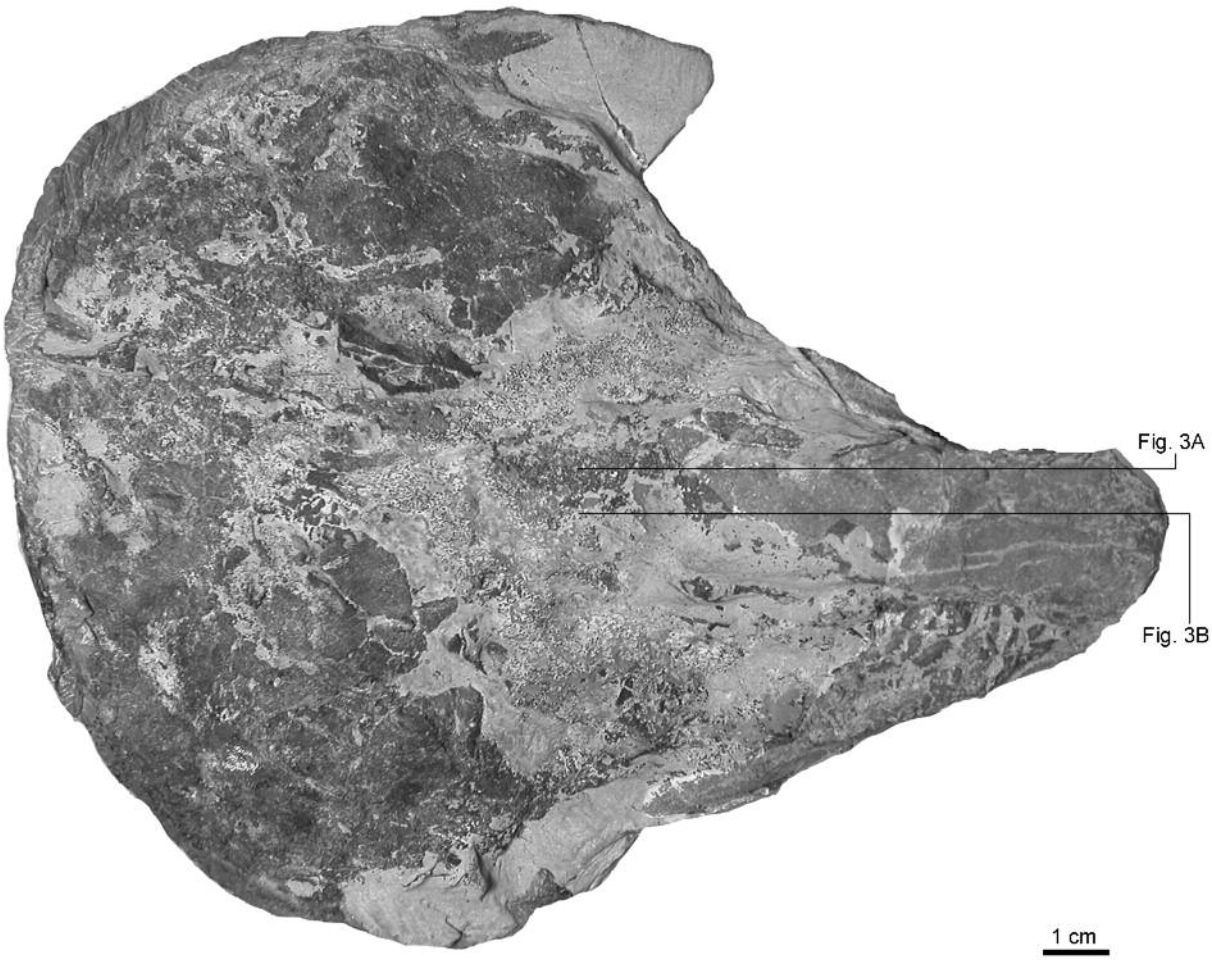

Fig. 1. Skull roof of a 3-dimensionally preserved partial skull described as *Caseodus varidentis* MUTTER & NEUMAN, 2008, specimen TMP 86.42.3, seen in dorsal view (anterior to the right). Cutting layers of Fig 2 (A and B) are indicated (figure modified from MUTTER & NEUMAN 2008)

dentition. These teeth have a central labial peg and labial buttresses projecting from the tooth shoulders. All other preserved teeth situated on the rostral portion of the neurocranium are reminiscent of pavement teeth with small and flat crowns rather than large, bulbous crowns with numerous buttresses like the teeth in the mesial and lateral tooth files of the lower jaw. Tooth morphology is surprisingly variable and the largest lateral lower tooth files consist of up to eight large and tightly interlocking teeth with a central labial peg and three to five buttresses projecting labiad from each tooth shoulder (Text-fig. 2).

NOVEL INFORMATION FROM NEUTRON SCANS

Neutron scans reveal that the ramus of each lower jaw housed four sectors with specifically shaped and variably large teeth, each sector of which contains at least one tooth file. The symphysial cartilage between the lower jaws containing the tooth whorl is the mandibular rostrum and is laterally adjoined by the lower jaw rami (MUTTER & NEUMAN 2008). The distal sector of each lower jaw ramus probably contained short, flat-crowned teeth arranged in several tooth files (Text-fig. 3A, B). The anteriorly adjoining sector contains the largest (lateral), possibly single tooth file (in each jaw) with very broad and large-crowned teeth with labial peg and labial buttresses (Text-figs 2D, 3B). This sector is the largest of all sectors. The teeth of all tooth files except for the symphysial teeth are arranged in interlocking batteries and oriented obliquely across the lower jaw rami. The two anteriorly adjoining (mesial) sectors are populated with morphologically similar but clearly smaller teeth and each contain at least one tooth file with teeth arranged in an analogous manner to the lat-

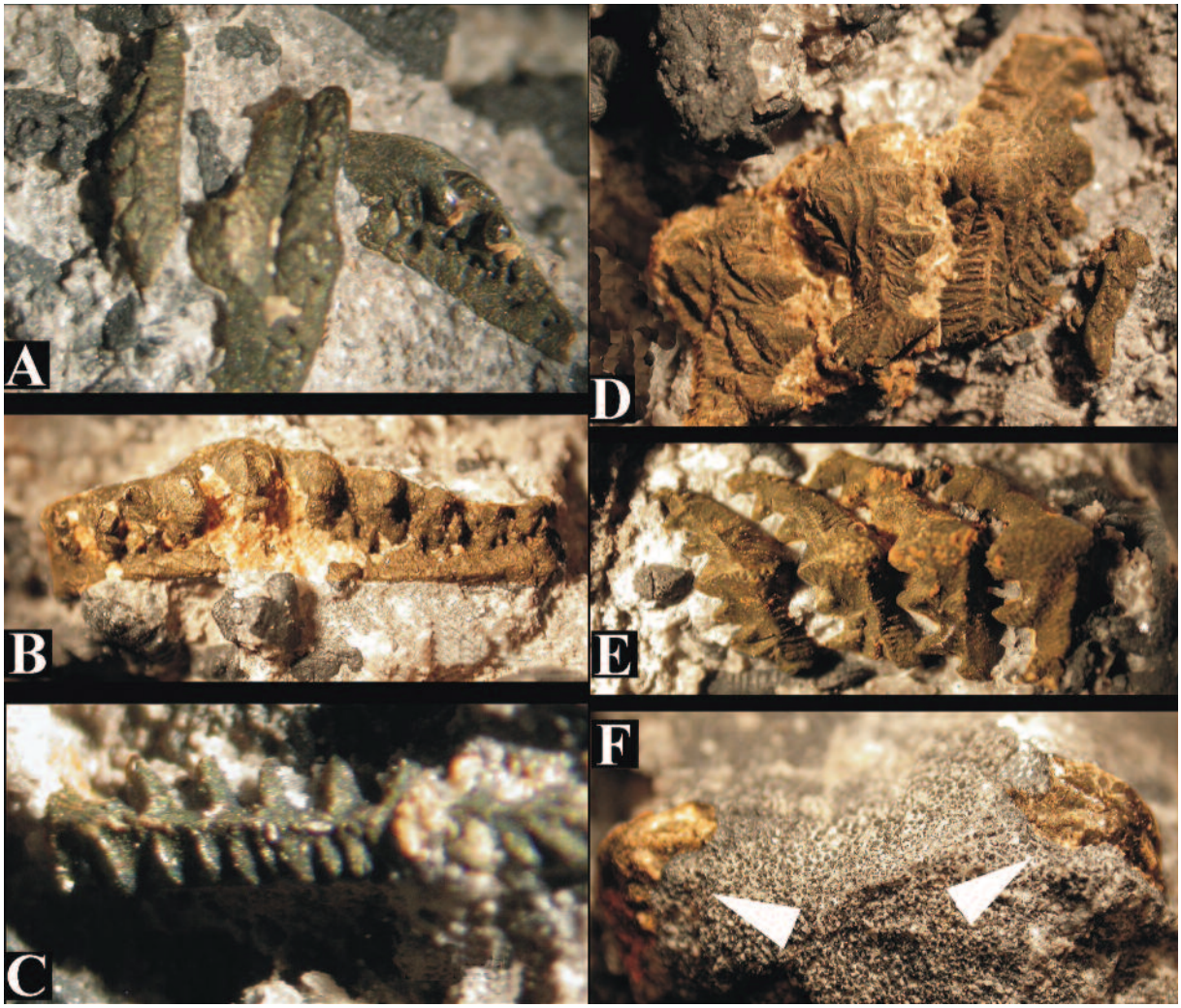

Fig. 2. Teeth visibly preserved in specimen TMP 86.42.3, described as *Caseodus varidentis* MUTTER & NEUMAN, 2008. A – latero-distal teeth in basal view. B – labial view of a distal tooth with slightly vaulted centre. C – a bar-shaped distal tooth in occlusal view. D – mesio-lateral teeth in occlusal view from the lower jaw. E – occlusal view of *in situ* mesio-lateral teeth from the right upper dentition. F – two abraded symphysial teeth (arrows) (figure modified from MUTTER & NEUMAN 2008)

eral tooth file (Text-figs 2E, 3A). The mandibular rostrum, most probably a separate skeletal element containing the tooth whorl (Text-fig. 3), is laterally completely enclosed by the lower jaw rami, is of the same depth and contains a similar number of teeth like the lateral and the two mesial tooth files. The symphysial teeth are unicuspid with steeply slanting tooth shoulders and apparently with sagittal edge (Text-fig. 3C-E). No complete view of the tooth whorl is possible and the anterior-most portion is missing. However, it appears the cusps of its teeth interlock with the tooth crowns of the mesial tooth files of both lower jaw rami and reach into the rostral portion of the neurocranium, leaving a narrow anterior mouth cavity.

CONCLUSIONS

It is concluded that all teeth in the symphysial tooth whorl were placed on an at least partly calcified, narrow mandibular rostrum enclosed laterally by the lower jaw rami – shorter, but comparable in position to the one in *Ornithoprion* ZANGERL, 1966. The depth of this mandibular cartilage was equivalent to the depth of the lower jaw, so that the symphysial teeth occupied the gap between the first mesial tooth files in both lower jaws and presumably acted against the anterior-most upper tooth file(s) (Text-fig. 2C-E). This information has important implications for assessment of body size of other eugeneodontids inferred from isolated tooth whorls.

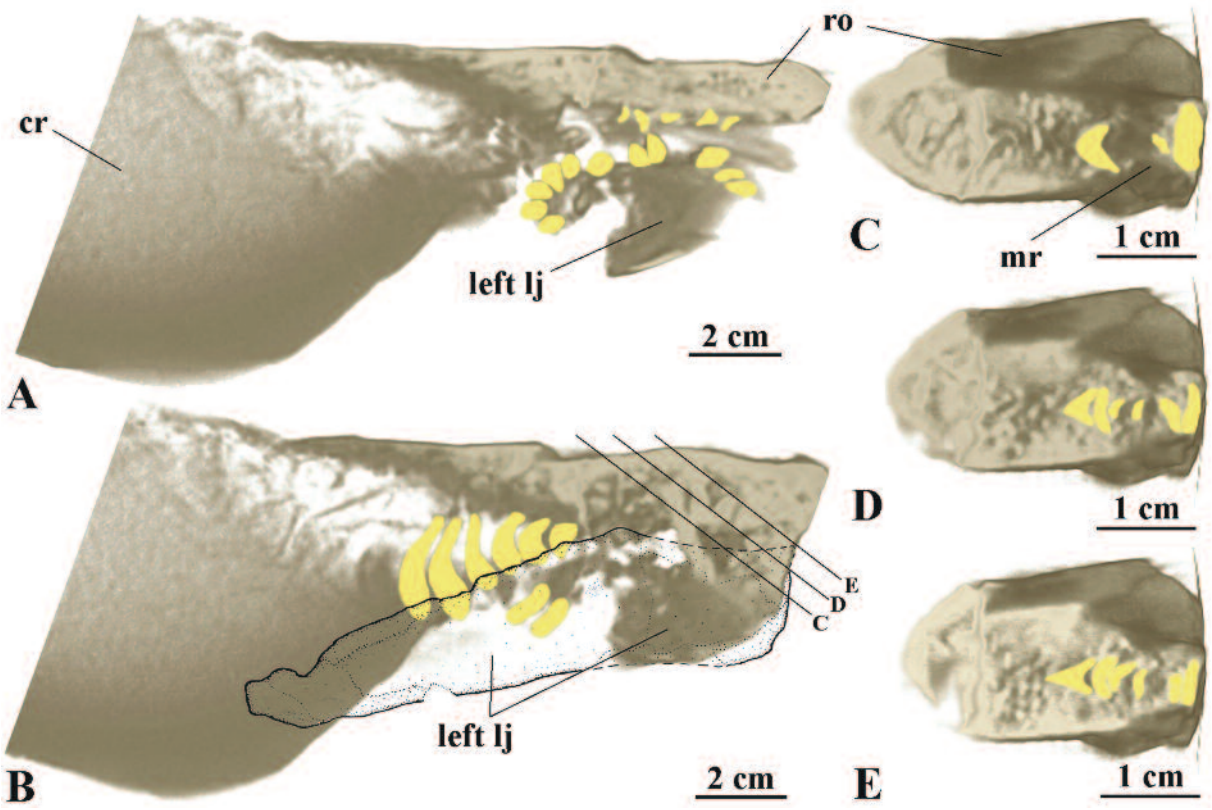

Fig. 3. Neutron scans of specimen TMP 86.42.3. A, B – serial sections through skull in right lateral view, showing parts of dentition (tooth files are shown in yellow, bright brownish areas are pyritized). A – two mesial tooth files; B – the lateral tooth file with superimposed lower jaw and indication of cutting layers for Figs 2C-E. C-E – serial sections through anterior tip of the rostral portion of the neurocranium (ro) and the mandibular rostrum (mr) in ventral view showing teeth in symphysial tooth whorl (anterior is to the right in all sections). Abbreviations: cr – concretion; lj – lower jaw; mr – mandibular rostrum (symphysial cartilage containing tooth whorl); ro – rostral portion of neurocranium

Apparently, only two sectors with two different types of teeth may have been present in the ventral wall of the neurocranium. The anterior tooth files of the upper dentition consist of more slender teeth (if compared to the lower jaw) but have a small central labial peg and better-developed buttresses than the anterior teeth of the lower jaws. In the posterior half, the upper dentition consists of a large number of flat-crowned teeth with reduced central labial peg and are reminiscent of distal teeth of the lower dentition.

There is no evidence of upper jaws in the neutron scans, and it is concluded that the anterior-most upper tooth file(s) and all pavement teeth - similar the distal tooth files in the lower jaw - were anchored in the rostral portion of the neurocranium as postulated by Bendix-Almgreen (1975) and Zangerl (1979, 1981) for some eugeneodontids. However, because there are larger teeth *in situ* beside pavement teeth, we assume upper jaws are incorporated in the neurocranium as is reported in *Sarcoprion* Nielsen, 1952. Proliferation of the symphysial tooth whorl does not require proposition of a mode of growth strikingly different from the mode of growth of other (eugeneodontid) tooth files, assuming the symphysial teeth migrated labiad while remaining attached to the dental lamina of a mandibular cartilage, rather than being shed after having passed their functional position.

A brief survey of relatively complete jaws suggests the presence of a mandibular cartilage may not be a synapomorphy of caseodontid sharks such as *Caseodus* Zangerl, 1981 and *Ornithoprion* Zangerl, 1966 but may have also occurred in edestoids such as the edestid *Lestrodus* Obruchev, 1953. Shape and length of the mandibular rostrum were varied and may have served different functions. Furthermore, although the lateral dentition of TMP 86.42.3 shows all characteristics of the genus *Caseodus* (and was originally described as a new species of *Caseodus* in Mutter & Neuman, 2008, see Text-fig. 3), the newly available neutron scans yield no evidence of upper jaws but instead evidence of roof-shaped symphysial teeth showing resemblance with teeth assigned to the agassi-

zodontid *Sarcoprion* NIELSEN, 1952. According to JANVIER (1996), *Caseodus* possesses mobile upper jaws, which contrasts assignment to this genus. However, lateral tooth morphology in this specimen is indistinguishable from *Caseodus*. There are also striking affinities with the jaw reconstruction of *Fadenia crenulata* by BENDIX-ALMGREEN, 1976 (sketches of BENDIX-ALMGREEN in ZANGERL, 1981, fig. 95D, E), suggesting the current taxonomic concept may over-interpret the actual eugeneodontid diversity. These taxonomic difficulties are linked with the very fragmentary nature of dental remains recovered to date, the abundance of seemingly diagnostic features and the lack of postcranial material in skeletal association with diagnostic tooth features.

Regardless of these conceptual shortcomings in assessing eugeneodontid diversity, the survival of the end-Permian extinction event by this unique group of highly specialized chondrichthyans sheds further light on this peculiarly selective extinction event. The absence of upper jaws is a primitive retention within this group of caseodontoids, because certain Palaeozoic members have been shown to be devoid of upper jaws (ZANGERL, 1981, p. 86). This further suggests that within this specialized group of chondrichthyans, it is once again a primitive member which survives that boundary (see also MUTTER & RIEBER 2005; MUTTER & *al*. 2007), linking Early Triassic members with Carboniferous stem groups.

Symphysial and mesial tooth files in the lower jaw formed a triangular chamber that was suitable for holding prey in place, while the mobile, short lower jaws along with the mandibular rostrum were used for (possibly repetitive) upward action of the tooth whorl against larger teeth contained in upper tooth files. Such mechanism would have been useful to force open flattened, shelled organisms. Numerous pavement teeth of the distal sector of the lower jaw and in the posteroventral wall of the rostrum primarily served as an abutment and were used for crushing prey.

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REFERENCES

BENDIX-ALMGREEN, S.E. 1975. Palaeovertebrate faunas of Greenland. *In*: A. ESCHER & W.S. WATT (*Eds*), Geology of Greenland, pp. 536-573. *The Geological Survey of Greenland*; Copenhagen.

JANVIER, P. 1996. Early Vertebrates, pp. 1-393. *Clarendon Press*; Oxford.

MUTTER, R.J., DE BLANGER, K. & NEUMAN, A.G. 2007. Elasmobranchs from the Lower Triassic Sulphur Mountain Formation near Wapiti Lake (BC, Canada). *Zoological Journal of the Linnean Society*, **149**, 309-337.

MUTTER, R.J. & NEUMAN, A.G. 2008. New eugeneodontid sharks from the Lower Triassic Sulphur Mountain Formation of Western Canada. *In*: L. CAVIN, A. LONGBOTTOM & M. RICHTER (*Eds*), Fishes and the Break-up of Pangaea. *Geological Society, London, Special Publications*, **295**, 9-41.

MUTTER, R.J. & RIEBER, H. 2005. *Pyknotylacanthus spathianus* gen. et sp. nov., a new ctenacanthoid from the Early Triassic of Bear Lake (Idaho, USA). *Revista Brasileira de Paleontologia*, **8**, 139-148.

NIELSEN, E. 1952. On a new or little known Edestidae from the Permian and Triassic of East Greenland. *Meddelelser om Grønland*, **144** (5), 1-55.

OBRUCHEV, D.V. 1953. A study of the edestids and work of A.P. Karpinskii. *Trudy Paleontologicheskogo Instituta Akademii Nauk SSSR*, **45**, 1-85. [*In Russian*]

ZANGERL, R. 1966. A new shark of the family Edestidae, *Ornithoprion hertwigi* from the Pennsylvanian Mecca and Logan Quarry shales of Indiana. *Fieldiana, Geologica,* **16**, 1-43.

— 1979. New chondrichthyans from the Mazon Creek fauna (Pennsylvanian) of Illinois. *In*: M.H. NITECKI (*Ed.*), Mazon Creek Fossils, pp. 449-500. *Academic Press*; New York.

— 1981. Chondrichthyes I – Paleozoic Elasmobranchii. *In*: H.-P. SCHULTZE (*Ed.*), Handbook of Paleoichthyology, **3A**, pp. 1-115. *Gustav Fischer Verlag*; Stuttgart.

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