

FRONTISPIECE. Flesh restoration of *Protochelydra zangerli* showing head shields and jaw coverings.

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**SKULL AND MANDIBLE OF PROTOCHELYDRA ZANGERLI
(TESTUDINES: CRYPTODIRA)**

by

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**SKULL AND MANDIBLE OF *PROTOCHELYDRA ZANGERLI*
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Since the description of *Protochelydra zangerli* (Erickson, 1973) significant new material has been recovered from the original site of discovery at Wannagan Creek Quarry. The initial description of the skull was based on an incomplete, partly crushed specimen of a small individual that lacked some of its surface details as well as a mandible. New specimens are represented by a large, complete skull of an adult exhibiting possible dimorphic characters, related to sexual difference or ontogenetic age, as well as other structures and features, either missing or not discernable in the holotype skull. A complete mandible further contributes to our knowledge of this taxon as the first record of the lower jaw. These specimens are all in the collections of the Science Museum of Minnesota (SMM).

The new materials were collected from paludal and lacustrine deposits of Wannagan Creek Quarry, which is located in a Late Paleocene flood basin once occupied by Fossil Lake Wannagan (Erickson, 1982; 1999). The flood basin was part of a broad floodplain system consisting of clays, silts, cross-bedded sand and crevasse splays, that resulted from breaches in the natural levees, which characterized the Late Paleocene landscape of western North Dakota (Royce, 1970; Jacob, 1972).

SYSTEMATIC PALEONTOLOGY

CRYPTODIRA Cope 1868

POLYCRYPTODIRA Gaffney and Meylan, 1988

PROTOCHELYDRA ZANGERLI Erickson, 1973

Holotype – SMM P72.34.20, skull.

Horizon and Locality – Bullion Creek Formation, Late Paleocene, Tiffanian 4; Wannagan Creek Quarry, NW 1/4 Sec. 18, T.141N.R.102W, Billings County, North Dakota, USA.

Referred specimens – SMM P74.24.183, skull; SMM P75.22.272, mandible. Both specimens from Wannagan Creek Quarry.

Amended Diagnosis – “Large-headed” turtle characterized by the following autpomorphies: frontal included in dorsal surface of orbital rim; maxilla deeply curved ventrally and bowed outwardly; a symphyseal "hook", very like that of *Chelydra* and *Macrolemys* present; maximal midline length (occipital condyle to rostral tip) equal to maximal breadth of skull; prominent shield sulci on dorsal and lateral surface of large skull; quadrate located as in most cryptodires; triturating surface wide and slightly concave; maxillary lateral margin elevated and acute; quadratojugal larger than jugal.

DESCRIPTION

Skull

The new skull identified as *Protochelydra zangerli*, P74.24.183, is complete with columella and an associated hyoid fragment. It is undistorted, larger than the type skull, and provides information which clarifies morphological aspects of this taxon (Fig. 1, A- D).

Severe crushing, especially of the posterior portion of the type skull, P72.34.20, altered it by displacing the squamosals and quadrates far forward of their normal positions. As observed in the new undistorted skull the squamosals and quadrates are located more posteriorly. Sutures are located as in the generic description with the noted exceptions of the frontal, which is incorporated in the formation of a short section of the upper margin of the orbit, separating the prefrontal and postorbital (Fig. 1B, D). The position of the quadratojugal-jugal suture is about halfway between the orbit and the quadrate funnel, not shown in the original reconstruction of the holotype skulls (Fig. 1B, D).

The new skull differs further in having a broader maxillary, jugal, and squamosal region, which can be attributed to age and possibly the sex of the individual. Cheek emargination is a deep, narrow notch about halfway between the posterior margin of the orbit and the anterior margin of the quadrate funnel. Cheek emargination in the smaller, holotype skull presents a deep, wide, arch-shape, that is apparently due to taphonomic modification. The quadratojugal is a large element, considerably larger than the jugal. The temporal emargination in each skull differs only in its irregular margin due to short, blunt projections arising from the posterior edges of the parietal and postorbital in the larger skull. Dorsal and lateral surfaces are more coarsely textured in the large skull, as well and prominent sulci for

head shields, barely discernable in the smaller skull, are well-defined (Fig. 1B, D). Another possible age related feature is a small notch in the posterodorsal rim of the orbit, that corresponds to the location of a head shield sulcus (Fig. 1 B-D). This feature, albeit subtle, occurs in the smaller, type skull as well. Similar features may also occur wherever a shield sulcus terminates, however they have no apparent taxonomic value. A tall blade-like supraoccipital crest is as shown for the type restoration. Ventrally the triturating surface is broad, slightly concave, and laterally curved to form high acute edges of the maxilla and premaxilla. The outer surface is smooth, indicating that it was sheathed by a horny rhamphotheca. The edge of the premaxilla is slightly elevated above the edge of the maxilla and forms an obtuse “beak”.

Mandible

The lower jaws are represented, for the first time, by a complete mandible P75.22.272 (Fig. 2). The mandible is as wide as it is long; expanded triturating surface with elevated labial ridge; tall coronoid; deep lateral fossa; well-developed, labia dentary process; and has further resemblance to some baenids in lacking a splenial, and the anteroventromedial wall is open as in *Chisternon* and *Baena* (Gaffney, 1982).

Dentary – The dentary extends nearly the full length of the lower jaw with a long extension reaching the base of the retroarticular process of the articular. Laterally it rises to nearly the top of the coronoid process. The triturating surface is slightly concave with low lingual and lateral edges, and is upturned anteriorly. On the lateral surface, a large fossa is present between a short, rugose, lower ridge, that reaches posteriorly to the level of the articular. There is a well-developed, sharply upturned, labial dentary process, which partly encloses the opening of the canalis mentalis medially. There is no indication of a medial symphyseal suture.

Coronoid – The coronoid is tall with a prominent coronoid process (Fig. 2C-E). Its anteromedial process forms the highest part of the lingual ridge, of the dentary. Posteriorly it divides and connects with the prearticular medially and the surangular laterally to form the anterior half of the fossa meckelii.

Articular – Positioned between the prearticular medially and surangular laterally, it makes up most of the shallow area of the articular. Its posterior end forms a short, blunt retroarticular process.

Angular – The angular shares a long contact with the prearticular medially reaching about mid jaw length. A small intermandibular foramen is preserved along this common suture below the level of the articular.

Prearticular – The prearticular is sutured with the coronoid to form the posterior half of the medial side of the opening of the Meckelian Canal. Its anteromedial extension also forms most of the upper margin of the open sulcus of the Meckelian Canal, and its posterior extension borders the medial edge of the articular, reaching nearly to the end of the retroarticular process. Posteriorlaterally it forms about one third of the area articular.

Surangular – The surangular and coronoid are united above the upper rugose ridge on the lateral surface of the dentary to form the lateral margin of the Meckelian Canal. A large foramen is located in a deep recess posteriolaterally, above the surangular-dentary suture.

In conclusion, the present discussion corrects errors in the original reconstruction of the skull. It further adds significantly to our knowledge of *Protochelydra* by providing new information on features that were not preserved in the holotype, due to toponymic modifications and/or the presumed young age of the holotype specimen. A complete mandible is also of importance as the first record of the lower jaws. Other fragmentary, associated skull and mandibular elements lend support to the above diagnosis, as well as an indication of the relative abundance of this taxon in the Late Paleocene.

Protochelydra zangerli is a “large-headed” fresh-water turtle, with general resemblance, of the skull, to chelydrids, such as *Chelydropsis murchisoni* (Gaffney and Schleich, 1994; Mlynarski, 1980) as well as to *Chelydra* and *Macroclmys*. The larger, more robust skull of P74.24.183, suggests the possibility of it representing a male individual (Bury, 1979).

The mandible, unlike the skull of *Protochelydra* however, is very similar to that of *Chelydropsis murchisoni* as well as to that of baenids *Palatobaena bairdi* (Gaffney, 1982) and *Palatobaena cohen* (Lyson and Joyce, 2009). Strong similarities are found in shared, derived characters of: a broad, anteriorly narrowing, triturating surface, with elevated margins; a tall Coronoid process; prominent labial dentary process; and, as in *Chisternon* and *Baena*, no indication of a splenial.

TABLE 1. Comparative measurements (in millimeters) between the new skull and Holotype skull of *Protochelydra zangerli*.

Skull	P72.34.20 (holotype)	P72.24.183
Maximal midline length, occipital condyle	77.0	90.0
to tip of premaxilla.		
Maximal width	70.0 (est.)	90.0
Minimal interorbital width	20.0 (est.)	24.0
Maximal orbital length	16.0	18.0
Minimal orbital height	13.0	18.0
Minimal distance between orbit and temporal emargination	16.0	23.0
Maximal midline length, center of quadrate to center of premaxilla	6.2 (est.)	76.0
Maximal width across quadrates	56.0 (est.)	77.5
Height of crista supraoccipital at level of occipital condyle	14.0	20.0

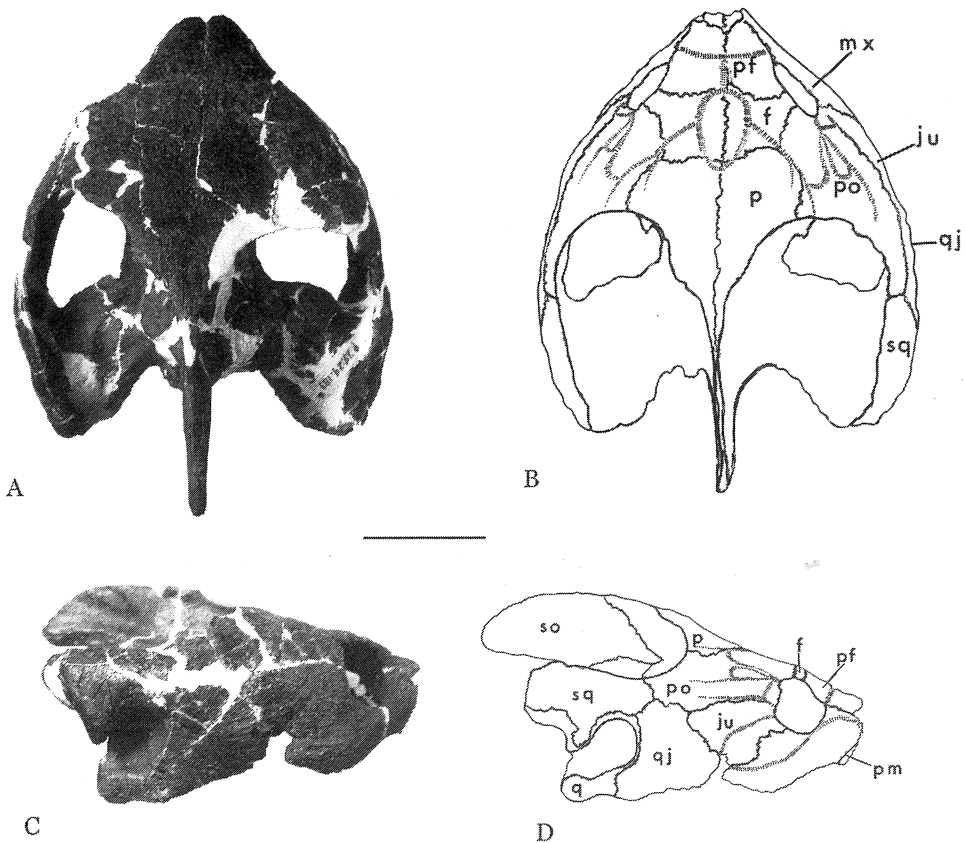


FIGURE 1. Skull of *Protochelydra zangerli* SMM P74.24.183 in dorsal and right lateral views. **A**, photograph; **B**, line drawing showing sutures and shield sulci (cross hatched); **C**, photograph; **D**, line drawing showing sutures and shield sulci (cross hatched). Abbreviations: **f**, frontal; **ju**, jugal; **mx**, maxilla; **p**, postorbital; **q**, quadrate; **qj**, quadratojugal; **sq**, sqamosal; **so**, suraorbital. Scale bar equals 3 cm.

TABLE 2. Measurements of mandible of
Protochelydra zangerli P75.22.272

Mandible	(mm)
Maximal length, midline	69.0
Maximal width across articulars	70.0
Maximal height at coronoid process	28.5

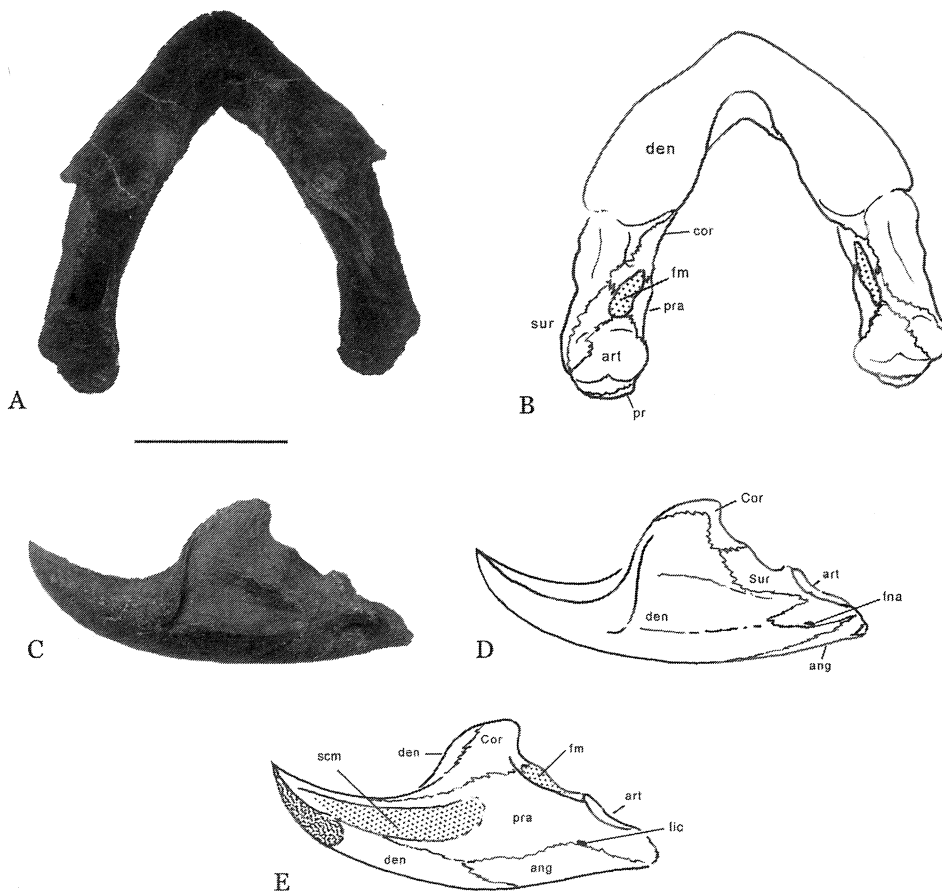


FIGURE 2. Mandible of *Protochelydra zangerli* SMM P75.22.272. **A**, photograph, dorsal view; **B**, line drawing, dorsal view; **C**, photograph, left lateral view; **D**, line drawing left lateral view; **E**, line drawing, right medial view. Abbreviations: **ang**, angular; **art**, articular; **cor**, coronoid; **den**, dentary; **fm**, foramen intermandibularis caudalis; **fm**, fossa meckelii; **pra**, prearticular; **rp**, retroarticular process; **scm**, sulcus cartilaginis meckelii; **sur**, surangular. Scale bar equals 3 cm.

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