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A SEA TURTLE SKULL (CHELONIIDAE: CARETTINI) FROM THE LOWER MIOCENE NYE FORMATION OF OREGON, U. S. A.

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ABSTRACT

A crown-group cheloniid from the lower Miocene Nye Formation of Oregon is described. This specimen is included in the Tribe Carettini based on the presence of two pairs of prefrontal scutes. This is the oldest representative of this tribe and the first Miocene record of a carettine from the western coast of North America. Its presence on the western coast of North America increases the biogeographic similarity between the Pacific and Atlantic seaboards of North America during the Miocene.

INTRODUCTION

This paper reports on the skull of a crown-group cheloniid from the lower Miocene of Oregon. Currently three groups of cheloniids are known from the Miocene. One of these, represented by *Euclastes huchtisoni* Lynch and Parham, 2003, is a group of basal cheloniids that has an extensive secondary palate, a flat triturating surface on the dentary and a primitive humerus (Lynch and Parham 2003). *Euclastes hutchisoni* is the youngest member of this lineage and is only known from the middle Miocene Temblor Formation of California. The second, represented by *Syllomus* Lydekker, 1889, has been interpreted as either sister-taxon to the Cheloniidae or a basal member of the crown group (Parham and Fastovsky 1997; Lynch and Parham 2003). This genus is widely distributed in the middle Miocene, being present on the Atlantic seaboard, Africa, and Japan (Weems 1974, 1980; Hasegawa et al., 2005) and is questionably present in the Temblor Formation of California (Lynch and Parham, 2003). The third group includes taxa within the crown-group Cheloniidae. The best known members of this group are *Procoplochelys grandaeva* (Leidy, 1851) and "*Procoplochelys" melii* (Misuri, 1910). *Procoplochelys grandaeva* is known from the middle Miocene of the eastern United States. It has been interpreted as being closely related to the extant *Lepidochelys* Fitzinger, 1843 and *Caretta* Merrem, 1820 on the basis of features of the shell, particularly the increased number of neurals, and has been placed with those turtle in the Tribe Carettini (see Zangerl and Turnbull, 1955). Weems (1974) described a partial skull of *Procoplochelys grandaeva* and listed a series of cranial features that support its placement in the Carettini, including the configuration of the basisphenoid-basioccipital suture, cross-sectional shape of the posterior projection of the supraoccipital and opisthotic, and broad contact between the quadrate and pterygoid. "*Procoplochelys" melii* from the Miocene Pietra Leccese sediments of south-eastern Italy has been interpreted as closely related to *Procoplochelys grandaeva* because it has an increased number of neurals (Zangerl and Turnbull, 1955). However, this generic assignment was questioned by Lapparent (2001) who considered this species to be an inderterminate member of the Chelonioidea. The Pietra Leccese sediments extend from the latest early Miocene to the earliest late Miocene (Chesi et al 2007). A skull of "*Procoplochelys" melii* was illustrated by Misuri (1910) and based on descriptions and illustrations of "*Procoplochelys" melii* by Misuri (1910), Zangerl and Turnbull (1955) figured the pattern of scutes on the dorsal surface of the skull. The illustration of the skull and shell of "*Procoplochelys" melii* published by Misuri (1910) was reproduced by Chesi et al. (2007).

The cheloniid skull from the lower Miocene Nye Formation of Oregon described here is included in the Carettini based on the derived feature of having two pair of prefrontal scutes on the skull roof, a feature that Parham and Fastovsky (1997) considered diagnostic of the group. Thus it occupies a pylogenetic position similar to that of *Procoplochelys*. Cranial remains of *Procolpochelys* are poorly known, however, and generic referral of the Oregon specimen must await discovery of better-preserved material than is presently available. Despite these uncertainties, this specimen is of interest in that it represents the oldest carettine, and the first occurrence of this tribe on the Pacific coast of North America during the Miocene.

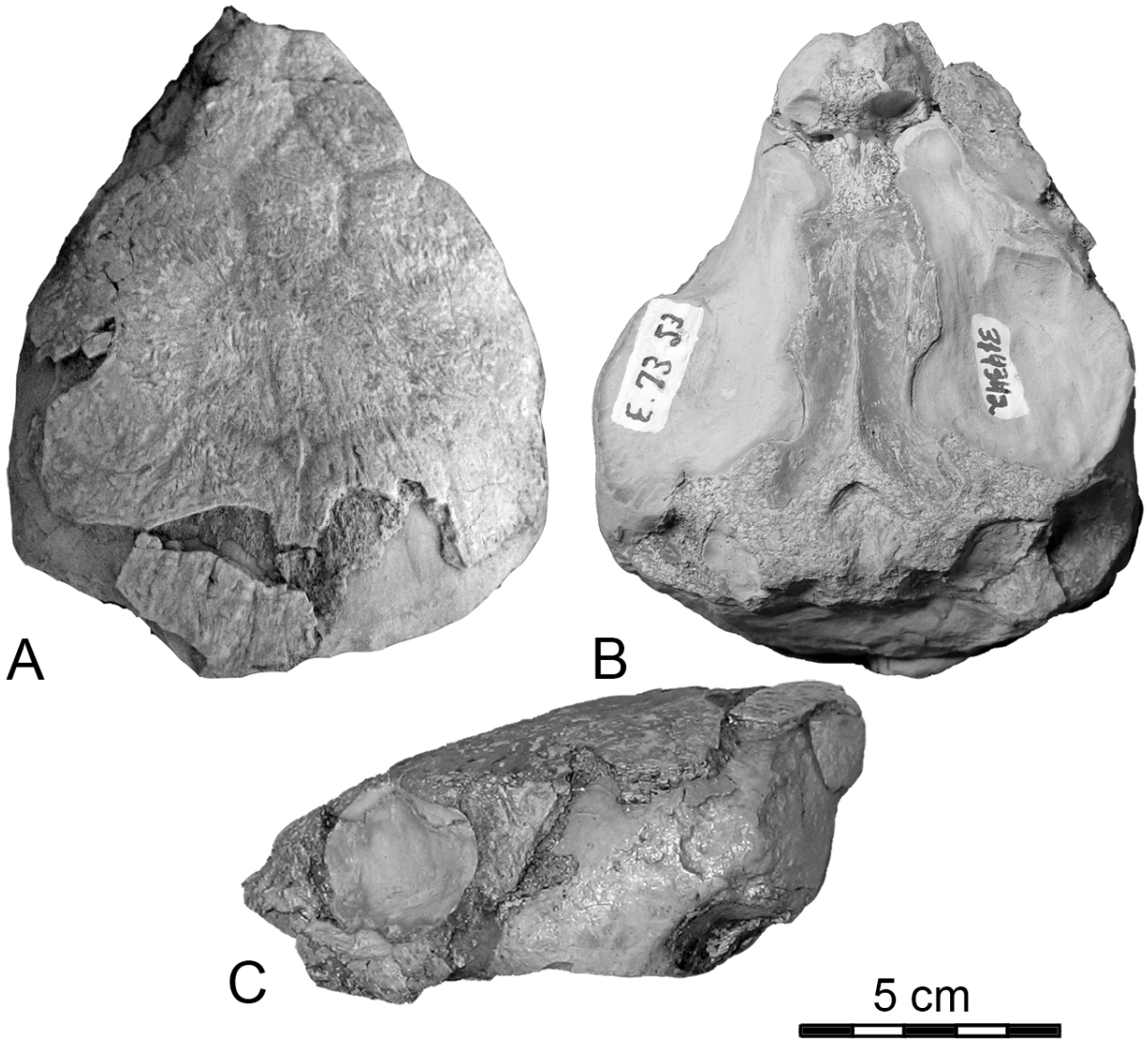

FIGURE 1. Photographs of UNM 314342, skull of Carettini gen. et sp. indet., in A) dorsal, B) ventral, and C) left lateral views.

Abbreviations: USNM: Smithonian Institute National Museum of Natural History; TMP: Royal Tyrrell Museum of Palaeontology.

SYSTEMATIC PALEONTOLOGY

Class Reptilia
Order Testudines
Suborder Cryptodira Gray, 1825
Pavorder Eucryptodira Gaffney, 1975
Family Cheloniidae Bonaparte, 1832
Subfamily Cheloniinae Gray, 1825
Tribe Carettini Zangerl and Turnbull, 1955
gen. et sp. indet.

Material—USNM 314342 is a three-dimensional skull missing the triturating surfaces and the lateral edge of the palate. The specimen was collected by E. M. Long in 1973 and was catalogued in the collections of the Smithsonian Institution in 1981.

Horizon and Locality—Nye Formation, Lincoln County, Oregon, 200 meters north of the mouth of Lost Creek at extreme low tide line. The Nye Formation (also referred to as the Nye Mudstone) has been dated as early Miocene (Prothero, 2001).

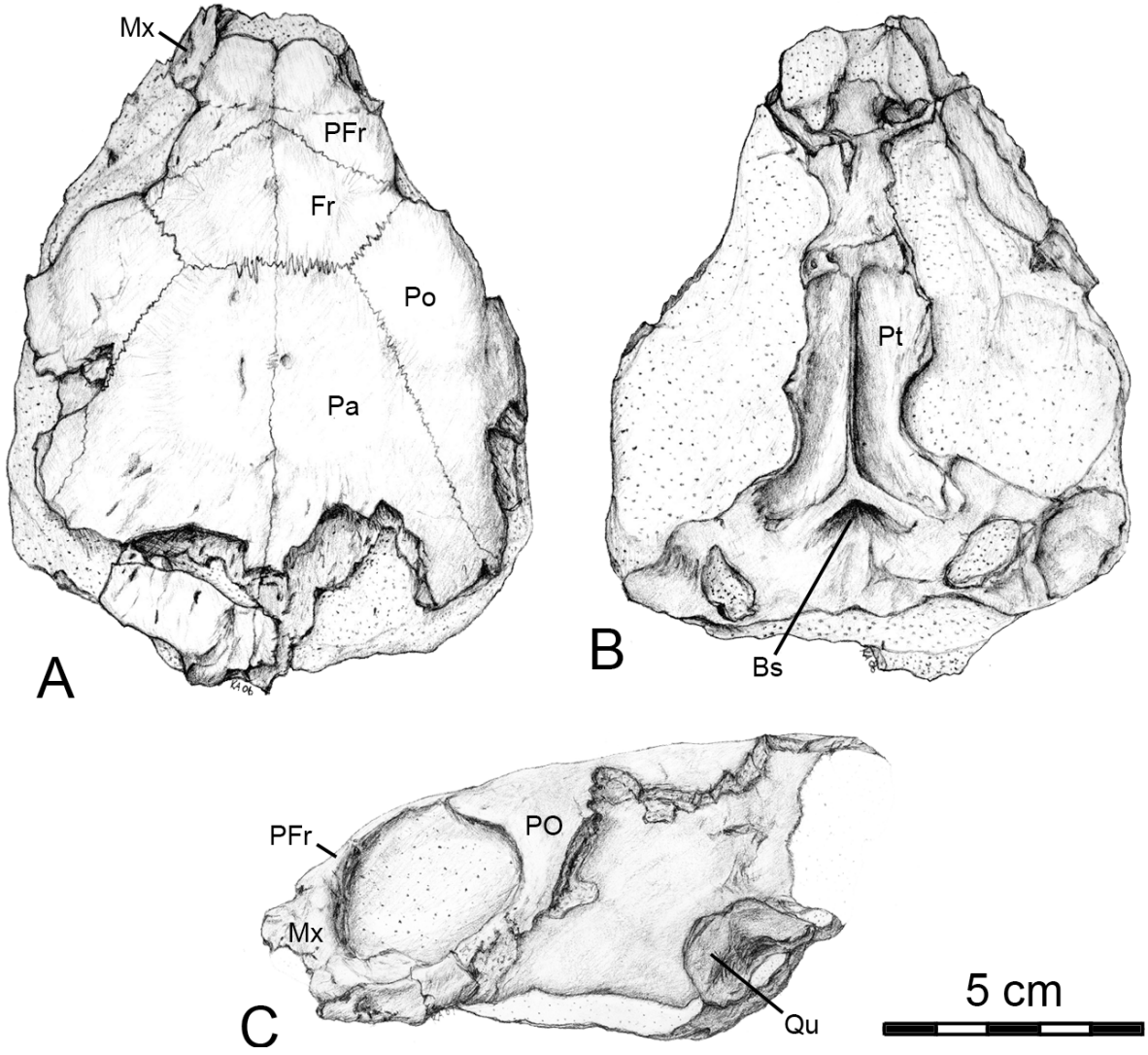

FIGURE 2. Interpretive drawings of UNM 314342, skull of Carettini gen. et sp. indet., in A) dorsal, B) ventral, and C) left lateral views. Abbreviations: Bs, basisphenoid; Fr, frontal; Mx, maxilla; Pa, parietal; PFr, prefrontal; PO, postorbital;Pt, pterygoid; Qu, quadrate

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Description—As seen in dorsal view, the skull has a triangular preorbital region that expands to a wide, sub-rectangular postorbital region (Figures 1, 2); the preorbital region is short and a distinct emargination is present for the orbits (Figs. 1A, 2A). The posterior half of the orbit is roofed by a narrow shelf formed by the postorbital. Although the posterior edge of the skull roof is not preserved, the intact portion plus impressions preserved in the matrix shows that there was little emargination of the posterior edge. In the proportions of the skull and its extensive skull roof, USNM 314342 is similar to the skull of *Natator depressus* (Garman, 1880). A striking feature of the skull is its low lateral profile (Figures 1C, 2C). Given its relatively undistorted condition, the low profile of USNM 31432 is interpreted here as a natural feature of the skull, rather than a preservational artefact.

Sulci on the skull roof are lightly impressed but distinct (Figure 3). The single frontal scute, single frontal-parietal scute, and pair of parietal scutes form a central row that gradually increases in width posteriorly. A small scute between the frontal-parietal scute and the paired parietal scutes may be a reduced interparietal. The frontal scute is distinctive in being six-sided with a V-shaped posterior margin that fits into a notch in the anterior edge of the parietal scute. Given this morphology, a divided parietal scute would be expected, but no trace of a mid-line sulcus is present on the parietal scute. The central row of scutes is bordered by five pairs of scutes: two pairs of prefrontal

scutes, a pair of supraocular scutes, and two pairs of temporal scutes. The sulcus separating the two pairs of prefrontal scutes on the right side of the skull is clearly developed. The suclus on the left side is largely obscured by a crack but can also be recognized. The supraocular scutes are intermediate in size compared to the frontal and frontal-parietal scutes. A pair of large temporal scutes covers the skull roof lateral to the frontal-parietal and parietal scutes.

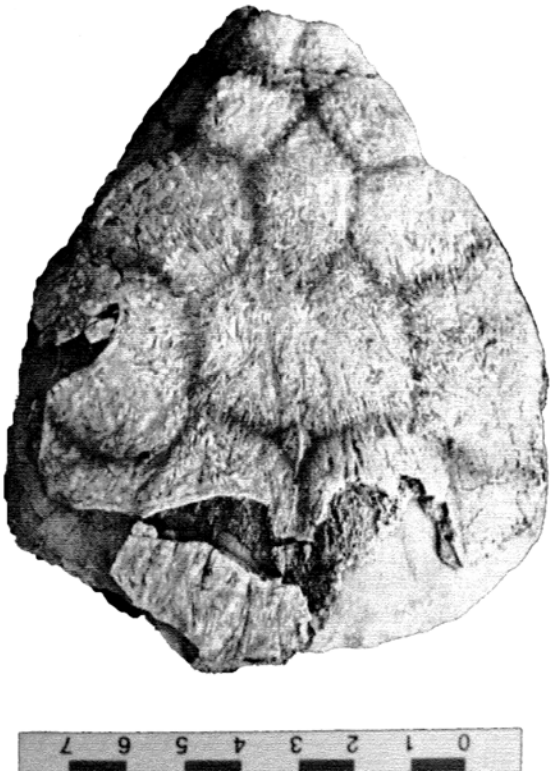

FIGURE 3. Interpretive drawings of UNM 314342, skull of Carettini gen. et sp. indet., in dorsal view showing sulci on the skull roof. Abbreviations: fr, frontal scute; fr-pa, frontal-parietal scute; ?int pa, possible interparietal scute; pa, parietal scute; prf, prefrontal scute; so, supraoccular scute; temp, temporal scute.

The sutures on the dorsal surface of the skull are clearly defined (Figure 2A). The prefrontal-frontal suture is widely V-shaped and anteriorly pointed. A broad area of contact with the prefrontals is present. The frontal narrowly enters into the margin of the orbit. The frontal-postorbital suture is relatively long and slopes posteromedially from the orbit to the junction between the frontal, parietal, and postorbital. The frontal-parietal suture is transversely oriented. The elongate parietal-postorbital suture extends posterolaterally to at least above the quadrate. Sutures marking the edges of the quadratojugal are not preserved, so at most that bone would have had a small area of exposure on the dorsal surface of the skull.

The bones surrounding the orbit are best seen in left lateral view (Figures 1C, 2C) (the right side of the skull preserves only the dorsal margin of the orbit). The bones of the cheek region are missing, including the ventral portion of the maxilla, but impressions of their inner surfaces are preserved in matrix infilling this region. The orbit is elongate anteroposteriorly, with its height being about half its length. The presence of an elongate orbit likely reflects the low height of the skull. The postorbital-jugal suture is present in a broken area near the posterior-ventral corner of the orbit. The maxilla-jugal suture cannot be identified. The maxilla-prefrontal suture meets the orbit near its anterodorsal corner.

In palatal view (Figures 1B, 2B), the triturating surfaces and the anterolateral parts of the palate are missing. Additionally, the ventral end of the quadrate is not preserved although the position of that bone relative to the basisphenoid is documented by the preserved portion. Both pterygoids are largely intact. A foramen palatinum posterius is absent. The pterygoid is elongate, and is strongly constricted just anterior to the basisphenoid; as a result, the posterior part of the pterygoid extends trongly laterally towards the quadrate. The ventral margin of the basisphenoid bears a V-shaped crest that opens posteriorly; a mid-ventral ridge extends from the vertex of the V-shaped crest to the anterior part of the pterygoids. The occipital condyle is missing, but a well-defined shallow groove leads from the base of the condyle to the excavation behind the V-shaped crest on the ventral surface of the basisphenoid.

Most of the occiput is covered by matrix, leaving only the ventral-most portion exposed. The large vena capita lateralis are visible in cross section on either side of the basioccipital. The canalis caroticus lateralis can also be identified in cross section; the diameter of this opening is 2 mm, which approximates that in a skull of *Lepidochelys* of similar size (measurements from specimen TMP1990.007.0625).

DISCUSSION

USNM 314342 is included in the Cheloniidae on the basis of skull proportions, the pattern of the sutures on the skull roof, and features of the palate. Palatal characters that Hirayama (1998) considered to be derived for the Cheloniidae include the absence of a foramen palatinum posterium and the presence of a V-shaped crest on the basisphenoid, and a mid-ventral ridge that extends anteriorly from this crest to the vomer. Although Hirayama (1998) considered the presence of this crest to be a feature present in all

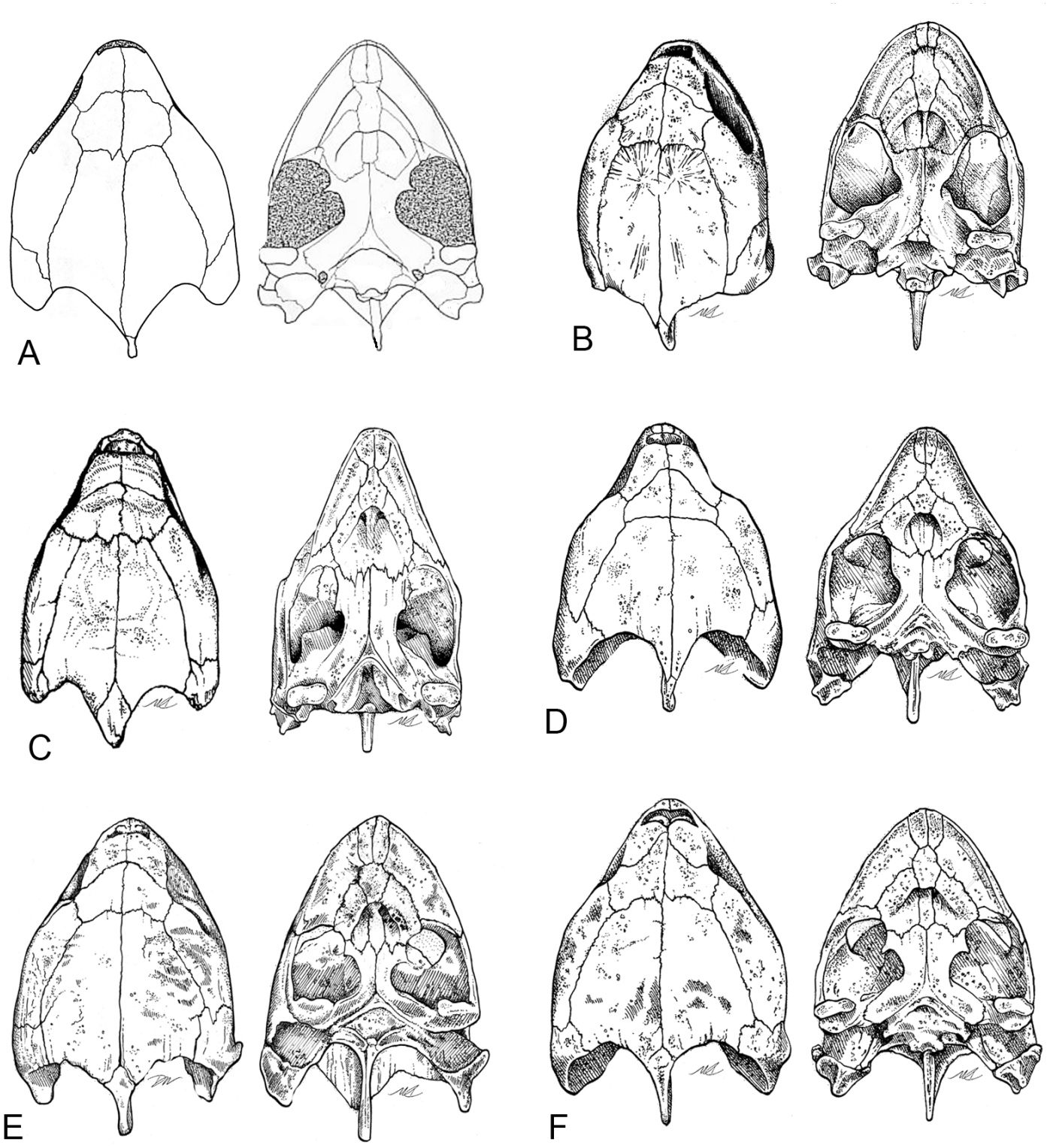

FIGURE 4. Drawings of recent cheloniid skulls in dorsal (left) and ventral (right) views. A) *Natator depressus*; B) *Chelonia mydas*; C) *Eretmochelys imbricata*; D) *Caretta caretta*; E) *Lepidochelys kempii*; F) *Lepidochelys olivacea*. A, modified from Zangerl et al., 1988. B-F from Wyneken, 2001.

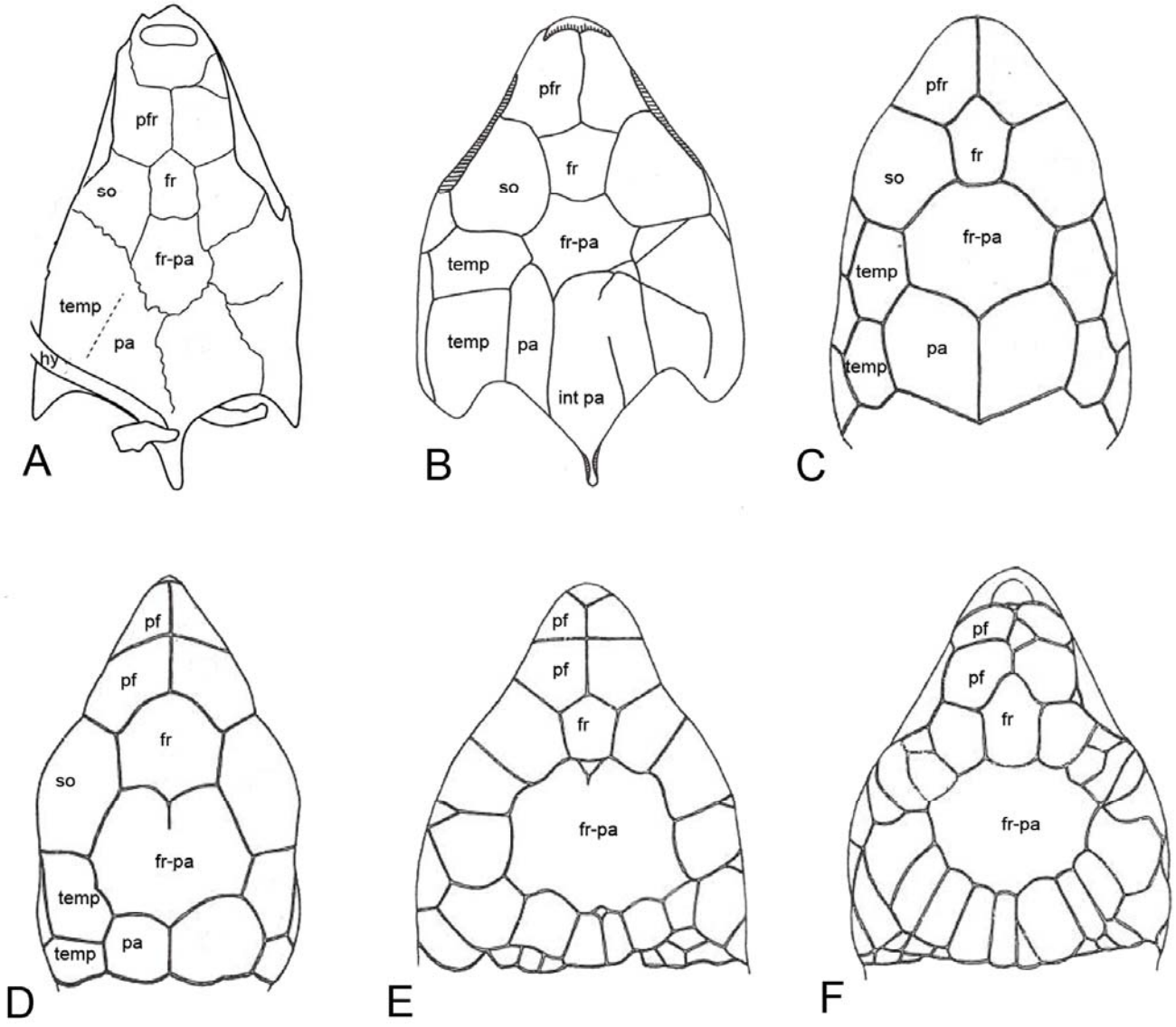

FIGURE 5. Drawings of recent and fossil cheloiid skulls in dorsal view showing the sculci on the skull roof. A) *Syllomus aegyptiacus*,modified from Hasagawa et al., 2005, Fig. 3; B) *Natator depressus*, from Zangerl et al, 1988, Fig.2; C) *Chelonia mydas*, from Zangerl, 1957, Fig 18; D) *Eretmochelys imbricata*, from Zangerl, 1957, Fig 18; E) *Caretta caretta*, from Zangerl, 1957, Fig 18; F) *Lepidochelys kempii*, from Zangerl, 1957, Fig 18. Abbreviations: fr, frontal scute; fr-pa, frontal-parietal scute; hy, hyoid; ?int pa, possible interparietal scute; pa, parietal scute; prf, prefrontal scute; so, supraoccular scute; temp, temporal scute.

derived cheloniids, Kear and Lee (2006) scored this feature as absent in *Chelonia*. This difference in interpretation reflects variation in the development of the ridge in extant cheloniids.

USNM 314342 differs from *Syllomus* and is similar to recent cheloniids in the proportions of the skull. The skull of *Syllomus* is relatively long and narrow, has little emargination of the skull roof for the orbit, and has an elongate preorbital region (Weems

1974, 1980; Hasegawa et al., 2005). In contrast, the proportions of USNM 314342 are closer to those of *Natator depressus*, *Carreta caretta* and *Lepidochelys olivacea* in having a subrectangular postorbital region and short preorbital region with an emargination for the orbit (Figure 3). Recent phylogenetic analyses have suggested that *Syllomus* may be within the crown-Cheloniidae (e.g., Lynch and Parham 2003). However, my observation of USNM 187382, a nearly complete skull of *Syllomus* from the middle Miocene Calvert Formation of North-eastern Virginia suggests that the genus is more primitive than extant cheloniids in that the canalis caroticus lateralis and base of the canalis caroticus internus were fully encased in bone. In extant cheloniids, ossification of the braincase is reduced so that the bony canalis caroticus internus terminates prior to the base of the palatal artery and a distinct canalis caroticus lateralis is absent. Unfortunately CT scans did not result in good enough resolution to discern these features in USNM 314342.

The pattern of scutes on the skull roof of USNM 314342 (Figure 3) is similar to that of *Syllomus*, *Natator*, and *Chelonia* (Figure 5A-C) in that the frontal, frontal-parietal, and parietal scutes show a successive increase in size posteriorly. USNM 314342 differs from *Syllomus*, *Chelonia*, and *Natator* but is similar to *Eretmochelys*, *Lepidochelys*, and *Caretta* (Figure 5D-F) in having two pairs of prefrontal scutes. Parham and Fastovsky (1997) concluded that the presence of two pair of prefrontal scutes was a derived feature uniting *Eretmochelys*, *Lepidochelys*. *Caretta* in the Carettini. Thus the presence of this feature in USNM 314342 suggests that this specimen is also referable to that tribe.

The arrangement of the bones of the skull roof in USNM 314342 is most similar to that of *Lepidochelys* and *Eretmochleys* among carettines in that the frontal enters the margin of the orbit and the suture between the frontal and postorbital is relatively long. In *Caretta* the frontal typically is excluded from the orbit by a contact between the postorbital and prefrontal. Additionally, the long, posterolaterally directed parietal-postorbtial suture matches that of *Lepidochelys* more closely than that of *Caretta*,(the parietal-squamosal contact is longer and the parietal-postorbital suture is reduced in *Caretta*). USNM 314342 is more similar to *Lepidochelys* than to any other member of the Carettini in that the constriction of the palate is located relatively far posteriorly, so that the posterior end of the pterygoid extends strongly laterally towards the quadrate (Figure 4). Although many of the above-listed similarities between USNM 314342 and *Lepidochelys* may be plesiomorphic, the relatively posterior position of the constriction of the palate and the strongly lateral orientation of the posterior processes of the pterygoid are here interpreted as derived features providing further support for Carettini relationships.

The presence of a member of the Carettini on the Pacific coast of North America in the early Miocene has biogeographic and biostratigraphic significance. Lynch and Parham (2003) noted that turtle assemblages from the Miocene of the eastern and western coasts of North America differ in composition. *Euclastes* is present on the Pacific coast but has not been recognized in the east. Also, while members of the Carettini have long been recognized from the Eastern Seaboard of North America, they have not previously been recognized in the western coast. Thus this report of a Miocene record of a member of Carettini from the Pacific coast of North America suggests that the apparent differences in the distribution of this tribe in the eastern and western coasts of North America is likely a result of a combination of small sample sizes and differences in local environments. As well, this specimen is significant in being the oldest member of the tribe Carettini and, therefore, documents that the chelonian sister tribes Chelonini and Carettini were distinct by at least the early Miocene.

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