Sullivan et al., eds., 2011, Fossil Record 3. New Mexico Museum of Natural History and Science, Bulletin 53.

RE-EVALUATION OF PACHYCEPHALOSAURIDS FROM THE FRUITLAND-KIRTLAND TRANSITION (KIRTLANDIAN, LATE CAMPANIAN), SAN JUAN BASIN, NEW MEXICO, WITH A DESCRIPTION OF A NEW SPECIES OF *STEGOCERAS* AND A REASSESSMENT OF *TEXACEPHALE LANGSTONI*

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Abstract—Two partial pachycephalosaurid skulls, from the upper Fruitland and lower Kirtland formations (Upper Cretaceous), are recognized as belonging to a new species of *Stegoceras* Lambe, *S. novomexicanum*, n. sp. *Stegoceras novomexicanum* differs from the only other recognized species of *Stegoceras* (*sensu* Sullivan, 2003) in possessing: a reduced and sub-rectangular posteromedial extension of the parietal; parallel squamosal sutural surface contacts of the posteromedial extension of the parietal; enlarged and medially positioned supratemporal fenestrae; and a small (adult) size. Fusion of the frontal and parietal in one specimen, coupled with a smooth dorsal surface of the frontoparietal dome, is consistent with an adult ontogenetic stage. Gross histology reveals four histomorphs, the fourth (outer-most layer) indicates arrested growth, further attesting to its mature state.

Stegoceras novomexicanum is known from, and restricted to, the upper Fruitland Formation (Fossil Forest Member) and lower Kirtland Formation (Hunter Wash Member); the collective vertebrates from these contiguous strata make up the Hunter Wash local fauna. Contrary to previous reports, the *Prenocephale* (= *Sphaerotholus*) -like pachycephalosaurids are not known from the early Kirtlandian, but are restricted to the Willow Wash local fauna of the upper Kirtland Formation (De-na-zin Member). *Stegoceras novomexicanum* is temporally younger (Kirtlandian) than the well-known *S. validum* from the Judithian of Alberta, Canada.

A reassessment of the newly named taxon *Texacephale langstoni* demonstrates that it is not based on diagnostic material and, therefore, is a *nomen dubium*.

INTRODUCTION

Two fragmentary pachycephalosaurid specimens (SMP VP-2555 and SVP VP-2790), both consisting of parts of the skull, were recently discovered in the upper part of the Fruitland Formation and lower part of the Kirtland Formation, respectively, in the San Juan Basin of northwestern New Mexico (Fig. 1). The sites, known as “Target 8” and “Target 9,” located on the Sargent Ranch, NM 7.5 minute USGS Quadrangle, were first noted by Kues et al. (1977) as an area strongly recommended for substantial fossil collecting to mitigate the impacts of then-proposed coal strip-mining. To our knowledge, we are the first to collect from these sites since the Kues et al. (1977) report. Numerous specimens of macro- and microvertebrates (fishes, turtles and dinosaurs) have been recovered from both places. The site is one of the best places in the San Juan Basin for documenting the Fruitland-Kirtland transition.

These new specimens force a re-evaluation of some previously described pachycephalosaurid fossils from the San Juan Basin, including NMMNH P-33898 (Williamson and Carr, 2002a; Sullivan and Lucas, 2006b), and also NMMNH P-30067 and P-30068 (Williamson and Carr, 2002b). Here, we describe these two new SMP pachycephalosaurid specimens from Target 8 and Target 9, upon which we name a new species of *Stegoceras*, and discuss the significance of these new pachycephalosaurid specimens with regard to pachycephalosaurid taxonomy, ontogeny, paleobiogeography, and temporal position, as well as their importance to the pachycephalosaurid fossil record in New Mexico and North America. We also re-evaluate *Texacephale langstoni* and comment on its affinities.

In this paper institutional abbreviations are: **CMN**, Canadian Museum of Nature, Ottawa, Ontario, Canada; **LSUMNS**, Louisiana State University Museum Natural Science, Baton Rouge, LA, USA; **MPM**, Milwaukee Public Museum, Milwaukee, WI, USA; **NMMNH**, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; **SMP**, The State Museum of Pennsylvania, Harrisburg, PA, USA; **TMP**. Royal Tyrrell Museum of Paleontology, Drumheller. Alberta, Canada; **UALVP**, University of Alberta, Laboratory of Vertebrate Paleontology, Edmonton, Alberta, Canada.

SYSTEMATIC PALEONTOLOGY

DINOSAURIA Owen, 1842
ORNITHISCHIA Seeley, 1887
PACHYCEPHALOSAURIDAE Sternberg, 1945
STEGOCERAS Lambe, 1902
STEGOCERAS NOVOMEXICANUM n. sp.
Figs. 3A-C, 4-7

Pachycephalosauridae indet. Williamson and Carr, 2002, p. 67.
Stegoceras validum Sullivan and Lucas, 2006b, fig. 1, p. 329.

Etymology – The species name is derived from the State of New Mexico, from which the holotype and paratypes came.

Diagnosis – Differs from *Stegoceras validum* (the holotype, CMN 515, Fig. 3D-F) in possessing the following features: posteromedial extension of the parietal reduced and sub-rectangular; squamosal sutural surface contacts of the posteromedial extension of the parietal roughly parallel; supratemporal fenestrae more medial and enlarged; gracile and small adult size (see Appendix for revised diagnoses of *Stegoceras* [*sensu stricto*] and *S. validum*).

Holotype – NMMNH P-33898, nearly complete frontoparietal (Fig. 3A-C).

Paratypes – SMP VP-2555, greater posterior part of left frontal and anterior-most portions of left and right frontals (Figs. 4-6); SMP VP-2790, incomplete parietal (Fig. 7).

Type Locality – NMMNH locality 4716, San Juan Basin, New Mexico. Precise coordinates retained at the NMMNH and are available to qualified researchers.

Paratype Locality – SMP VP-2555 is from the upper Fruitland Formation (Fossil Forest Member), late Campanian (early Kirtlandian)

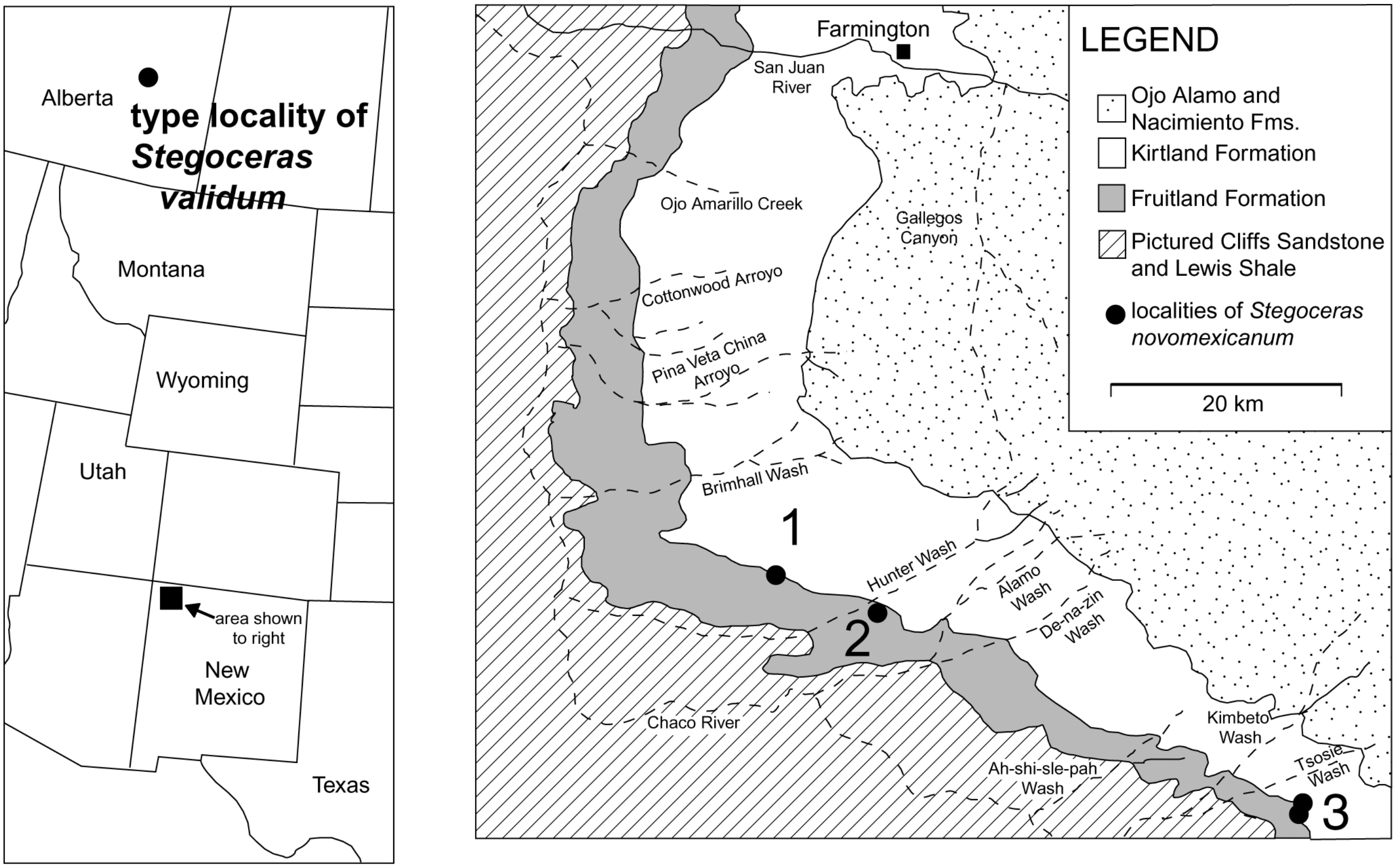

FIGURE 1. **Left**, region where *Stegoceras* (*sensu stricto*) specimens have been found; **Right**, locality map indicating the *Stegoceras novomexicanum* n. sp., localities in the San Juan Basin, New Mexico. **1**, NMMNH L-3097 (locality of NMMNH P-30067); **2**, NMMNH L-4716 (locality of NMMNH P-33933); and **3**, SMP loc. 450 (locality of VP-2555); SMP loc. 461 (locality of SMP VP-2790). Modified from Sullivan and Lucas (2006), after Brown (1983).

at SMP locality 450 ("Target 8"), San Juan Basin, New Mexico Forest Member), late Campanian (early Kirtlandian); SMP VP-2970 is from the lower part of the Kirtland Formation (Hunter Wash Member), late Campanian (early Kirtlandian) at SMP locality 461 ("Target 9"), San Juan Basin, New Mexico.

Formation/Age – Upper Fruitland Formation (Fossil Forest Member) to lower Kirtland Formation (Hunter Wash Member), late Campanian (early Kirtlandian).

Emended Description – The description presented by Sullivan and Lucas (2006b, p. 329) is emended by the following observations: the posteromedial extension of the parietal reduced and sub-rectangular; squamosal sutural surface contacts of the posteromedial extension of the parietal parallel; supratemporal fenestrae are large and relatively close together; and small size.

Remarks – The features that serve to distinguish *Stegoceras novomexicanum* from *S. validum* (posteromedial extension of the parietal reduced and sub-rectangular; squamosal sutural surface contacts of the posteromedial extension of the parietal parallel; supratemporal fenestrae more medial and enlarged; and small adult size) are either present or inferred to be present in the two paratype specimens (SMP VP-2555 and VP-2790) based on cross comparisons with the holotype.

We note here that the anterior margins of the supratemporal fenestrae are intact in the holotype *Stegoceras novomexicanum* (NMMNH P-33898) and the general shape of the posteromedial extension of the parietal is narrow compared to the holotype of *Stegoceras validum* (CNM 515). While it could be argued that the holotype of *S. novomexicanum* represents an immature individual, we believe that it is mature and it is taxonomically distinct from *S. validum*. When considering other features that are present in the referred material, it is evident that we are dealing with a species that is nearly full grown based on: 1) smoothness of the frontoparietal dome (in SMP VP-2555, a slightly larger and more mature individual); 2) a capping histological layer in both SMP VP-2555 and SMP VP-2790, suggesting arrested growth; and 3) partial fusion of the frontals, as well as the frontoparietal, as seen in SMP VP-2555. These observations are discussed in greater detail below. In addition, when considering that the New Mexico specimens are biostratgraphically younger and geographically separate from *S. validum*, these additional facts would further support the recognition of a separate species.

Description of paratype material – SMP VP-2555 (Fig. 4-6) consists of a nearly complete left frontal with the anterior part of the right frontal and anterior part of the parietal. There are two main sections: the greater anterior part of the right frontal with the anterior-most part of the left frontal fused (Fig. 4) and the greater posterior part of the left frontal with part of the parietal fused (Fig. 5). The posterior portion of the frontal is broken near the frontal-parietal suture, with a dorsal portion of the parietal fused to the frontal medially. The left frontal is missing a section between the anterior part that is fused with the right frontal and the main posterior part of the left frontal. The sutural surface of the right frontal, lying above and adjacent to the right olfactory roof impression, is visible. Posteriorly, the ventral portion is marked by two sutural grooves (Fig. 4D) that are divided by a prominent medial ridge which runs parallel to the right olfactory roof impression. A section above the anterior portion of the postorbital articulation surface, and lateral to the fused parietal part, is broken. Viewed ventrally, the right frontal is broken posterolaterally along the border of the posterior olfactory roof impression. In lateral view, the broken surface extends somewhat anteriorly, resulting in nearly two-thirds of the right frontal being

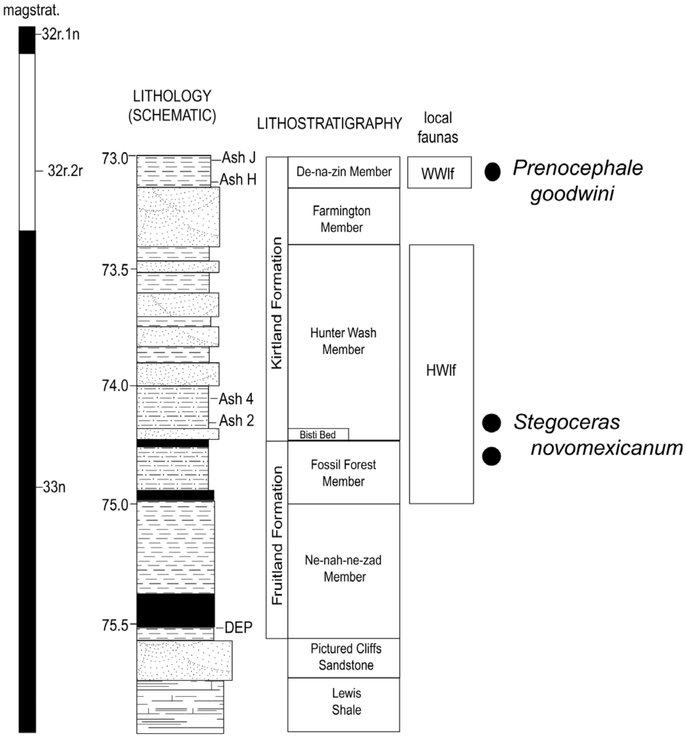

FIGURE 2. Stratigraphic distribution of *Stegoceras novomexicanum* n. sp. and *Prenocephale goodwini*.

absent posteriorly. Medially, the left frontal is sheared in a sub-sagittal plane, exposing the histology (microstructure) of the anterior part of the dome (frontal and incomplete parietal section).

The dorsal surface of the right and left fused anterior portions of the frontals is relatively smooth with only a few pits (Fig. 4A). The dorsal surface is curved, forming the posterior extension of the frontal nasal boss. Along the posterior lateral margin, textural rugosity, associated with the supraorbitals, is present.

The posterior section of the left frontal, including the fused-parietal portion, is highly-domed posteriorly with the anterior surface of the dome sloping 45 º from the horizontal (Figs. 5A, C, D, 6). Following Goodwin (1990), the dome measures approximately 31.55 mm high (measured from the frontoparietal suture on the roof of the braincase to the terminal point of the dome along a 90º vertical projection). The lower dorsal surface of the dome is pitted and has a node-like texture along the left anterolateral edge immediately above the sutural surfaces of the anterior and posterior supraorbitals. The highest portion of the dome is smooth, with little to no surface texture.

The sutural surfaces of the peripheral elements on the frontals are well-developed. They include, on the anterior right frontal, the nasal and the right anterior supraorbital articulation surface (Fig. 4C). On the anterior part of the left frontal, there is part of the nasal articulation surface (Fig. 4D). On the posterior part of the left frontal are the articulation surfaces for the anterior supraorbital, the posterior supraorbital, and the anterior part of the postorbital (Fig. 5C). The thickest articulation surface is the medial part of the left posterior supraorbital articulation surface, which measures 10.71 mm, or approximately one third the height of the dome.

Ventrally, the anterior parts of the frontals preserve only the right olfactory lobe impression (Fig. 4B). The ventral surface, measured along the midline from the anterior part of the frontals to the posterior of the olfactory lobe impression, is 24.61 mm. The left posterior section preserves the impressions of the entire left orbital roof and the left cerebrum (Fig. 5B). The orbital roof impression has several pits on its surface concentrated mostly towards the midline. There are also several faint ridges radiating out from the internal rim of the orbital roof impression. Although there is a fracture that runs through the middle of the rim and extends to the edge of the cerebrum impression, there is a sutural groove (Fig. 5B) for the left laterosphenoid, left orbitosphenoid, and the left accessory orbital ossification 3 (see Goodwin et al., 1998). This groove is deep and has an irregular edge medially for the attachment of the above mentioned elements; laterally along the margin, the orbital rim is smooth. Posterolaterally, there is a prominent, inverted "V"-shaped facet for the insertion of the ventral anterior portion of the left postorbital (Fig. 5B-C). The posterior edge of the left frontal is slightly sloped dorsocaudally and is sutured on the medial half. The lateral half towards the inverted, postorbital "V"-shaped facet is generally smooth. This sloped surface represents the sutural attachment of the parietal.

The sheared sub-sagittal surface of the left frontal (Figs. 5D and 6), including a small anterior section of the parietal, reveals the gross histology of the anterior portion of the frontoparietal dome. We recognize and identify four distinct "histomorphs" that we believe represent growth stages (Fig. 6). These are, from oldest to youngest, a: h1) inner core region of densely-packed, vascular bone characterized by small, homogeneous pores; h2) a thin, surrounding layer of vascular bone characterized by elongated, radiating pores; h3) a lens of highly-porous, vascular bone, characterized by larger and more heterogeneous pores; and h4) an avascular, dense bony layer. The inner core measures 11.10 mm at its thickest point; the thin, surrounding layer is relatively uniformly thick, and measures 3.10 mm at its thickest point (dorsally); the vascular lens measures 12.17 mm at its thickest point below the highest part of the dome; and the capping, avascular layer is uniformly thick, thinning slightly towards the anterior of the dome, and measures 3.40 mm at its thickest part.

The second paratype**,** SMP VP-2790 (Fig. 7), is an anterior portion of an incomplete parietal. The parietal is broken on both the lateral sides where it joins with the left and right postorbitals. On the right side, part of the sutural contact for the right postorbital is present. A section is missing posteriorly at the midline.Ventrally, the left cerebral roof impression is missing due to breakage along the ventral surface of the parietal.

The parietal measures approximately 33.56 mm along the dorsal surface of the inferred midline, from the frontoparietal suture to the posterior border. The maximum length, measured along the midline of the broken ventral surface is approximately 27.38 mm. The slope (dorsal surface to the horizontal) of the parietal is approximately 67º (compared to 47º for NMMNH P-33898).

The dorsal surface (Fig. 7A) is relatively flat and pitted, with no node-like structures present. The pits are relatively large and irregular. There is a curious, parabolic depression (Fig. 7A) on the left side of the parietal, immediately adjacent to the midline, measuring approximately 8.70 mm (maximum length). The morphology of the posterior border is difficult to characterize due to breakage along the medial and right lateral parts of the parietal. On the left lateral side, the posterior edge of the parietal is smooth, clearly indicating the presence of a supratemporal fenestra. Adjacent to that on the medial side, there is a slightly damaged, rugose area that we believe represents the posteromedial extension of the parietal.

Ventrally, the right supratemporal rim is well-developed, forming the internal border of the supratemporal region (Fig. 7B). The left supratemporal region is damaged. The angle of the right supratemporal rim with the midline is approximately 65°.

The frontoparietal articulation surface of the parietal is incomplete, with much of the right side preserved, with the ventral and lateral portions of the left side broken and missing (Fig. 7C). Maximum thickness of the frontoparietal contact, measured along the midline, is 25.42 mm.

Microscopic observation reveals the gross histology on the broken surface of the left lateral side of the parietal. Three distinct layers or "histomorphs" are present, from ventral to dorsal, these are: 1) a dense

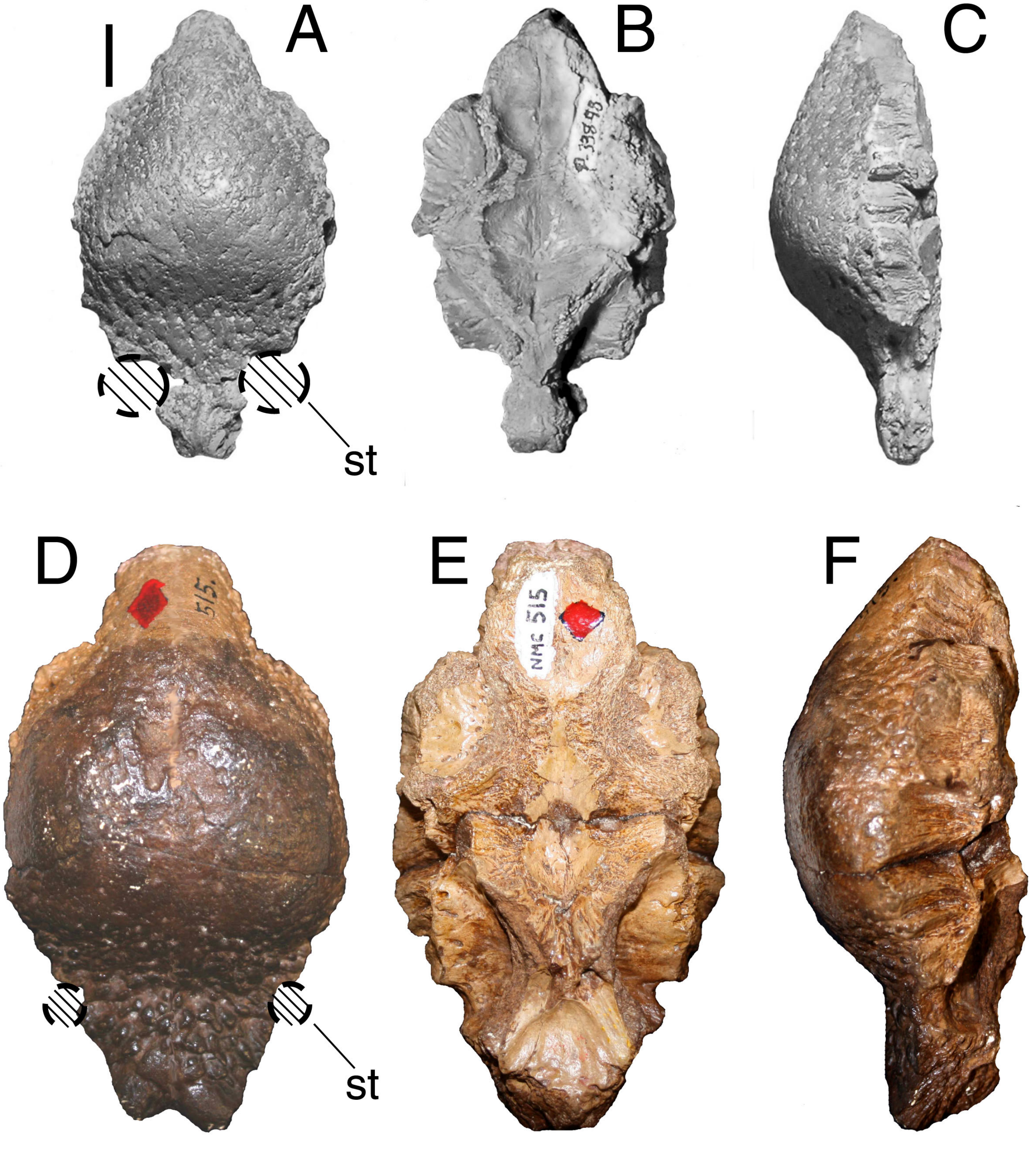

FIGURE 3. *Stegoceras novomexicanum* (NMMNH P-33983, holotype), nearly complete frontoparietal from the upper Fruitland Formation (Fossil Forest Member), San Juan Basin, New Mexico. **A**, dorsal view; **B**, ventral view; and **C**, right lateral view. *Stegoceras validum* (CMN 515, holotype), nearly complete frontoparietal from the Oldman Formation, Alberta, Canada. **D**, dorsal view; **E**, ventral view; and **F**, right lateral view. **Abbreviation: st** = supratemporal fenestra. Bar scale = 1 cm.

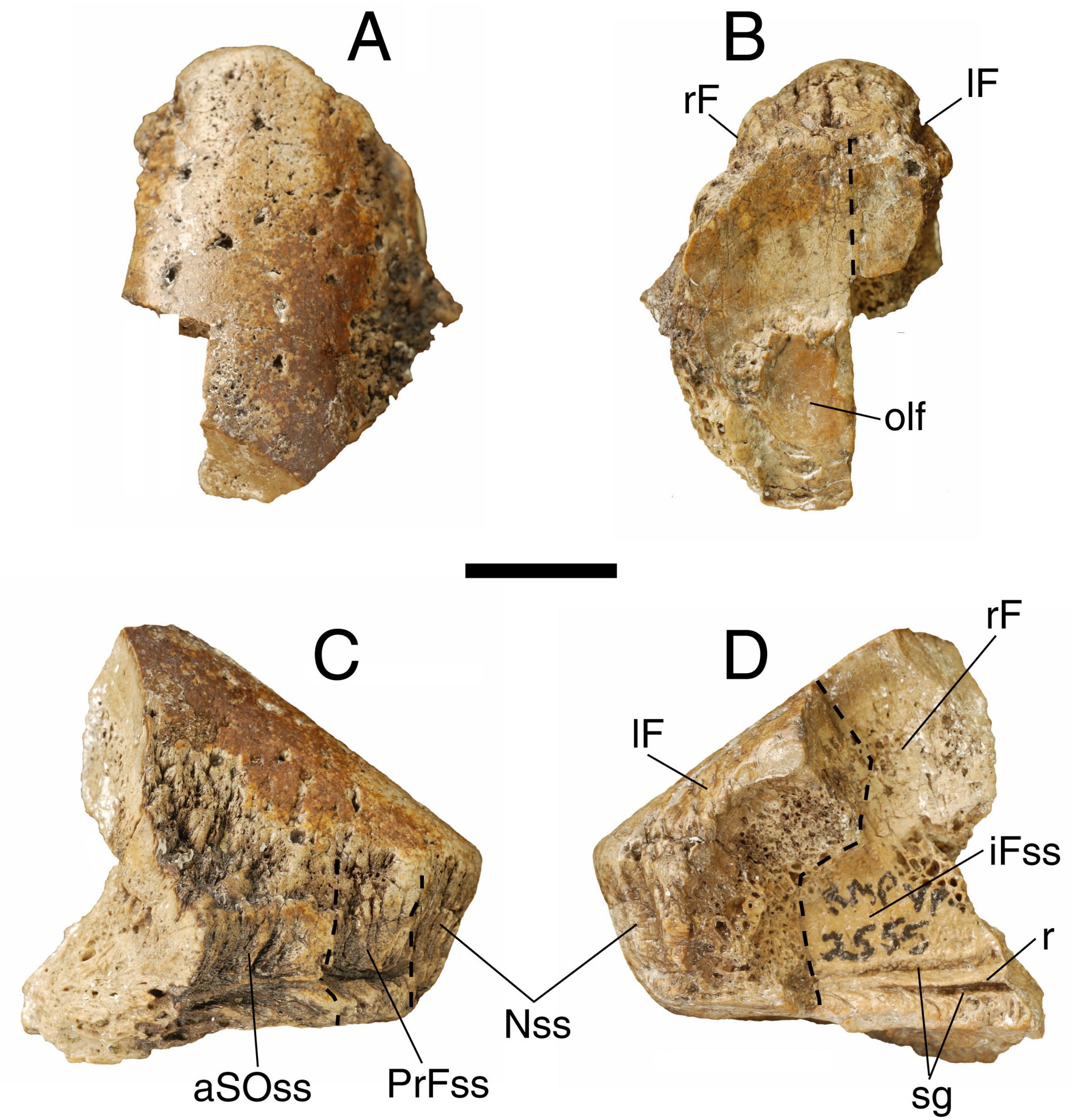

FIGURE 4. *Stegoceras novomexicanum* (SMP VP-2555, paratype), incomplete left and right frontals. **A**, anterior left and right section of frontal (dorsal view); **B**, anterior left and right section of frontal (ventral view) showing the impression of the right olfactory bulb; **C**, anterior section of right frontal (lateral view); **D**, anterior left and right sections of frontal (medial view), showing the articulation surface of the right frontal section posteriorly. **Abbreviations: aSOss** = anterior supraorbitals sutural surface; **iFss** = infrafrontal sutural surface; **lF** = left frontal; **Nss** = nasal sutural surface; **olf** = olfactory impression; **rPrFss** = right prefrontal sutural surface; **rF** = right frontal; **r** = ridge; and **sg** = sutural groove. Scale bar = 1 cm.

and moderately vascularized layer with long, bony struts; 2) a dense, less vascularized layer, with traces of minute bony struts; and 3) a very dense top layer with little vascularization and fewer traces of minute bony struts. The maximum thickness for the dense, less vascularized layer measures approximately 1.70 mm and 1.60 mm for the very dense top layer. The extent of the ventral layer cannot be measured due to breakage.

Remarks – Although SMP VP-2555 is incomplete, comparison to NMMNH P-33898, referred to *Stegoceras validum* by Sullivan and Lucas (2006; misnumbered as P-33893 in text and P-33983 in fig. 1 caption), suggests it belongs to the same taxon, based on identical morphology of the ventral surfaces and similar size. We note that, although the overall frontal length is comparable between the two specimens, SMP VP-2555 is slightly wider by about 5 mm. It is also worth noting, the frontoparietal ratios of the holotype (NMMNH P-33898) departs from the frontoparietal ratios of CMN 515 (holotype of *S. validum*) and CMN 138 (referred specimen of *S. validum*). These ratios are 1.21 (for NMMNH P-33898) to 0.92 (CMN 515) and 0.95 (CMN 138). This indicates a relatively longer parietal in *S. validum*.

In addition, the dome in SMP VP-2555 is 25% higher than that of NMMNH P-33898. Because SMP VP-2555 is relatively the same length of NMMNH P-33898, although it has a much higher dome, we conclude that SMP VP-2555 represents an adult or possibly sub-adult individual. This is consistent with our observations of the gross histology of the dome that we interpret as exhibiting growth rates of ontogenetic development consisting of: 1) a normal period of growth followed by; 2) a short rapid growth spurt; 3) resumption of a more normal rate; terminating with; 4) a thin, dense avascular layer of bone (Figs. 5D and 6). This last layer is arguably the same layer as "Zone III," figured by Goodwin and Horner (2004, fig. 5A, C), and not their other "Zone III" (Goodwin and Horner, 2004, fig. 5D). In addition, the smooth dorsal surface on this highly inflated dome suggests a late ontogenetic stage, presumably an adult. Moreover, the anterior portion of the frontal, which is fused dorsally, without a trace of the intrafrontal suture in SMP VP-2555, further supports the interpretation of an adult stage. We note that MPM 8111 has an intrafrontal suture that is visible dorsally as well as internally (Horner and Goodwin, 2009, fig 4.) suggesting that it represents a subadult ontogenetic stage. The New Mexico specimen, SMP VP-2555, clearly represents a more advanced stage, having the intrafrontal suture unfused internally half way above the olfactory impression (see Fig. 4D). There is no evidence that the intrafrontal suture or the frontoparietal suture, ever completely fuses internally, therefore using these features to gauge subadult/adult ontogenetic stages is ambiguous, as suggested by Horner and Goodwin (2009). There may always be traces of the intrafrontal suture, even in the adult stage.

SMP VP-2790 is larger than NMMNH P-33898. The size of SMP VP-2790 compares readily to the size of SMP VP-2555, which suggests that they represent similar growth stages. Thus, SMP VP-2790 is also probably an adult. The steeper slope suggests a higher dome, which is consistent with our interpretation of SMP VP-2790 being an adult. Moreover, the smooth anterior portion of the parietal surface is probably a continuation of the smooth dorsal surface of the frontal, which has been correlated to the adult ontogenetic stage by Goodwin and Horner (2004).

The histomorphs seen in the parietal (SMP VP-2790) cross-section differ slightly from those of the left frontal (SMP VP-2555) and, in fact, are similar to those illustrated by Goodwin and Horner (2004, fig. 5D). However, we believe "Zone III" of Goodwin and Horner (2004, fig. 5D) can be sub-divided into two distinct layers. The ventral-most layer (1) is equivalent to the upper part of their "Zone II," the dense, less vascularized layer (2) is equivalent to most of their "Zone III," and the outer, very dense layer (3) is the capping of their "Zone III." We interpret a capping layer present above their "Zone III" in fig. 5D to be equivalent in their fig. 5A, 5C (Goodwin and Horner, 2004). We believe that when this capping layer is thick and well-developed, it indicates decreasing growth. We believe that the less-vascularized outer layer can be correlated to the smooth outer surface of the dome. Thus, we interpret this last, well-developed layer (h4 in SMP VP-2555) to be that of an arrested growth stage, consistent with reaching maturity.

DISCUSSION

The characters that we used to diagnose *Stegoceras novomexcanum* may individually be variable, but collectively, we interpret the differences to be taxonomically significant.

Only a few pachycephalosaurid specimens have been recovered from New Mexico. One specimen (NMMNH P-33898) has previously been reported from the Fruitland Formation (Fossil Forest Member) (Williamson and Carr, 2002a; Sullivan and Lucas, 2006b), while another (NMMNH P-30067), has been reported from the Kirtland Formation (Hunter Wash Member) (Williamson and Carr, 2002b). A third specimen (NMMNH P-30068), originally reported from the Farmington Member (Williamson and Carr, 2002b), is most certainly from the Hunter Wash Member (see below), and two additional specimens (NMMNH P-27403 and SMP VP-1084) are from the De-na-zin Member (Sullivan, 2000; Williamson and Carr, 2002b). The material discussed herein is noteworthy, not only because it increases the number of specimens known from New Mexico, but also offers new insights into their morphology.

As currently interpreted, vertebrate fossils from the upper part of the Fruitland Formation (Fossil Forest Member) through the Kirtland Formation (*sensu* Sullivan and Lucas, 2006a) are of Kirtlandian age (75.0-72.8 Ma) (Sullivan and Lucas, 2003, 2006a). Vertebrates from the upper part of the Fruitland Formation (Fossil Forest Member) and the lower part of the Kirtland Formation (Hunter Wash Member) belong to the Hunter Wash local fauna (HWlf), and date to approximately 74.5 Ma (Sullivan and Lucas, 2006a). Fossil vertebrates from the upper Kirtland Formation (De-na-zin Member) belong to the Willow Wash local fauna (WWlf) and date to approximately 73.0 Ma (Williamson and Sullivan, 1998; Sullivan and Lucas, 2003, 2006a).

A badly weathered, incomplete frontoparietal dome (NMMNH P-30067, Fig. 8) is from the Hunter Wash Member (Kirtland Formation). The frontoparietal of NMMNH P-33898 is slightly shorter (75 mm) than that of the frontoparietal of NMMNH P-30067, which is approximately 87.5 mm measured medially (Williamson and Carr, 2002b). However, we estimate that SMP VP-2555 has a frontoparietal length of approximately 103 mm. Although the size is consistent with *S. novomexicanum*, taking into account that the posterior-most part of the parietal of NMMNH P-30067 is missing, the general shape of the frontoparietal is more inflated, reminiscent of *Prenocephale* and the newly named *Texacephale langstoni* (Longrich et al., 2010, see below). However, on the left posterior margin of the parietal, there is a small, smooth downward sloping section approximately 5 mm wide, which may represent the anterior border of the left supratemporal fenestra. There is no indication of a corresponding fenestra on the other side. NMMNH P-30067 also has a pedicel-like ventral surface, similar to that described for *Texacephale langstoni*, but this is clearly an artifact of erosion (see discussion below). We tentatively retain it as Pachycephalosauridae indeterminate.

The other specimen (NMMNH P-30068), consisting of a left dentary, left squamosal fragment, and frontoparietal fragment, originally reported from the Farmington Member of the Kirtland Formation was identified as cf. "*Sphaerotholus*" *goodwini* by Williamson and Carr (2002b). Re-evaluation of this material calls into question not only their identification of a frontoparietal fragment, but also their taxonomic identification.

The squamosals of *Stegoceras validum* are distinct in that they form a prominent squamosal shelf, adorned with numerous nodes. In contrast, the squamosals of *Prenocephale* (= *Sphaerotholus*) are less prominent and are characterized by a single row of discrete nodes. NMMNH P-30068 is more like the former, therefore referral to *Prenocephale* (= *Sphaerotholus*) *goodwini* is not correct. We cannot confirm the identity of the frontoparietal fragment and note confusion in

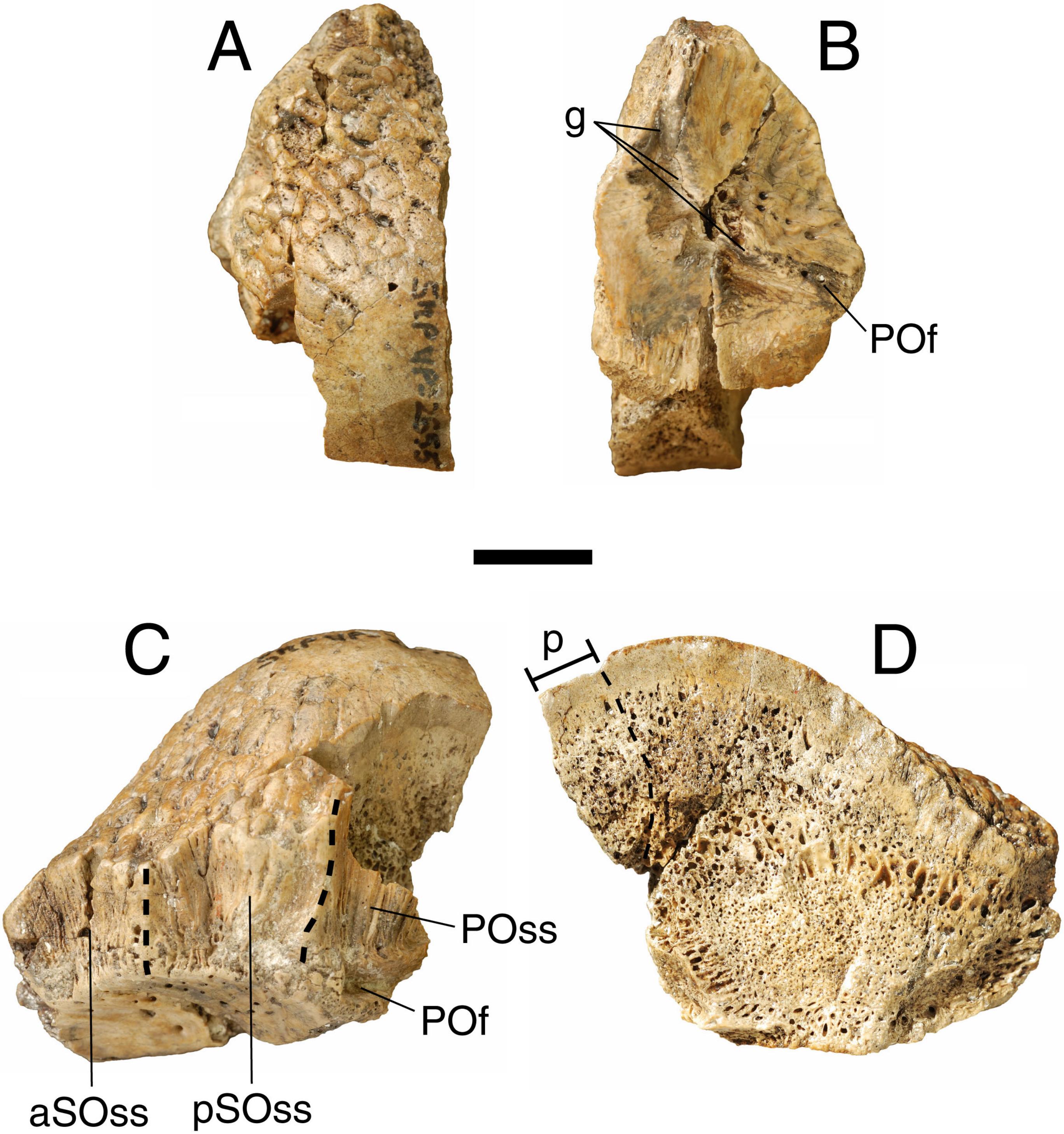

FIGURE 5. *Stegoceras novomexicanum* (SMP VP-2555, paratype), incomplete left and right frontals. **A**, greater portion of left frontal and anterior portion of the parietal (dorsal view), **B**, greater portion of left frontal and anterior portion of the parietal (ventral view) showing the roof of the left orbital and left cerebrum impression; **C**, greater portion of left frontal and anterior portion of the parietal (lateral view) showing sutural surfaces for the left nasal, anterior supraorbital, posterior supraorbital, and anterior part of the postorbital; and **D**, parasagittal section of the greater portion of left frontal and anterior portion of the parietal (medial view) showing the internal structure ("histomorphs"). **Abbreviations: aSOss** = anterior supraorbitals sutural surface; **g** = groove; **p** = parietal; **POf** = postorbital facet; **POss** = postorbital sutural surface; and **pSOss** = posterior supraorbitals sutural surface. Scale bar = 1 cm.

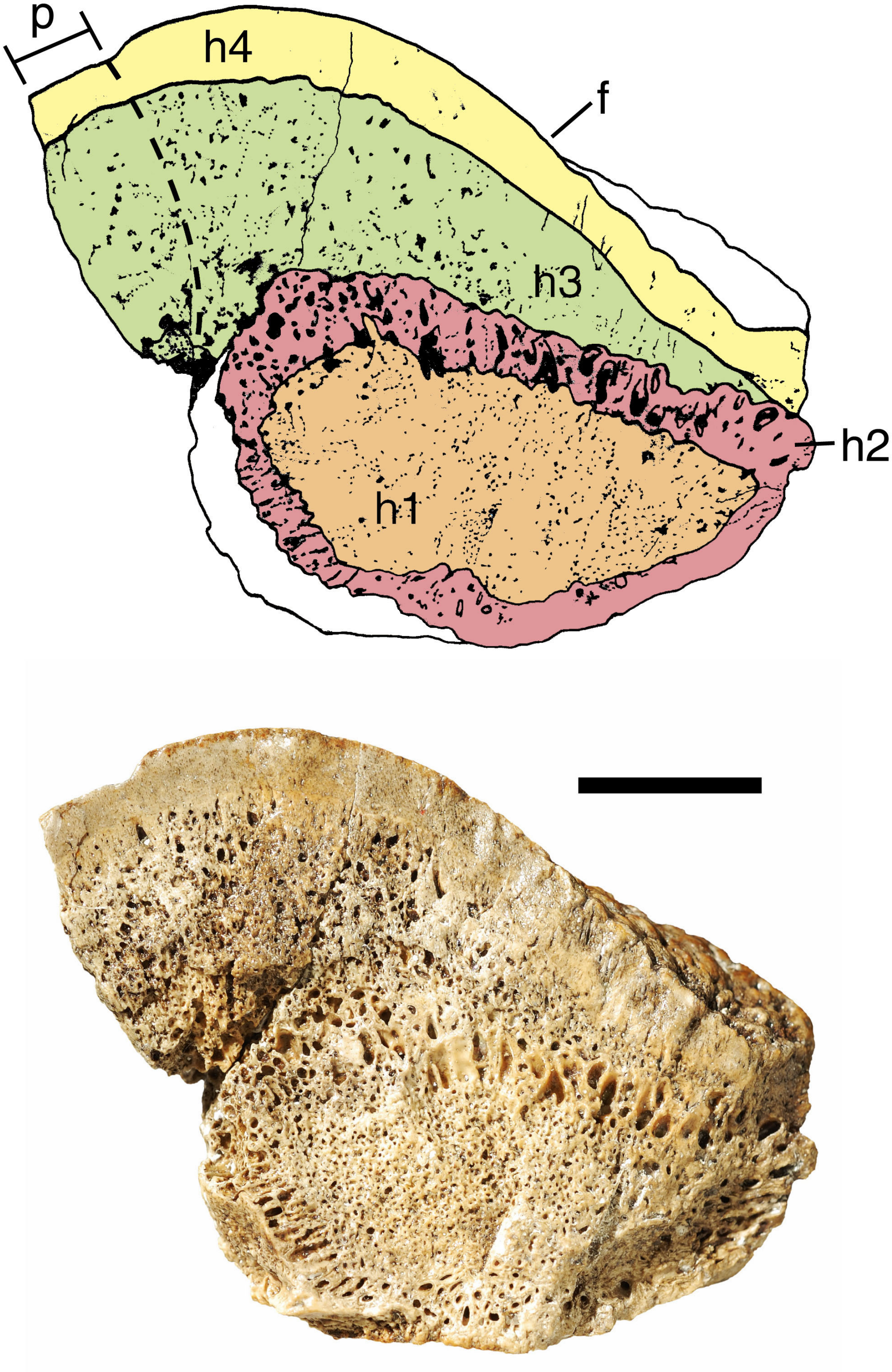

FIGURE 6. *Stegoceras novomexicanum* (SMP VP-2555, paratype), parasagittal section of the greater portion of left frontal and anterior portion of the parietal (medial view) showing the internal structure ("histomorphs"); line drawing (**above**), photo (**below**). **Abbreviations: f** = frontal; **h1 (histomorph 1)** = inner core region of densely-packed, vascular bone characterized by small, homogeneous pores; **h2 (histomorph 2)** = a thin, surrounding layer of vascular bone characterized by elongated, radiating pores; **h3 (histomorph 3)** = a lens of highly-porous, vascular bone, characterized by larger and more heterogeneous pores; **h4 (histomorph 4)** = an avascular, dense bony layer; and **p** = parietal. Scale bar = 1 cm.

the identity and labeling of the frontoparietal and squamosal in their figures 7B and 7C, and the call-outs in their description and dentary sections of the text (Williamson and Carr, 2002b, p. 788, 790). Our identification of NMMNH P-30068 as more *Stegoceras*-like, is consistent with the new material described above. We note, too, that the size of NMMNH P-30068 is similar to other specimens recovered from the Hunter Wash local fauna (upper Fruitland and lower Kirtland formations).

Williamson and Carr (2002b) described the incomplete left dentary of NMMNH P-30068 and noted that it differed in some respects from dentaries of *Stegoceras validum* based on UALVP-2. Differences noted by Williamson and Carr (2002b) include: 1) smaller size; 2) mesiodistally short teeth; and 3) rostral teeth with basal cingula and mesial basal projections. They also noted minor differences between the dentary of NMMNH P-30068 with those of UALVP-2 in the rostral end, the lateral surface of the osteodermal covering on the angular, the depth of the Meckelian groove and the number of alveoli (15 in NMMNH P-30068 versus 17 in UALVP-2). Although some of these differences might be ontogenetic and/or variable, the number of differences lends support to the recognition of a distinct species for the New Mexico material.

In addition, the material was acquired illegally from Indian land, confiscated, and now resides in the NMMNH collections (Williamson and Carr, 2002b). The stratum from which NMMNH P-30068 came, together with the holotype of *Bistahieversor sealeyi* (= "*Albertosaurus*") (NMMNH P-25049), was identified as the Farmington Member of the Kirtland Formation (Williamson and Carr, 2002b; Carr and Williamson, 2010). However, we note that exposures of the Farmington Member are extremely limited, are high in the Kirtland Formation, and crop out only in the eastern part of the Bisti/De-na-zin Wilderness, which calls into question the published stratigraphic provenance of Williamson and Carr (2002b) and Carr and Williamson (2010). Indeed, the locality (NMMNH locality P-3097, sec. 31, T24N, R14W) is far to the west of the Bisti/De-na-zin Wilderness, where only the lower part (Hunter Wash Member) of the Kirtland Formation has been mapped (Brown, 1983). Therefore, the correct stratigraphic horizon is the Hunter Wash Member of the Kirtland Formation, which is consistent with our taxonomic identification of the specimen. Thus, *Prenocephale goodwini* is restricted to the De-na-zin Member of the Kirtland Formation.

We argue that there are four "*Stegoceras*-like" specimens (NMMNH P-30068, P-33898, SMP VP-2555 and VP-2790) and one indeterminate pachycephalosaurid specimen (NMMNH P-30067) from the HWlf. Only two specimens of *Prenocephale* (= *Sphaerotholus*) *goodwini* are known: NMMNH P-27403 (holotype) and SMP VP-1084 (Sullivan, 2000, 2003, 2006b; Schott et al., 2009), a taxon known only from the WWlf of the Kirtland Formation (De-na-zin Member). Their stratigraphic distribution is presented in Fig. 2.

The new material is interesting because it suggests that these are near fully-grown individuals based on our interpretation of the parasagittal cross-section of SMP VP-2555. The four recognized histomorphs on this specimen are interpreted as representing a growth sequence. The first represents a normal growth stage (h1) that is indicated by homogeneous pore size. This is followed by an abrupt accelerated growth stage (h2) that is indicated by pores that are enlarged and stretched, forming a distinct ring around h1. This ring suggests rapid growth outward in all directions. The third (h3) is a return to more normal growth, represented by a smaller pore size, which is more heterogeneous than that seen in h1. Lastly, a distinct, arrested growth stage (h4) is indicated by an avascular, highly-compact outer layer. On the right lateral broken surface of the anterior portion of the frontals, all four histomorphs are visible. Only the outer two layers (h3 and h4) are visible on the lateral sides of SMP VP-2790 because the ventral portion is broken.

Consequently, these observations throw into question the taxonomic identification of Sullivan and Lucas (2006b). We note that a number of specimens of *Stegoceras validum* are much larger than that of NMMNH P-33898, SMP VP-2555 and SMP VP-2790 based on the well-known skull of UALVP-2 and a number of skulls in the collections of the TMP and the CMN. Comparison to the holotype of *Stegoceras validum* (CMN 515), a specimen we infer represents the same growth stage as NMMNH P-33898, unequivocally shows that the New Mexico specimens are much smaller, so we interpret them as a species distinct from *S. validum*.

Comparison of SMP VP-2790 to CMN 138 shows that the posterior edge of the parietal of SMP VP-2790 rises up rapidly from the anterior margin of the supratemporal fenestra, while the posterior part of the parietal of CMN 138 is depressed, resulting in a very prominent parietosquamosal shelf, both laterally and posteriorly. This suggests that CMN 138 is not fully mature, which is consistent with the more developed dome and parietosquamosal shelf of UALVP-2. However, we note that SMP VP-2790 is not fused to the frontal, whereas CMN 138 is. This suggests that fusion of the frontoparietal and inflation of the dome are temporally and ontogenetically variable.

SMP VP-2790 is slightly larger than NMMNH P-33898. The slope of the parietal is nearly the same in both specimens, however the parietal appears to be slightly more inflated in SMP VP-2790. The posterior margins of both specimens are nearly identical in size and morphology, with the exception that the posteromedial extension of the parietal is broken off in SMP VP-2790. *Stegoceras validum* differs from the New Mexico specimens in that the posteromedial extension of the parietal is more robust and trapezoidal in shape, whereas in NMMNH P-33898 it is less well-developed and sub-rectangular in shape, with the articulation surfaces of the squamosal being nearly parallel, rather than splayed. Therefore, the supratemporal fenestrae are closer to the midline in *Stegoceras novomexicanum* than in *S. validum*.

Although the dome of NMMNH P-33898 is not fully-developed, we believe it represents a near fully-grown individual and is the same ontogenetic stage as CMN 515 and CMN 138. Therefore, three New Mexico specimens (NMMNH P-33898, SMP VP-2555 and SMP VP-2790) represent roughly the same ontogenetic stage. Lastly, NMMNH P-30068 is also probably from a subadult or adult individual about the same size as NMMNH P-33898 based on comparable measurements of the left dentary as compared to the left dentary of UALVP-2.

While the New Mexico specimens (NMMNH P-33898, SMP VP-2555 and SMP VP-2790) are of similar size, they clearly differ in ontogenetic development. However, we do not believe that the differences in the fusion of the frontoparietal and the degree of doming are significant. Fusion and doming are sequentially variable, but the New Mexico specimens probably represent near fully mature individuals. The histomorphs seen in both SMP VP-2555 and SMP VP-2790 are interpreted as fully-grown, mature individuals based primarily on the capping, outer layer (h4). This suggests that the dome in *Stegoceras novomexicanum* did not develop further. This fact is corroborated by, and consistent with, the observation of Sereno (2000) that the dome of *Stegoceras validum* did not fully form to incorporate the peripheral elements (supraorbitals, postorbitals and squamosals).

TAXONOMIC STATUS OF THE PACHYCEPHALOSAURID *TEXACEPHALE LANGSTONI*

Of particular interest is the newly named taxon *Texacephale langstoni*, recently described by Longrich et al. (2010). The holotype specimen (LSUMNS 20010), a weathered frontoparietal dome, bears close similarity to NMMNH P-30067. Both specimens are highly-domed, bear similar peripheral sutural surfaces, and a "pedicel-like" ventral surface. However, the characters used to diagnose this taxon are not taxonomically sufficient because they are either insignificant, not unique, or are an artifact of preservation.

The "vertical flanges" identified by Longrich et al. (2010) as an autapomorphy of *Texacephale langstoni* are simply the irregular, interlocking sutural surfaces of the frontoparietal dome with the peripheral skull elements. These so-called "flanges" have no pattern, are seen on every pachycephalosaurid where these surfaces are exposed, and have no taxonomic utility. Their prominence in pachycephalosaurid specimens is variable among, and within, taxa and no consistent pattern has ever been demonstrated or recognized. Therefore, we consider this to be a dubious feature and of no taxonomic importance at the genus and species level.

The "tall nasal boss" of *Texacephale langstoni* compares readily to NMMNH P-27403 and SMP VP-1084, both considered *Prenocephale goodwini*. The nasal boss in LSUMNS 20010 is similar to many other pachycephalosaurid nasal bosses, with no distinguishing characteristics. Therefore, this character is not unique with regard to *Texacephale langstoni*.

The third "diagnostic" character of *Texacephale langstoni*, "skull roof elevated above the roof of the braincase by a low pedicel" is clearly an artifact of erosion around the periphery of the ventral surfaces of the frontoparietal. A "pedicel-like" platform is also seen in NMMNH P-33067. Close examination of the roof of the braincase, using a binocular microscope, reveals that the ventral surface of the frontoparietal dome has a different histology compared to the rest of the dome. The bone making up the roof of the braincase is 2-3 mm thick and is layered, with the vascularized tissue oriented horizontally, with overlying vascular tissue oriented vertically, in a radial pattern, as identified by Horner and Goodwin (2009). This dense, horizontally-layered, ventral surface of the braincase region (cerebral fossa) is more compact and thus is more resistant to mechanical weathering, resulting in a "pedicel-like" platform. The "pedicel" is clearly a "pre-depositional" wear feature that has no taxonomic utility.

The three characters used to diagnose *Texacephale langstoni* are thus considered by us to be invalid as they are either morphological features seen in other pachycephalosaurids or are preservational in nature, having no taxonomic value. We note that LSUMNS 20010 bears strong resemblance to NMMNH P-30067 and may represent the same taxon. However, given the condition and nature of both specimens, we also regard LSUMNS 20010 as Pachycephalosauridae indeterminate.

Aside from the defining characters used by Longrich et al. (2010), we note additional characters that are either misinterpreted or misrepresented. They use a hybrid nomenclature for peripheral skull elements, contrary to that used by Sereno (2000), Sullivan (2003), and Schott et al. (2009). Moreover, they do not delineate the lateral borders of any of the peripheral elements. We are unable to comment on the presence of the supratemporal fenestrae in LSUMNS 20010 based on their figs. 3 and 4. We note that in fig. 4D, "stf" refers to the anterior border of the supratemporal fenestrae, their "sfe." In fig. 4B, "sfe" should be "sfo" (supratemporal fossa), and in figs. 4D and F, "stf" should be "sfo" (also supratemporal fossa) from their figure caption. Their fig. 4A and the corresponding photograph (fig. 3A) do not convincingly show the supratemporal fenestrae on either side. With regard to the peripheral elements, the sutural contacts of both the right and left postorbital make up the better posterior half of the sutural surface on their respective sides, a condition similar to that in the genus *Prenocephale*. We take issue with their statement that the roof of the orbit faces somewhat laterally. Examination of other specimens shows that this condition is widespread among pachycephalosaurids, including *Prenocephale*. We disagree with their assessment that the depth of the supratemporal fossae is significant and note that the depth is equivocal. Deep supratemporal fossae are primitive, and thus not taxonomically significant. Moreover, the shape and the depth of the fossae, due to developmental changes of the adductor muscles through the course of ontogeny, make it an unreliable character. The concave profile of the "posterodorsal" surface of the dome is not all that different from the profile of most pachycephalosaurids. The absence of the posteromedial projection of the parietal argues more forcefully for a *Prenocephale*-like condition unless it is broken. But there is no indication of breakage reported by them (Longrich et al. 2010). The difference in the heights of the sutural surfaces, being distinctly taller on the right

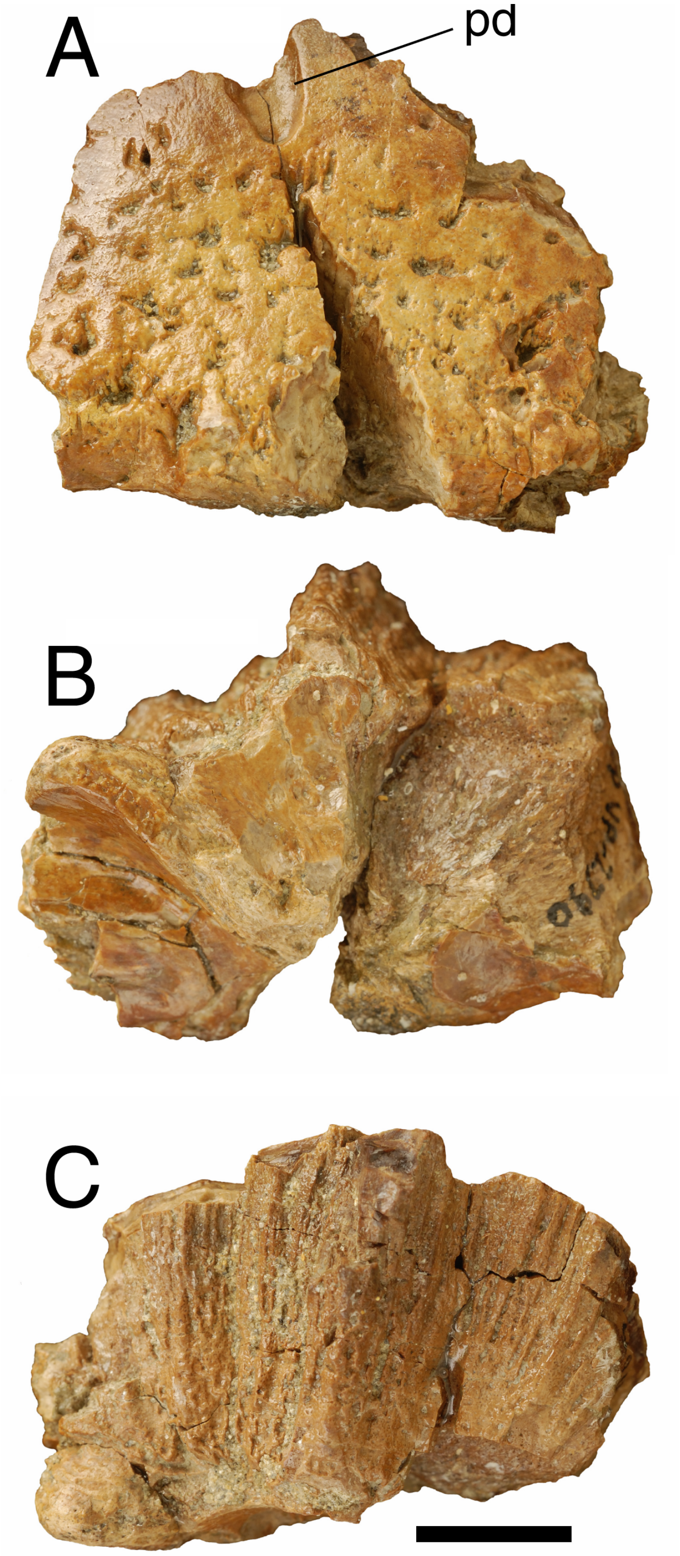

FIGURE 7. *Stegoceras novomexicanum* (SMP VP-2790, paratype), incomplete parietal. **A**, dorsal view; **B**, ventral view; and **C**, anterior view of the frontoparietal suture. **Abbreviation: pd** = parabolic depression. Scale bar = 1 cm.

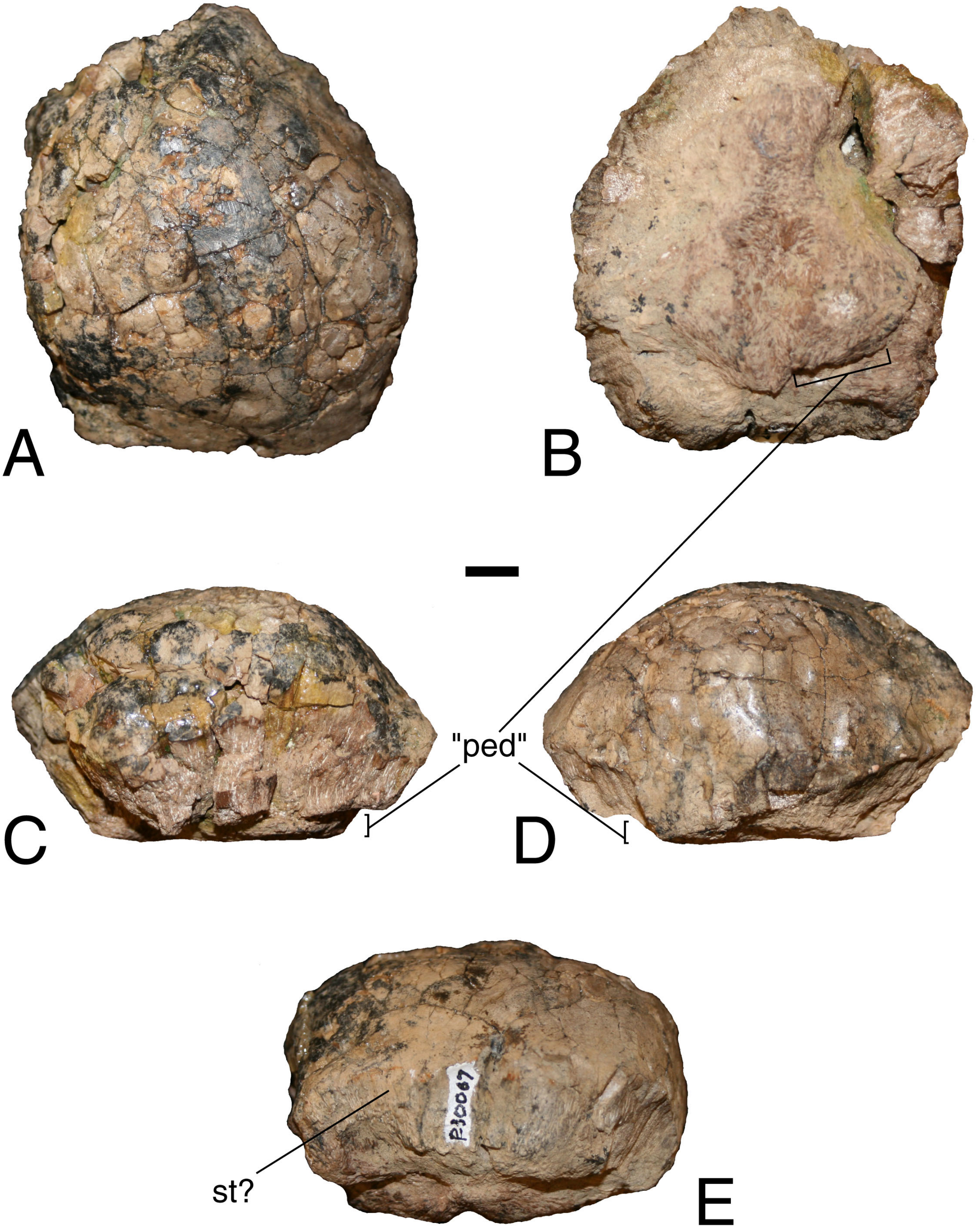

FIGURE 8. Pachycephalosauridae indet. (NMMNH P-30067), nearly complete frontoparietal dome, with special reference to the "pedicel-like platform" and possible supratemporal fenestra (see text for discussion). **A**, dorsal view; **B**, ventral view; **C**, left lateral view; **D**, right lateral view; **E**, posterior view. **Abbreviations: "ped"** = "pedicel-like platform", **st?** = supratemporal fenestra? Scale bar = 1 cm.

compared to the those on the left, has nothing to do with differential expansion of the dome, rather it is an artifact of preservation.

PALEOBIOGEOGRAPHY AND TEMPORAL POSITION OF *STEGOCERAS*

Stegoceras (*sensu lato*) has recently undergone a major reallocation of species (Sullivan, 2000, 2003, 2006). Thus, most of the species previously placed in *Stegoceras* have been removed and placed into new genera except one, *Stegoceras validum* (Sullivan, 2000, 2003, 2006; Schott et al., 2009), and the defining characters of *Stegoceras* (*sensu stricto*) have been greatly limited. Consequently, *Stegoceras* (*sensu lato*), which once spanned some 14 million years, now has a more restricted temporal range (late Judithian–early Kirtlandian), 78.3 Ma to 74 Ma, approximately 5 million years in duration (Eberth, 2005; Sullivan, 2006).

Stegoceras validum (*sensu stricto*) is known solely from Judithian strata of Alberta, Canada. Some specimens of *Stegoceras* (*sensu lato*), most notably those in the collections of the Museum of the Rockies (MOR), Bozeman, MT, have been identified by other workers as coming from outside Canada (Goodwin and Horner, 2004; Horner and Goodwin, 2009). We note that all of the MOR specimens (including MOR-391, MOR-479, and MOR-480) identified as "*Stegoceras*" are not referable to this genus (RMS, pers. observ.). Thus, the remaining specimens identified as *Stegoceras* must be considered questionable. *Stegoceras validum* occurs in the Oldman and Dinosaur Park formations of Alberta, which are late Judithian (middle-late Campanian) (Eberth, 2005; Sullivan, 2006).

In contrast, *Stegoceras novomexicanum* is known from the upper Fruitland and lower Kirtland formations of the San Juan Basin, New Mexico, which is early Kirtlandian (as noted above). Thus, this smaller and distinct species is not only from a temporally distinct unit, but is also from a distinct geographic region.

It is noteworthy that *Stegoceras novomexicanum* represents a distinct species that is not only stratigraphically younger than *S. validum*, but is also a smaller pachycephalosaurid and is from a different geographic region. The presence of a new species of *Stegoceras* suggests that pachycephalosaurids were more diverse in North America than previously thought.

With regard to the age and stratigraphic position of the holotype of *Texacephale langstoni* (LSUMNS 20010), we note the age of the Aguja Formation, Big Bend region, Texas is equivocal. Conflicting ages for this unit, based on U-Pb analyses of zircon, of 72.6 ± 1.5 ma and 76.9 ± 1.2 ma, have been given by Breyer et al. (2007) and Befus et al. (2008), respectively. Moreover, the precise stratum from which the former date was derived is uncertain; it may be from either the Aguja Formation or the overlying the Javelina Formation (Breyer et al., 2007). Consequently, the age of LSUMNS 20010 could be as old as late middle Campanian (late Judithian) or as young as early late Campanian (early Kirtlandian).

CONCLUSIONS

The New Mexico specimens represent a new species, *Stegoceras novomexicanum*, that is distinct from *S. validum* based on: 1) posteromedial extension of the parietal reduced and sub-rectangular; 2) squamosal sutural surface contacts of the posteromedial extension of the parietal parallel; 3) supratemporal fenestrae more medial and enlarged; and 4) small adult size. The two species are geographically and temporally distinct: *S. validum* from the older (Judithian) Oldman and Dinosaur Park formations of Alberta, Canada, and *S. novomexicanum* from the younger (Kirtlandian) upper Fruitland and lower Kirtland formations. *S. novomexicanum* is a component of the Hunter Wash local fauna, which straddles both the upper Fruitland and lower Kirtland formations, and is restricted to these strata. The specimen (NMMNH P-33898, holotype of *Stegoceras novomexicanum*), assigned by Williamson and Carr (2002a) to Pachycephalosauridae indeterminate, is not *Prenocephale*-like, rather it is clearly referable to the genus *Stegoceras* based on morphology that is also seen in the holotype (CMN 515) of *S. validum*. Furthermore, the specimen NMMNH P-30068, described by Williamson and Carr (2002b), is also referable to the new species *S. novomexicanum* rather than to cf. *Prenocephale* (= *Sphaerotholus*) *goodwini*. Therefore, *Prenocephale goodwini* is restricted to the De-na-zin Member (upper Kirtland Formation), Willow Wash local fauna, and *Stegoceras novomexicanum* is restricted to the Fossil Forest and Hunter Wash members (upper Fruitland-lower Kirtland formations), Hunter Wash local fauna.

Four histomorphs, representing growth stages, are recognized based on gross histology within the dome of *Stegoceras novomexicanum*. These are, from oldest to youngest: h1) inner core region of densely-packed, vascular bone characterized by small, homogeneous pores; h2) a thin, surrounding layer of vascular bone characterized by elongated, radiating pores; h3) a lens of highly-porous, vascular bone, characterized by larger and more heterogeneous pores; and h4) an avascular, dense, bony outer layer. The dense, bony outer layer is interpreted to be a terminal, capping layer, indicating no further growth.

The characters used by Longrich et al. (2010) to diagnose *Texacephale langstoni* are taxonomically invalid. Their other observations regarding the specimen are considered to be faulty, or misinterpreted, largely due to the poor preservation of the weathered specimen. Thus, we regard this taxon as a *nomen dubium*. The specimen, does, however, bear some resemblance to NMMNH P-30067, which approaches *Prenocephale goodwini*, though we consider it to be an indeterminate pachycephalosaurid.

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NOTE ADDED IN PROOF

This paper went to press prior the publication of Lehman (2010). We disagree with his conclusions that the Texas pachycephalosaurids are referable to *Stegoceras* (*sensu lato*) or "*Gravitholus*," which we consider a *nomen dubium* (see Sullivan, 2003, 2006). Moreover, the San Carlos Formation specimen (TMM 42532-3) in particular, appears to be similar to *Prenocephale goodwini* based on the relatively high dome in the parietal region and the incorporation of the peripheral elements (i.e., anterior supraorbitals, posterior supraorbitals, postorbitals, and squamosals) into the dome. The high dome noted by Lehman (2010) in this specimen is the same condition noted for "*Texacephale*" (Longrich et al., 2010) and is likely to represent the same pachycephalosaurid taxon, probably *P. goodwini*. However, they are all too poorly preserved and incomplete to make any generic identification. We regard all the Texas pachycephalosaurids as indeterminate pachycephalosaurids.

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APPENDIX

Revised diagnosis of *Stegoceras validum.*

SYSTEMATIC PALEONTOLOGY

DINOSAURIA Owen, 1842
ORNITHISCHIA Seeley, 1887
PACHYCEPHALOSAURIDAE Sternberg, 1945
STEGOCERAS Lambe, 1902

Troodon Leidy, 1856 (in part), p. 72.
Stegoceras Lambe, 1902, p. 68.
Stegoceras validus Lambe, 1902; Hatcher, Marsh and Lull, 1907 (in part), p. 98, pl. 2, figs. 1-2.
Stegoceras validus Lambe, 1902; Lambe, 1918 (in part), p. 35, pls. 1-2.
Troodon validus (Lambe, 1902); Gilmore, 1924, p. 11, pls. 1-6, pl. 8, figs. 3-4; pls. 9-15.
Troodon validus (Lambe, 1902); Gilmore, 1931, pl. 1, fig. 2.
Troodon validus (Lambe, 1902); Brown and Schlaijker, 1943 (in part), p. 128, pl. 33, pl. 34, figs. 1-6, pl. 37, figs. 4-5, pls. 43-44.
Stegoceras validus Lambe, 1902; Sternberg, 1945 (in part), p. 536.
Stegoceras validus Lambe, 1902; Galton, 1971 (in part), text-figs. 4B, 5-6.
Stegoceras validus Lambe, 1902; Wall and Galton, 1979 (in part), p. 1177, fig. 1 J-L, P-R, fig. 2I.
Stegoceras browni Wall and Galton, 1979, p. 1178, figs. 3G, 4D.
Ornatotholus browni (Wall and Galton, 1979); Galton and Sues, 1983, p. 469, fig.1A-J.
Stegoceras validum (Lambe, 1902); emend. Sues and Galton, 1987, p. 5, text-figs. 1-14, p. 32, pl. figs. 1-3, pl. 3, pl. 4, fig. 4; pl. 8, figs. 1-4,11-12.
Ornatotholus browni (Wall and Galton, 1979); Sues and Galton, 1987, p. 28.
Stegoceras validus Lambe, 1902; Sereno, 2000 (in part), fig. 25.3.
cf. *Stygimoloch* sp. Williamson and Carr, 2006, p. 323, fig. 1.

Type species – *Stegoceras validum* (Lambe, 1902); emend. Sues and Galton, 1987.

Revised Diagnosis – Differs from all other pachycephalosaurid genera in having a pronounced parietosquamosal shelf with an incipient frontoparietal dome; nasals inflated; postorbital situated posterolaterally on the dome; ornamentation consisting of numerous minute tubercles on lateral and posterior sides of squamosals with a prominent dorsal row of up to six tubercles on each squamosal and as many as two nodes on the posteromedial extension of the parietal. Posteromedial extension of the parietal either sub-rectangular or trapezoidal in shape. Supratemporal fenestrae closed or open and relatively small, and positioned either adjacent or lateral to the midline. *Stegoceras* (*sensu stricto*) is late middle Campanian through early late Campanian (late Judithian-early Kirtlandian) (Eberth, 2005; Sullivan, 2006).

Remarks – *Stegoceras* (*sensu stricto*) includes the monotypic genus *Ornatotholus*, which is recognized as a junior subjective synonym (Sullivan, 2000, 2003). Two species are presently recognized: *S. validum* and *S. novomexicanum* n. sp. (see text).

STEGOCERAS VALIDUM (Lambe, 1902)

Stegoceras validus Lambe, 1902, p. 68, pl. 21, figs. 1-2.
Stegoceras validus Lambe, 1902; Hatcher, Marsh and Lull, 1907 (in part), p. 98, pl. 2, figs. 1-2.
Stegoceras validus Lambe, 1902; Lambe, 1918 (in part), p. 35, pls. 1-2.
Troodon validus (Lambe, 1902); Gilmore, 1924, p.11, pls. 1-6, pl. 8, figs. 3-4; pls. 9-15.
Troodon validus (Lambe, 1902); Gilmore, 1931, pl. 1, fig. 2.
Troodon validus (Lambe, 1902); Brown and Schlaijker, 1943 (in part), p. 128, pl. 33, pl. 34, figs. 1-6, pl. 37, figs. 4-5, pls. 43-44.
Stegoceras validus Lambe, 1902; Sternberg, 1945 (in part), p. 536.
Stegoceras validus Lambe, 1902; Galton, 1971 (in part), text-figs. 4B, 5-6.
Stegoceras validus Lambe, 1902; Wall and Galton, 1979 (in part), p. 1177, fig. 1 J-L, P-R, fig. 2I.
Stegoceras browni Wall and Galton, 1979, p. 1178, figs. 3G, 4D.
Ornatotholus browni (Wall and Galton, 1979); Galton and Sues, 1983, p. 469, fig.1A-J.
Stegoceras validum (Lambe, 1902); emend. Sues and Galton, 1987, p. 5, text-figs. 1-14, p. 32, pl. figs. 1-3, pl. 3, pl. 4, fig. 4; pl. 8, figs. 1-4,11-12.
Ornatotholus browni (Wall and Galton, 1979); Sues and Galton, 1987, p. 28.
Stegoceras validus Lambe, 1902; Sereno, 2000 (in part), fig. 25.3.
cf. *Stygimoloch* sp. Williamson and Carr, 2006, p. 323, fig. 1.

Revised diagnosis – Differs from *Stegoceras novomexicanum* in having a posterior extension of the parietal that is trapezoidal in shape; supratemporal fenestrae small, or absent, and, where open, located more laterally from the midline; squamosal sutural surface contacts splayed; robust and larger size.

Lectotype – CMN (formerly NMC, and previously GSC) 515, nearly complete frontoparietal (Fig. 2A-C).

Type locality – East side of the Red Deer River below the mouth of Berry Creek, Alberta, Canada.

Horizon – Oldman and Dinosaur Park formations.

Referred Material – See Sullivan (2003).

Remarks – The robust nature and size of the specimen, the trapezoidal posterior extension of the parietal, squamosal sutural surface contacts splayed, and the position and size of the supratemporal fenestrae, are clearly different and serve to separate *Stegoceras validum* from *S. novomexicanum*, n. sp. *Stegoceras validum* is known solely from the Oldman and Dinosaur Park formations (middle to early late Campanian; late Judithian).