

TAXONOMY OF *SHUVOSAURUS*, A LATE TRIASSIC ARCHOSAUR FROM THE CHINLE GROUP, AMERICAN SOUTHWEST

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Abstract—The distinctive, edentulous archosaur *Shuvosaurus inexpectatus* Chatterjee, 1993, was named based on a skull, whereas the postcrania of the same taxon were named *Chatterjeea elegans* Long and Murry, 1995. *Effigia okeeffeae* Nesbitt and Norell, 2006, is the name for the associated skull and postcranium of *Shuvosaurus* and *Chatterjeea*. Therefore, only one generic name, *Shuvosaurus* (= *Chatterjeea*, = *Effigia*), is valid, and the supposed diagnostic features of *Effigia* indicate that, at most, its type material represents a species of *Shuvosaurus* (*S. okeeffeae*) distinct from the type species of *Shuvosaurus* (*S. inexpectatus*). *S. inexpectatus* has a well documented, early Revueltian distribution in Texas-New Mexico, whereas *S. okeeffeae* is well documented from only one Apachean locality in New Mexico.

INTRODUCTION

One of the most unusual tetrapods recovered from the Upper Triassic Chinle Group of the American Southwest is *Shuvosaurus* from the Bull Canyon Formation in West Texas. Originally described as an ornithomimosaurian dinosaur by Chatterjee (1993), *Shuvosaurus* has an edentulous beak, enormous orbits and other features that are, indeed, reminiscent of an ostrich dinosaur. Recently, Nesbitt and Norell (2006) and Nesbitt (2007) described a remarkably similar taxon, *Effigia*, from the Rock Point Formation of the Chinle Group in New Mexico. Here, we argue that *Effigia* is a junior subjective synonym of *Shuvosaurus*.

Institutional abbreviations: AMNH = American Museum of Natural History, New York; TTUP = Texas Tech University Museum, Lubbock.

PREVIOUS STUDIES

Chatterjee (1993) named *Shuvosaurus inexpectatus* for TTUP 9280, a nearly complete skull, left lower jaw and a dorsal vertebra (holotype) and additional, less complete cranial material, part of an atlas and a right scapula (referred specimens) from the Post quarry in the Revueltian Bull Canyon Formation in West Texas. Chatterjee (1993) regarded *Shuvosaurus* as a coelurosaurian theropod dinosaur close to ornithomimosaurians based on a cladistic analysis.

Long and Murry (1995) named *Chatterjeea elegans* for relatively small postcranial material (most notably the holotype, TTUP 9001, a nearly complete postcranial skeleton) of an archosaur from the Post quarry. Chatterjee (1985) had earlier considered these specimens to be juvenile postcrania of *Postosuchus*. Puzzled by the relative abundance of *Chatterjeea* postcrania in the Post quarry, and apparent absence of cranial material of this taxon, Long and Murry (1995, p. 162) suggested that the cranial material named *Shuvosaurus* might belong with the postcranium named *Chatterjeea*. As Long and Murry (1995) acknowledged, this would make *Shuvosaurus* the senior synonym of *Chatterjeea*.

Rauhut (1997) briefly redescribed the skull of *Shuvosaurus* and reaffirmed Chatterjee's conclusion that it is a theropod dinosaur. However, Hunt et al. (1998) argued against the dinosaurian affinities of *Shuvosaurus* and tentatively supported the argument of Long and Murry (1995) that *Shuvosaurus* and *Chatterjeea* are one taxon. Heckert and Lucas (2000) considered *Shuvosaurus* to be a non-dinosaur, as did Mackovicky et al. (2004).

Rauhut (2003) continued to regard *Shuvosaurus* as a bizarre theropod. He also suggested that *Gojirasaurus* from the Revueltian Bull Canyon Formation of east-central New Mexico (Carpenter, 1997) is based on postcrania of *Shuvosaurus*. The type material of *Gojirasaurus* consists of partial postcrania of a large (>5 m total length) theropod dinosaur, and cranial material of *Shuvosaurus* was found at the type

locality of *Gojirasaurus* (Carpenter, 1997; Hunt, 2001). This association, and Rauhut's conclusion that the type skull of *Shuvosaurus* is that of a juvenile (hence its adult postcrania would be as large as those of *Gojirasaurus*), were the basis for Rauhut's suggestion.

Lehane (2005) provided a very detailed description of the cranial anatomy of *Shuvosaurus*. He also assigned it to the Theropoda.

Nesbitt and Norell (2006) and Nesbitt (2007) recently erected *Effigia okeeffeae* for associated cranial and postcranial specimens from the Whitaker quarry at Ghost Ranch, New Mexico, in the Apachean Rock Point Formation of the Chinle Group. *Effigia* has a skull nearly indistinguishable from that of *Shuvosaurus*, and a postcranium remarkably similar to that of *Chatterjeea*, so we argue here that the two taxa are synonymous. The association of a *Shuvosaurus* skull and *Chatterjeea* postcranium in *Effigia* confirms previous suggestions that *Shuvosaurus* and *Chatterjeea* represent one taxon.

SHUVOSAURUS AND CHATTERJEEA

The associated postcrania and skull of *Effigia* demonstrate that the *Shuvosaurus* skull belongs with a *Chatterjeea* postcranium as was postulated previously (Long and Murry, 1995; Hunt et al., 1998; Nesbitt and Norell, 2006; Nesbitt, 2007). Thus, *Chatterjeea elegans* Long and Murry, 1995 is a junior subjective synonym of *Shuvosaurus inexpectatus* Chatterjee, 1993. Furthermore, the associated postcrania demonstrate that *Shuvosaurus* is a suchian archosaur, not a theropod dinosaur (Nesbitt and Norell, 2006; Nesbitt, 2007). The postcrania of *Gojirasaurus* are those of a dinosaur, so despite a taphonomic association, *Gojirasaurus* and *Shuvosaurus* do not represent the same taxon.

TAXONOMIC STATUS OF EFFIGIA

Effigia is very similar to *Shuvosaurus* in many anatomical features that distinguish both from other suchians, especially the edentulous premaxilla, maxilla and dentary and the long dorsal process of the premaxilla (Fig. 1). Nesbitt and Norell (2006, p. 1045) and Nesbitt (2007, p. 6) listed six characteristics that supposedly distinguish *Effigia* from *Shuvosaurus*. Here, we evaluate these characteristics:

1. "Presence of both a dorsal and posterior process of the maxilla": In *Shuvosaurus*, the skull has a relatively small maxilla that sutures to the nasal dorsally, and thus is excluded from contacting the lacrimal. In other words, the maxilla does not form much of the dorsal margin of the antorbital fenestra. In contrast, *Effigia* has been reconstructed to have a dorsal process of the maxilla that forms much of the dorsal border of the antorbital fenestra and meets the lacrimal. This difference appears to us to be genuine, despite damage to and distortion of the holotype skulls of both *Shuvosaurus* and *Effigia*.

2. "Small posterior process of the premaxilla": Both *Shuvosaurus*

and *Effigia* have a long posterior process of the premaxilla that contacts and separates the nasals dorsal to the external nares. There is no difference between the taxa in the shape of this process, or its relative length. Nesbitt (2007) correctly abandoned this putative diagnostic feature listed by Nesbitt and Norell (2006).

3. “Relatively shorter dentary”: The lower jaw of the holotype of *Shuvosaurus* is not complete, and most of it between the symphyseal region and the mandibular fenestra has been reconstructed (Chatterjee, 1993, fig. 5A; Rauhut, 1997, fig. 1; Lehane, 2005, fig. 5) (Fig. 1C). Existing bone maps of the lower jaw of *Shuvosaurus* do not distinguish dentary-surangular or dentary-angular sutures, which should be anterior to the posterior end of the reconstructed missing portion of the lower jaw. Nesbitt (2007, p. 32) states that “the dentary of *Shuvosaurus* (TTUP 9280) is slightly longer than that of *Effigia*” but no quantification or documentation of this statement is provided, and given the reconstruction in the former, would be difficult to assess at best. Based on available data, we conclude that relative lengths of the dentaries of *Shuvosaurus* and *Effigia* are not demonstrably different.

4. “Presence of a large pit on the posterior side of the lacrimal:” Nesbitt (2007, p. 15) clarifies this by stating that “even though preservation of the lacrimal of *Shuvosaurus* is poor, the element lacks the posterior fossa and is much more mediolaterally compressed than that of *Effigia*.” The bone is mediolaterally compressed and damaged in the *Shuvosaurus* skull (TTUP 9280) so whether or not it has a small fossa, as in the *Effigia* skull, might be problematic. Nevertheless, this may be a genuine difference between *Shuvosaurus* and *Effigia*, although the biological significance of the “large pit” is undetermined.

5. “Absence of posterior process of squamosal”: Nesbitt (2007) describes a supposed difference in shape between the squamosals of *Shuvosaurus* and *Effigia*. The *Shuvosaurus* squamosal is tetradiate with a prominent posterior process. That of *Effigia* is supposedly triadate, with a posterior convexity, but lacks a distinct posterior process (Nesbitt, 2007, fig. 14). However, Nesbitt’s (2007, fig. 4) illustration of the holotype of *Effigia okeeffeae*, AMNH FR 30587, shows a tetradiate squamosal with a distinct posterior process (Fig. 1A), as does the reconstruction of the skull of *Effigia* by Nesbitt and Norell (2006, fig. 1) (Fig. 1B). However, Nesbitt’s (2007, fig. 14) illustration shows a somewhat different squamosal outline for *Effigia*.

According to Nesbitt (2007), the quadratojugals are unknown in *Effigia*, so the long, trapezoidal quadratojugals shown in the reconstruction of Nesbitt and Norell (2006, fig. 1) are hypothetical. One possibility, suggested by Nesbitt’s (2007, fig. 14A) close-up photograph of the left squamosal of AMNH FR 30587, is that part of the quadratojugal is present as part of the ventral end of what he identifies as the squamosal. Given the great similarity of the skulls of *Effigia* and *Shuvosaurus*, a small and triangular quadratojugal in *Effigia* seems more likely than the long, trapezoidal element hypothesized by Nesbitt and Norell (2006).

6. “Small fossa on posterolateral side of squamosal”: Nesbitt (2007, p. 18) clarifies this feature, stating that “a small, well-defined depression is located on the posterior portion of the [squamosal] body. This depression opens ventrally and is surrounded by a small rim of bone.” *Shuvosaurus* apparently lacks this depression (Nesbitt, 2007), and like the pit on the lacrimal the biological significance of this fossa is unknown.

DISCUSSION

Of the six putative diagnostic differences between *Effigia* and *Shuvosaurus*, the shape of the maxilla, a pit of unknown significance in the lacrimal and some differences in squamosal shape appear to be unambiguous differences. The other supposed differences are not replicable (premaxilla, dentary). The difference in the maxilla (longer dorsal process in *Effigia*) is a difference in the degree of development of a feature, which can vary ontogenetically, dimorphically, or simply with individual variation, not in strict presence/absence. The biological significance of the distinctive features of the lacrimal and squamosal are unknown, so there

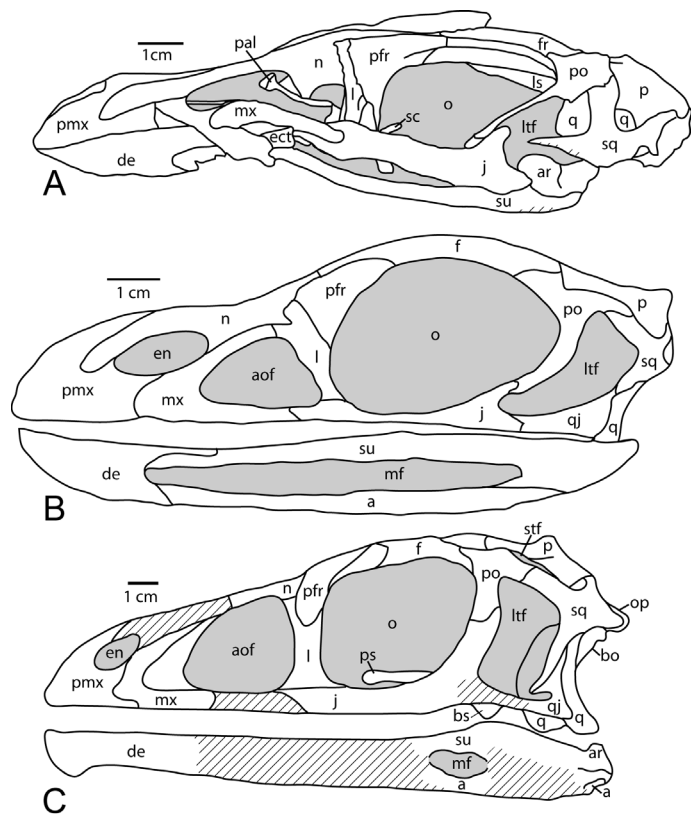


FIGURE 1. Comparison of the skulls of *Effigia* and *Shuvosaurus*. **A**, Drawing of left side of holotype skull of *Effigia okeeffeae*, AMNH FR 30587, as preserved (after Nesbitt, 2007, fig. 4). **B**, Reconstruction of skull of *Effigia okeeffeae* in left lateral view (after Nesbitt and Norell, 2006, fig. 1). **C**, Reconstruction of skull of *Shuvosaurus inexpectatus* in left lateral view (after Lehane, 2005, fig. 5). Diagonal lines represent reconstructed portions. Abbreviations are: a = angular, aof = antorbital fenestra, ar = articular, bo = basioccipital, bs = basisphenoid, de = dentary, en = external nares, f = frontal, j = jugal, l = lacrimal, ltf = lateral temporal fenestra, mf = mandibular fenestra, mx = maxilla, n = nasal, o = orbit, op = opisthotic, p = parietal, pfr = prefrontal, pmx = premaxilla, po = postorbital, ps = parasphenoid, q = quadrate, qj = quadratojugal, sq = squamosal, stf = supratemporal fenestra, su = surangular.

is no way to evaluate the significance of variation in these features with the small sample at hand. Indeed, so little is known of cranial variation in *Shuvosaurus*/*Effigia* that the taxonomic significance of the differences is open to question.

We conclude that the anatomically minor difference(s) used to diagnose *Effigia* from *Shuvosaurus* do not merit generic separation. We note that in Nesbitt’s (2007) detailed description of *Effigia*, he mentions some other anatomical differences between it and *Shuvosaurus* that are not part of the diagnosis of *Effigia*. However, these differences, and those that were used to diagnose *Effigia* from *Shuvosaurus* strike us as minor anatomical differences, almost all of which are of unknown biological significance, that could easily represent variation within a taxon. Indeed, in the cladistic analysis of *Effigia* among basal archosaurs published by Nesbitt (2007, fig. 54), *Effigia* and *Shuvosaurus* are scored identically (for known characters) for the 83 characters analyzed (Nesbitt, 2007, appendix 5). This means that there are no phylogenetically informative differences between *Effigia* and *Shuvosaurus* by Nesbitt’s (2007) analysis, so they are not even distinct cladotaxa.

Many of the differences in the drawings of the reconstructed skulls of *Effigia* and *Shuvosaurus* (Fig. 1) reflect artistic license in the reconstruction of damaged, distorted and incomplete fossils. Thus, for example, if the posterior portion of the skull of the *Effigia* skull were raised dorsally so that the long axis of the lateral temporal fenestra were

vertical (and there is no reason not to do this since the distortion there is clearly diagenetic and artificial), the two reconstructions would be much more similar.

We thus consider *Effigia* Nesbitt and Norell, 2006 to be a junior subjective synonym of *Shuvosaurus* Chatterjee, 1993. Pending further information on cranial variation in *Shuvosaurus*, we very tentatively regard the Ghost Ranch material as a distinct species, *S. okeeffeae*, distinguished from *S. inexpectatus* by the difference in the maxilla originally

used to differentially diagnose *Effigia* from *Shuvosaurus*. *S. inexpectatus* has a well documented early Revueltian distribution in Texas-New Mexico (Hunt, 1991), whereas *S. okeeffeae* is well documented only from one Apachean locality in New Mexico.

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