Lucas, S.G. and Spielmann, J.A., eds., 2007, The Global Triassic. New Mexico Museum of Natural History and Science Bulletin 41.

OLDEST RECORDS OF THE LATE TRIASSSIC THEROPOD DINOSAUR *COELOPHYSIS BAURI*

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Abstract— *Coelophysis bauri* is a well-known theropod dinosaur from the Upper Triassic of the southwestern United States. Prior to this study, it was only known from extensive remains from the Whitaker quarry, in the Rock Point Formation, of north-central New Mexico. Here, we document fossils of *C. bauri* from the Upper Triassic Snyder quarry, north-central New Mexico and from the Petrified Forest National Park. Both of these new records are from the Painted Desert Member of the Petrified Forest Formation, stratigraphically below the Rock Point Formation. This extends the biostratigraphic range of *C. bauri* to the early Revueltian (early-middle Norian) through the Apachean (late Norian-?Rhaetian). Thus, *C. bauri* is no longer an index taxon of the Apachean land-vertebrate faunachron.

INTRODUCTION

Coelophysis bauri, one of the best-known Late Triassic dinosaurs, has been known from a single locality, the Whitaker quarry at Ghost Ranch, New Mexico (e.g., Colbert, 1989) (Fig. 1). Here, we describe and photographically illustrate specimens referable to *C. bauri* from the Upper Triassic (Revueltian) Snyder quarry, north-central New Mexico, compare these specimens with another *C. bauri* fossil described from broadly correlative strata in the Petrified Forest National Park of Arizona (Padian, 1986) and summarize the biostratigraphic range of *C. bauri* based on these additional specimens. In this paper, NMMNH = New Mexico Museum of Natural History and Science, Albuquerque and UCMP = University of California Museum of Paleontology, Berkeley.

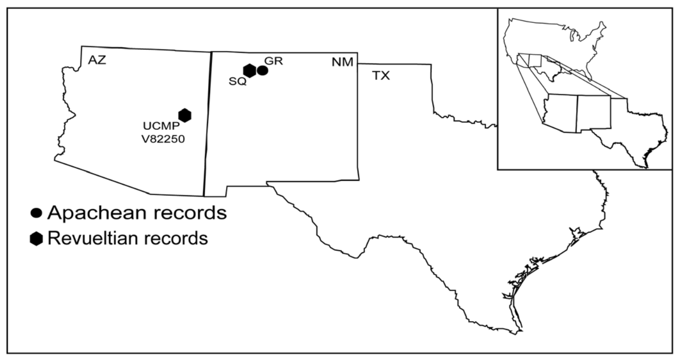

FIGURE 1. Index map showing the distribution of *Coelophysis* fossil localities in Arizona, New Mexico and Texas. Biostratigraphic subdivision after Lucas (1998). Abbreviations: GR – Ghost Ranch and SQ – Snyder quarry.

PREVIOUS STUDIES

Coelophysis bauri is one of the best, if not the best, known Triassic dinosaurs and has been the subject of numerous publications for more than 100 years. In this section we highlight key works that are relevant to our discussion. These include the initial naming of *Coelophysis bauri*, the publication of the Ghost Ranch specimens, the *Rioarribasaurus* vs. *Coelophysis* controversy and the taxonomic relationship of *C. bauri* to *Megapnosaurus* (=“*Syntarsus*”).

In 1881, David Baldwin, while collecting for Edward Drinker Cope, discovered small theropod dinosaur fossils at three localities in the Upper Triassic strata of northern New Mexico; one locality was noted as “Gallina Canyon” and the other two localities as “Arroyo Seco.” After studying these specimens, Cope published two papers on the material. The first (Cope, 1887a) described two new species that Cope assigned to Marsh’s genus *Coelurus*. *C. longicollis*, the larger of the two, was named based on one vertebra from each of the cervical, dorsal and caudal series, plus a femur. The other species, *C. bauri*, was based on a cervical vertebra, a sacrum and a distal femur. The second paper (Cope, 1887b) was a review of North American Triassic vertebrates, in which Cope revised his interpretation of the *C. longicollis* and *C. bauri* material as distinct taxa, instead referring it to the European genus *Tanystropheus* (then perceived as a dinosaur, not a protorosaur). In this same publication, Cope named a third species, *T. willistoni*, that was smaller than the other two. This species was named based on an incomplete acetabular border and a single dorsal centrum. Neither of the two Cope publications included illustrations or locality information, nor were specimen numbers or types designated. In 1889, Cope removed *T. longicollis*, *T. bauri* and *T. willistoni* from the genus *Tanystropheus*, based on the morphology of the neural canals of the centra, and gave these three species the new generic name *Coelophysis* (Cope, 1889).

Later work by Huene (1915) recognized the three species of *Coelophysis*, primarily by size differences, and while he illustrated the material for the first time, he, like Cope, neither provided specimen numbers nor designated any types. It fell to Hay (1930) to designate *Coelophysis bauri* as the type species of *Coelophysis*; *C. bauri* was selected because the other two species were judged to be undiagnostic. The other species were synonymized with *C. bauri* by Colbert (1947).

Colbert (1947) initially described a massive bonebed of complete articulated and disarticulated skeletons of a small theropod from Ghost Ranch, Rio Arriba County, New Mexico. This quarry became known by a variety of names, including the Ghost Ranch quarry, the *Coelophysis* quarry and the Whitaker quarry (after the initial discoverer of the site). Colbert (1947) referred to the theropods from that quarry as *Coelophysis*, but provided no justification for his assignment. Colbert (1964) rediagnosed *Coelophysis bauri* based on the Ghost Ranch material, followed later by a complete osteology (Colbert, 1989). Subsequently, he (Colbert, 1990) described variation in *C. bauri*, again based solely on the Ghost Ranch sample.

In his monographic description of the large, Early Jurassic coelophysoid *Dilophosaurus*, Welles (1984) designated lectotypes for *Coelophysis bauri* and *C. longicollis*, and provided *Longosaurus* as a new generic name for *C. longicollis*, thus creating the binomial *Longosaurus longicollis*. Colbert (1989) also designated a lectotype for *C. bauri*, apparently unaware of the lectotype designation in Welles’

(1984) previous work.

Padian (1986) was the first to point out discrepancies between Cope's holotype material of *Coelophysis* and the Ghost Ranch theropod. Specifically, Padian (1986) noted that of the 24 characters used by Colbert (1964) to diagnosis *Coelophysis bauri*, only eight can be assessed in Cope's syntypes. Hunt and Lucas (1991) expanded upon this line of reasoning by noting that the lectotypes of *C. bauri* and *Longosaurus longicollis* designated by Welles (1984) were ineligible to become lectotypes because the designated material was not part of the original syntypes. Thus, Hunt and Lucas (1991) affirmed the validity of the lectotype for *C. bauri* that Colbert (1989) had proposed. In addition, they designated a lectotype for *C. willistoni*, the only remaining of Cope's species for which a lectotype had not yet been designated. Summarily, Hunt and Lucas (1991) pointed out that none of the lectotypes of Cope's initial three species of *Coelophysis* were in any way diagnostic below the level of Theropoda indet. and that "[n]one of the Whitaker quarry material should ever have been assigned to *Coelophysis*" (p. 195). Thus, they proposed a new generic and specific name for the Whitaker quarry material, *Rioarribasaurus colberti*. In addition, they noted (p. 195) that an attempt to "petition the International Commission on Zoological Nomenclature to conserve the name *Coelophysis bauri*, by designating a neotype, would be met with rejection, simply because the type material of the taxon is extant."

Even though Hunt and Lucas (1991) provided a "by-the-book" argument, frequently citing the International Code of Zoological Nomenclature, which was supplemented by support from Sullivan (1993, 1994, 1995) and Huber (1994), a petition for the designation of a neotype of *Coelophysis bauri* from the Ghost Ranch material was submitted to the International Commission on Zoological Nomenclature (ICZN) by Colbert et al. (1992). They disputed the claim of Hunt and Lucas (1991) that the stratigraphic level of the Ghost Ranch quarry was demonstrably different than the level that yielded the holotype material of *C. bauri*; they also noted that individual bones of the Ghost Ranch material are identical to those of the holotype of *C. bauri* and that the name *Coelophysis bauri* is well entrenched in the literature, both technical and popular, and in the public consciousness. Sullivan et al. (1996) addressed these observations, demonstrating that the Ghost Ranch sample comes from a distinct horizon, with dramatically different preservation than the original material collected by Baldwin. The resultant decision of the ICZN (1996) was to designate a neotype of *C. bauri* from the Ghost Ranch material – this was accomplished by making the holotype of *R. colberti* the neotype of *C. bauri* – rendering *Rioarribasaurus colberti* a junior objective synonym of *Coelophysis bauri*.

Raath (1969) named and described "*Syntarsus*" (=*Megapnosaurus*) *rhodesiensis* based on an incomplete articulated skeleton, lacking the skull and cervical vertebrae, from the Early Jurassic Forest Sandstone Formation near Bulawayo, Zimbabwe (then Rhodesia). Raath (1969) compared "*S.*" *rhodesiensis* to *Coelophysis bauri* and was struck by the similarity between the two taxa. However, he did note a handful of minor differences, mostly confined to the hip and tarsus. Additional work by Raath (1977) provided further description of numerous "*S.*" *rhodesiensis* specimens, and allowed for a better comparison between "*S.*" *rhodesiensis* and *C. bauri*. Raath (1977, table 19) noted further differences between the skulls and forelimbs of the two taxa (reiterated by Colbert [1989]); he subsequently detailed the variation present in the African specimens (Raath, 1990).

In addition, Rowe (1989) and Tykoski (1998) described a new species of "*Syntarsus*," "*S.*" *kayentakatae*, from the Early Jurassic Kayenta Formation of Arizona. Over the years the close taxonomic association between "*Syntarsus*" and *Coelophysis* has only grown closer with numerous differences between the taxa being resolved as more specimens are examined. Paul (1988, 1993) was the first to suggest that "*S.*" *rhodesiensis* and *C. bauri* be placed in the same genus. Downs (2000) further reiterated the synonymy of the two genera based on his analysis of the Ghost Ranch material. Ivie et al. (2001) pointed out that the generic name *Syntarsus* was preoccupied by a beetle and proposed the generic name *Megapnosaurus* ("big dead lizard") for the theropod. Bristowe and Raath (2004) recently placed both species of *"Syntarsus"* in the genus *Coelophysis*, although they remain listed separately in Tykoski and Rowe (2004). Smith and Merrill (2006) found significant morphometric variation between *Coelophysis* and "*Syntarsus*," and argued that the two genera should not be synonymized. In addition, they noted variation within the Whitaker quarry sample, which they interpreted as a result of sexual dimorphism. This assertion thus counters the claim by Smith (1997) that the variation within the Whitaker sample could have systematic significance. The one generally agreed on feature between Bristow and Raath (2004) and Smith and Merrill (2006) is that *Coelophysis bauri* is more closely related to "*S.*" *rhodesiensis* then either is to "*S.*" *kayentakatae*. Thus, *Coelophysis* currently contains two species, *C. bauri* (the type species) and *C. rhodesiensis*; and *Megapnosaurus* (= "*Syntarsus*") *kayentakatae* is a closely related taxon (Tykoski, 2005; Ezcurra, 2006; Ezcurra and Novas, 2006).

Hunt et al. (1998) named a fragmentary coelophysid *Camposaurus arizonensis* (originally described by Lucas et al. [1992]), for ceratosaurian postcrania from the *Placerias* quarry in the Bluewater Creek Formation of east-central Arizona. Some workers (e.g., Long and Murry, 1995; Irmis, 2005) consider this material indistinguishable from *Coelophysis*, whereas others recognize it as a valid, distinct taxon (Tykoski and Rowe, 2004; Heckert et al., 2005), a position we follow here.

Sullivan and Lucas (1999) built upon Sullivan et al. (1996) and described a new theropod, *Eucoelophysis baldwini*, from exposures of the Painted Desert Member of the Petrified Forest Formation in the vicinity of Orphan Mesa. They also referred one of the specimens (a proximal pubis) originally collected by Baldwin to this taxon. Subsequently, Heckert et al. (2000, 2003) referred abundant theropod material from the Snyder quarry, at the same stratigraphic horizon some distance (~2 mi) to the west, to *Eucoelophysis* sp. based on the similar morphology of the tibia and fibula, but refrained from referring them to *E. baldwini*, largely because of differences in the femur. Ezcurra (2006) recently redescribed *Eucoelophysis* as a non-dinosaurian dinosauriform, but agreed that the Snyder material described by Heckert et al. (2000; and thus by extension Heckert et al., 2003) is distinct from *E. baldwini*.

SNYDER QUARRY MATERIAL

The Snyder quarry is a bone bed in the upper part of the Painted Desert Member of the Petrified Forest Formation a few km from Ghost Ranch, in north-central New Mexico (Zeigler et al., 2003) (Fig. 1). Phytosaurs dominate the Snyder quarry assemblage, but theropod fossils also are present.

Heckert et al. (2000, 2003) provided a preliminary discussion of the theropod material from the Snyder Quarry. Here, we expand on their summary and describe additional material that has been prepared since that publication. We agree with Heckert et al. (2000, 2003) that there are two distinct size grades of theropod represented within the Snyder quarry assemblage, one significantly larger than the other. However, we conclude that the material of the smaller theropod is attributable to the theropod dinosaur *Coelophysis bauri*, not *Eucoelophysis baldwini*, which is now considered a non-dinosaurian dinosauriform (Ezcurra, 2006). In addition, Ezcurra (2006) noted that the Snyder quarry material more closely resembles dinosaurs than the dinosauriform *Eucoelophysis*. Specifically, he assigned it to Coelophysoidea indet., cf. Coelophysidae based on the following synapomorphies of the Coelophysoidea: premaxillary body craniocaudally lengthened, heterodont premaxilla, premaxillary nasal process forms more than half of the rostrodorsal narial border, subnarial gap, rostral end of the maxillary alveolar border sharply upturned and cervical vertebrae craniocaudally elongated. Additionally, Ezcurra (2006) noted that the alveolar ridge defining the ventral margin of the antorbital fossa indicates a close relationship of the Snyder quarry small theropod skull to *Liliensternus*, and the square rostral end of the antorbital fossa resembles *Zupaysaurus* (Ezcurra and Novas, 2005) and members of the Coelophysidae (sensu Rauhut, 2003).

Theropoda Indet.

Much of the theropod fossil material recovered from the Snyder quarry consists of isolated ribs, centra and miscellaneous bone fragments. However, only the centra may be identifiable to Theropoda indet. due to neural arch morphology, whereas the rest can only be identified to Reptilia indet., Tetrapoda indet. or Vertebrata indet. Here, we focus only on the more diagnostic elements.

Small Theropod

The smaller of the two theropods initially described by Heckert et al. (2000) is represented by an incomplete skull with associated cervical vertebrae (NMMNH P-30852) (Figs. 2, 3A-D), two incomplete skeletons (NMMNH P-29047 and NMMNH P-31661) (Figs. 3E-F, 4, 6E-I), a set of associated hindlimbs (NMMMH P-29046) (Figs. 5D-M, 6A-D) and several isolated hindlimb elements (NMMNH P-31293, P-54617 through P-54620) (Figs. 5A-C, N-O). These specimens are summarized in Tables 1 and 2, with metrics of each specimen in Appendix. Specimens NMMMNH P-29046, P-29047, P-30852 and P-31661 were all found in close proximity to each other (within ~2m laterally), but repetition of elements (especially left tibiae) indicates the presence of at least three individuals of similar size.

TABLE 1. *Coelophysis bauri* specimens from the Snyder quarry (NMMNH locality 3845) described in the text.

Specimen Number	Taxon	Description	Note
P-29046	Derived coelophysoid	Partial skeleton – complete left femur, incomplete right femur, complete left tibia and proximal left fibula	Identified as *Eucoelophysis* sp. by Heckert et al. (2000, fig. 3D; 2003, fig. 2D, 3F). Not identified by specimen number by Heckert et al. (2000).
P-29047	Coelophysoidea indet.	Partial skeleton – incomplete right ilium, nearly complete right ischium, proximal left tibia, incomplete left fibula, two complete proximal phalanges, a proximal end of a proximal phalanx, a distal phalanx and an ungual.	Identified as *Eucoelophysis* sp. by Heckert et al. (2000, fig. 3B-C; 2003, fig. 2B-C, 3D-E). Not identified by specimen number by Heckert et al. (2000).
P-30852	*Coelophysis bauri*	Incomplete skull, lower jaws and two cervical vertebrae.	Identified as *Eucoelophysis* sp. by Heckert et al. (2000, fig. 3A; 2003, fig. 2A, 3A-B). Not identified by specimen number by Heckert et al. (2000).
P-31661	Coelophysidae indet.	Partial skeleton – various cervical rib fragments, left scapulocoracoid, right radius, left? metacarpal, manual ungual and partial sacrum.	Identified as *Eucoelophysis* sp. by Heckert et al. (2000, 2003, fig. 3C). Used for scapulocoracoid description by Heckert et al. (2000), but not identified by specimen number.
P-31293	Saurischia indet.	(4) incomplete left tibia and associated cervical rib	
P-54617	Derived coelophysoid	(1) right tibia	Recently prepared; described here for the first time.
P-54618	*Coelophysis* sp.	(1) distal right femur	Recently prepared; described here for the first time.
P-54619	*Coelophysis* sp.	(1) distal right femur	Recently prepared; described here for the first time.
P-54620	*Coelophysis* sp.	(1) large right femur	Recently prepared; described here for the first time.

NMMNH P-30852

NMMNH P-30852 is an incomplete skull that includes the left premaxilla, the left maxilla, left lacrimal, left prefrontal, most of both lower jaws and two articulated anterior cervical vertebrae, probably cervicals three and four (Figs. 2, 3A-F). This specimen also provides a rare opportunity to examine the internal surfaces of the various skull elements of *Coelophysis*, as much of the Ghost Ranch material has only the external surfaces of the cranial bones exposed.

The left premaxilla is complete and roughly triangular, with a very thin nasal process projecting posteriorly and a more robust maxillary process. The narial fossa is present where the two processes meet, which also demarcates the anterior margin of the external nares. Four tooth sockets are preserved, the third of which houses an unerupted tooth, whereas the other teeth are incomplete.

The left maxilla is incomplete and is missing its posterior portion. The nearly complete ascending process of the anterior maxilla is triangular. Much of the posterior maxilla is very fragmentary, preserving only the portion directly above the tooth row. Ten teeth, in various states of completeness, are present. The total number of tooth sockets cannot be assessed due to mediolateral crushing of the specimen. The length of the maxilla, as preserved, is ~101 mm.

The left lacrimal (Fig. 3E-F) is complete and has an inverted L-shape. The posterodorsal margin of the element is slightly curved, not linear. A low ridge on the lateral surface of its jugal process extends dorsally, curves and continues anteriorly on the dorsal process of the lacrimal, demarcating the posterodorsal margin of the external antorbital fossa. A small elliptical opening is present on the medial side of the maxillary process. A triangular depression is present on the medial side of the base of the jugal process. Notably, the length of the base of the lacrimal is greater than 30% of the height of the ascending process.

A disarticulated right postorbital is attached to an amalgamation of lower jaw elements, so it can only be seen in lateral view. Overall, it is roughly T-shaped, with the jugal process slanted anteroventrally. A ventrally-projecting triangular process is present on the medial side of the confluence of the frontal, squamosal and jugal processes of the postorbital.

The mandibles are both present, but incomplete. The right jaw preserves more of the tooth row and is more complete posteriorly but is missing its anterior tip. The left lower jaw preserves the anterior tip, but is missing its posterior one-third. Both exhibit little crushing in comparison to the right maxilla.

The left lower jaw preserves an incomplete dentary, portions of the angular, surangular and ?splenial. However, as preserved, it is difficult to discern the sutures between the dentary, angular and surangular. In the left dentary, 20 tooth sockets are preserved, 12 of which bear teeth; portions of the anterior dentary are obscured by the right maxilla, so presumably there are one or two tooth sockets that are not visible.

Anteriorly, the left dentary is relatively short and elliptical in cross-section, with the long axis oriented dorsoventrally, whereas posteriorly the dentary thickens dorsoventrally. All that is preserved of the posterior end of the lower jaws is their ventral margins. An unbroken, slightly curved dorsal margin in this area preserves the ventral margin of the external mandibular fenestra. The ?splenial has been displaced dorsally and is sharply triangular and concave in lateral view.

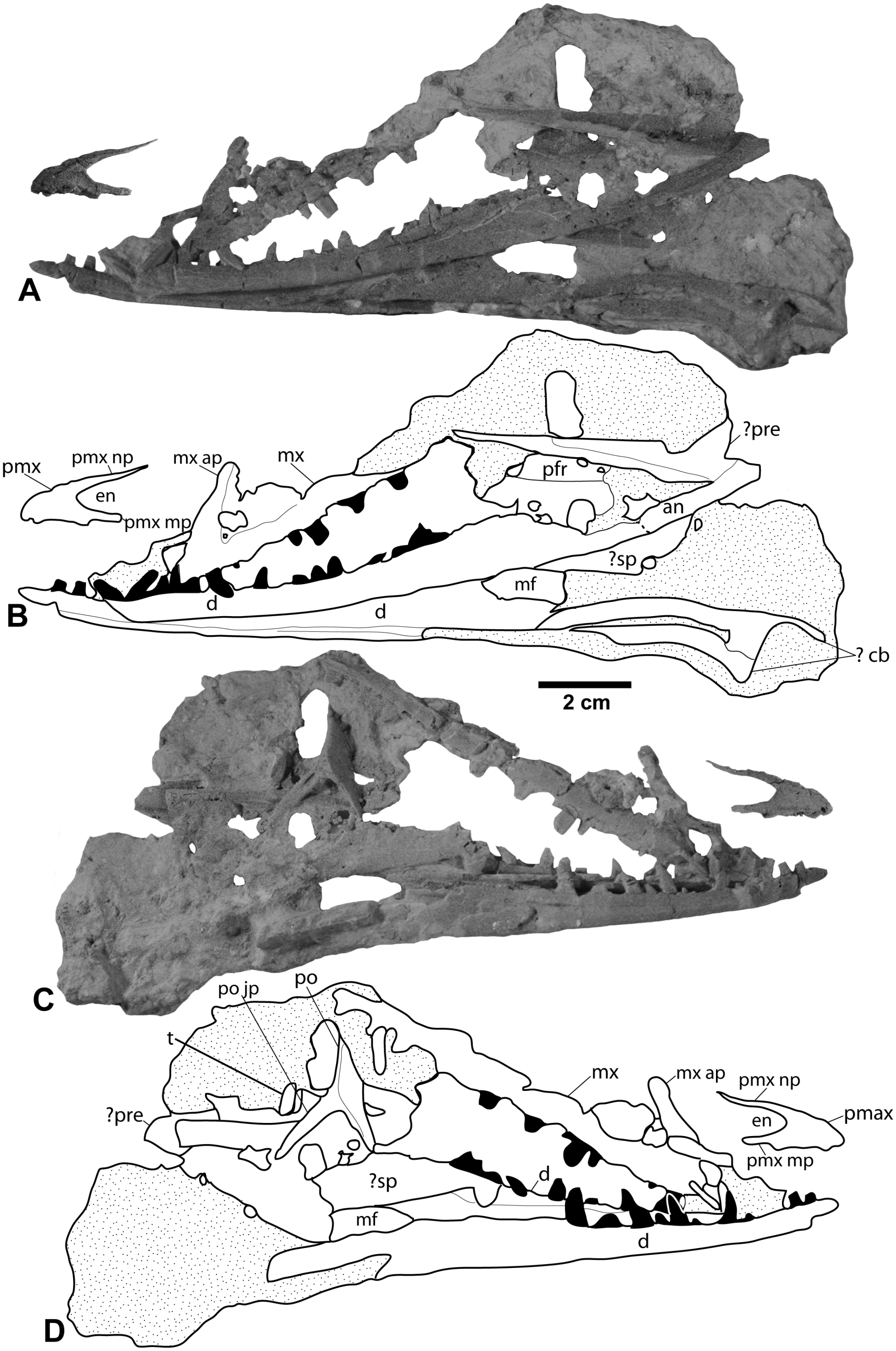

FIGURE 2. **A-D**, NMMNH P-30852, *Coelophysis bauri*, incomplete and partially disarticulated skull. **A-B**, photograph and line drawing of skull in left lateral view. **C-D**, photograph and line drawing of skull in right lateral view. Teeth are darkened. Abbreviations: **an**, angular; **?cb,** ?ceratobranchial; **d**, dentary; **en**, external nares; **mf**, mandibular fenestra; **mx**, maxilla; **mx ap**, ascending process of maxilla; **po**, postorbital; **po jp**, jugal process of postorbital; **pmx**, premaxilla; **pmx mp**, maxillary process of premaxilla; **pmx np**, nasal process of the premaxilla;**?pre**, prearticular; **?sp**, splenial; **t**, isolated tooth.

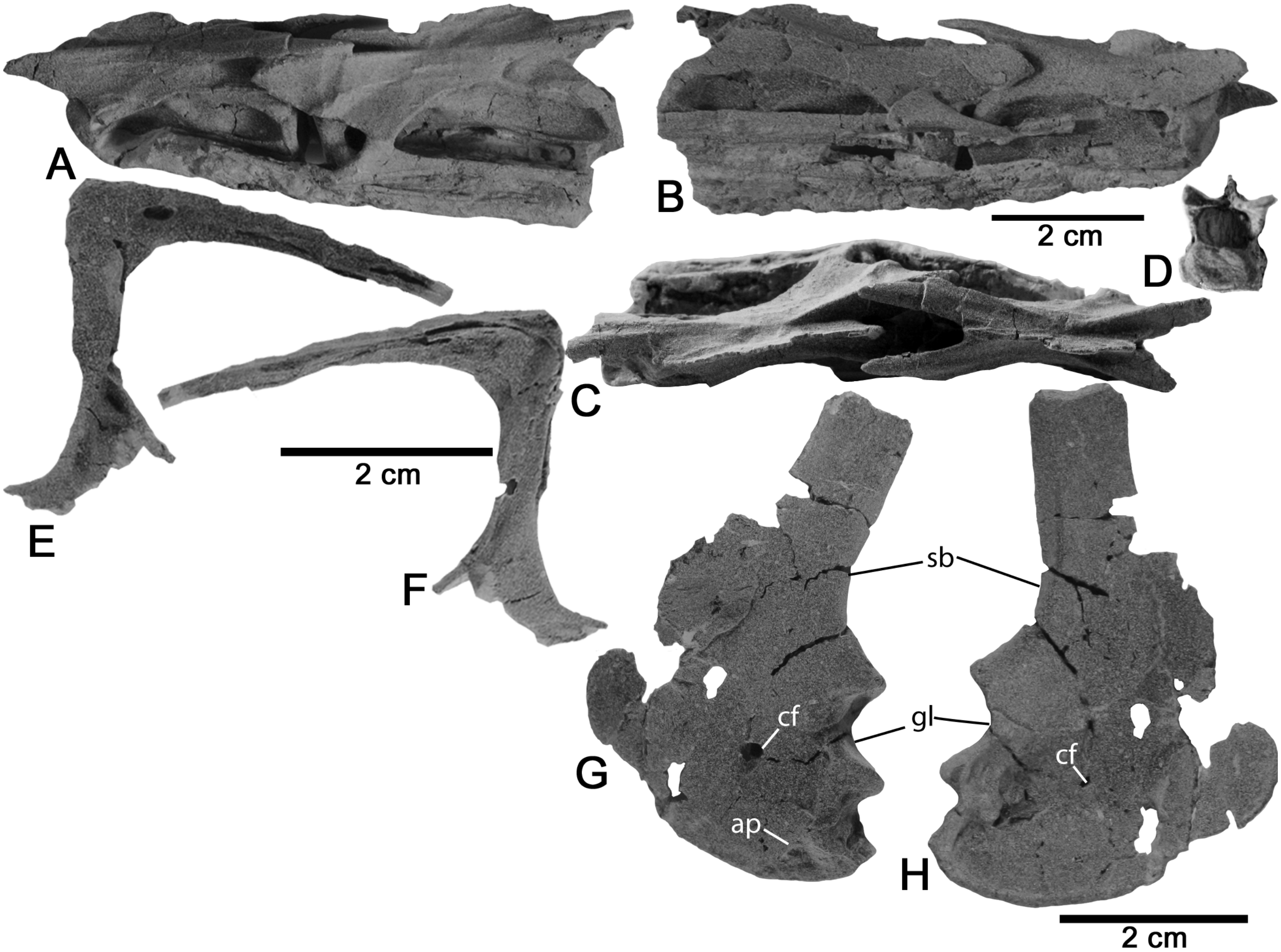

FIGURE 3. **A-F**, NMMNH P-30852, *Coelophysis bauri*. **A-D**, cervical vertebrae in **A**, left lateral, **B**, right lateral, **C**, dorsal and **D**, anterior views. **E-F**, left lacrimal in **E**, medial and **F**, lateral views. **G-H**, NMMNH P-31661, *Coelophysis bauri*, left scapulocoracoid in **G**, lateral and **H**, medial views. Abbreviations: **ap**, acromial process; **cf**, coracoid foramen; **gl**, glenoid; **sb**, scapular blade.

The right dentary preserves 17 readily discernable alveoli; some of the posteriormost sockets are not visible. Of the 17 sockets, 10 are tooth-bearing. The anterior dentary is either complete to the symphysis of the lower jaws or nearly so. The posterior portion is missing.

The ?angular is rotated dorsally from its natural position, its medial surface (Fig. 2A-B). The element is triangular with a long pointed process extending anteriorly and a dorsal expansion of the element posteriorly. If correctly interpreted, the relatively smooth edge along the dorsal margin of the ?angular forms the ventral border of the internal mandibular fenestra.

A pair of elongate, mediolaterally compressed elements with slightly expanded posterior ends are present below the lower jaws. Heckert et al. (2003) identified these elements as ?ceratobranchials and we concur with their tentative interpretation, because this pair of elements is positioned where the ceratobranchials would have been in vivo (Colbert, 1989, fig. 47A).

Two cervical vertebrae, associated with the skull, are articulated and nearly complete, missing only their neural spines, the right postzygapophysis of the posterior vertebra and portions of the cervical ribs (Fig. 3A-B). Both are amphicoelous with the anterior articular surfaces angled anteriorly, have elongate triangular pre- and postzygapophyses and elliptical caudal fossa on the lateral sides of the centra that deepen posteriorly. The orientation of laminae (centrodiapophyseal and ventral lamina) in these vertebrae are identical to the morphology of *Coelophysis bauri* and *Liliensternus liliensterni* (Ezcurra and Cuny, 2007, fig. 1). In addition, the posterior vertebra has an accessory canal slightly above and running parallel to the neural canal. This can only be seen in posterior view, because the anterior end of the posterior vertebra is obscured by the articulated postzygapophyses of the vertebra immediately anterior to it. Such accessory canals are also present in the Ghost Ranch sample of *Coelophysis bauri* and were discussed extensively (as "lateral tunnels" by Colbert (1989, p. 78-80)). The cervical ribs are preserved in a block of matrix beneath the centra. The anterior vertebra is missing both the articular ends of the cervical ribs, although an element on the right side of the vertebrae may be a disarticulated anterior cervical rib. The left cervical rib of the posteriormost vertebra has a complete anterior articular surface in articulation. Both cervical ribs are extremely elongate, with those of the anterior vertebra extending posteriorly beyond the posterior vertebra.

NMMNH P-29047

NMMNH P-29047 is an incomplete right pelvis and hindlimb that includes an incomplete right ilium, incomplete right ischium, proximal left tibia, left fibula missing its distal end and five manual and pedal elements (Figs. 4F-J, 6E-I).

The incomplete right ilium (Fig. 4F-H) preserves much of the

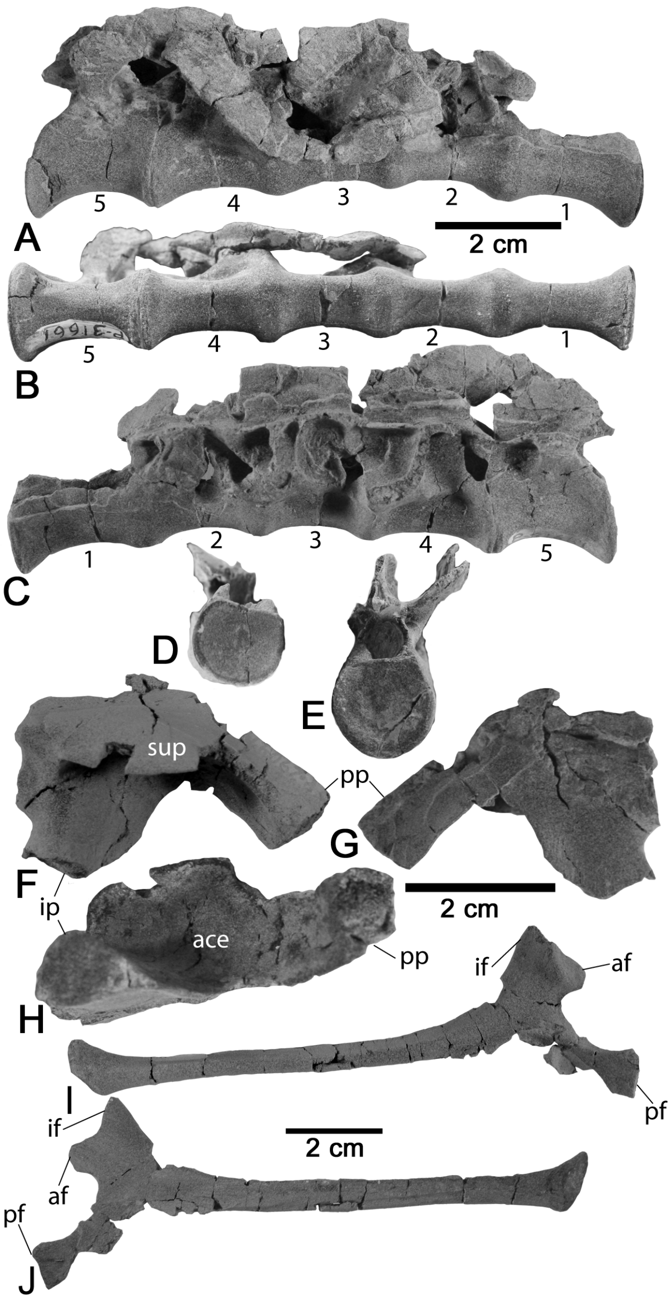

FIGURE 4. **A-E**, NMMNH P-31661, *Coelophysis bauri*, incomplete sacrum in **A**, right lateral, **B**, ventral, **C**, left lateral views, **D**, anterior view of first sacral vertebra and **E**, posterior view of fifth sacral vertebra. **F-J**, NMMNH P-29047, *Coelophysis bauri*. **F-H**, incomplete right ilium in **F**, lateral, **G**, medial and **H**, ventral views. **I-J**, right ischium in **I**, lateral and **J**, medial views. In **A-C**, the vertebrae are numbered. Abbreviations: **ace**, acetabulum; **af**, acetabular facet; **if**, iliac facet; **ip**, ischial peduncle; **pf**, pubic facet; **pp**, pubic peduncle; **sup**, supra-acetabular crest.

acetabular region (both ischial and pubic peduncles and the supra-acetabular crest), but the iliac blade is missing. The anterior margin of the pubic peduncle is also missing, as is the anterior portion of the supra-acetabular crest. The supra-acetabular crest extends from a buttress posterior to the acetabulum to a point relatively low on the pubic peduncle. This creates a dorsal "hood" over the acetabulum, a feature also seen in UCMP 129618 (see below). In ventral view, the acetabulum is suboval; the anterior acetabulum is slightly wider mediolaterally than the posterior portion.

The single right ischium (Fig. 4I-J) is nearly complete except for minor fragments missing from its ventral margin the acetabulum. The iliac articular facet is subtriangular. The acetabular facet (or antitrochanter) is subrectangular and oriented anterodorsally. The pubic facet is triangular. When articulated with the ilium, nearly the entire acetabulum can be delineated: overall, it is elliptical, with the long axis oriented dorsoventrally. The shaft of the ischium is straight, projects posteroventrally and is triangular in cross-section with a circular lateral edge. The rugose medial margin of the ischial shaft demonstrates the articulation of the left and right ischia. The shaft terminates at a small, convex expansion that appears lunate in distal view.

The proximal left tibia (Fig. 6E-G) is broken below the level of the fibular crest. In proximal view, the tibia is subtriangular anteriorly and rectangular posteriorly. There is a slight depression on the medial margin of the proximal tibia; just lateral to this depression is a groove for the reception of the proximal fibula. The cnemial crest is prominent and concave medially, and a distinct groove extends down the shaft from this concavity. A distinct notch is present on the posterior margin of the proximal end of the tibia; an identical notch is present on UCMP 129618 (see below). The fibular crest extends down the proximal quarter of the shaft, and the site of articulation with the fibula extends laterally from the fibular crest as a pyramidal process that is oriented posteriorly. A single nutrient foramen is present just below and posterior to the level of the fibular crest.

The left fibula lacks much of the shaft and its distal end (Fig. 6H-I). In cross section, the proximal fibula is a rounded rectangle that thins anteroposteriorly along the length of the shaft. On the medial side of the fibula is a process extending anteroventrally from the posterior edge of the proximal end that articulates with the fibular crest of the tibia.

The various manual and pedal elements include a complete, elongate metacarpal IV, the distal end of a metatarsal, a complete elongate proximal phalanx, a complete, stout, distal phalanx and a curved terminal manual phalanx. These bones do not differ from the same elements in the Ghost Ranch specimens of *Coelophysis bauri* (Colbert, 1989).

NMMNH P-31661

NMMNH P-31661 comprises parts of a skeleton that consists of numerous cervical rib and rib fragments, a partial left scapulocoracoid, a right radius, an incomplete sacrum, a metacarpal and a terminal pedal phalanx (Figs. 3G-H, 4A-E). These fragments were all collected from a single small jacket, so we consider them associated and to represent a single individual.

Most of the cervical ribs and rib fragments preserve the articular facets and the anterior portions of the rib. Most notable is a prominent anterior expansion of the anterior cervical rib.

The left scapulocoracoid (Fig. 3G-H) is incomplete, missing portions of its anterior margin and most of the scapular blade, though the glenoid is well preserved. In addition, no suture between the scapula and coracoid can be distinguished. The posterior-facing glenoid is saddle shaped, with the ventromedial margin slightly downturned. The pyramidal acromial process lies just ventral to the glenoid, projecting laterally from the element. A ridge runs from the acromial process anteriorly. A moderately-sized coracoid foramen is present, at approximately the level of the ventral margin of the glenoid. In medial view, the coracoid is concave.

The right radius is complete. The proximal radius is elliptical, with the long-axis oriented anteroposteriorly. The radial shaft is also elliptical, though the anteroposterior edges taper to a point. The distal radius is subcircular and has its long axis oriented mediolaterally.

The incomplete sacrum (Fig. 4A-E) includes all five centra expected in a coelophysoid, though in varying degrees of completeness. The first centrum has none of its neural arch preserved. The second centrum includes an incomplete neural arch. The third centrum includes a complete neural arch, the base of the neural spine and portions of the right transverse process. The fourth includes a complete neural arch and the base of the neural spine and the fifth preserves a complete neural

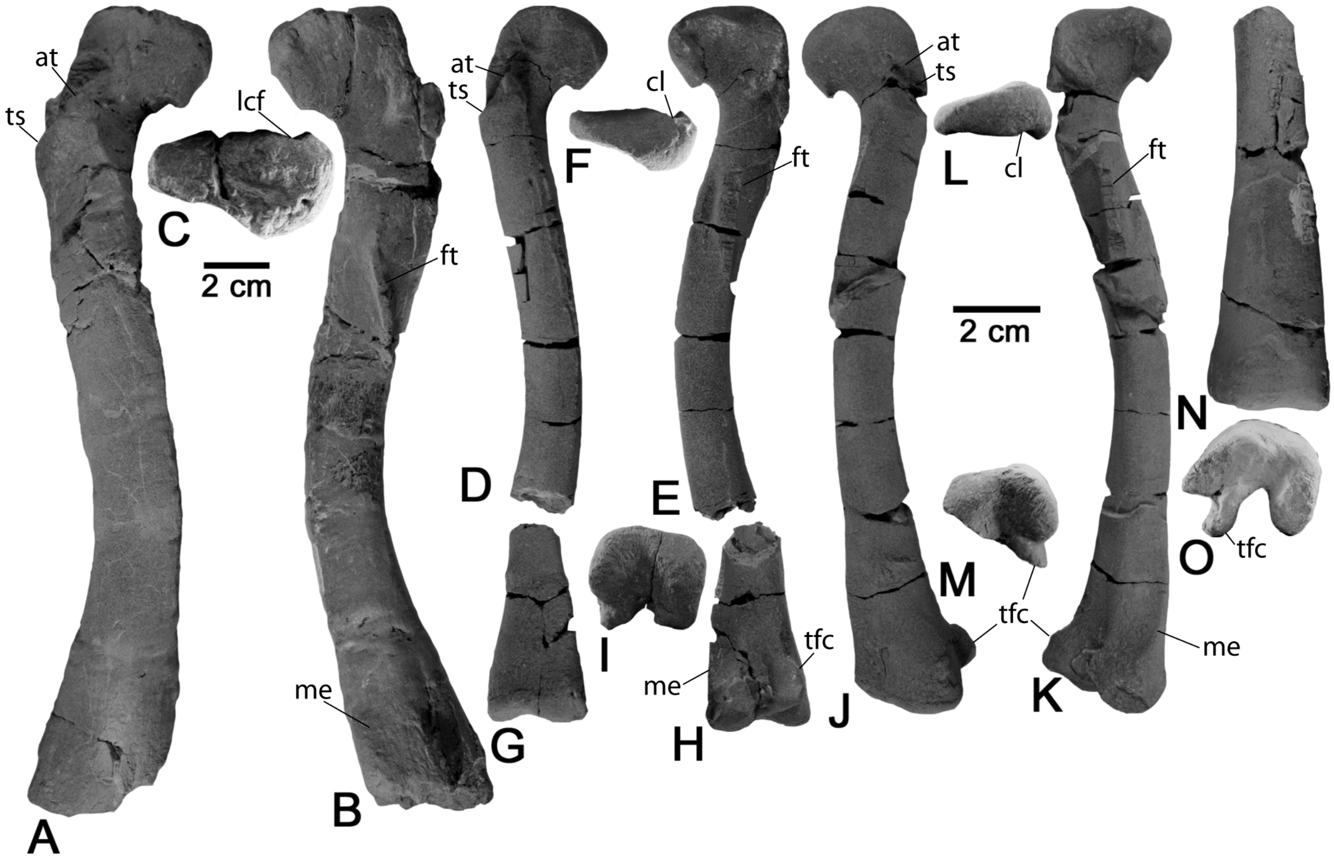

FIGURE 5. **A-C**, NMMNH P-54620, *Coelophysis bauri*, large right femur missing distal condyles in **A**, anterior, **B**, posterior and **C**, medial views. **D-M**, NMMNH P-29046, *Coelophysis bauri*. **D-I**, right femur in **D, G** anterior, **E, H**, posterior, **F**, proximal and **G**, distal views. **J-M**, left femur in **J**, anterior, **K**, posterior, **L**, proximal and **M**, distal views. **N-O**, NMMNH P-54618, *Coelophysis bauri*, distal right femur in **N**, anterior and **O**, distal views. Abbreviations: **at**, anterior trochanter; **cl**, sulcus for capitular ligament; **ft**, fourth trochanter; **me**, medial epicondyle; **tfc**, tibiofibular crest; **ts**, trochanteric shelf.

arch, the base of the neural spine and a complete right transverse process. All the left transverse processes are missing, whereas the portions of the medial ilium are still adhered to the incomplete right transverse processes of the third through fifth vertebrae. All the centra are nearly rectangular in ventral view and slightly waisted. The anterior articular surface of the first centrum and the posterior articular surface of the fifth centrum are circular and suggest that the sacral vertebrae are amphicoelous. The first through fourth centra are seamlessly fused, whereas the fifth is adhered but demarcated by a distinct line. Colbert (1989) documented this condition in large individuals of *Coelophysis bauri*. Comparison with the NMMNH Whitaker quarry material shows this to be common in small *C. bauri* individuals as well.

The single metacarpal is likely from the right manus, based on the orientation of its distal end. Its proximal end is rectangular and expanded compared to the thinner shaft of the element, which is circular in cross-section. The distal end of the metacarpal has two distinct condyles; the lateral is larger and extends more distally than the medial. The single ungual is not highly curved, as are terminal manual phalanges, so it appears to pertain to the pes. In proximal view, the phalanx is subtriangular. Along either side of the distal two-thirds of the phalanx is a groove just above the ventral surface. These elements are exactly as Colbert (1989) described them in *Coelophysis bauri*.

NMMNH P-29046

Four hindlimb elements – two femora, a left tibia and a proximal left fibula – were found in association, and are proportionate to each other in size, so we consider them to belong to a single individual (Figs. 5D-M, 6A-D). The left femur (Fig. 5J-M) is virtually complete, with a slightly offset break midway along the shaft, and lacking only a portion of the medial distal condyle. The right femur is broken near its distal end, although based on comparisons to the left femur, very little of the element is actually missing. The left tibia is complete, although the shaft is interrupted by two diagenetic fractures that give the element an artificial kinked appearance overall.

The femora are mirror images of each other, but otherwise identical. Each has a prominent greater trochanter that is confluent with the femoral head. The head has a hooked appearance, with a sulcus, visible in proximal view, for the capitular ligament. The hooked appearance of the femoral head differs from the femur illustrated by Colbert (1989, fig. 80), however, many consider Colbert's illustration to be of a non-dinosaurian archosaur (J. Harris, pers. commun.). The anterior ("lesser") trochanter is triangular, robust (compare with Raath, 1977, figs. 15-16) and extends along the anterior surface of the shaft. A trochanteric shelf separates the anterior trochanter and the proximal femoral shaft. This shelf wraps laterally around the shaft to its posterolateral edge. The fourth trochanter, situated on the posterior shaft, begins just below the level of the terminus of the trochanteric shelf and extends distally to above the midpoint of the shaft. Overall, the femoral shaft is subtriangular in cross section. Distally, the tibiofibular crest is subtriangular and extends posteriorly from the lateral condyle. A prominent medial epicondyle is present as a prominent groove running along the distal shaft to meet the distal end of the femur.

The proximal tibia (Fig. 6A-D) is very similar to those described above for NMMNH P-29047, including the cleft along the posterior margin of the proximal end and the flange on the medial side of the proximal shaft for articulation with the fibula. The distal tibia is rhom-

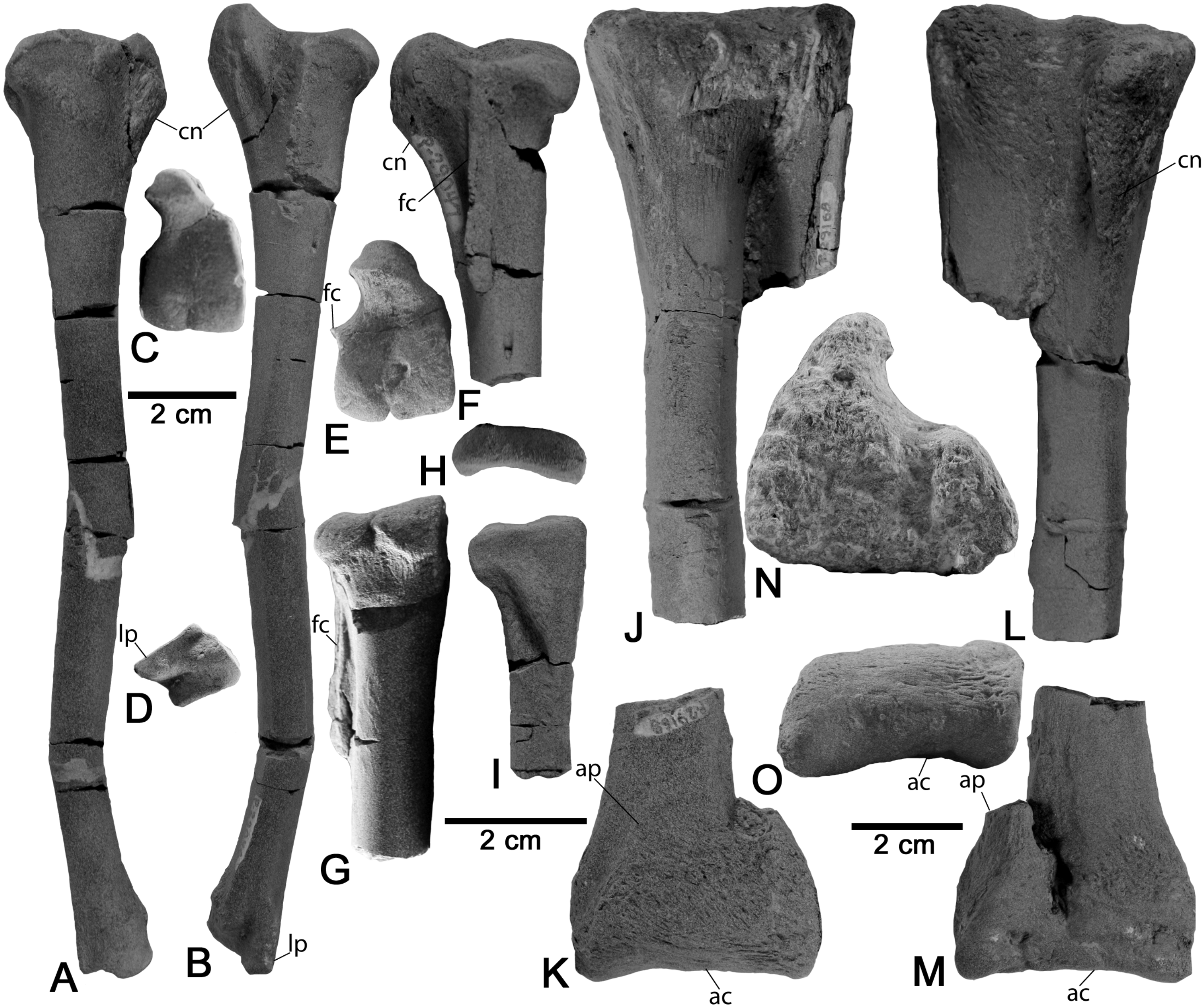

FIGURE 6. **A-D**, NMMNH P-29046, *Coelophysis bauri*, left tibia in **A**, medial, **B**, lateral, **C**, proximal and **D**, distal views. **E-I**, NMMNH P-29047, *Coelophysis bauri*. **E-G**, proximal left tibia in **E**, proximal, **F**, lateral and **G**, posterior views. **H-I**, left fibula in **H**, proximal and **I**, medial views. **J-O**, NMMNH P-29168, large Snyder quarry coelophysoid, fused right tibia/fibula in **J**, **K**, posterior, **L**, **M**, anterior, **N**, proximal and **O**, distal views. Abbreviations: **ac**, astragalocalcaneum; **ap**, ascending process of astragalus; **fc**, fibular crest; **cn**, cnemial crest; **lp**, lateral process of distal tibia.

boidal in distal view. A process on its anterior side for the recepetion of the astragalocalcaneum runs ventrolaterally. A prominent lateral expansion is present, giving the distal tibia a rectangular shape in anterior view. A ridge is also present on the posterior surface. None of the tibiae and fibulae examined in this study are fused to each other; such fusion is variable in *Coelophysis bauri* according to Colbert (1989, p. 107).

The proximal left fibula is morphologically identical to the same element of P-29047 described above, although it is slightly smaller.

Isolated Hindlimb Elements

The other isolated limb elements from the Snyder quarry consist of femora and tibiae in various stages of completeness (Tables 1-2).

Of these, one deserves special mention: NMMNH P-54620, a large right femur missing its distal condyles (Fig. 5A-C). This femur is considerably larger than all the other material referred to the small theropod. The length of this element is 235 mm, as preserved. While this specimen stands out as the largest representative element of the smaller theropod from the Snyder quarry sample, and equivalent in size to UCMP 129618, it is nevertheless slightly smaller than some of the largest *Coelophysis bauri* femora from the Ghost Ranch quarry (the largest of which we are aware is a ~240 mm long femur in the State Museum of Pennsylvania block).

Referral to a Single Taxon

We consider these records to all pertain to a single taxon based on the similarity of like elements, especially the tibiae of NMMNH P-29047 and NMMNH P-29046, the similarity in overall size and the various features that are identical to *Coelophysis bauri* (see below), and fall well within the range of variation others have documented in coelophysoid theropods, including *C. bauri* (Colbert, 1990), *C. rhodesiensis* (Raath, 1990) and *Megapnosaurus kayentakatae* (Tykoski, 1998).

Large Theropod

The larger of the two theropod taxa represented in the quarry, originally noted by Heckert et al. (2000), is represented by a single element, NMMNH P-29168, a fused right tibia and fibula with most of their shafts missing (Fig. 6J-O). The proximal tibia does not have the cleft along the posterior margin as seen in the smaller individual discussed above, but it does have a prominent cnemial crest. The fibula is fused to the lateral condyle of the proximal tibia. The distal tibia and fibula are fused to the astragalocalcaneum. This fusion is extensive: the ascending process of the astragalus is barely discernable on the anterior distal tibia. Just lateral to this process is a prominent groove oriented ventrolaterally. Also, whereas the distal tibia does have a lateral process, it does not extend beyond the level of the shaft, and so is not nearly as extensive as the same feature in the small theropod. We consider this specimen Coelophysoid indet. based on the presence of a deep fossa on the craniolateral surface of the ascending process of the astragalus.

COMPARISON OF THE SNYDER THEROPOD MATERIAL WITH UCMP 129618

Padian (1986) described UCMP 129618, an incomplete skeleton of a theropod dinosaur, from the Painted Desert Member of the Petrified Forest Formation, Chinle Group, of the Petrified Forest National Park, Arizona (UCMP locality V82250). The skeleton includes one dorsal and one anterior caudal centrum, an incomplete right pelvis (Fig. 7), an incomplete left ischium, fragmentary femora (Figs. 8-9), both tibiae (Fig. 10), a left fibula (Fig. 10B-E) and right distal tarsals, metatarsals and phalanges. The specimen was collected in the southwestern portion of the northern half of Petrified Forest National Park, near Lacey Point at a location that subsequently came to be known informally as "Dinosaur Hill." Fossils from Dinosaur Hill come from the uppermost Kachina Point Bed and the fine-grained sediments immediately overlying it (Heckert and Lucas, 2002).

Padian (1986) identified the skeleton as *Coelophysis bauri* based on comparisons to Cope's syntypes of *C. bauri*, not the neotype. When comparing UCMP 129618 to the Ghost Ranch material, Padian (1986, p. 56) noted that "there are differences between the Ghost Ranch and Petrified Forest specimens that may require taxonomic reevaluation when full descriptions of the former are published." With the Ghost Ranch material now serving as the neotype of *C. bauri* it is worth reviewing the comparison to see if Padian's (1986) initial concerns were warranted. Padian (1986) was not the only one to have doubts about the assignment of the UCMP 129618 to *C. bauri*: Long and Murry (1995) also noted that UCMP 129618 is "considerably different from the Ghost Ranch specimens" (p. 187) but did not provide any specific differences. Heckert and Lucas (1998) considered UCMP 129618 an indeterminate ceratosaur. Hunt et al. (1998) noted that the presence of an obturator foramen, a feature that Padian (1986) cited specifically as distinguishing UCMP 129618 from the Ghost Ranch *Coelophysis* material, was in fact shared by both taxa. Thus, while many workers have noted a general difference between the Ghost Ranch *Coelophysis* material and UCMP 129618, no specific differences have been enumerated in the literature. In contrast to these other studies, we find numerous similarities between *Coelophysis* and UCMP 129618.

Fortunately, all the major elements that comprise UCMP 129618 – the incomplete hip, femora, tibiae and fibula – are also represented in the various incomplete skeletons of the small Snyder theropod. The ilia of both animals have prominent supra-acetabular crests that give their acetabula a "hooded" appearance. The proximal femora are identical, sharing a hooked greater trochanter, a triangular anterior trochanter, a trochanteric shelf that wraps laterally around the femoral shaft and a sulcus for the capitular ligament. Likewise, the distal femora are also similar, with prominent, subtriangular tibiofibular crests and prominent medial epicondyles. The tibiae share the following characteristics: a notch along the posterior margin of the proximal tibia, prominent cnemial crest and rhomboid distal tibia with rectangular lateral projection. The fibulae of UCMP 129618 and the small Snyder theropod are also similar. These features shared by both taxa are present in the coelophysoids *Liliensternus liliensterni*, *Coelophysis rhodesiensis* and *Coelophysis bauri*. In addition, given the close temporal and geographic distribution of these taxa, it is most parsimonious to assign both to the same taxon.

COMPARISONS WITH *COELOPHYSIS BAURI*

Utilizing recent phylogenetic analyses of basal theropods (Ezcurra, 2006; Ezcurra and Novas, 2006), examination of *Coelophysis bauri* material from the NMMNH Ghost Ranch quarry block, plus published descriptions of *C. bauri* (Colbert, 1989), we compared the small Snyder theropod and UCMP 129618 to *C. bauri*. Here, we compare these theropods to other Late Triassic basal theropods, based on the diagnoses provided by Ezcurra (2006) and Ezcurra and Novas (2006).

The following characteristics, listed by Ezcurra (2006) and Ezcurra and Novas (2006) as unambiguous apomorphies of coelophysoids are possessed by the Snyder/UCMP theropod: angle between rostral margin and alveolar margin of premaxilla equal or less than 40° (19° in NMMNH P-30852); presence of a ventral process at the caudal end of premaxiallary body (which we refer to above as the maxillary process of the premaxilla); absence of a subnairal foramen; axial diapophysis present; postaxial cervical neural spines dorsoventrally low; articulation facet of pubic penduncle of ilium with pronounced kink and cranial part facing almost entirely cranially. Of note is that the rostral end of the dentary does not appear to be dorsally expanded; a feature that argues against the Snyder/UCMP theropod being a coelophysoid. But, since the dentaries of NMMNH P-30852 are incomplete this is likely the cause of this anomalous feature, especially given the presence of various apomorphies possessed by the Snyder/UCMP theropod that are characteristic of more exclusive clades within Coelophysoidea.

The following characteristics are listed by Ezcurra (2006) and Ezcurra and Novas (2006) as unambiguous apomorphies of the Coelophysidae (consisting of *Coelophysis* and *Megapnosaurus* [= "*Syntarsus*"]) also possessed by the Snyder/UCMP theropod: mediolateral width of anterior end of dentary equal to that of caudal part, caudoventral process of the coracoid tapering and projected beyond the caudal margin of the glenoid fossa, supraacetabular crest and lateral brevis fossa continuous as a well developed ridge, with non-distinct separation between both structures.

The Snyder/UCMP theropod possesses the following characteristics, listed by Ezcurra (2006) and Ezcurra and Novas (2006) as unambiguous apomorphies of *Coelophysis*: absence of promaxillary foramen, rostral process of postorbital at about the same level as or slightly higher than the squamosal process, resulting in a T-shaped postorbital. The angle of the ascending process of the maxilla in NMMNH P-30852 is ~36° as preserved, although the anterior end of the maxilla in NMMNH P-30852 is not visible and thus would increase the length of the maxilla, consequently reducing the angle of the ascending process. This is an important feature since Ezcurra (2006) and Ezcurra and Novas (2006) list an angle of the ascending process of the maxilla less than 35° as an apomorphy of *Coelophysis*.

Bristowe and Raath (2004) used the width of the base of the vertical ramus of the lacrimal, being greater than 30% of its height as a characteristic distinguishing *Coelophysis bauri* from *C. rhodesiensis* (although this feature is also present in *Eoraptor*, *Megapnosaurus* (= "*Syntarsus*") *kayentakatae* and *Zupaysaurus*). The presence of this character in the Snyder/UCMP theropod demonstrates that this material can be identified to *C. bauri*. This is the most logical result given that *C. bauri* is the only coelophysid reported from Upper Triassic strata in North America. In addition to the strict character analysis, side-by-side comparisons of *Coelophysis bauri* and the Snyder/UCMP theropod show that they are identical, as noted throughout the description above.

Table 2 demonstrates that all the material discussed above pertains to basal theropods, while some material (NMMNH P-29046 and P-54167l; UCMP 129618) can be identified to the genus *Coelophysis*. Only NMMNH P-30852 can be definitively identified as *Coelophysis bauri*. However, parsimony would dictate that all the basal theropod

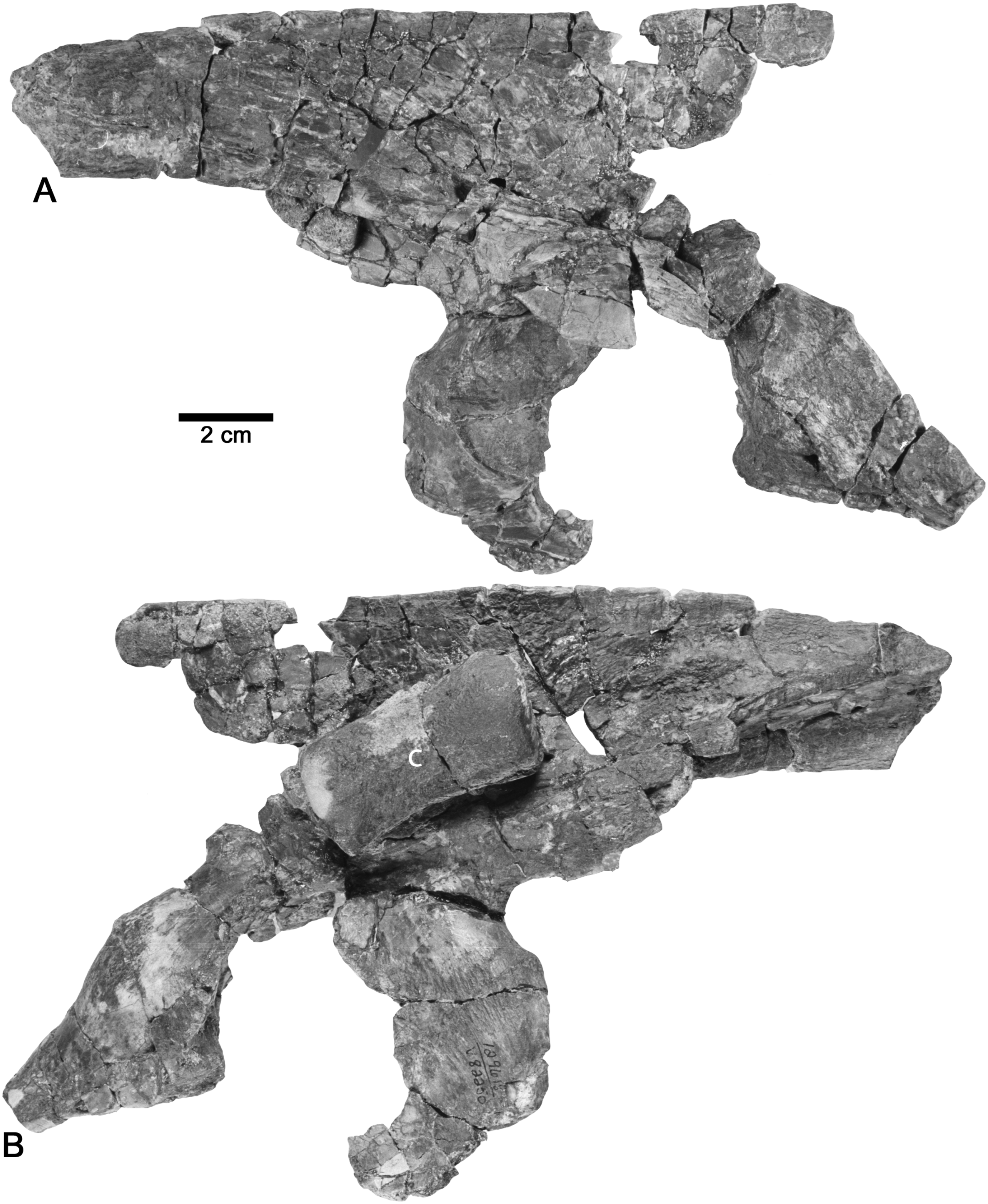

FIGURE 7. **A-B**, UCMP 129618, *Coelophysis bauri*, partial right pelvis in **A**, lateral and **B**, medial view. Note centrum (**c**) adhered to medial ilium.

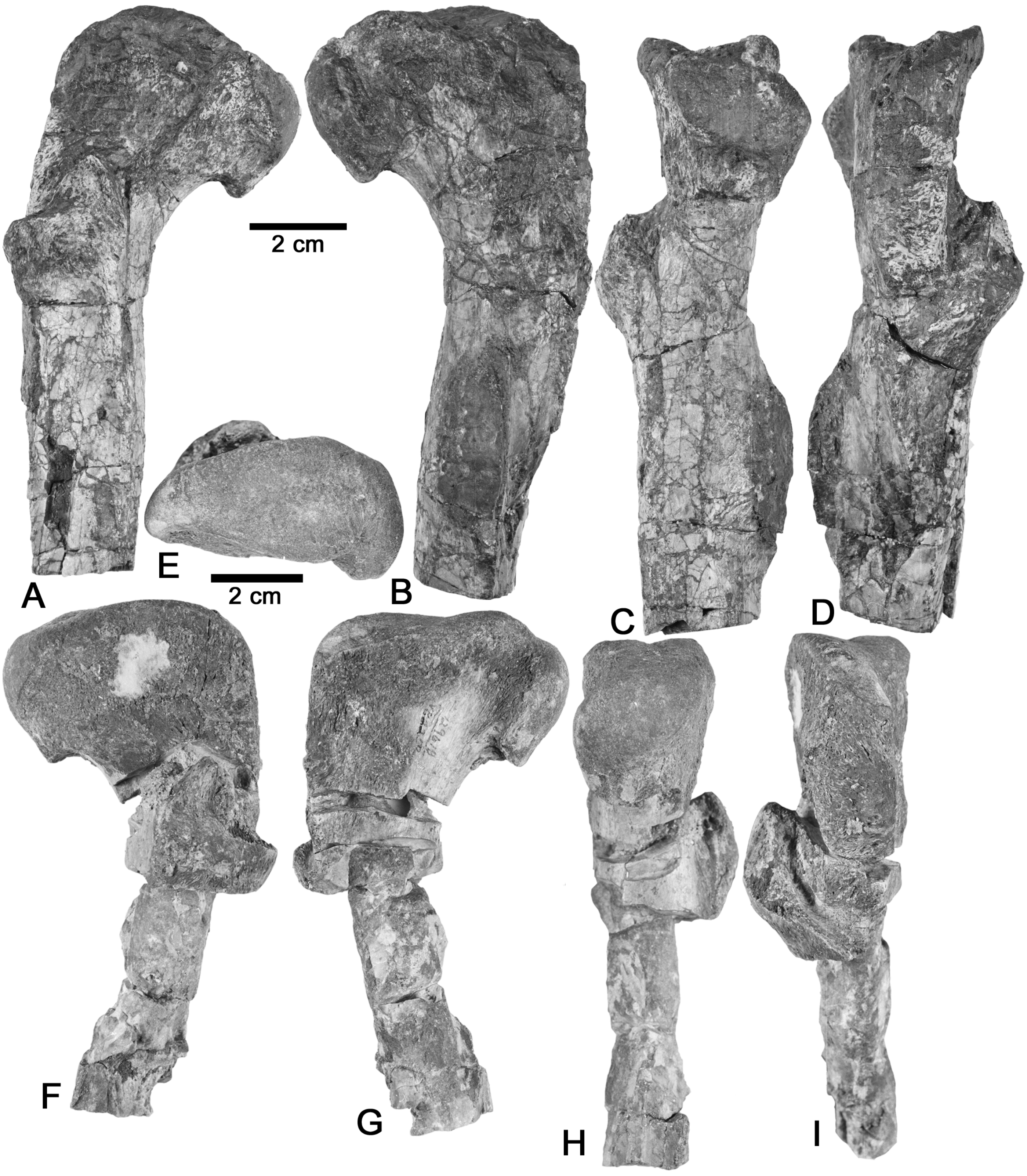

FIGURE 8. **A-I**, UCMP 129618, *Coelophysis bauri*, proximal femora. **A-D**, right proximal femur in **A**, anterior, **B**, posterior, **C**, medial and **D**, lateral views. **E-I**, left proximal femur in **E**, proximal, **F**, anterior, **G**, posterior, **H**, medial and **I**, lateral views.

material from the Snyder quarry is assignable to a single taxon. We believe it is most parsimonious to assign this material to *Coelophysis bauri* because none of the aforementioned taxa, other than *Coelophysis* and *Camposaurus*, existed in the Late Triassic of North America as far as is currently known.

THE BIOSTRATIGRAPHIC RANGE OF *COELOPHYSIS BAURI*

Coleophysis bauri was previously known only from the Ghost Ranch Whitaker quarry, Rio Arriba County, New Mexico, in the Rock Point Formation. The Rock Point Formation is of Apachean age (late

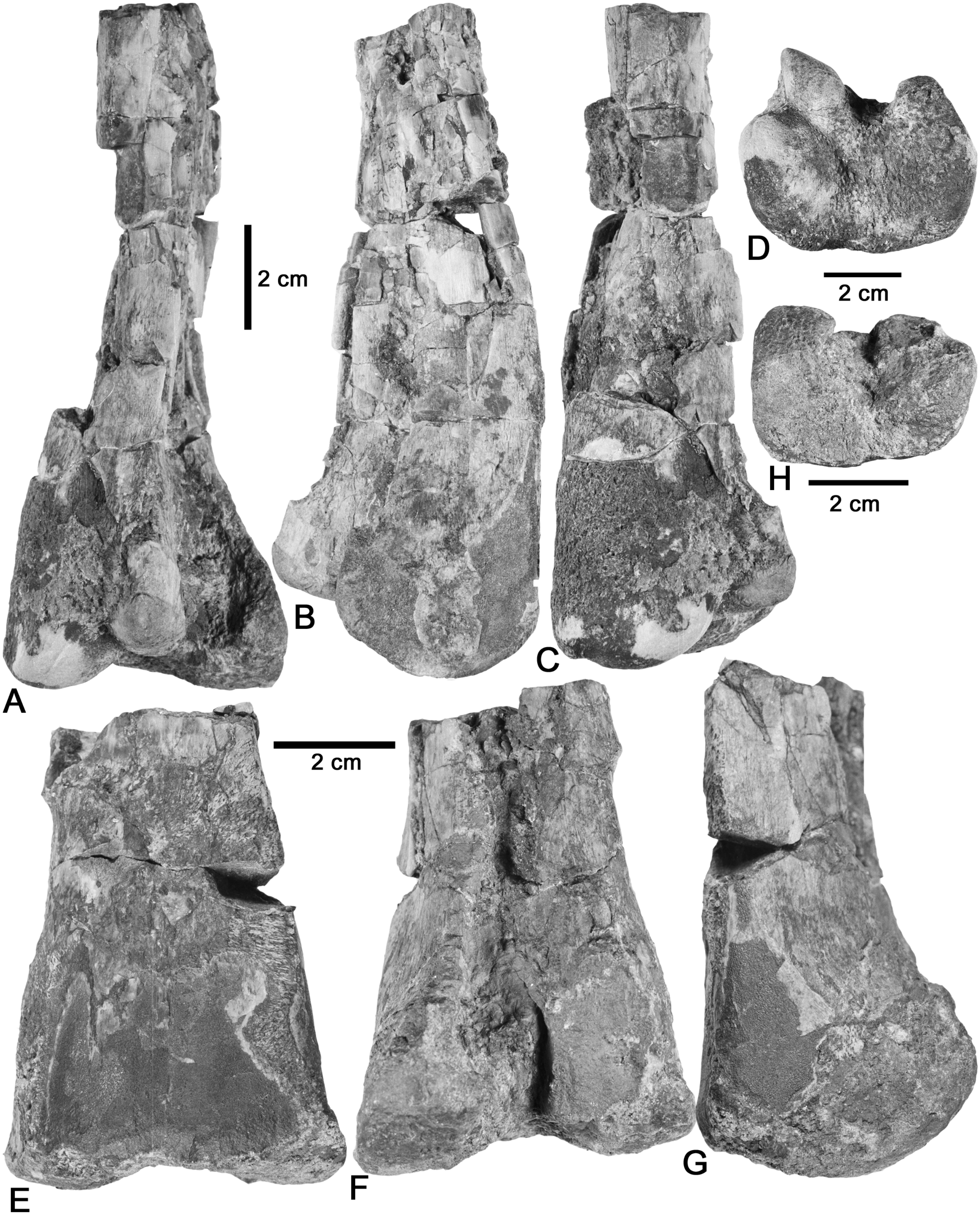

FIGURE 9. **A-H**, UCMP 129618, *Coelophysis bauri*, distal femora. **A-D**, left distal femur in **A**, posterolateral, B, medial, **C**, lateral and **D**, proximal views. **E-H**, right distal femur in **E**, anterior, **F**, posterior, **G**, medial and **H**, distal views.

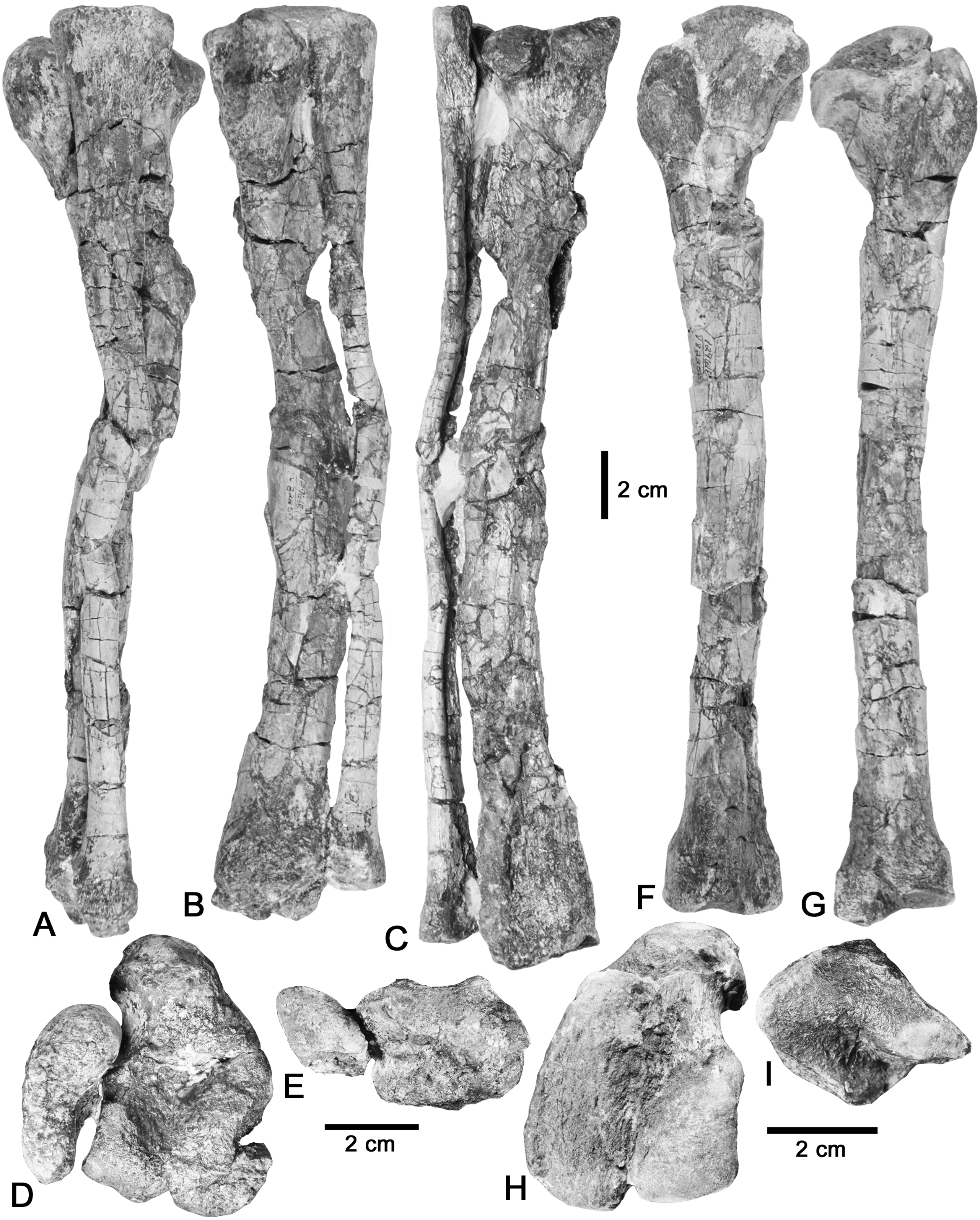

FIGURE 10. **A-I**, UCMP 129618, *Coelophysis bauri*, tibiae and fibula. **A-E**, left tibia and fibula in **A**, lateral, **B**, anterior, **C**, posterior, **D**, proximal and **E**, distal views. **F-I**, right tibia in **F**, medial, **G**, lateral, **H**, proximal and **I**, distal views.

TABLE 2. Specimens discussed in the text, with list of diagnostic characters and taxon to which the individual specimen can be identified.

Specimen Number	Identifiable Taxon	Diagnostic Features
P-29046	Derived coelophysoid	—Anterior trochanter on femur triangular: found only in *Herrerasaurus*, *Coelophysis*, *Liliensternus liliensterni*, and *Dilophosaurus* (Rauhut, 2003, p. 113). —Distal end of femur anteroposteriorly broad and distally flattened: found only in *Eoraptor*, *Herrerasaurus*, *Staurikosaurus*, *Coelophysis* and *Dilophosaurus* (Rauhut, 2003, p. 114-115). —Fibular condyle on proximal tibia confluent with cnemial crest anteriorly in proximal view: found only in *Herrerasaurus*, *Staurikosaurus*, *Coelophysis*, *Gojirasaurus*, *Liliensternus liliensterni*, *Dilophosaurus*, *Segisaurus* and *Elaphrosaurus* (Rauhut, 2003, p. 115). —Lateral process on distal tibia polygonal-shaped: found in all coelophysoids more derived than *Dilophosaurus* (Sereno, 1999).
P-29047	Coelophysoidea indet.	—Dolichoiliac pelvis: found in *Coelophysis* and derived theropods, not found in *Eoraptor*, *Herrarsaurus* and *Staurikosaurus* (Rauhut, 2003, p. 102). —Articular facet of pubic penducle of ilium with pronounced kink and anterior part facing almost entirely anteriorly: found in *Coelophysis*, *Liliensternus liliensterni*, *Lophostropheus airlensis*, *Dilophosaurus* and ornithomimosaurs (Rauhut, 2003, p. 107). —Fibular condyle on proximal tibia confluent with cnemial crest anteriorly in proximal view: found only in *Herrerasaurus*, *Staurikosaurus*, *Coelophysis*, *Gojirasaurus*, *Liliensternus liliensterni*, *Dilophosaurus*, *Segisaurus* and *Elaphrosaurus* (Rauhut, 2003, p. 115).
P-30852	*Coelophysis bauri*	—L-shaped lacrimal: found in all theropods except *Herrerasaurus* (Rauhut, 2003, p. 55). —Lack of promaxillary foramen: diagnostic of *Coelophysis* (Ezcuraa, 2006; Ezcurra and Novas, 2006). —Width of the base of the lacrimal is greater than 30 percent of its height: distinguishable character of *Coelophysis bauri* from *C. rhodesiensis* (Bristowe and Raath, 2004, p. 39).
P-31661	Coelophysidae indet.	—More than three sacral vertebrae: found in all theropods except for *Herrerasaurus*, *Staurikosaurus* and *Eoraptor* (Rauhut, 2003, p. 84-85). —Caudoventral process of the coracoid tapering and projected beyond the caudal margin of the glenoid fossa: diagnostic of the Coelophysidae (Ezcurra, 2006; Ezcurra and Novas, 2006).
P-31293	Saurischia indet.	—Fibular condyle on proximal tibia confluent with cnemial crest anteriorly in proximal view: found only in *Herrerasaurus*, *Staurikosaurus*, *Coelophysis*, *Gojirasaurus*, *Liliensternus liliensterni*, *Dilophosaurus*, *Segisaurus* and *Elaphrosaurus* (Rauhut, 2003, p. 115).
P-54617	Derived coelophysoid	—Lateral process on distal tibia polygonal-shaped: found in all coelophysoids more derived than *Dilophosaurus* (Sereno, 1999).
P-54618	*Coelophysis* sp.	—Distal end of femur anteroposteriorly broad and distally flattened: found only in *Eoraptor*, *Herrerasaurus*, *Staurikosaurus*, *Coelophysis* and *Dilophosaurus* (Rauhut, 2003, p. 114-115). —Proximal surface of femur with transversely extended groove: diagnostic of *Coelophysis* sp. (Ezcurra, 2006; Ezcurra and Novas, 2006).
P-54619	*Coelophysis* sp.	—Distal end of femur anteroposteriorly broad and distally flattened: found only in *Eoraptor*, *Herrerasaurus*, *Staurikosaurus*, *Coelophysis* and *Dilophosaurus* (Rauhut, 2003, p. 114-115). —Proximal surface of femur with transversely extended groove: diagnostic of *Coelophysis* sp. (Ezcurra, 2006; Ezcurra and Novas, 2006).
P-54620	*Coelophysis* sp.	—Anterior trochanter on femur triangular: found only in *Herrerasaurus*, *Coelophysis*, *Liliensternus liliensterni*, and *Dilophosaurus* (Rauhut, 2003, p. 113). —Proximal surface of femur with transversely extended groove: diagnostic of *Coelophysis* sp. (Ezcurra, 2006; Ezcurra and Novas, 2006).
UCMP 129618	Derived coelophysoid	—Dolichoiliac pelvis: found in *Coelophysis* and derived theropods, not found in *Eoraptor*, *Herrarsaurus* and *Staurikosaurus* (Rauhut, 2003, p. 102). —Articular facet of pubic penducle of ilium with pronounced kink and anterior part facing almost entirely anteriorly: found in *Coelophysis*, *Liliensternus liliensterni*, *Lophostropheus airlensis* and ornithomimosaurs (Rauhut, 2003, p. 107). —Anterior trochanter on femur triangular: found only in *Herrerasaurus*, *Coelophysis*, *Liliensternus liliensterni*, and *Dilophosaurus* (Rauhut, 2003, p. 113). —Distal end of femur anteroposteriorly broad and distally flattened: found only in *Eoraptor*, *Herrerasaurus*, *Staurikosaurus*, *Coelophysis* and *Dilophosaurus* (Rauhut, 2003, p. 114-115). —Fibular condyle on proximal tibia confluent with cnemial crest anteriorly in proximal view: found only in *Herrerasaurus*, *Staurikosaurus*, *Coelophysis*, *Gojirasaurus*, *Liliensternus liliensterni*, *Dilophosaurus*, *Segisaurus* and *Elaphrosaurus* (Rauhut, 2003, p. 115). —Lateral process on distal tibia polygonal-shaped: found in all coelophysoids more derived than *Dilophosaurus* (Sereno, 1999).

Norian-Rhaetian?) (Lucas and Tanner, 2007). The presence of the phytosaur *Redondasaurus* in the Whitaker quarry fauna (Rinehart et al., 2004) demonstrates that the assemblage pertains to the Apachean land-vertebrate faunachron (lvf) of Lucas and Hunt (1993).

The Snyder quarry is stratigraphically lower than the Whitaker quarry. It is in the upper part of the Painted Desert Member of the Petrified Forest Formation (Lucas et al., 2003, 2005). The fauna of the Snyder quarry includes the aetosaur *Typothorax coccinarum* and the phytosaur *Pseudopalatus buceros*, both of which indicate a Revueltian (early-middle Norian) age (Heckert et al., 2005).

UCMP 129618 was recovered from strata low in the Painted Desert Member of the Petrified Forest Formation, Petrified Forest National Park, Arizona (Heckert and Lucas, 2002). This record of *Coelophysis bauri*, like the Snyder quarry record, also is Revueltian.

These additional records extend the biostratigraphic range of *Coelophysis bauri* from Apachean to early Revueltian (Fig. 11). This indicates that the temporal range of *C. bauri* encompasses much of Norian time. Thus, the biostratigraphic utility of *C. bauri* is reduced, and it is no longer an index fossil of the Apachean (e.g., Lucas, 1998).

ACKNOWLEDGMENTS

The late John Estep photographed UCMP 129618. Numerous volunteers of the New Mexico Museum of Natural History and Science helped in the excavation and preparation of the Snyder quarry material. Martin D. Ezcurra and Jerry D. Harris provided reviews that improved the manuscript.

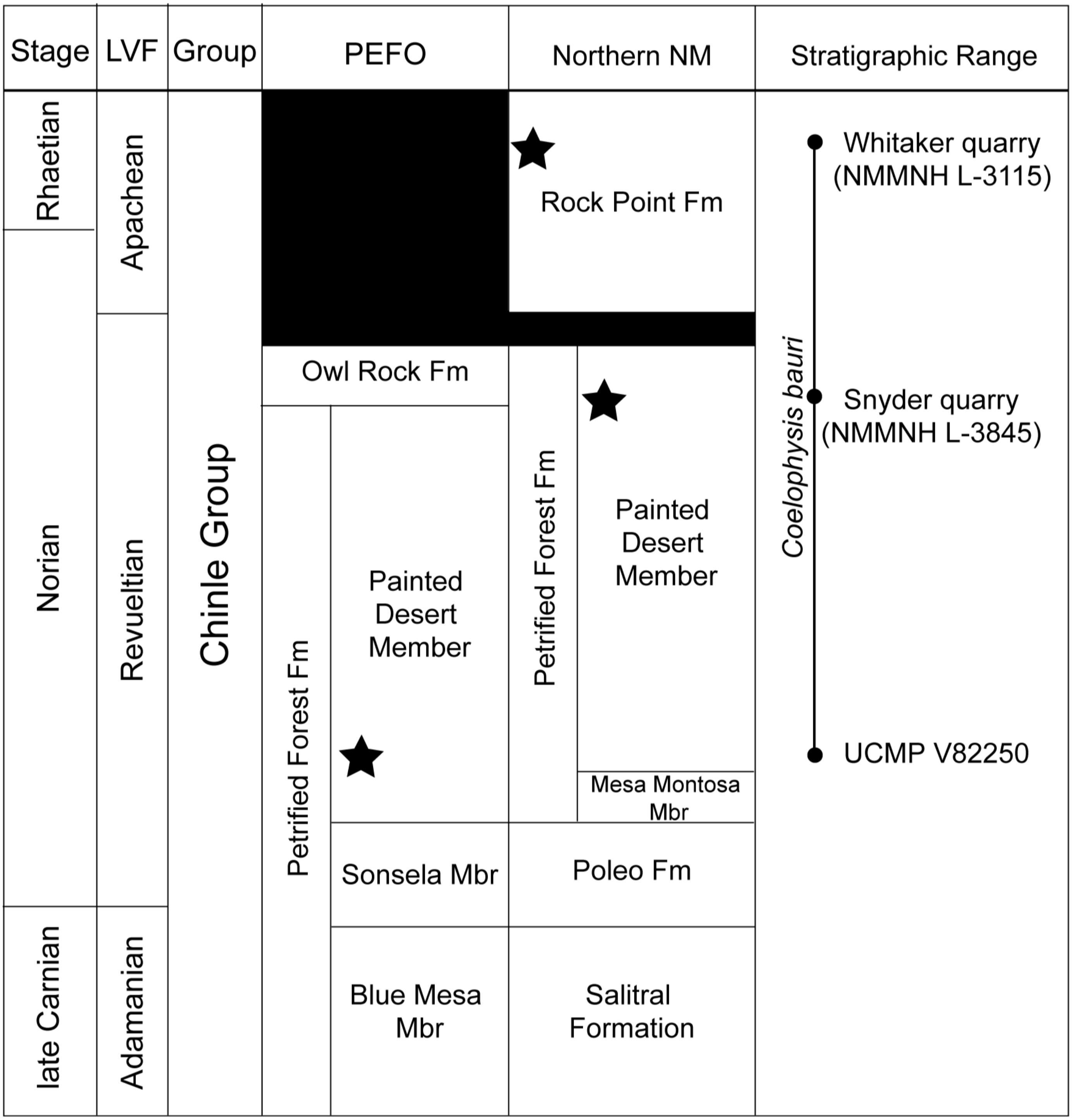

FIGURE 11. Biostratigraphic distribution of *Coelophysis bauri* occurrences in the southwestern USA. See text for discussion.

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APPENDIX

Measurements (in mm) of selected elements from the Snyder quarry *Coelophysis bauri* sample and UCMP 129618. In reference to proximal and distal limb bones, the length is an anteroposterior measurement, whereas the width is a mediolateral measurement. Midshaft diameter is midshaft length/midshaft width. Abbreviations: AP = as preserved; NA = not applicable, indicating a feature is not preserved in a specimen; NM = not measured, the feature is present but due to preservation cannot be measured; * = based on metrics in Padian (1986); ** = measurements of NMMNH C-3086 a cast of the right ilium, proximal and distal femora, both tibiae and left fibula of UCMP 129618.

Skull Metrics
Coelophysis bauri

Specimen Number	Description	Length of left premaxilla	Height of left premaxilla	Length of right maxilla	Length of left lacrimal	Height of left lacrimal
NMMNH P-30852	Incomplete and partially disarticulated	25.9	13.1	98.2 AP	40.7	31.8
		Length of the base of the lacrimal	**Length of left lower jaw**	**Length of right lower jaw**	**Length of ?cerato-branchials**	
		17.1	133.9	122.4	54.6/38.2	

Vertebrae Metrics
Coelophysis bauri

Specimen Number	Description	Length of articulated vertebrae	Height of articulated vertebrae	Width of articulated vertebrae
NMMNH P-30852	Cervical vertebrae 3 and 4 articulated	78	18.1	13.7

Scapuocoracoid Metrics
Coelophysis bauri

Specimen Number	Left/Right	Description	Length	Height	Glenoid height
NMMNH P-31661	Left	Incomplete	32.7 AP	51.5 AP	11.9

Radius Metrics
Coelophysis bauri

Specimen Number	Left/Right	Description	Length	Midshaft width	Max. proximal length	Max. prox width	Max. distal length	Max. distal width
NMMNH P-31661	Right	Complete	51.8	3.4	7	4.2	4.8	5.9

Ilia Metrics
Coelophysis bauri

Specimen Number	Left/Right	Description	Length	Height	Iliac blade length	Acetabular length	Min. Acetabular height
NMMNH P-29047	Right	Missing iliac blade	41.4 AP	27.7 AP	NA	28.3	8.4
UCMP 129618	Right	Incomplete w/ fused incomplete pubis and ischium	211.4 AP**	117.5 AP**	164.6**	54.7 **	50 AP**

Ischium Metrics
Coelophysis bauri

Specimen Number	Left/Right	Description	Length	Length of ilia articular surface	Width of ilia articular surface
NMMNH P-29047	Right	Complete	115.3	16.6	8.9

Femora Metrics
Coelophysis bauri

Specimen Number	Left/Right	Description	Length	Midshaft width	Max. proximal length	Max. prox width	Max. distal length	Max. distal width
NMMNH P-29046	Left	Complete	155.5	11.7	12.2	25.7	20.5	22.6
NMMNH P-29046	Right	Midshaft break	112.9/47 AP	10.8	12.2	24.7	22.9	23.3
NMMNH P-54618	Right	Distal	89.1 AP	12.9	NA	NA	22.5	26.9
NMMNH P-54619	Right	Distal	100.1	13.7	NA	NA	26.1	27.3 AP
NMMNH P-54620	Right	Missing distal end	235 AP	22.4	23.1	38.7 AP	NA	NA
UCMP 129618	Left	Complete	245*	NM	24.4**	49**	43.9**	49.4**
UCMP 129618	Right	Missing ~10 mm of shaft	235*	NM	24.6**	50.0**	38.0 AP**	51.3**

Tibiae Metrics
Coelophysis bauri

Specimen Number	Left/Right	Description	Length	Midshaft width	Max. proximal length	Max. prox width	Max. distal length	Max. distal width
NMMNH P-29046	Left	Complete	164.0	10.0	27.9	18.5	13.8	17.9
NMMNH P-29047	Left	Proximal	47.6 AP	NA	25.3	16.7	NA	NA
NMMNH P-31293	Left	Midshaft break	115.1/25.5 AP	8.9	21.5	12.7	10.8	14.6
NMMNH P-54617	Right	Missing distal end	149.9 AP	8.3 AP	23.5	16.5	NA	NA
UCMP 129618	Left	Partial fused with left fibula	247**	18.2**	54.3**	35.3**	27.9**	34.9**
UCMP 129618	Right	Complete	261.4**	19.0**	54.3**	36.5**	27.8**	37.2**

Fused Tibia/Fibula Metrics
Snyder quarry large Coelophysid

Specimen Number	Left/Right	Description	Length	Midshaft width	Max. proximal length	Max. prox width	Max. distal length	Max. distal width
NMMNH P-29168	Right	Midshaft break	107.6/50.1 AP	17.5	44.2	46.5	19.4	39.4

Fibulae Metrics
Coelophysis bauri

Specimen Number	Left/Right	Description	Length	Max. proximal length	Max. prox width
NMMNH P-29046	Left	Proximal	34.6 AP	16.7	7.0
NMMNH P-29047	Left	Proximal	36.9 AP	15.0	5.3