Family ?Rauisuchidae Price, 1946

Type Revueltian occurrence: NMMNH locality 16.

Referred specimens from type Revueltian: NMMNH locality 16; NMMNH P-4351, cervical vertebra.

First occurrence: Several genera from the Anisian (Triassic) of Africa, Asia and Europe. Rauisuchidae as utilized here includes Poposauridae, Prestosuchidae etc. of other workers pending a thorough revision of these taxa.

Last occurrence: *Fasolasuchus tenax* from late Norian/?Rhaetian (Triassic) of Argentina and undescribed taxon from the Apachean (late Norian/?Rhaetian) Whitaker quarry, New Mexico.

Acme zone: Anisian-Ladinian (Triassic).

Discussion: This specimen is similar to vertebrae of rauisuchians, but is not definitely assignable to this family.

Crocodylomorpha Hay, 1930
Sphenosuchia Bonaparte, 1971
Sphenosuchidae Huene, 1922
gen. et sp. indeterminate

Type Revueltian occurrences: NMMNH localities 1, 57, 124, 169, 459, 501: UMMP locality 5 miles west of San Jon in Badlands.

Referred specimens from type Revueltian: NMMNH locality 1; NMMNH P-4658, 2 cervical vertebrae; NMMNH P-4659, vertebrae; NMMNH P-4663, cervical, dorsal, caudal vertebrae; NMMNH P-4673, cervical vertebra; NMMNH P-16754, vertebrae; NMMNH P-16764, premaxilla: NMMNH locality 57; NMMNH P-4120, premaxilla, vertebral fragments; NMMNH P-17346, partial skeleton (cervical, dorsal, sacral and caudal vertebrae, partial pubes, ischia and ilia, premaxilla and maxilla fragments): NMMNH locality 124; NMMNH P-4573, sacral vertebrae: NMMNH locality 169; NMMNH P-4874, lower jaw: NMMNH locality 459; NMMNH P-16839, caudal centrum: NMMNH locality 501; NMMNH P-17229, osteoderm: 5 miles west of San Jon in badlands; UMMP 4771 (in part), three dorsal and one caudal centrum.

First occurrence: *Dyoplax arenaceus* from the late Carnian (Triassic) of Germany.

Last occurrence: *Kayentasuchus* sp. from the Sinemurian/Pliensbachian (Jurassic) of the western United States.

Acme zone: None.

Discussion: Several specimens in the Bull Canyon vertebrate fauna represent a sphenosuchian. The best specimens are NMMNH P-17346, which is a partial skeleton, and NMMNH P-4663, which is a partial vertebral column. The former specimen is the most diagnostic, although elements in common between the two specimens are nearly identical in size and morphology. NMMNH P-17346 contains sacral vertebrae that are indistinguishable from Chinle Group sphenosuchians that have been assigned to *Hesperosuchus agilis* (Colbert, 1952; Clark et al., 2000) and cf. *Sphenosuchus* sp. (Parrish, 1991). Unfortunately, the most potentially diagnostic elements in the Bull Canyon specimen are the fragmentary ilia, ischia and pubes. These elements are totally lacking in the holotypes of *Sphenosuchus* (Walker, 1990) and *Hesperosuchus* (Colbert, 1952). Parrish's (1991) specimen from Revueltian-age strata in Arizona includes portions of the pubes that are proximally, narrower anteroposteriorly. The ilium of the Bull Canyon Formation specimen indicates an imperforate, or nearly so, acetabulum, a less derived condition than seen in the European *Terrestrisuchus* (Crush, 1984), which is also of Norian age. There is a buttress above the acetabulum in NMMNH P-17346, which has previously not been recognized in the Sphenosuchidae. This buttress was the apparently the main reason behind Long and Murry (1995, fig. 146) assigning an ilium from the Whitaker quarry to *Postosuchus* despite the fact that the specimen was surrounded by osteoderms of a sphenosuchian. The Whitaker quarry specimen obviously pertains to the taxon described by Clark et al. (2000) from the same locality. In conclusion, a distinct sphenosuchid is present in the Bull Canyon Formation, but it is not represented by diagnostic specimens. Most Bull Canyon sphenosuchias specimens probably pertain to this taxon. However, NMMNH P-4673 is a cervical vertebra that has a much wider and less longitudinally arched centrum. This probably represents a second taxon.

Family ?Sphenosuchidae Huene, 1922

Type Revueltian occurrences: NMMNH localities 1, 156.

Referred specimens from type Revueltian: NMMNH locality 1; NMMNH P-4660, centrum: NMMNH locality 156; NMMNH P-4559, centrum.

First occurrence: *Dyoplax arenaceus* from the late Carnian (Triassic) of Germany.

Last occurrence: *Kayentasuchus* sp. from the Sinemurian/Pliensbachian (Jurassic) of the western United States.

Acme zone: None.

Discussion: These vertebrae are similar to specimens assigned above to the Sphenosuchidae but they are not diagnostic of that family.

Crocodylotarsi Benton and Clark, 1988
incertae sedis
gen. et sp. nov.

Type Revueltian occurrences: NMMNH localities 1, 162, 182, 467, 523, 527, 534-535: UMMP locality 5 miles west of San Jon in badlands.

Referred specimens from type Revueltian: NMMNH locality 1; NMMNH P-4691, left proximal femur; NMMNH P-4888, right proximal femur (large); NMMNH P-4902, partial dorsal vertebra; NMMNH P-4869, ?scapula blade; NMMNH P-16929, sacral vertebrae; NMMNH P-16920, proximal ischium; NMMNH P-16922, many osteoderm fragments; NMMNH P-16930, cervical vertebra; NMMNH P-16923, partial carapace; NMMNH P-16685, osteoderm: NMMNH locality 162; NMMNH P-4665, 11 vertebrae (cervical [1], dorsal [7], dorso-sacral [2], anterior caudal [1]): NMMNH locality 182; NMMNH P-16912, iliac blade: NMMNH locality 523; NMMNH P-17455, many osteoderm fragments; NMMNH P-17459, dorsal vertebra: NMMNH locality 467; NMMNH P-16932; small scavenged skeleton, portions of a large specimen and rauisuchian teeth: NMMNH locality 527; NMMNH P-17474, osteoderm fragments: NMMNH locality 534; NMMNH P-17384, osteoderm fragment: NMMNH locality 535; NMMNH P-17352, distal tibia: 5 miles west of San Jon in Badlands; UMMP 4771 (in part), proximal femur.

First and last occurrence: Revueltian (Triassic: early-middle Norian) of New Mexico and Arizona.

Acme zone: Revueltian (Triassic: early-middle Norian).

Discussion: This highly distinctive crocodylotarsan is distinguished by wide, rectangular paramedian osteoderms with an irregular pattern of deep pits and no lateral osteoderms, and a wide tarsus that has a small astragalar medial process and corresponding medial calcaneal concavity. It is known from several localities in the Revuelto and Barranca badlands and has recently been recognized from the lower Painted Desert Member of the Petrified Forest Formation at Petrified Forest National Park. This distinctive new taxon will be described in more detail elsewhere.

NMMNH P-16932 is the most complete specimen and consists of an articulated series of dorsal osteoderms with associated osteoderms and two ribs, many other elements of comparable size and a proximal femur and right astragalus and calcaneum of a larger individual. The articulated block consists of seven dorsal vertebrae. The anterior three vertebrae have associated paramedian osteoderms, one pair for each vertebra. The osteoderms are thick and have a deep ornamentation of rounded, irregularly placed pits. The posterior dorsal vertebra is heavily grooved, and a laterally compressed, serrated tooth (?rauisuchian) is preserved on this vertebra. Several skull fragments are present, one of which is a portion of a maxilla which preserved the tip of a replacement tooth. This tooth has large dorsally directed denticles. A fragment of a larger isolated tooth has a 5 mm wide root that flares to a 6 mm wide crown that has longitudinal striations.

Numerous partial osteoderms and one complete osteoderm are in the collection. The complete osteoderm is rectangular and is 64 mm long, 33 mm wide and 5 mm thick. The dorsal surface is covered by an irregular pattern of deep, rounded pits. The medial end of the osteoderm is thickened. The osteoderm thins at its lateral and anterior margins. A smooth strip runs along the anterior margin and broadens near the lateral margin.

This taxon represents a crocodylotarsan because it possesses: (1) a hemicylindrical calcaneal condyle for the fibula; (2) a flexed tibial facet on astragalus; (3) a single articulation between astragalus and calcaneum; and (4) single paramedian osteoderm per vertebra (Benton and Clark, 1988; Sereno, 1991). Further, it is assignable to a clade containing derived crurotarsans (= Suchia of Sereno, 1991) on the basis of an advanced "crocodile-normal" tarsus (Benton and Clark, 1988). However, the pit in the calcaneum to receive the astragalar process is shallower than in other members of this clade and thus is arguably less derived. The heavy dorsal armor is reminiscent of the aetosaurs, but there are no lateral osteoderms preserved in this taxon, and the morphology of the lateral margins of the paramedian osteoderms indicates that none were present. I note, however, that *Redondasuchus* has no lateral osteoderms. On the basis of the tarsal configuration, this taxon might represent a sister taxon of the Stagonolepididae.

The orientation of the large denticles on its teeth indicates that this taxon was herbivorous. This is consistent with the heavy dorsal armor, which is rare in carnivores that are not semiaquatic. The articulated specimen represents an animal about 1.5 m long. Other specimens indicate individuals about twice as large.

gen. et sp. nov.?

Type Revueltian occurrences: NMMNH localities 1, 171.

Referred specimens from type Revueltian: NMMNH locality 1; NMMNH P-4664, neural arches; NMMNH P-4680, distal femur; NMMNH P-4700, distal femur; NMMNH P-4955, caudal vertebra; NMMNH P-16687, osteoderm fragment; NMMNH P-16919, fragmentary skeleton; NMMNH P-16924, proximal ischium; NMMNH P-16925, part of carapace; NMMNH P-16928, proximal pubis; NMMNH P-16931, quadrate: NMMNH locality 171; NMMNH P-16730, neural spine.

First and last occurrence: Revueltian (Triassic: early-middle Norian) of New Mexico and Arizona.

Acme zone: Revueltian (Triassic: early-middle Norian).

Discussion: Several fragmentary specimens show similarities in morphology to the specimens of the new species discussed above.

Crocodylotarsi Benton and Clark, 1988
Family Indeterminate

Type Revueltian occurrences: NMMNH localities 1, 84, 124, 129, 162, 164-165, 171, 182, 518, 521, 523, 527, YPM locality 6649.

Referred specimens from type Revueltian: NMMNH locality 1; NMMNH P-4870, distal femur; NMMNH P-4676, distal femur; NMMNH P-4677, distal tibia; NMMNH P-4678, distal tibia; NMMNH P-4679, distal femur; NMMNH P-4681, distal femur; NMMNH P-4858, basicranium; NMMNH P-4955, 3 caudal vertebrae; NMMNH P-16670, distal tibia; NMMNH P-16691, neural arch fragment; NMMNH P-16692, neural arch fragment; NMMNH P-16726, central fragments; NMMNH P-16743, top of neural spine; NMMNH P-16898, fragmentary skeleton of ?new animal possibly intermixed with specimen of another genus; NMMNH P-16908, proximal tibia: NMMNH locality 84; NMMNH P-16661, centrum fragment: NMMNH locality 124; NMMNH P-4625, metapodial: NMMNH locality 129; NMMNH P-4491, vertebral fragment: NMMNH locality 162; NMMNH P-16630, vertebrae: NMMNH locality 164; NMMNH P-4692, proximal tibia: NMMNH locality 165; NMMNH P-4919, distal tibia: NMMNH locality 171; NMMNH P-16897, end of centrum: NMMNH locality 182; NMMNH P-4949, scapula fragment: NMMNH locality 518; NMMNH P-17416, metapodial: NMMNH locality 521; NMMNH P-17222, vertebral fragments: NMMNH locality 523; NMMNH P-17460, centrum fragment: NMMNH locality 527; NMMNH P-17361, partial astragalus; NMMNH P-17476, distal femur; NMMNH P-17501, distal tibia: YPM locality 6649; uncataloged caudal vertebra.

First occurrence: Several genera from the Anisian (Triassic) of Africa, Asia and Europe.

Last occurrence: Several Recent genera.

Acme zone: Late Carnian-late Norian (Triassic).

Discussion: A variety of specimens show similarities to crocodylotarsan taxa but cannot be identified further.

?Crocodylotarsi Benton and Clark, 1988

Type Revueltian occurrence: NMMNH locality 132.

Referred specimens from type: NMMNH locality 132; NMMNH P-4585, femoral shaft.

First occurrence: Several genera from the Anisian (Triassic) of Africa, Asia and Europe.

Last occurrence: Several Recent genera.

Acme zone: Late Carnian-late Norian (Triassic).

Discussion: NMMNH P-4585 is a femoral shaft that is reminiscent of crocodylotarsans.

Saurischia Seeley, 1888
Theropoda Marsh, 1881
Herrerasauridae Benedetto, 1973
gen et sp. nov. 1

Type Revueltian occurrences: NMMNH localities 163, 169, 176, 499, 503: UMMP locality San Juan (sic), New Mexico.

Referred specimens from type Revueltian: NMMNH locality 163; NMMNH P-4666, pubis fragments: NMMNH locality 169; NMMNH P-16607, tooth fragment: NMMNH locality 176; NMMNH P-16656, dorsal, caudal centra: NMMNH locality 499; NMMNH P-17258, fragmentary skeleton (vertebrae, scapula fragments): NMMNH locality 503; NMMNH P-17134, dorsal and caudal vertebral and pelvic fragments: San Juan (sic), New Mexico; UMMP 7274 (in part), two dorsal centra.

First and last occurrence: Revueltian (Triassic: early-middle Norian) of New Mexico.

Acme zone: Revueltian (Triassic: early-middle Norian).

Discussion: This is the most common dinosaur in the lower Bull Canyon Formation fauna. It is represented by three fragmentary skeletons (NMMNH P-16656, NMMNH P-17134, NMMNH P-17258) from the Revuelto and Barranca Creek badlands.

NMMNH P-17134 is a partial skeleton that includes both anterior and posterior dorsal centra. An anterior dorsal centrum is 47 mm long with a width of 34 mm whereas a posterior member of the series is 39 mm long and 39 mm wide. Thus, posterior dorsal centra are shorter and wider than anterior dorsal centra. NMMNH P-16656 also includes both anterior and posterior dorsal centra.

gen et sp. nov. 1?

Type Revueltian occurrences: NMMNH localities 1, 498.

Referred specimens from type Revueltian: NMMNH locality 1; NMMNH P-16946, centra: NMMNH locality 498; NMMNH P-17154, centra.

First and last occurrence: Revueltian (Triassic: early-middle Norian) of New Mexico.

Acme zone: Revueltian (Triassic: early-middle Norian).

Discussion: Two poorly preserved centra are tentatively assigned to this taxon.

gen et sp. nov. 2

Type Revueltian occurrences: NMMNH localities 110, 114, 124, 128

Referred specimens from type Revueltian: NMMNH locality 110; NMMNH P-4569, partial skeleton including dorsal centra, proximal left femur, partial astragalus, metatarsal fragments and phalanges (Fig. 7A-C): NMMNH locality 114; NMMNH P-4440, centrum fragment: NMMNH locality 124; NMMNH P-4380, vertebral fragment: NMMNH locality 128; NMMNH P-4375, vertebral fragment.

First and last occurrence: Revueltian (Triassic: early-middle Norian) of New Mexico.

Acme zone: Revueltian (Triassic: early-middle Norian).

Discussion: This taxon is restricted to the upper Bull Canyon Formation. Some specimens were previously attributed to *Coelophysis* (Lucas et al., 1985d, fig. 3D-O). It is a herrerasaurid because the ascending process of the astragalus does not form a wall that separates the anterior and dorsal surfaces (Novas, 1989).

?gen et sp. nov. 2

Type Revueltian occurrence: NMMNH locality 155.

Referred specimens from type Revueltian: NMMNH locality 155; NMMNH P-4547, phalanx.

First and last occurrence: Revueltian (Triassic: early-middle Norian) of New Mexico.

Acme zone: Revueltian (Triassic: early-middle Norian).

Discussion: NMMNH P-4547 is a phalanx that appears very similar to specimens referred to gen et sp. nov. 2 in the but it cannot be definitely be placed in this genus

Herrerasauridae Benedetto, 1973
indeterminate

Type Revueltian occurrences: NMMNH localities 1, 73, 110, 463.

Referred specimens from type Revueltian: NMMNH locality 1; NMMNH P-4927, posterior dorsal centrum: NMMNH locality 73; NMMNH P-17325, posterior dorsal centrum: NMMNH locality 110; NMMNH P-4766, posterior dorsal centrum: NMMNH locality 463; NMMNH P-16844, posterior dorsal vertebrae.

First occurrence: *Herrerasaurus* and *Staurikosaurus* from the Adamanian (late Carnian) of South America, *Caseosaurus* from the Adamanian of North America.

Last occurrence: *Chindesaurus* and two undescribed taxa from the Revueltian (early-middle Norian) of North America.

Acme zone: None.

Discussion: A number of isolated centra are identifiable as herrerasaurid posterior dorsal centra (Lucas et al., 1985d, fig. 3P-Q). These centra are relatively