Goniopholis kirtlandicus Wiman--Forgotten crocodile from the Kirtland Formation, San Juan Basin, New Mexico

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Goniopholis kirtlandicus Wiman—forgotten crocodile from the Kirtland Formation, San Juan Basin, New Mexico

by Donald L. Wolberg, Vertebrate Paleontologist, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM

Crocodilian bone, armor, and teeth are common in Late Cretaceous and Early Tertiary deposits of the San Juan Basin and elsewhere. In the Fruitland and Kirtland Formations of the San Juan Basin, Late Cretaceous crocodiles were important carnivores of the reconstructed stream and stream-bank community (Wolberg, 1980). In the Kirtland Formation, a mesosuchian crocodile, *Goniopholis kirtlandicus,* discovered by Charles H. Sternberg in the early 1920's and not described until 1932 by Carl Wiman, has been all but ignored since its description and referral. Specimens referred to other crocodilian genera may actually represent *G. kirtlandicus* or other mesosuchians. A better understanding of the distribution of *G. kirtlandicus* may aid in determining age relationships in Late Cretaceous deposits of the San Juan Basin.

Numerous studies related to Late Cretaceous vertebrate faunal assemblages of the San Juan Basin frequently mention crocodiles, but usually only in passing. Published work includes Gilmore (1916, 1919, 1935), Bauer (1916), Reeside (1924), Colbert (1950), Powell (1972, 1973), and Wolberg and LeMone (1980). Unpublished reports include Kues and others (1977) and LeMone and others (1977, 1979).

Gilmore (1916) reported crocodiles and *Brachychampsa* sp. from the Kirtland and "crocodiles" from the Ojo Alamo Sandstone. Later, in 1919, he reported "crocodiles" from the Fruitland, Kirtland, and Ojo Alamo but noted in 1935 that "the Crocodilia and Pisces are too fragmentary to be of assistance" (p. 187). Reeside (1924) lists *Crocodylus* sp. and *Brachychampsa*? sp. for the Kirtland Formation. Powell (1972, 1973) lists *Crocodylus* sp. and *Brachychampsa*? sp. for the Fruitland and Kirtland Formations. *Crocodylus* sp. and *Brachychampsa*? sp. are also mentioned by Kues and others (1977), LeMone and others (1977, 1979), and Wolberg and LeMone (1980). Few detailed analyses of crocodilians have been done, and the Late Cretaceous crocodiles of the San Juan Basin have not been adequately studied.

Early paleontology in San Juan Basin

Charles H. Sternberg, a well-known fossil collector of the late 1800's and early 1900's, sold a number of reptilian specimens he collected in 1921 in the San Juan Basin to Carl Wiman, paleontologist at the Paleontological Institute of Uppsala University (Sternberg, 1932). Wiman (1930) described *Pentaceratops*

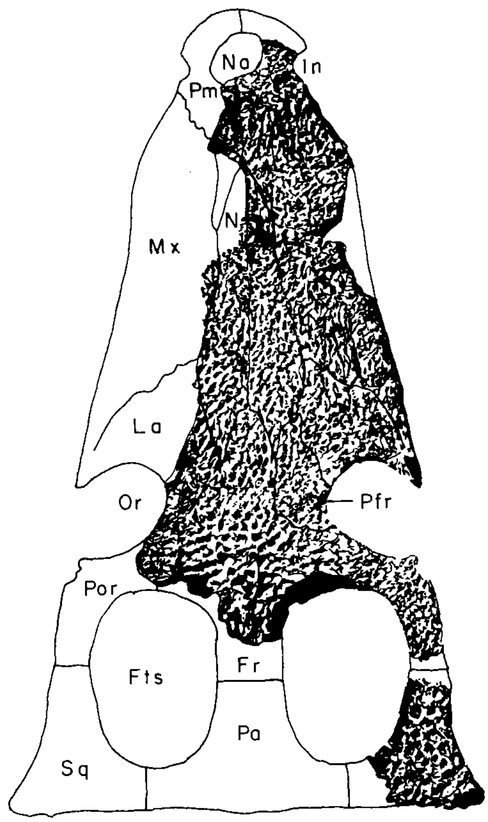

FIGURE 1—RECONSTRUCTION OF DORSAL ASPECT OF *GONIOPHOLIS KIRTLANDICUS*, approximately ¼ size. Abbreviations: **Na**, external nares; **In**, indentation for pseudo-canine of mandible; **Pm**, premaxillary; **Mx**, maxillary; **N**, nasal; **La**, lacrimal; **Pfr**, prefrontal; **Or**, orbit; **Por**, postorbital; **Fr**, frontal; **Fts**, superior temporal fossa; **Pa**, parietal; **Sq**, squamosal (after Wiman, 1932).

fenestra, a ceratopsian dinosaur found by Sternberg in Kimbeto Wash. Sternberg found a similar specimen in 1922 and sold it to the American Museum of Natural History. Henry Fairfield Osborn, the well-known American paleontologist, published a description of this specimen and named it *Pentaceratops sternbergii* (Osborn, 1923).

Wiman (1931) published a description of still another dinosaur found by Sternberg in 1921, the hadrosaur *Parasaurolophus tubicen. P. tubicen* is characterized by the development of a cranial crest (Lull and Wright, 1942) that may have functioned as a visual and acoustical display organ (Hopson, 1975). Wiman suggested a similar idea in his 1931 paper and proposed that the narial cavities of *Parasaurolophus* were vocal resonating chambers.

Apparently included with this material shipped to Wiman was a partial skull that Wiman described as a new species of crocodile, *Goniopholis kirtlandicus.* Wiman published a description of *G. kirtlandicus* in 1932 in the *Bulletin of the Geological Institute of Uppsala.* Notice of this species has not appeared in any American publication. Kälin (1955) presented a description and illustration of the species in French, but essentially repeated Wiman (1932).

Locality information for *Goniopholis kirtlandicus*

The skeletal material referred to *Goniopholis kirtlandicus* includes most of the right side of a skull, a squamosal fragment, and a portion of dorsal plate. The referral of the dorsal plate probably represents an interpretation of the proximity of the material when found. Figs. 1 and 2, taken from Wiman (1932), illustrate this material.

Wiman (1932, p. 181) recorded the following locality data, provided by Sternberg: "Skull of Crocodile. Kirtland shales a 100 feet below the Ojo Alamo Sandstone in the blue cley. Barrel Springs Wash, 2.5 miles S. Trading Store (Post), Ojo Alamo Wash New Mexico. CH. H. STERNBERG 1921." In his description of the specimen, Wiman notes that the bones are light gray externally but are darker, almost black ("fast schwarz"), on

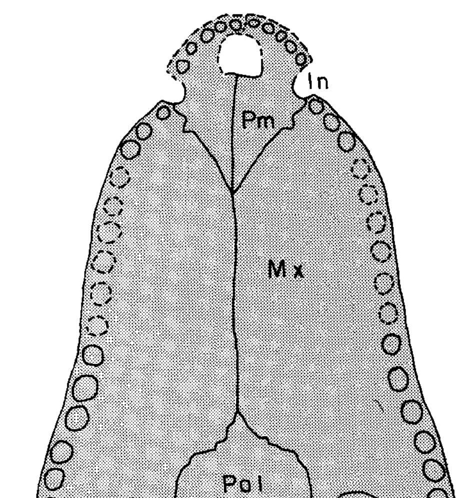

FIGURE 2—RECONSTRUCTION OF THE PALATAL ASPECT OF *GONIOPHOLIS KIRTLANDICUS,* approximately ¼ size. Abbreviations: **Pm**, premaxillary; **Mx**, maxillary; **Pal**, palatine; **Or**, orbit; **In**, indentation for pseudo-canine of mandible (redrawn from Wiman, 1932, with modifications).

freshly fractured surfaces. He notes that the enclosing matrix consists of a yellow-gray, fine-grained sandstone that proved to be very hard during preparation.

The old Ojo Alamo Trading Post was situated along Alamo Wash in SE¼NW¼ sec. 8, T. 24 N., R. 11 W. at an elevation of approximately 6,340 ft (Clemens, 1973). Sternberg noted that *G. kirtlandicus* was found approximately 2.5 mi south of the trading post in Barrel Springs Wash, now known as De-na-zin Wash. Sternberg probably overestimated the distance south of the trading post. The specimen probably came from near the middle of sec. 20, T. 24 N., R. 11 W.; a distance of 2.5 mi south of the trading post site would have placed Sternberg in the extreme southern portion of sec. 20, out of De-na-zin Wash (fig. 3).

The stratigraphic definitions of the uppermost Cretaceous and lowermost Tertiary units in the San Juan Basin have been discussed at length by Baltz and others (1966), Fassett and Hinds (1971), and Clemens (1973). The boundary between the Kirtland and Ojo Alamo Formation, long disputed by various authors (Brown, 1910; Sinclair and Granger, 1914), lies within the area of the old Ojo Alamo Trading Post. Fassett and Hinds (1971) mapped as Kirtland the area described by Sternberg's description to Wiman. Sternberg (1932) seems certain of his stratigraphic units; moreover, he reports lengthy discussions with J. B. Reeside, who was also in the field in 1921; Reeside probably provided Sternberg with stratigraphic information. Sternberg's stratigraphy (1932) appears to be coincident with interpretations published by Reeside (1924), and *G. kirtlandicus* must have been found in the Kirtland Formation (fig. 4).

Genus *Goniopholis*

Goniopholis was described by Owen on the basis of fossil material from the Wealden Cretaceous of England. The type species is *Goniopholis crassidens*. In addition to the type species and *G. kirtlandicus*, the following species have been recognized (Wiman, 1932; Kälin, 1955):

- *G. simus* Owen, 1878, from the Wealden of England and Belgium,
- *G. felix* Marsh, 1877, from the Jurassic of Colorado, and
- *G. gilmori* Holland, 1905, from the Jurassic of Wyoming.

With other genera that range in age from Late Jurassic to Cretaceous, *Goniopholis* is included in the family Goniopholidae. Romer (1966) suggested that *Goniopholis* and its allies were central to crocodilian evolution and formed the mesosuchian stock from which the eusuchians evolved in the Late Jurassic or Early Cretaceous. *Goniopholis* was of typical crocodilian form with a broad and not overly long skull. The secondary palate was relatively more advanced than in other mesosuchians and extended farther back than in other forms.

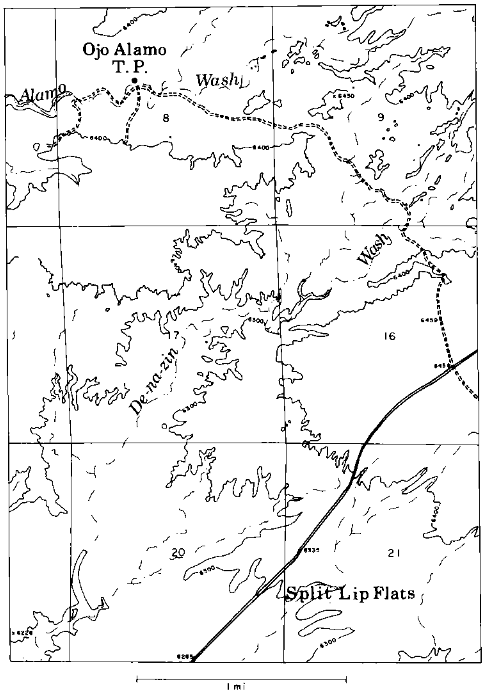

FIGURE 3—MAP OF THE OLD OJO ALAMO TRADING POST AREA, T. 24 N., R. 11 W. Sternberg's locality data for *Goniopholis kirtlandicus* indicated that the specimen came from Barrel Springs Arroyo (now De-na-zin Wash), 2.5 mi south of the trading post. As can be seen from the map, Sternberg must have overestimated the distance.

Description of *Goniopholis kirtlandicus*

Wiman (1932) described *G. kirtlandicus* in detail and suggested reconstructions for missing portions of the skull and palate (figs. 1 and 2). He further distinguished the morphology of *G. kirtlandicus* from the other recognized species referred to the genus.

In *G. kirtlandicus*, the skull is triangular in shape (dorsal view) and less than twice as long as wide at the reconstructed base. The skull is moderately broad with the external nares well anterior and the orbits posterior and marginal. The specimen retains the right premaxillary, both nasals, the right lacrimal, both prefrontals, the frontal, the right postorbital, and most of the right squamosal. The superior temporal openings must have been well developed and roughly elliptical in outline, larger than the orbital openings.

Wiman's reconstruction of the palate shows a rather blunt snout region with ten teeth in the premaxillaries. The maxillaries broaden posteriorly and show spaces for 18 teeth along the external margin of each maxillary. Wiman's palatal reconstruction is slightly broader than his dorsal reconstruction.

The teeth in *G. kirtlandicus* are roughly conical but apically rounded and blunt (side view). Antero-posteriorly, the teeth are slightly recurved lingually with a distinct medial crest or ridge. Prominent apical-basal directed ridges or enamel rugae give the teeth a wrinkled or corrugated appearance. The premaxillary teeth appear to be much smaller than the marginal maxillary teeth. The gaps for the pseudo-canines appear relatively small in size.

On the basis of the observable morphology of *G. kirtlandicus*, the species is separable from other members of the genus noted above. If additional specimens of *G. kirtlandicus* occur in existing collections, they should be separable from eusuchians, given adequate material.

Crocodilian phylogeny

The crocodiles belong to the reptilian subclass, the Archosauria (the "ruling reptiles"), which includes the dominant animals of the Mesozoic Era, the dinosaurs and pterosaurs. Along with other members of the subclass, the order Crocodilia originated within the order Thecodontia sometime during the Triassic. The Crocodilia includes five suborders: Protosuchia, Archaeosuchia, Mesosuchia, Sebecosuchia and the Eusuchia (Romer, 1966). Since their appearance during the Triassic (fig. 5) members of Crocodilia have remained relatively generalized in structure and have retained many primitive characters, except for the development of a specialized palate. The crocodiles have adapted to an aquatic environment by developing a powerful tail for swimming, partially webbed feet, and—most importantly—a secondary palate that separates breathing and swallowing functions. This last adaptation is obviously useful for an animal that takes at least part of its food under water.

Modern crocodiles represent the last surviving remnant of the archosaurian branch that dominated the Mesozoic world. These recent, still-surviving members of the Eusuchia are actually a relatively late adaptive radiation that first appeared in the Lower Cretaceous and includes two families, the Gavialidae and the Crocodylidae.

The gavials are presently restricted to the major rivers of India, Pakistan, and Burma but earlier in the Cenozoic had a much greater distribution that included North and South America, Europe, and Africa.

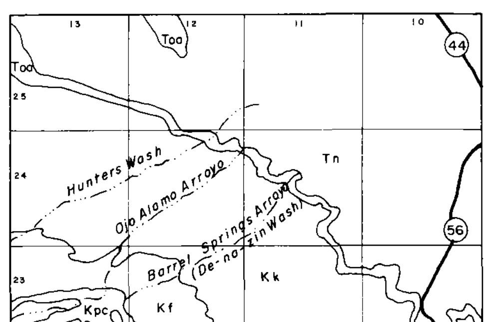

FIGURE 4—GENERALIZED GEOLOGIC MAP showing units present in the area of Ojo Alamo Trading Post. *Goniopholis kirtlandicus* must have been found in the Kirtland Formation in the southern portion of T. 24 N., R. 11 W. Abbreviations: **Tn**, Nacimiento Formation; **Toa**, Ojo Alamo Formation; **Kk**, Kirtland Formation; **Kf**, Fruitland Formation; **Kpc**, Pictured Cliffs Formation (after Fassett and Hinds, 1971; Clemens, 1973).

The Crocodilidae includes the caimans, crocodiles, and alligators. The crocodiles, generally characterized by a narrower snout than the alligators, are relatively broadly distributed through tropical America, Africa, and southern Asia. The alligators, with a broader snout than the crocodiles, have a restricted range and occur only in the Western Hemisphere, except for a single species that survives in the Yangtze River of China.

The Goniopholidae (and the included species *Goniopholis kirtlandicus*) belonged to the Mesosuchia, the crocodile suborder that appeared during the Jurassic. In overall appearance and probably in life habits as well, the goniopholids were similar to modern crocodilians. They attained substantial size, had broad but not especially long snouts, and substantial teeth. Their vertebrae, however, still retained primitive features and were amphicoelus (concave at either end). Although the palate was advanced in structure over earlier species, it was still more primitive than that in the Eusuchia.

Towards the end of the Cretaceous the mesosuchians and many other reptilian lines of descent declined. Although mesosuchians survived into the Early Tertiary in some areas (Romer, 1966), competition with the expanding eusuchian lineage was most likely a factor in their decline. The mesosuchians were similar in form and probably in life habits to the eusuchians but lacked more progressive eusuchian features such as secondary palate development. In all likelihood, the eusuchians were better able to exploit the available habitats that both suborders occupied.

A general cause for widespread extinctions may have operated late in the Cretaceous; certainly many archosauran lines terminated at the end of Cretaceous time. A combination of adverse environmental conditions and increased competition from the eusuchians may have isolated mesosuchians in ever-dwindling refuges, finally resulting in their extinction.

Conclusions

The recognition—intended by Wiman almost 50 years ago—of *Goniopholis kirtlandicus* as a component of Kirtland Formation (Late Cretaceous) faunas establishes the presence of both mesosuchians and eusuchians in the San Juan Basin. Therefore, fossil collections should be reexamined to identify additional mesosuchian material. Material previously referred to *Crocodylus* sp. or *Brachychampsa*? may actually represent *Goniopholis*, either *G. kirtlandicus* or other mesosuchian forms. Additional *G. kirtlandicus* material will enhance our understanding of the species. Similarly, other mesosuchian forms may be discovered. Whether mesosuchians also occur in the underlying Fruitland Formation and in the overlying Ojo Alamo Sandstone is an important question. The highest occurrence of *G. kirtlandicus* in the San Juan Basin may have a significant bearing on the age relationships of the Ojo Alamo Formation and may be helpful in understanding the problem of Late Cretaceous extinctions.

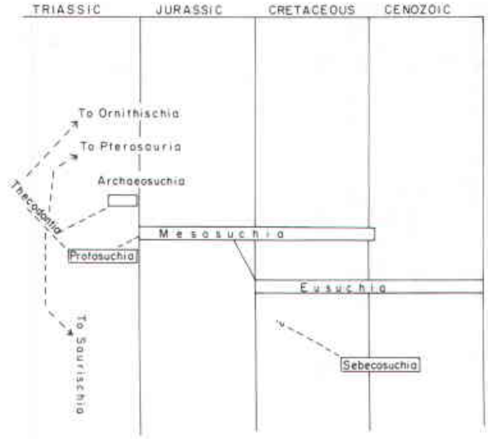

FIGURE 5—GENERAL PHYLOGENETIC RELATIONSHIPS OF CROCODILIAN SUBORDERS (rectangles) and other archosaurian orders for reference.

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References

Baltz, E. H., Ash, S., and Anderson, R., 1966, History of nomenclature and stratigraphy of rocks adjacent to the Cretaceous-Tertiary boundary, western San Juan Basin, New Mexico: U.S. Geological Survey, Prof. Paper 524-D, 23 p.

Bauer, C. M., 1916, Stratigraphy of a part of the Chaco River Valley: U.S. Geological Survey, Prof. Paper 98-P, p. 271-278

Brown, B., 1910, The Cretaceous Ojo Alamo beds of New Mexico with a description of the new dinosaur genus *Kritosaurus:* American Museum of Natural History, Bull., v. 28, p. 267-274

Clemens, W. A., 1973, The roles of fossil vertebrates in interpretation of Late Cretaceous stratigraphy of the San Juan Basin, New Mexico, *in* Cretaceous and Tertiary rocks of the southern Colorado Plateau, J. E. Fassett, ed.: Four Corners Geological Society, Mem., p. 154-167

Colbert, E. H., 1950, Mesozoic vertebrate faunas and formations of northern New Mexico: Society of Vertebrate Paleontology, Guidebook 4th field conference, p. 57-73

Fassett, J. E., and Hinds, J. S., 1971, Geology and fuel resources of the Fruitland Formation and Kirtland Shale of the San Juan Basin, New Mexico and Colorado: U.S. Geological Survey, Prof. Paper 676, 76 p.

Gilmore, C. W., 1916, Vertebrate faunas of the Ojo Alamo, Kirtland and Fruitland Formations: U.S. Geological Survey, Prof. Paper 98-Q, p. 279-308

———, 1919, Reptilian faunas of the Torrejon, Puerco and underlying Upper Cretaceous formations of San Juan County, New Mexico: U.S. Geological Survey, Prof. Paper 119, 71 p.

———, 1935, On the reptilia of the Kirtland Formation of New Mexico, with descriptions of new species of fossil turtles: U.S. National Museum, Proceedings, v. 83, no. 2978, p. 159-188

Hopson, J., 1975, The evolution of cranial display structures in hadrosaurian dinosaurs: Paleobiology, v. 1, no. 1, p. 21-43

Kälin, J., 1955, Crocodilia, *in* Traite de paleontologie, v. 5, Jean Piveteau, ed.: Paris, Masson et Cie, p. 695-784

Kues, B. S., Froehlich, J. W., Schiebout, J. A., and Lucas, S., 1977, Paleontological survey, resource assessment, and mitigation plan for the Bisti-Star Lake area, northwestern New Mexico: Albuquerque, Report to the Bureau of Land Management

LeMone, D. V., and others, 1977, Applicant's paleontological assessment and continuing studies for the proposed Star Lake coal mine: Chaco Energy Company, 152 p.

LeMone, D. V., and others, 1979, Paleontological clearance assessment and evaluation report, state lands, Bisti Project: Western Coal Company, 69 p. and appendices

Lull, R. S., and Wright, N. E., 1942, Hadrosaurian dinosaurs of North America: Geological Society of America, Spec. Paper 40, 242 p.

Osborn, H. F., 1923, A new genus and species of Ceratopsia from New Mexico, *Pentaceratops sternbergii:* American Museum Novitates, no. 93, 3 p.

Powell, J. S., 1972, The Gallegos Sandstone (formerly Ojo Alamo Sandstone) of the San Juan Basin, New Mexico: M.S. thesis, University of Arizona, 131 p.

———, 1973, Paleontology and sedimentation models of the Kimbeto Member of the Ojo Alamo Sandstone, *in* Cretaceous and Tertiary rocks of the southern Colorado Plateau, J. E. Fassett, ed.: Four Corners Geological Society, Mem., p. 111-122

Reeside, J. B., Jr., 1924, Upper Cretaceous and Tertiary formations of the western part of the San Juan Basin of Colorado and New Mexico: U.S. Geological Survey, Prof. Paper 134, 70 p.

Romer, A. S., 1966, Vertebrate paleontology, third edition: University of Chicago Press, 468 p.

Sinclair, W. J., and Granger, W., 1914, Paleocene deposits of the San Juan Basin, New Mexico: American Museum of Natural History, Bull., v. 33, p. 297-316

Sternberg, C. H., 1932, Hunting dinosaurs on Red Deer River, Alberta, Canada: San Diego, published by author, 261 p.

Wiman, C., 1930, Über Ceratopsia aus der oberen Kreide in New Mexico: Nova Acta Regiae Societatis Scientiarum Upsaliensis, ser. IV, v. 7, no. 2, p. 1-19

———, 1931, *Parasaurolophus tubicen* n. sp. aus der Kreide in New Mexico: Nova Acta Regiae Societatis Scientiarum Upsaliensis, ser. IV, v. 7, no. 5, p. 1-11

———, 1932, *Goniopholis kirtlandicus* n. sp. aus der oberen Kreide in New Mexico: Geological Institutions of the University of Uppsala, Bull., v. 23, p. 181-192

Wolberg, D. L., 1980, Data base and review of paleofaunas and floras of the Fruitland Formation, Late Cretaceous, San Juan Basin, New Mexico, with interpretive observations and age relationships: New Mexico Bureau of Mines and Mineral Resources, Open-file Rept. 117, 70 p.

Wolberg, D. L., and LeMone, D. V., 1980, Paleontology of the Fruitland Formation near Bisti, San Juan Basin, New Mexico—a progress report: New Mexico Bureau of Mines and Mineral Resources, Annual Report 1978-79, p. 55-57 □

Oil production in New Mexico for the first three months of 1980 was 19,460,604 bbls, an increase of 38,873 bbls over the same period in 1979. Gas production was 291,777,639,000 cu ft, an increase of 2,013,104,000 over the same 1979 period (J. Ramey, Oil Conservation Division, N.M. Energy and Minerals Dept.).