



On the occurrence of *Gillicus arcuatus* (Cope, 1875) (Pisces, Ichthyodectiformes†) in Mexico

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Abstract

This work provides the description of the first specimen of the species *Gillicus arcuatus* (Cope, 1875) collected in Mexico. This ichthyodectiform fossil was collected in a marl flagstone quarry on Los Pilotes Ranch, Múzquiz County, Coahuila. The rocks of the quarry are of Turonian age, and constitute part of the Eagle Ford Formation. This *Gillicus arcuatus* specimen fits within the known temporal distribution of *Gillicus*, but extends the geographical distribution of this species to include Northern Mexico, where once the North American Western Interior Sea and the Western Tethys Sea converged. Los Pilotes Ranch is the southernmost fossil locality so far known where *Gillicus* has been found.

Keywords: *Gillicus*, Ichthyodectiformes, Turonian, Eagle Ford Formation, Coahuila.

Resumen

Se describe el primer ejemplar de la especie *Gillicus arcuatus* (Cope, 1875) colectado en México. Este fósil Ichthyodectiforme fue recolectado en las cantera de lasjas margosas explotada en el Rancho Los Pilotes, Múzquiz, Coahuila, los cuales son de edad Turoniana y constituyen parte de la Formación Eagle Ford. Este ejemplar de *Gillicus* coincide con la distribución temporal conocida del género y extiende la distribución geográfica del mismo hasta el norte de México, en donde alguna vez se encontraban las aguas del Mar Interior de Norteamérica y del oeste del Mar de Tetis. Rancho Los Pilotes es la localidad más sureña hasta ahora conocida en donde se han colectado restos de este género.

Palabras clave: *Gillicus*, Ichthyodectiformes, Turoniano, Formación Eagle Ford, Coahuila

1. Introduction

The Ichthyodectiformes are a primitive extinct group of basal teleosts established by Bardack and Sprinkle (1969). They appeared in the Middle Jurassic, became a diverse and successful group during almost all of the Cretaceous. Their fossils have been collected in marine deposits of North America, Europe, Lebanon, Australia, South America, Asia and Africa. Today, the order Ichthyodectiformes is subdivided in three suborders (Alvarado-Ortega, 2004; Taverne and Chanet, 2000). Occithrissopoidei includes *Occithrissops* Schaeffer and Patterson, 1984. Allothrissopoidei involves *Allothrissops* Nybelin, 1964, and *Antractithrissops* Arratia *et al.*, 2004. The suborder Ichthyodectoidei includes at least eighteen genera: *Saurocephalus* Harlan, 1824; *Saurodon* Hays, 1830; *Thrissops* Agassiz, 1833; *Cladocycclus* Agassiz, 1841; *Chiomystus*, Cope, 1885; *Proportheus* Jaekel, 1909; *Chirocentrites* Heckel, 1849; *Ichthyodectes* Cope, 1870, *Xiphactinus* Leidy, 1870; *Gillicus* Hay, 1898; *Prymnetes* Cope, 1871a, Hay, 1898; *Eubiodectes* Hay, 1903, *Cooyoo* Lees and Bartholomai, 1987; *Prosaurodon* Stewart, 1999; *Faugichthys* Taverne and Chanet, 2000; *Vallecillichthys* Blanco and Cavin, 2003; *Unamichthys*, Alvarado-Ortega, 2004; and *Heckelichthys* Taverne, 2008.

When Bardack (1965) reviewed the chirocentrid fishes, a clupeomorph group that once included a large part of the genera located today within the order Ichthyodectiformes, he wrote in relation to the Mexican ichthyodectiforms known then: —it is too fragmentary for a positive assignment. Nevertheless, the study of fossils from an increasing number of fish localities recently discovered shows that the ichthyodectiforms are common elements in the Cretaceous assemblages of Mexico. To date, Mexican fossil fish specimens complete enough for reliable taxonomic assignment within this order are: 1) A Jurassic *Thrissops*-like specimen from Mazapil, Zacatecas (Villaseñor *et al.*, 2006). 2) The Albian ichthyodectiforms from the Tlayúa quarry, Puebla, which include *Unamichthys espinosai* Alvarado-Ortega, 2004, and at least two other undescribed forms (Alvarado-Ortega, 2005). 3) The holotype and single specimen as far known of *Prymnetes longiventer* Cope, 1871a, from an unknown and perhaps Early Cretaceous locality near Tuxtla Gutiérrez, Chiapas [recently, some probable *Prymnetes* specimens were collected in El Chango quarry, near Tuxtla Gutiérrez, Chiapas (Ovalles-Damián *et al.*, 2006). Although the age of El Chango quarry was considered as Albian by Vega *et al.* (2007), if its fossil fish assemblage is regarded it is probably Cenomanian (Alvarado-Ortega, *pers. obs.*, 2008)]. 4) *Vallecillichthys multivertebratum* Blanco and Cavin, 2003, from the Turonian deposits at Vallecillo quarry, Nuevo León (see Blanco-Piñón and Alvarado-Ortega, 2007). 5) A specimen assigned to *Saurodon* from the Turonian marls of La Mula quarry, Múzquiz, Coahuila (Alvarado-Ortega *et al.*, 2006a). 6) A few undescribed specimens that resemble *Unamichthys* from the Albian-Cenomanian outcrops of

the Muhi quarry, Hidalgo State (Alvarado-Ortega, 2005). In addition, Alvarado-Ortega *et al.* (2006b) reported some Ichthyodectoidei isolated remains from the Late Cretaceous sediments of the Mexcala Formation, Guerrero. Fish remains from Xilitla, San Luis Potosí, previously described by Maldonado-Koerdell (1956) as *Xiphactinus* and *Ichthyodectes* as well as one from Tlaxiaco, Oaxaca, reported by Felix (1891) as *Thrissops*, do not show enough characters to support such taxonomic identifications.

Hay (1898) named *Gillicus*, a fossil fish genus in order to include *Portheus arcuatus* Cope, 1875, and *Ichthyodectes polymicrodus* Crook, 1892. The specimens used to describe both species are from the Smoky Hill Chalk (Early Coniacian to Early Campanian) of the Niobrara Formation, Kansas (for age see Carpenter, 2003). Firstly, Cope (1875) described *Portheus arcuatus* based upon imperfect remains that later he referred to *Ichthyodectes*, thus naming the species *I. arcuatus* Cope, 1877. Crook (1892) described *Ichthyodectes polymicrodus*; right after, Cope (1892) recognized Crook's species as *Ichthyodectes arcuatus*. In Europe, Woodward (1901) named *Ichthyodectes serridens* based on a single specimen from the British Gault Clay (Albian), Folkestone, Kent, England; which Hay (1903) later placed within the genus *Gillicus* as *G. serridens*.

Bardack (1965, 1968), listed the synonyms of *Gillicus arcuatus* and the localities where its remains had been collected in the USA and Canada, including: Carlile Shale (Turonian-Santonian), Minnesota and South Dakota; Austin Chalk (Early Coniacian - Late Santonian), Texas; Pierre Shale (Early Coniacian to Early Campanian), Wyoming; and the Boyne Member of the Vermilion River Formation [McNeil and Caldwell (1981) recognized this member as the Niobrara Formation; nevertheless Christopher *et al.* (2006) integrated this member as the upper part of the Carlile Formation], Manitoba. Applegate (1970) reported the occurrence of *Gillicus* from Early Campanian Selma Formation sediments in Alabama (for age see Smith and Mancini, 1983). According to Stewart and Carpenter (cited in Carpenter, 2003), *Gillicus* is also present in Late Albian-Early Turonian sediments of the Dakota Formation, Colorado; and recently Tanimoto and Kinkyo (2001) found remains of this genus in the Lower Maastrichtian outcrops of Izumi group, Japan.

The aim of the present paper is to provide a description of the first Mexican fossil remain belonging to the species *Gillicus arcuatus* (Cope, 1875). Local workers discovered this specimen in 2006, during the quarrying of the Late Cretaceous (Turonian) marls that crop out into Los Pilotes Ranch, 130 Km northwest of Múzquiz, Coahuila (Figure 1).

2. Location and Geology

The high quality of the vertebrate and invertebrate fossils recently collected in an increasing number of localities near Múzquiz, Coahuila, including Los Pilotes Ranch, has

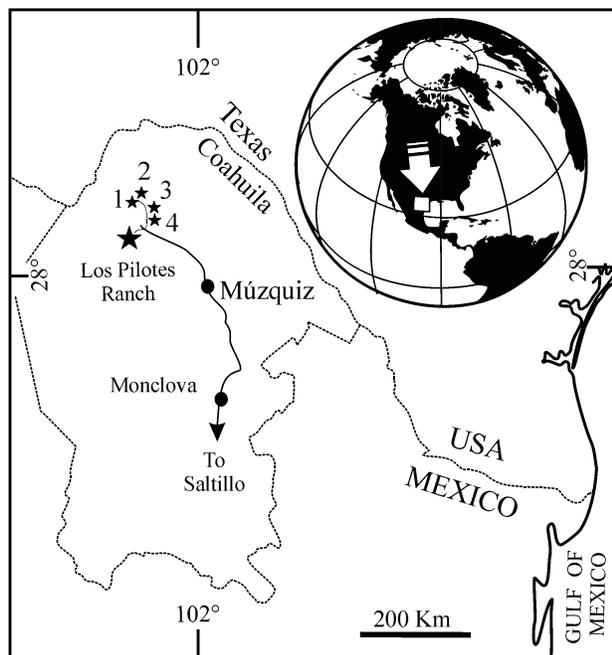


Figure 1. Map showing location of Los Pilotes Ranch and other fossil quarries near Múzquiz, Coahuila, Nuevo León, México. 1, La Mula; 2, Venustiano Carranza; 3, Los Temporales; 4, El Rosario.

attracted the attention of paleontologists (Stinnesbeck *et al.*, 2005; Alvarado-Ortega *et al.*, 2006a). According to Vega *et al.* (2007), the marine fossil bearing strata exposed within Los Pilotes Ranch are equivalent in lithology and age (Turonian) to those described for La Mula quarry and the lower part of El Rosario quarry (see Nyborg *et al.*, 2005; Stinnesbeck *et al.*, 2005; Alvarado-Ortega *et al.*, 2006a), also near Múzquiz.

Unfortunately the first fossils from Los Pilotes Ranch, including the *Gillicus* specimen herein described, do not have proper stratigraphic control because local workers have been the fossil collectors in Los Pilotes Ranch. Nevertheless, at present the fossil assemblage from this locality includes abundant teleostean fish remains belonging to *Enchodus* sp., *Laminospondylus* sp., a small *Omosama*-like fish, some complete unidentified clupeomorph fishes, and abundant isolated scales, as well as some remains of plesiosaurs, crustaceans, ammonites, inoceramids, and planktonic foraminifera. Additional fieldwork is required to recognize the stratigraphic position of the fossiliferous strata seen at Los Pilotes Ranch, and how it fits into the Late Cretaceous sequence of Northeastern Mexico.

Blanco-Piñón and Alvarado-Ortega (2005), as well as Stinnesbeck *et al.* (2005), noted that the vertebrates from the localities near Múzquiz (including Los Pilotes Ranch) are phosphatized and that in many cases they preserve soft tissues. According to these authors, this kind of fossil preservation suggests that the deposition of these specimens occurred on an open marine shelf with an oxygen-depleted bottom.

3. Material and Methods

3.1. Abbreviations

The abbreviations follow Patterson and Rosen (1977) and Alvarado-Ortega (2004) (see Figures 2-4).

Institutional abbreviations: AMNH, American Museum of Natural History, New York, USA; DNPM, Departamento Nacional de Produção Mineral, Brazil; IGM, Colección Nacional de Paleontología, Instituto de Geología, Universidad Nacional Autónoma de México; MUZ, Museo Histórico de Múzquiz, Coahuila, Mexico; UERJ-PMB, Universidade do Estado do Rio de Janeiro; USNM, United States National Museum, Smithsonian Institute, USA.

3.2. Comparative material

The following specimens were reviewed for comparative purposes;

Cladocyclus gardneri Agassiz, 1841: AMNH 1841, AMNH 11877, UERJ-PMB 510, UERJ-PMB 520; Early Cretaceous (Aptian-Albian), Romualdo Member, Santana Formation, Ceará, Brazil.

Gillicus arcuatus (Cope, 1875): AMNH 8571; Late Cretaceous, Niobrara Formation, Kansas, USA.

Ichthyodectes ctenodon Cope, 1870: AMNH 2005, AMNH 2005; Late Cretaceous, Niobrara Formation, Kansas, USA.

Prymnnetes longiventer Cope, 1871a, USNM 4090 (silicone peel deposited in IGM), Chiapas, Mexico, from unknown locality and age.

Saurocephalus Harlan, 1824: DNP 1269-P (*Saurocephalus* sp.), fragment of jaw, Late Cretaceous (Maastrichtian), Gramame Formation, Pernambuco, Brazil.

Saurodon Hays, 1830: IGM 6762 (*Saurodon* sp.), Late Cretaceous (Turonian), Eagle Ford Formation, La Mula Quarry, Coahuila, Mexico. AMNH 9907 (*S. leanus*), Late Cretaceous (Campanian), Niobrara Chalk, Montana, USA.

Unamichthys espinosai Alvarado-Ortega, 2004: IGM 8373 and IGM 8374, Early Cretaceous (Albian), Tlayúa Quarry, Middle Member of Tlayúa Formation, Puebla, Mexico.

4. Systematic Paleontology

- Subdivision Teleostei Müller, 1845
- Order Ichthyodectiformes Bardack and Sprinkle, 1969
- Suborder Ichthyodectoidei Romer, 1966
- Family Ichthyodectidae sensu Patterson and Rosen, 1977 (in part)
- Subfamily Gillicinae Taverne, 2008
- Genus *Gillicus* Hay, 1898

Gillicus arcuatus (Cope, 1875)

4.1. Referred specimens

MUZ 47a and MUZ 47b (part and counterpart), a partial head showing both jaws and parts of the opercular series and ethmoid bones (Figures 2, 3).

4.2. Preparation

MUZ 47b was simply hardened because it only preserves the impression of the left side of the specimen as well as the internal view of some broken bones. MUZ 47a, which preserves both sides of the head, was prepared using pin vises under a stereoscopic microscope to remove fragments of loose clay matrix, and baths of 5% acetic acid to dissolve its limestone fraction, in order to disclosure the external surface of the right side of the head. The total preparation of MUZ 47b was not possible because the strong compression of the bones, as well as their permineralization by calcite, make them extremely fragile. At the end of the preparation, MUZ 47 a and b were hardened with Glyptol.

4.3. Locality

The Turonian limestone marl strata at Los Pilotes Ranch, 180 Km northwest of Múzquiz town, Coahuila, northeastern Mexico. According to Vega *et al.* (2007), these strata belong to the Eagle Ford Formation (Figure 1).

4.4. Description

4.4.1. General features

The specimen shows both sides of the head including part of the ethmoid area, upper and lower jaws, and fragments of the opercular series. The length of the head (from the tip of the ethmoid area to the posterior border of the opercle) is 17.5 cm. Following the proportions of *Gillicus* published by Bardack (1965), who found that the head is contained 6.5 times in the standard length (SL), the SL of MUZ 47 could reach 114 cm.

4.4.2. Ethmoid area

Although the ethmoid area is not entirely preserved, it shows the pattern found in other Cretaceous Ichthyodectiformes (Figure 2). Only the anterior tip of rostrodermethmoid is preserved; it is covering the anterodorsal border of the ethmoid area. The nasal capsule is not preserved except for part of its floor that shows both well ossified ethmopalatines, which also are preserved just partially (Figures 2 and 3). In MUZ 47b the ventral border of the ethmopalatine is projected over the anterior part of the maxilla and must reach the palatine head; here this bone has two concave articular surfaces, the anterior of these surfaces articulates the anterior dorsal process of the maxilla, and the posterior one must reach the rectangular and massive

palatine head (not preserved) (Figure 3). The ventral section of the ethmopalatine, between its two concave articular surfaces, projects between both maxillary dorsal processes. Below the ethmopalatines there is an unpaired bone, very badly preserved, that could be the remains of a vomer or parasphenoid (Figure 3).

4.4.3. Hyopalatine series

Few elements of the hyopalatine series are preserved for an accurate description (Figure 2). An impression of the ventral section of hyomandibula is preserved above the quadrate. The impression of a large clove shaped symplectic is preserved on the preopercle in MUZ 47a. The quadrate is triangular in shape with a dorsal border slightly concave and a stout rounded articular head directed antero-ventrally. The anterior end of the palatine is massive and forms an expanded head (dislike malleolus *sensu* Patterson and Rosen, 1977) that articulates with the ethmopalatine (dorsally) and posterior maxillary dorsal process.

4.4.4. Upper jaw

The maxilla is saber-shaped; its oral profile is sinuous and it is straight dorsally (Figure 2). The depth along the maxilla is irregular due the sinuousness of its ventral profile and the gentle roundness of its posterior tip; nevertheless its middle and anterior sections are about 16 mm in depth and contained 4.6 times in the maxilla length (75 mm). The lateral face of this bone, mainly on the anterior half, is covered with tiny pores. The supramaxilla bears two stout, rectangular dorsal processes on its anterior third; the posterior articulates with the ventral border of the palatine head, whereas the anterior one articulates with the ethmoid bones. Although it is not clear what bones of the ethmoid area contact the facet for this anterior maxillary process, involvement of the ethmopalatine is probable (Figure 3). Regarding the space between preserved teeth and the size of the alveolar border of the maxilla, is possible to suggest that that this bone probably had 55 to 65 small, conical and hollow teeth located in deep sockets and forming a single row along its alveolar border. These teeth are about regular in shape and size (Figure 3), the mean of their crown height is around 1.5 mm; nevertheless, those located on the concave section of the maxilla are slightly longer (2 mm). A lot of these teeth are regularly and so closely spaced that they almost contact each other (therefore the empty free spaces could be considered as empty alveoli where the dental replacement was occurring). The maxilla anterior tip shows a shallow notch in its lateral surface where the premaxilla attaches (Figure 2).

The premaxilla is rhomboidal, about twice deeper than long (Figure 2). This bone has a single articulation, in which the posterior part of its lateral internal surface attaches to the anterior and shallow facet of the maxilla. In MUZ 47, the premaxilla seems to overlap the ethmoid area, but it is not clear if this bone articulates with another bone. In MUZ 47 the premaxilla teeth resemble those described in the maxilla;

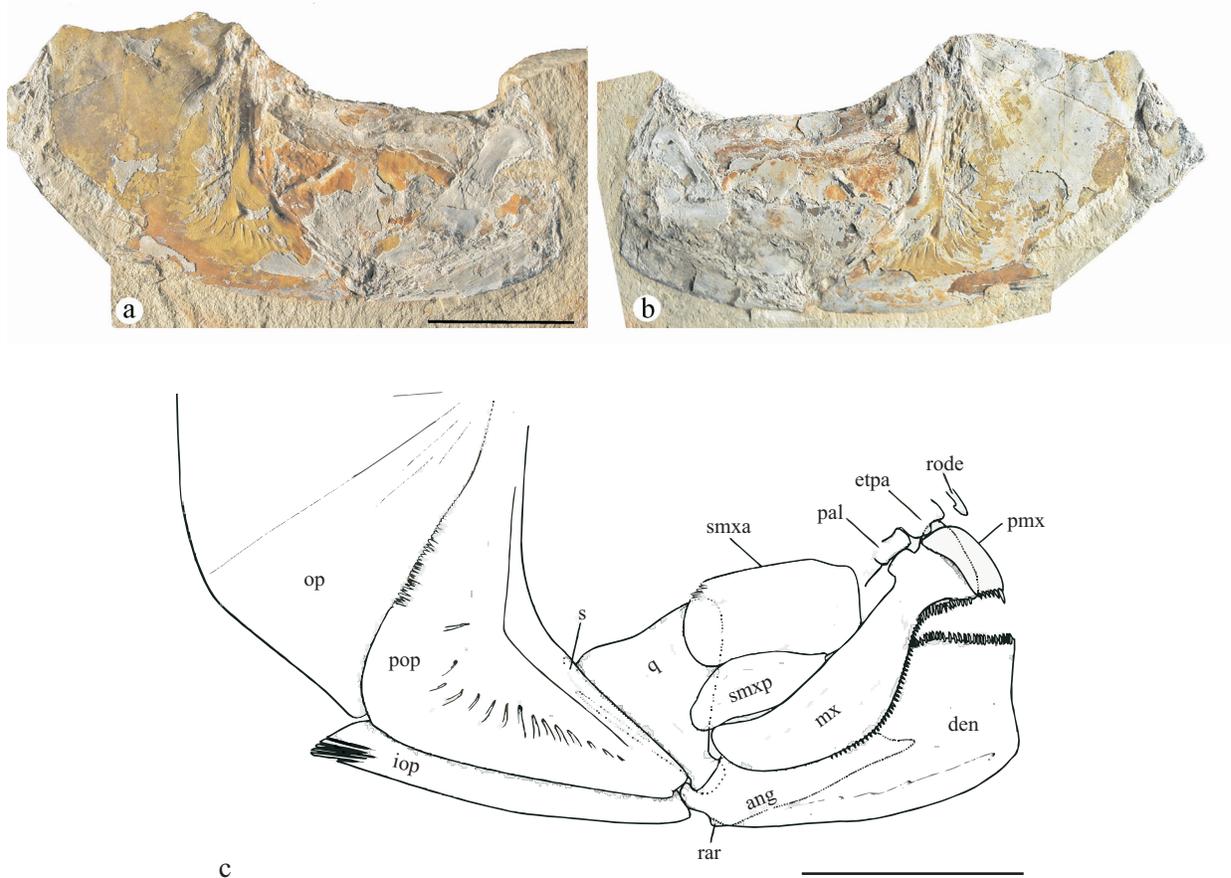


Figure 2. MUZ 47, *Gillicus arcuatus*, from Los Pilotes Ranch, Múzquiz County, Coahuila, Mexico. a, MUZ 47b (part), impression of the right side of the head. b, MUZ 47a (counterpart), right side of the head. c, Reconstruction of the specimen based on MUZ 47 a and b. Abbreviations: ang, angular; etpa, ethmopalatine; iop, interopercle; den, dentary; mx, maxilla; op, opercle; pal, palatine; pmx, premaxilla; pop, preopercle; rar, retroarticular; rode, rostrodermethmoid; s, symplectic; smxa, supramaxilla anterior, smxp, supramaxilla posterior; q, quadrate. Scale bars equal 5 cm.

these are similar in shape and form a single row, but they are larger. This specimen preserves the impression of two fangs with 4mm crown, followed by at least 4 teeth with crowns decreasing in length from 3 to 2 mm (Figure 2).

There are two supramaxillae covering the large part of the anterior surface of the cheek. The anterior supramaxilla is rectangular, the largest, and seems to be about twice the size of the ovoid posterior supramaxilla. Based on the impression of external bones found in MUZ 47b (Figure 2), it is considered herein that the posterior border of the anterior supramaxilla is finely denticulated or fringed, a condition that probably was also present in the posterior supramaxilla (Figure 2). The supramaxillae are placed above of the posterior half of the maxilla and its surfaces are ornamented with fine parallel grooves. These observations are in part estimated as neither the whole profiles nor surfaces of these bones are preserved.

4.4.5. Lower jaw

The lower jaw is rectangular (Figure 2, 3). The anterior border of the dentary symphysis is straight and respecting

to its slightly convex ventral profile, it is projected upward forming an angle near to 90°. The retroarticular process is well developed, occupies the posterior fifth of the jaw, and externally it is made up by the angular. The length of the lower jaw in MUZ 47 is 75 mm along its ventral margin; its depth is 25 mm at the anterior edge of the symphysis. The symphysis is contained 3.0 times in the length of the dentary. At the base of the retroarticular process the jaw shows a robust, but small ventral protrusion that herein is interpreted as remains of the retroarticular bone. Although in MUZ 47, the dentary bone forms the large part of the lower jaw, many of its details are obscured or badly preserved. The coronoid process and a large part of the dentary alveolar border are covered. The anterior part of the alveolar border shows a gently sinuous profile in which a row of regular, conical, and hollow teeth about 2 mm in length are preserved. The lateral external surface shows some spaced pits for the mandibular sensory canal spaced along a ridge on its ventral margin.

4.4.6. Opercular series

The opercular bones are not well preserved; nevertheless

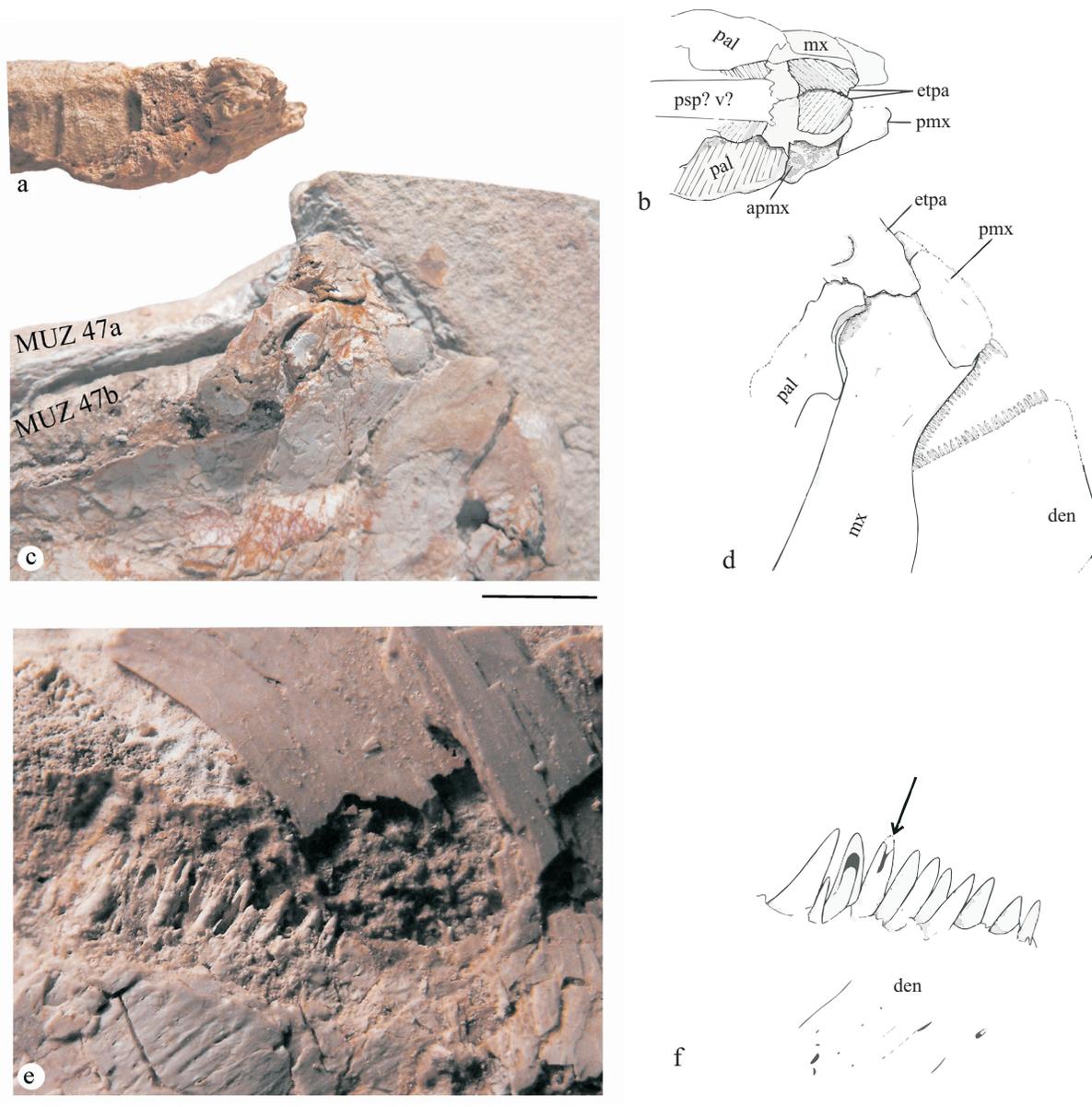


Figure 3. Details of MUZ 47, *Gillicus arcuatus* from Los Pilotes Ranch, Múzquiz, Coahuila. a and b, MUZ 47b, dorsal view and reconstruction of the ethmoid area. c, MUZ 47b after preparation (overlapped on MUZ 47a) and showing a close-up of left side of the ethmoid area. d, reconstruction of ethmoid area and jaws based on c. e and f, hollow dentary teeth (see arrow) preserved in MUZ 47b (right side of the head) and reconstruction. Abbreviations: apmx, anterior articular process of the maxilla; etpa, ethmopalatine; den, dentary; mx, maxilla; pal, palatine; pmx, premaxilla; psp, parasphenoid; v, vomer. Scale bars equal 2 cm.

some of them show discernable characters (Figure 2). Although the opercle lacks its dorsal border, in lateral view this bone is kidney-shaped, almost flat, and shows radiating ridges displaced from the hyomandibular facet (not preserved in MUZ 47). The preopercle shows the typical L-shape, in which the dorsal limb is the larger and the ventral border is projected forward reaching the posterior border of the lower jaw. The preopercle has a gently curved anterior margin and slightly concave ventral profile. A well-expanded wing of thin bone forms the posteroventral corner of this bone. The section preserved of the preopercle

dorsal limb shows a finely denticulated or fringed margin. The preopercular sensory canal has 12 pits on the ventral and three on the dorsal branch. The interopercle is a long and shallow flat bone, located below, and overlapped by the preopercle. The interopercle shows a deeply denticulated or fringed posterior margin.

4.4.7. Scales

MUZ 47 has a single scale exposed on its lateral surface; it is located beyond the opercle. This scale is ovoid, slightly deeper than long, and shows a number of central pits. No

other external ornaments (circuli or radii) are visible on this scale.

5. Discussion

Although MUZ 47 is largely incomplete, it is recognizable as a member of the order Ichthyodectiformes because a pair of well ossified ethmopalatine bones occupies the nasal capsule floor, articulating with the dorsal head of the palatine (Figure 3). According to Patterson and Rosen (1977), the occurrence of the ethmopalatines is a synapomorphic character of the order Ichthyodectiformes. These authors also noted that the species placed in the suborder Ichthyodectoidei share the presence of other synapomorphic characters; the large head of the palatine has disclike malleolus shape, and the ethmopalatine is completely ossified (with membranous outgrowths forming a complex suture that strongly attaches this bone to the rostromethmoid anteriorly and lateral ethmoid posteriorly). MUZ 47 shows both these diagnostic characters, supporting its inclusion within the suborder Ichthyodectoidei.

Patterson and Rosen (1977) included all Cretaceous ichthyodectiform genera then known plus the Jurassic European *Thrissops* species in the suborder Ichthyodectoidei. Although Patterson and Rosen (1977) recognized only two Ichthyodectoidei families (Saurodontidae and Ichthyodectidae), since then new ideas on the systematics of this suborder have been put forward involving the higher-level systematics of the group and its included families (Taverne, 1975; Maisey, 1991; Stewart, 1999; Taverne and Chanet, 2000; Alvarado-Ortega, 1998, 2004, 2005, and Taverne 2008).

5.1. Saurodontidae

This family was originally erected by Cope (1871b) (also see Bardak and Sprinkle, 1969) to include *Saurodon* and *Saurocephalus*, and today it also includes *Prosaurodon* (see Stewart 1999). The saurodontids are highly specialized strongly prognathous fishes that evolved an unusually long lower jaw and a triangular, edentulous prementary that together are projected forward beyond the premaxilla. MUZ 47 does not show any of these specialized saurodontid characters on its lower jaw, precluding its inclusion within this family. This family corresponds to the subfamily Saurodontinae suggested by Taverne and Chanet (2000) and Taverne (2008).

5.2. Ichthyodectidae

This family was originally erected by Crook (1892) to include *Gillicus*, *Xiphactinus* and *Ichthyodectes*; this group was considered as the subfamily Ichthyodectinae by Taverne and Chanet (2000). Patterson and Rosen (1977) considered the family Ichthyodectidae to include *Thrissops*

and all the Cretaceous non-saurodontid ichthyodectiforms. Maisey (1991) reestablished the original composition of the family Ichthyodectidae. Later, Stewart (1999) pointed out the paraphyletic condition of this family. Finally, Blanco-Piñón and Alvarado-Ortega (2007) suggested the rearrangement of Crook's (1892) family, arguing the inclusion of *Vallecillichthys* and the possible exclusion of *Gillicus*. The family Ichthyodectidae *sensu* Taverne and Chanet (2000) and Taverne (2008) corresponds to the suborder Ichthyodectoidei suggested by Patterson and Rosen (1977). However, the family Ichthyodectidae *sensu* Patterson and Rosen (1977) represents an unnatural group (see Alvarado-Ortega 2005). In this paper Ichthyodectidae is used in part in the Systematic Palaeontology section just to retain the subfamily Gillicinae, recently named by Taverne (2008) to suggest a new hypothesis of *Gillicus* relationships.

According to Blanco-Piñón and Alvarado-Ortega (2007), the monophyly of the group comprised of *Ichthyodectes*, *Xiphactinus* and *Vallecillichthys* is supported by the occurrence of a broad parasphenoid angle (the ventral surface formed between the otic and ocular section of the parasphenoid ranges between 149°-160°), the hyomandibular facet and ocular section of the parasphenoid projected in parallel to each other, and enlarged premaxilla fangs. Nevertheless, Taverne (2008) later suggested two additional characters, an increase in the number of vertebrae and a short anal fin (with only 11-13 rays). Although none of these characters is preserved in MUZ 47 except the presence of anterior fangs in the premaxilla, the exclusion of this fish from this group is strongly justified because the occurrence of a very deep lower jaw. The lower jaw in *Ichthyodectes*, *Xiphactinus*, and *Vallecillichthys* is rectangular and comparable to those seen in Early Cretaceous Ichthyodectiformes (*Unamichthys*, *Cladocycclus*, *Chiromystus*, and *Eubiodectes*); in contrast, in MUZ 47 and other *Gillicus* specimens the lower jaw is very deep (see below). In other wise, the fangs in the premaxilla is a homoplastic character [these fangs are noted in Jurassic and other Cretaceous ichthyodectoids (see Maisey, 1991, among others) and their sizes are not easily comparable among these genera]. In MUZ 47 and other *Gillicus* specimens these teeth are always millimetric.

5.3. Cladocyclidae

Maisey (1991) named this family to include *Cladocycclus*, *Chiromystus* and *Chirocentrites*, indicating that only in these fishes the posterior border of the supraoccipital crest overhangs the occiput. Alvarado-Ortega (1998, 2004, 2005) and Stewart (1999) demonstrated that this is an unnatural group because the condition could be a plesiomorphy among ichthyodectoids and it has been seen in *Thrissops* and *Xiphactinus*.

5.4. Unamichthyidae

Alvarado-Ortega (2004) suggested placing *Unamichthys*

in its own family. The singularity of this genus (and family) is supported by the occurrence of unfused parietal bones. Cavin (2008) based on an unpublished work [addresses as Cavin & Forey (2008)], suggested that *Unamichthys* and both *Gillicus* species (*G. serridens* and *G. arcuatus*) form a monophyletic group; nevertheless the differences between *Gillicus* and *Unamichthys* include the dissimilar proportions of their lower jaws among other characters (see below).

Regarding the published phylogenetic hypotheses on Ichthyodectiformes (Maisey, 1991; Alvarado-Ortega, 1998, 2004, 2005; Stewart, 1999; Taverne and Chanet, 2000; and Taverne 2008), it is possible to address a remarkable tendency in the evolution of the lower jaw among the ichthyodectoids (Figure 4). *Thrissops* is the basal and the single Jurassic ichthyodectoid so far known; other Jurassic Ichthyodectiformes (*Allothrissops*, *Antarcticthrissops*, and *Occithrissops*), and basal teleosts such as *Leptolepis coryphaenoides* (see Wenz, 1967), show the plesiomorphic condition that consists of a triangular lower jaw, in which the dentary has an alveolar border projected anteroventrally, from a shallow symphysis to a wide and deep posterior coronoid process, and where the anterior border or symphysis depth is contained about 8 times in the length of

its ventral border. Among the Cretaceous ichthyodectiforms the lower jaw is rectangular, and the alveolar and ventral borders are projected almost in parallel to each other. This shape is found in all ichthyodectoid genera so far known, except *Thrissops*, and if its proportions are regarded it has at least three derived conditions (Figure 4). In *Cladocycclus* as probably *Chiromystus* [a valid genus that Taverne (2008) regards synonymous of *Cladocycclus*], *Unamichthys*, *Eubiodectes*, *Xiphactinus*, *Ichthyodectes*, *Vallecillichthys*, *Cooyoo*, *Hakelichthys*, and *Prosaurodon*, the rectangular lower jaw is moderately deep; here the alveolar border length is contained about 4-5 times in the length of the ventral border of dentary. In saurodontids the rectangular lower jaw seems to be shallow because this ratio is about 6 times, causing them to have prognathic lower jaws. Finally, *Gillicus* and *Chirocentrites coronini*, which constitute Taverne's (2008) subfamily Gillicinae, have extremely deep lower jaws, such that the ratio of depth to length ranges between 2-3 times. Taverne (2008) redescribed the species placed within *Chirocentrites*, leaving *C. coronini* as the single member of this genus and erecting the genus *Heckelichthys* to place *H. vexillifer* and *H. microdon* (previously known as *Chirocentrites vexillifer*

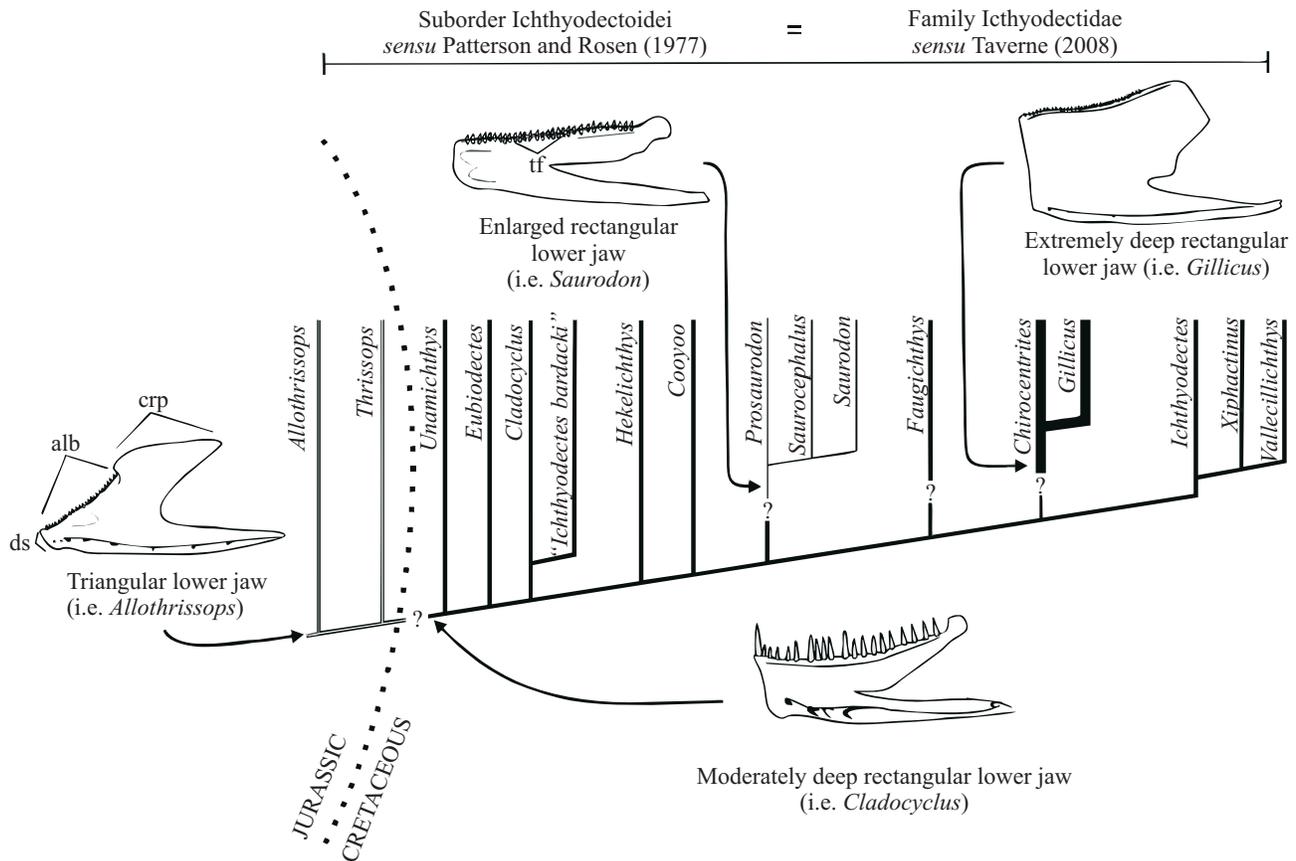


Figure 4. Dentary shapes found among Ichthyodectiformes drawn on Taverne's (2008) phylogenetic hypothesis (question marks added by the authors). All dentaries shown in external lateral view except *Saurodon*, shown in medial view. Abbreviations: alb, alveolar border; ds, dentary symphysis; crp, coronoid process; tf, tooth foramen.

and *C. microdon*, respectively). According Taverne (2008), *Chirocentrites* differs from *Gillicus* because the former bears irregular and larger teeth, which in the anterior end of the premaxilla and dentary become fangs. In *Gillicus*, the teeth are minute and regular in shape. MUZ 47 is identified as *Gillicus* because the proportions of its symphysis match with those seen in Gillicinae and the teeth are like those described for *Gillicus* species (compare dentary bones in the Figures 2 and 4). Additionally, the maxilla ventral border is concave in *Gillicus* (Bardack, 1965) and gently convex in *Chirocentrites corinini* (Taverne 2008, fig. 2); here again, MUZ 47 most closely resembles *Gillicus*.

Although Bardack (1965, 1968) recognized that *Gillicus arcuatus* and *G. serridens* are valid species, he noted that they do not show morphological differences from each other. He considered that these species are “tentatively distinct” only because they have “different geographic and geological positions.” Since Bardack’s work, new fossils of *Gillicus* have been collected in localities within a wide geographical and temporal distribution (it is known from North America, Europe, and Eastern Asia, and ranged in age from Late Albian to Early Maastrichtian); nevertheless a detailed review and a comparative study still are required to confirm the validity of both *Gillicus* species. Regarding that *G. serridens* is just “tentatively distinct” from *G. arcuatus* and that they do not show significant differences as Bardack (1965) noted, herein MUZ 47 is identified as *Gillicus arcuatus* as it fits the description as well as temporal of the type species.

6. Conclusions

Specimen MUZ 47, collected in the Turonian limestone marl strata at Rancho Los Pilotes, near Múzquiz, Coahuila, shows enough characters for its confident identification as a specimen belonging to the species *Gillicus arcuatus*. This is the first record of this genus within Mexican territory. The occurrence of this specimen represents the southernmost record of this genus so far collected.

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