An Early Cretaceous astropectinid (Echinodermata, Asteroidea) from Patagonia (Argentina): A new species and the oldest record of the family for the Southern Hemisphere

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ABSTRACT. Asterozoans are free living, star-shaped echinoderms which are important components of benthic marine faunas worldwide. Their fossil record is, however, poor and fragmentary, probably due to dissarticulation of ossicles. In particular, fossil asteroids are infrequent in South America. A new species of starfish is reported from the early Valanginian of the Mulichinco Formation, Neuquén Basin, in the context of a shallow-water, storm-dominated shoreface environment. The specimen belongs to the Astropectinidae, and was assigned to a new species within the genus *Tethyaster* Sladen, *T. antares* sp. nov., characterized by a R:r ratio of 2.43:1, rectangular marginals wider in the interbrachial angles, infero-marginals (28 pairs along a median arc) with slightly convex profile and flat spines (one per ossicle in the interbrachials and two per ossicle in the arms). Both the sedimentologic features of the bearing bed, and the taphonomic signature point to a rapid burial. Considering the presence of well-developed fascioles, it is likely that the specimen was already half buried at the beginning of its taphonomic pathway. This record represents the oldest finding of Astropectinidae in the Southern Hemisphere and the first record of the genus *Tethyaster* for the Lower Cretaceous of South America.

Keywords: Astropectinidae, *Tethyaster*, Early Cretaceous, Patagonia, Neuquén Basin, Mulichinco Formation.

RESUMEN. Un astropectínido (Echinodermata, Asteroidea) cretácico temprano de Patagonia (Argentina): Una nueva especie y el registro más antiguo de la familia para el Hemisferio Sur. Los asterozoos son echinoderms de vida libre, con forma de estrella, y componentes importantes de las faunas marinas bentónicas a nivel mundial. Su registro fósil, sin embargo, es pobre y fragmentario, probablemente debido a la desarticulación de los osículos. En particular, los asteroideos fósiles son poco frecuentes en América del Sur. Se presenta aquí una nueva especie de estrella de mar de edad valanginiana proveniente de la Formación Mulichinco (cuenca Neuquina), en un contexto de ambiente somero de ‘shoreface’ dominado por tormentas. El espécimen pertenece a la Familia Astropectinidae y fue asignado al género *Tethyaster* Sladen. *T. antares* sp. nov., se caracteriza por una relación R:r de 2.43:1, marginales rectangulares más anchos en los ángulos interbraquiales, inferomarginales (28 pares a lo largo de un arco medial) con perfil ligeramente convexo y espinas planas (una por osículo en las áreas interbraquiales y dos por osículo en los brazos). Las características sedimentológicas y tafonómicas indican un enterramiento rápido. La presencia de fascioles bien desarrolladas sugiere la posibilidad de que el espécimen se hallara parcialmente enterrado al comienzo de su ruta tafonómica. Este registro representa el hallazgo más antiguo de Astropectinidae en el Hemisferio Sur y el primer registro del género *Tethyaster* en el Cretácico Inferior de Sudamérica.

1. Introduction

Asterozoans are free living, marine echinoderms characterized by a star-shaped or pentagonal body and arms which radiate from the central disc (Twenhofel and Shrock, 1935). They present an oral side (where the mouth opens in living position this side is downwards, contacting the sea floor) and an aboral side (the opposite one). Within Asterozoa, asteroids (or starfishes) are distinguished from ophiuroids (brittle stars) by the lack of strong separation of disc from arms and other features. Body fossils of any group of starfish are seldom preserved, since the discrete skeletal elements (ossicles) of the endoskeleton most commonly disarticulate after death. Thus, fossil forms mostly comprise dissociated ossicles only (Villier et al., 2004). Whole skeletons are rare and usually preserved under exceptional conditions that prevented disarticulation (Spencer and Wright, 1966).

During the Mesozoic, there was an important radiation within asteroids (Wright, 1967). A large number of these lineages have extant representatives (Blake, 1982), and fossil specimens can be morphologically very similar to the living ones (Blake, 1986). Many fossil asteroid examples, when preserved as whole specimens, are known either from one single sample or from a single bed containing more than one specimen. Even when dealing with such limited record, assignment of Mesozoic findings to extant taxa is possible if quality of preservation is good enough and certain key morphological features are preserved (Blake, 1986). Compared to the other families of asteroids, the Astropectinidae have a relatively good fossil record, due to their robust skeletal plates. Although Astropectinidae are environmentally broad ranging and numerically important in recent settings, the discovery of body fossils remains rare (Blake and Sturgeon, 1995).

Fossil asteroids in general are infrequent in South America. The oldest records are known from the Lower Devonian of Argentina and Brazil (Haude, 1995; Melo, 1988); late Mesozoic examples are from the Upper Cretaceous of Brazil (Maury, 1930; Castro Manso, 2006). In Chile, trace fossils found in the Lower Cretaceous (mid-late Hauterivian-Barremian/Aptian?) Apleg Formation have been assigned to Asteriacites lumbricalis and ascribed to asteroids (Bell, 2004); however, no asteroid body fossils from the Lower Cretaceous of South America have been reported up to this moment. The geographically closest Cretaceous record comes from the Antarctic Peninsula (Medina and Del Valle, 1983).

A new asteroid fossil specimen was found in a level of the Lower Cretaceous Mulichinco Formation, Neuquén Basin, Argentina. The aim of this study is to report the existence of this material, provide a systematic assignment and description of the specimen, present taphonomic and palaeoecological information about it, and comment on the importance and the palaeobiogeographic implications this finding has on the record of the Astropectinidae.

2. Geological setting and palaeontological frame

The Neuquén Basin (Fig. 1) is located in the west-central part of Argentina, between 34° and 41°S, spanning mainly over Northern Patagonia and Southern Cuyo regions. It contains over 7,000 m thick marine and continental deposits of Late Triassic to Paleogene age (Vergani et al., 1995; Legarreta and Uliana, 1999). Most of the Jurassic and Lower Cretaceous deposits are represented by highly fossiliferous marine facies of diverse nature associated with transgressions from the Pacific Ocean (Howell et al., 2005).

The Mulichinco Formation (Weaver, 1931; Mendoza Group) is a 200 to 400-m-thick mainly clastic, marine to continental succession (Schwarz, 2002) of early Valanginian age (Aguirre-Urreta et al., 2005) exposed in the Neuquén province (Argentina), in the area between the Agrio River to the south and the limit with the Mendoza Province to the north. Nearby the study area, the Mulichinco Formation comprises clastic and carbonate lithologies that have been interpreted as deposited in non-deltaic, open shallow marine environments (Schwarz et al., 2006). The sample was recovered from the lowermost levels of this unit, in the outcrops located along the National Road 40 at the Pampa Tril area (37°15’S, 69°47’W; Fig. 1).

The sandstone containing the studied specimen represents the top of one of several coarsening upward successions (Figs. 2-3), which present a thickness of 2.5 to 4 m. Their bases consist of massive shale beds, followed by heterolithic intervals which are in turn covered by sandstones with current, wave or combined-flow ripple laminations, or hummocky stratification. These successions
culminate in sandstones with wave ripple lamination and abundant trace fossils assigned to *Asteriacites*, and escape structures. Very similar successions were interpreted, in the neighbouring site of Vega de Escalone (Fig. 1), as shallow-water, storm-dominated shoreface deposits (Rodríguez et al., 2007). The same interpretation is valid for this facies in Pampa Tril. The bed containing the studied sample varies laterally from medium to fine-grained sandstone with wave or combined-flow ripple lamination.

Except for some internal moulds of ammonoids (*Lissonia riveroi* zone; Aguirre-Urreta and Rawson, 1999), no other body fossils are found in this particular facies. *Asteriacites* is a resting trace that has been attributed to asterozoans, both asteroids and ophiuroids. Rodríguez et al. (2007) described the ones found in Vega de Escalone as *Asteriacites lumbricalis* and attributed them to ophiuroids. They are the only other evidence of asterozoans in this facies.

### 3. Material and Terminology

**Material:** The studied specimen is housed in the collection of the Área de Paleontología, Departamento de Ciencias Geológicas, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Ciudad Universitaria, Pabellón II, C1428EGA, Buenos Aires, Argentina, under the repository number CPBA 16991.

**Terminology:** Morphological terms follow Spencer and Wright (1966) and Blake and Sturgeon (1995):
‘ventral’ for the entire lower side of the specimen, ‘dorsal’ for the upper side, and ‘oral’ strictly for the area surrounding the mouth. ‘Abradial’ indicates the region of the ossicle opposite to the arm axis, the converse of ‘adradial’; ‘proximal’ means toward the centre of the disc and ‘distal’ indicates the contrary. ‘R’ is used for the length from disc centre to arm tip, and ‘r’ for the length from disc centre to interradial edge. Fascioles are parallel, radially directed channels between plates.

4. Systematic Palaeontology

Class Asteroidea Blainville, 1830
Subclass Neoasteroidea Gale, 1987
Order Paxillosida Perrier, 1884
Family Astropectinidae Gray, 1840

Discussion: Many members of the Astropectinidae, including extant *Tethyaster* are characteristic in presenting relatively small discs; usually elongated,
triangular, pointed, straight-sided arms; well-developed marginals with contacts facets smaller than the total length of the ossicle; fasciolar inferomarginals with spines on the outer margin of the arms in the ventral side, small actinal plates, and a bare-like oral plate (Spencer and Wright, 1966; Blake, 1981; Blake and Sturgeon, 1995). All of these features are present in this specimen. Other characteristics, such as the presence of paxillae on the dorsal surface and a large madreporite located close to the margin, can only be observed on a dorsal view, and are therefore unknown in this specimen.

**Genus Tethyaster Sladen, 1889**  
*Tethyaster antares* new species  
Figs. 4-5

**Diagnosis:** *Tethyaster* of small size, with a R:r ratio close to 2.4:1. Arms short and triangular in outline. Marginal ossicles rectangular, with a height at least equal to the width of the ossicle, wider in the interbrachial angles and narrower in the extremes of the arms. Inferomarginals with slightly convex profile, with approximately 28 pairs along a median arc. Marginal fascioles deep and wide. Spines of the inferomarginals large, flat and truncated; one spine per ossicle for the marginals of the interbrachial area and two spines per ossicle for the marginals of the arms.

**Description:** The body is rather flat, the disk is relatively large, the maximum radius (R) is 37 mm, and the minimum radius (r) is 15 mm. Arms are relatively short and have a wide base (13.5 mm wide). The specimen shows five arms; two of them are complete, one is almost complete, and two are fractured showing less than a third of their original length. The complete arms are 22.8 and 20.6 mm long. The interbrachial angles are rounded, varying from 92° to 113°. The arms are triangular in outline, pointed and straight-sided.
Marginals are stout, rectangular, not very high, at least equal to the ossicle width, wider than long (up to four times wider than long, especially in the interbrachial angles) and narrower near the arm tips (where they are almost squared). They are orientated perpendicular to the arm axis but with the abradial extreme of every ossicle leaning to some extent towards the distal sector of the arm; this tendency increases distally. Superomarginals and inferomarginals are equal in size. The inferomarginals are slightly convex in transverse profile, with the ventral surface covered with large and conical granules. There are approximately 28 pairs of marginals along a median arc. Interbrachial marginal ossicles are numerous.

FIG. 4. *Tethyaster antares* n. sp., Mulichinco Formation, Patagonia, Early Cretaceous. Holotype (CPBA 16991). Scale bars: 1 cm in 1; 0.25 cm in 2-3; 0.1 cm in 4-6. 1. Slab fragment bearing the starfish in oral view; 2. Close-up of an actinal area. The arrow points the location of one fasciole; 3. Close-up of an arm in ventral view. The lines indicate two different marginals with unequal size along the arm; 4. Close-up of an arm tip in ventral view. The arrow points the ambulacral ossicles; 5. Close-up of marginal ossicles in interbrachial arcs. The lines indicate the granules on marginal surface. The arrow points at the single spine per ossicle; 6. Close-up of marginal ossicles in the arm. The arrow points at the two spines per ossicle.
Marginal fascioles are deep and wide. The contacts between marginals are partially covered with sediment; however, it can be distinguished that contacts are shorter than the total width of the ossicle and begin at the second third of the marginal towards the ambulacral side. Distally in the arms, these contacts are even closer to the ambulacral side. The inferomarginals bear large, rather flat spines on the abradial edge one per ossicle in the interbrachials and two per ossicle in the arms, extended distally in each arm and truncated at the ends. InterMarginal areas with short, conical spines. Terminals could not be observed. Actinal areas are large. Actinal ossicles are small, lined up in series in the intermediate actinal areas, becoming larger towards the oral sector. At least two series of actinals are extended towards the arms, reaching up to two thirds of the arm’s length. Numerous small, conical spines are present over the actinal ossicles.

Ossicles of the oral frame are partially exposed. The mouth angle ossicles are rather large, keel-like and prominent.

Ambulacral ossicles are asymmetrical, with a more expanded abradial portion. Adamubulacral ossicles are aligned with the ambulacral ones.

**Etymology:** The specific epithet derives from the giant red star Antares, of the Scorpion (scorpion) constellation, visible mainly from the Southern Hemisphere.

**Holotype:** CPBA 16991. It is a nearly complete specimen in ventral view.

**Occurrence:** Lowermost levels of the Mulichinco Formation at the Pampa Tril locality (37°15′S, 69°47′W), Neuquén Basin, Argentina.

**Remarks:** The genus *Tethyaster* presents: a relatively large disc for the family; rounded interbrachial angles; deep fascioles; numerous pairs of interbrachial marginals; supero- and inferomarginal ossicles of similar size, large and covered with granules; inferomarginals with flattened spines and well-developed actinal areas, with more than one line of actinals extended within the arms (Clark and Clark, 1954; Blake, 1986). This specimen presents all these features, and the proportions and body shape correspond to those typical of the genus. Next, there is a list of characteristics of the other Astropectinidae genera that allow the inclusion of this specimen within the genus *Tethyaster* and rule out the others.

*Astropecten* Gray, 1840 presents: a small disc; angular interbrachials; markedly reduced actinal areas; actinal ossicles restricted to the disc; subquadangular marginals and a long spine projected horizontally from each marginal forming an edge along the whole outline of the starfish. The inferomarginals are ornamented with horseshoe shaped tubercles, which are also present in *Pentasteria* Valette, 1929 (Jurassic and Cretaceous, Europe) and in *Archastropecten*...
Hess, 1955 (Jurassic and Cretaceous, Europe). Craspidaster Sladen, 1889 shows small and inconspicuous spines on the marginals and no actinals in the arms, as well as Ctenopleura Fisher, 1913, which also presents a small disc and acute interbrachial angles. Dipsacaster Alcock, 1893 has more quadrangular, high and stout marginals, and infero- and superomarginals of different size, like in Astropecten, Ctenopleura, Aldebarania Blake and Sturgeon, 1995, Ctenophoraster Fisher, 1906, Patagiaster Fisher, 1906 and Psilaster Sladen, 1885. Aldebarania (Maastrichtian, North America) presents lower inferomarginals that protrude beyond the superomarginals, and also shorter and wider arms. Advenaster Hess, 1955 (Jurassic and Cretaceous, Poland and India) presents a relatively small central disc, with non-rounded interbrachial angles and, as well as in Archaeastropecten, shallow fascioles and large articular contacts between marginals. Eokainaster Blake, 1981 (Jurassic, North America) shows a very small disc and elongated arms with no actinal ossicles, and angular interbrachial arcs. Bathybiaster Daniellsen and Koren, 1883 is similar to T. antares sp. nov. in the body proportions, the presence of rounded interbrachials and subequal marginal ossicles, but the actinal areas in Bathybiaster are small and the spines on the marginals are inconspicuous. The interbrachial angle is not rounded in Prothrisssanctias Villier et al., 2007 (Berriasian, Algeria) and Persephonaster Wood-Mason and Alcock, 1891. Astrocratis Blake and Sprinkle, 1996 (Campanian, North America) shows a small disc with actinal areas reduced, subquadrangular marginals and elongated arms. Plutonaster Sladen, 1899 shows a similar appearance but has shallower fascioles and moderate or small actinal areas. Coulonia de Loriol, 1873 (Cretaceous of Spain, Switzerland and Morocco, and Tertiary of the United Kingdom) presents similar marginal and body proportions but shows only one series of actinals to each side of the ambulacral arms in the arms, and no spines or granules on the inferomarginals.

Tethyaster antares sp. nov. is different from the rest of the species known for this genus. All Recent species show R:r ratios ranging from 3.2:1 to 4.8:1, and are usually larger, from 120 mm to 275 mm long (Blake, 1986). The type species, T. subinermis (Philippi, 1837) -Recent, Mediterranean Sea and eastern North Atlantic- is differentiated from T. antares sp. nov. by the presence of spines with acute tips in the inferomarginals, as well as in T. aulaphorus (Fisher, 1911) -Recent, Philippines and Taiwan-, T. grandis (Verrill, 1899) -Recent, Gulf of Mexico- and T. pacei (Mortensen, 1925) -Recent, South Africa-. In T. canaliculatus (Clark, 1916) -Recent, Gulf of California- the arms are narrower and more elongated, and the inferomarginals maintain their height: width ratio along all the body margin. T. vestitus (Say, 1825) -Recent, western North Atlantic- and T. grandis bear much longer arms and proportionally smaller marginals. T. magnificus (Bell, 1882) -Recent, Saint Helena and Ascension Islands- has a denser cover of spines on the ventral side (Clark and Clark, 1954).

The fossil species of Tethyaster present R:r proportions inferior to the ones present in the Recent taxa, generally not greater than 3:1. T. jurassicus Blake, 1986 (Camel Formation, Jurassic, Utah, USA) is differentiated from T. antares sp. nov. by the presence of longer arms, conical spines and acute tips on the inferomarginals, which are of regular size along the arms and interbrachials. ?T. albertensis Hall and Moore, 1990 (Cardium Formation, Turonian, Alberta, Canada) presents similar characteristics to T. antares n. sp., but equally to T. jurassicus, the marginals maintain a regular size along the entire margin and bear conical spines in groups of three in each inferomarginal. T. guerangeri Breton, 1996 (Sables et Grés du Mans Formation, Cenomanian, France) has a higher number of marginals per arm than T. antares n. sp. (35-40 instead of approximately 28), a higher R:r ratio (3:1) and inferomarginals with a very convex profile. The fossil species of Tethyaster are more similar among them than are the extant species of the genera. More research including both fossil and living species, is necessary for a better understanding of the genus.

5. Astropectinid ecology, taphonomy and palaeoecological inferences

Extant paxillosidans, and astropectinids in particular, live semi-infaunally on soft sandy or muddy substrates (Blake and Aronson, 1998; Jagt, 2000). They are capable of self-burial due to the presence of deep fascioles, which are deep in Tethyaster. Astropecten and Luidia Forbes, 1839, two common extant paxillosidan genera, are capable of self-burial, pushing sediment laterally from beneath their bodies and gradually sinking beneath the surface (Heddle, 1967); in both these genera, the presence of fascioles allows unobstructed water...
flow over the animal’s body surface, thereby aiding in self-burial (Blake and Aronson, 1998; Blake and Reid, 1998).

Blake and Aronson (1998) point out that asteroid self-burial evolved in the Cretaceous, and that ‘the oldest clearly identified fasciole-bearing taxon is from the Early Cretaceous’ (Hauterivian and Barremian; Hess and Blake 1995). The specimen reported here comes from slightly older deposits of Valanginian age, showing that well-developed fascioles (Figs. 4.2, 5) were already present at even earlier times.

Astropectinids are voracious predators that feed on molluscs and echinoderms (including other astropectinids), amongst other invertebrates, but they may also consume algae and inorganic detritus (e.g., Ortega et al., 2011). They actively search for prey and are able to shallowly dig into the substrate to get it (see Ortega et al., 2011 and references therein). Studies on the diet of recent Tethyaster specimens (Penchaszadeh and Molinet, 1983) show that this taxon is the top carnivore in the food web of echinoderms and molluscs, and as it would be expected for such predators, their population density is very low.

Fossilization of articulated starfish is rare, it requires a rapid burial and thick coverage so that the body remains beyond reworking by normal biological or physical agents. Otherwise, exceptional preservation can take place on low-energy settings in which bioturbation is minimal or absent. Post-mortem collapse of starfish bodies is expected, and since ossicles are not fused to each other they are easily dispersed; recrystallization is common, especially in coarse-grained lithologies, and results in the obliteration of surface details (Jagt, 2000). Articulated remains are extremely rare, and are expected to usually happen in storm-generated beds or other kind of rapid deposition events (Hess, 1972; Goldring and Stephenson, 1972; Meyer, 1984, 1988; Jagt, 2000). For example, Blake and Reboul (2011) reported numerous specimens from Morocco at depths of 30 m or less, in a situation more similar to the case under study here, even though their material came from limestones rather than sandstones. Taking into account that seastars are a conservative group regarding general morphological features (Jagt, 2000), and particularly in the case of Tethyaster (according to Breton, 1996), and given that no significant change is observed in the genus since its first representatives known from the Jurassic (see below), Mesozoic Tethyaster specimens were most likely capable of self-burial as well. This feature of astropectinids enhances their preservation potential (Blake and Aronson, 1998). It is possible that this specimen was already ‘half buried’ at the beginning of its taphonomic route. It was preserved in life position at the base of the stratum. Regarding its taphonomical properties, no sign of pre-burial disarticulation, abrasion, predation or scavenging was found. The missing fragments of some of the rays are probably due to postburial fragmentation due to sediment weight and compaction. Some recrystallization is observed. Given the sedimentological features of the bed, the taphonomical properties of the sample, and the life habit of extant astropectinids, it is inferred that burial was rapid. Even when storm-related deposits are found within this facies, sedimentary structures of this particular level do not indicate the action of storms (similarly to the case reported by Breton, 1996), but wave action is evidenced by the presence of wave ripples. Complete burial was probably post-mortem, and in this case, a mixture of a previous half-buried state, and steady sediment input favored preservation.

6. The fossil record of the Astropectinidae and palaeobiogeographical implications

According to Villier et al. (2004), the earliest undisputed record of the Astropectinidae dates from the Aalenian, suggesting an Early Jurassic origin of the family (see Villier et al., 2004). An overview of the main record of astropectinid fossils is given by Jagt (2000). Most Jurassic records were reported from Europe, India and the USA (e.g., Blake, 1981, 1986; Breton, 1997; Gale, 2011; Hess, 1973; Kutscher and Röper, 1999; Spencer and Wright, 1966; Srivastava et al., 2010; Villier, 2008; Villier et al., 2004).

Known Cretaceous records are mostly European, with other occurrences taking place in Canada, USA and northern Africa (e.g., Blake and Reboul, 2011; Blake and Sprinkle, 1996; Blake and Sturgeon, 1995; Breton, 1996; de Loriot, 1873; Hall and Moore, 1990; Hérenger, 1944; Hess, 1970; Hess and Blake, 1995; Jagt, 2000; Néraudeau and Breton, 1993; Neumann and Hess, 2001; Neumann and Jagt, 2011; Smith et al., 1988; Spencer and Wright, 1966; Villier, 2008; Villier et al., 2007; Vullo et al., 2003). Regarding Lower Cretaceous records, Villier et al. (2007) have suggested that the sparseness of astropectinid occurrences could be more related to certain biases rather
than being a reflection of low starfish diversity. Some of these biases include unequal sampling efforts throughout the world, with findings centred mainly in Europe; likewise, literature is often restricted to very well-preserved specimens, and disarticulated ossicles are seldom given attention. Additional issues according to Villier and Kutscher (1999) and Villier et al. (2007) are given by the scarcity of lithofacies suitable for the preservation of starfish remains, and the problematic taxonomic scheme which was mainly constructed during the nineteenth century and requires an updated and thorough review.

Tertiary records are more widespread, with occurrences in Europe, the Antarctic Peninsula, Africa and all through America (northern, central and southern), and range from the Paleocene to the Pliocene (e.g., Blake and Aronson, 1998; Breton and Vizcaíno, 1997; Brünich Nielsen, 1926; Donovan, 2001; Donovan et al., 1993, 2003, 2005; Jagt, 2000; Jagt et al., 2009; Kroh and Nebelsick, 2003; Kutscher et al., 2004; Oyen and Portell, 2001). The only fossil record known for the Astropectinidae in South America comes from the Miocene of Chile (Kutscher et al., 2004). The specimen studied here is therefore the oldest record of the Family Astropectinidae in South America and the entire Southern Hemisphere.

At the family level, the relatively sparse record of the Astropectinidae is in contrast with their importance in Recent faunas (for example, along the South American Atlantic margin; Martínez, 2008) and their capability of surviving in a broad range of environments (Jagt, 2000). The study of ossicles as isolated elements can provide a family-level classification and, to a certain extent, genus and species classification (Villier et al., 2004), but unfortunately this approach has been infrequent in studies from the Southern Hemisphere.

The genus Tethyaster is known from the Middle Jurassic to nowadays, with little morphological change. Blake (1986) has even regarded this genus as a ‘living fossil’. Examples are known from the mid Cenomanian of France (Tethyaster guerangeri, Breton, 1996) and the Turonian of Canada (?Tethyaster albertensis, Hall and Moore, 1990), though the latter were assigned to the genus with doubts. Breton and Vizcaíno (1997) tentatively assigned disarticulated starfish ossicles, mostly marginals, to ?Tethyaster. In South America, Kutscher et al. (2004) interpreted the Miocene starfish fragments from Chile as closely related to Tethyaster. Therefore, the specimen of Tethyaster reported herein also represents the first record of the genus for the Lower Cretaceous of the Southern Hemisphere (Fig. 6).

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**FIG. 6.** Palaeogeographic reconstruction for the Lower Cretaceous (from Smith et al., 1994; modified from Lazo, 2007). Note the location of the Jurassic, Cretaceous (including this new record) and Tertiary records of the genus Tethyaster. Can.: Canada; Fr.: France; Ut.: Utah, USA.
7. Conclusions

- For the first time a starfish is described from material coming from the lower section of the Mulichinco Formation, Neuquén Basin, Argentina. Once the presence of starfish body fossils in this basin is noticed, it is expected that more specimens will be found.
- The taxonomic analysis allows us to assign this material to the class Asteroidea, order Paxillosida, family Astropectinidae, genus Tethyaster. The species T. antares n. sp. is proposed.
- This specimen shows that well-developed fascioles were already present at early Valanginian times. It is very likely that Tethyaster antares n. sp. was capable of self-burial.
- This specimen expands both the palaeogeographic and temporal record of the group, since it represents: i) the oldest record of the Family Astropectinidae in the Southern Hemisphere; and ii) the first record of Tethyaster for the Lower Cretaceous of the Southern Hemisphere.

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Haude, R.


Gray, J.E.


Hall, R.L.; Moore, S.


Goldring, R.; Stephenson, D.G.


Gray, J.E.


Hall, R.L.; Moore, S.


Haude, R.


Heddle, D.


Hérenger, L.


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