

A NEW GENUS AND SPECIES OF CHAPERIIDAE (BRYOZOA: CHEILOSTOMATA) FROM THE EARLY MIOCENE OF PATAGONIA (ARGENTINA)

JUAN LÓPEZ-GAPPA^{1,3}, AND LEANDRO M. PÉREZ^{2,3}

¹Museo Argentino de Ciencias Naturales. Av. Ángel Gallardo 470, 1405 Ciudad Autónoma de Buenos Aires, Argentina. lgappa@macn.gov.ar

²División Paleozoología Invertebrados, Museo de Ciencias Naturales, Paseo del Bosque s/n, 1900 La Plata, Argentina. pilosaperez@gmail.com

³Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina.

Abstract. The family Chaperiidae reaches its highest biodiversity in the southern hemisphere. The main morphological feature characterizing the family is a pair of calcareous laminar structures associated with the insertion of the operculum occlusor muscles. The aim of this study is to describe *Aluis spinettai* gen. et sp. nov., from material collected in the Monte León, the Chenque and the Puesto del Museo formations (early Miocene, Patagonia, Argentina). *A. spinettai* has erect bilaminar colonies, crenulated sutures between zooids, an extensive cryptocyst and spherical ovicells; gymnocyst, oral spines and avicularia are absent. The new species exhibits a remarkable morphological convergence with a species of *Aspidostoma* from the early Miocene (Chenque Formation) of Patagonia. In some areas of the colony, the cryptocysts were pierced by circular drill holes made by an unknown predator. The stratigraphic distribution of *A. spinettai* ranges from ~19 to 17 Ma (Burdigalian). Its presence suggests a correlation between the upper levels of the Monte León Formation and the lower levels of the Chenque Formation. The paleogeographic distribution of this new species spans at least 500 km along the southern Atlantic coast of South America. The living representatives of the Chaperiidae in the Southwest Atlantic do not seem related with *A. spinettai*.

Key words. Cheilostome bryozoan. Predatory drill holes. Monte León Formation. Chenque Formation. Puesto del Museo Formation.

Resumen. UN NUEVO GÉNERO Y ESPECIE DE CHAPERIIDAE (BRYOZOA: CHEILOSTOMATA) DEL MIOCENO TEMPRANO DE PATAGONIA (ARGENTINA). La familia Chaperiidae alcanza su máxima biodiversidad en el hemisferio sur. El principal rasgo morfológico que caracteriza a la familia es un par de láminas calcáreas asociadas con la inserción de los músculos oclusores del opérculo. El propósito de este trabajo es describir a *Aluis spinettai* gen. et sp. nov., a partir de material obtenido en las Formaciones Monte León, Chenque y Puesto del Museo (Mioceno temprano, Patagonia, Argentina). *A. spinettai* posee colonias erectas bilaminares, suturas crenuladas entre los zooides, un extenso criptocisto y ovicelas esféricas, y carece de gimnocisto, espinas orales y avicularias. La nueva especie exhibe una notable convergencia morfológica con una especie del género *Aspidostoma* del Mioceno temprano (Fm. Chenque) en Patagonia. En algunas zonas de la colonia los zooides presentaban perforaciones circulares en el criptocisto realizadas por un depredador desconocido. *A. spinettai* presenta una distribución estratigráfica que va desde ~19 a 17 Ma (Burdigaliano). Su presencia sugiere una correlación entre los niveles superiores de la Formación Monte León y los inferiores de la Formación Chenque. La distribución paleogeográfica de esta nueva especie abarca al menos 500 km a lo largo de la costa atlántica austral de Sudamérica. Los representantes actuales de la familia Chaperiidae en el Atlántico Sudoccidental no parecen relacionados con *A. spinettai*.

Palabras clave. Briozoo queilostomado. Orificios perforados por depredadores. Formación Monte León. Formación Chenque. Formación Puesto del Museo.

THE FAMILY Chaperiidae, established by Jullien (1888), has an almost worldwide distribution but reaches its highest biodiversity in the southern hemisphere. It nowadays consists of 13 genera whose stratigraphic range extends from the Cretaceous to Recent. While *Amphiblestrella* Prud'homme, 1961, *Bryochaperia* Zăgorsek, 2001 and *Catenariopsis* Maplestone, 1899 are entirely fossil, the remaining genera are either exclusively Recent or have both fossil and Recent representatives.

The main morphological feature characterizing the

family is a pair of calcareous laminar structures associated with the insertion of the operculum occlusor muscles that were called "occlusor laminae" by Harmer (1926). Gordon (1982) published a valuable review of the family, providing a sound taxonomic framework and a key to the genera mainly based on the presence/absence and the characteristics of the oral spines, avicularia and ovicells.

In the Recent marine fauna of the southern Southwest Atlantic, the family is represented by species of *Chaperia* Jullien, 1888 and *Chaperiopsis* Uttley, 1949. These are *Chaperia*

acanthina (Lamouroux, 1825), *Chaperia taylori* Ramalho and Calliari, 2015, *Chaperiopsis auriculata* Hayward and Winston, 2011, *Chaperiopsis cervicornis* (Busk, 1854), *Chaperiopsis erecta* (Busk, 1884), *Chaperiopsis galeata* (Busk, 1854), *Chaperiopsis indefensa* Hayward and Thorpe, 1988, *Chaperiopsis orbiculata* Hayward and Thorpe, 1988, *Chaperiopsis patulosa* (Waters, 1904) and *Chaperiopsis propinqua* Hayward and Thorpe, 1988 (see López Gappa, 2000). The fossil record of the Chaperiidae in southern South America is scarce. Only *Chaperia acanthina*, *C. galeata*, and *C. laticella* Canu, 1908 are known from Miocene localities in the Province of Chubut, Argentine Patagonia (Canu, 1908).

The aim of this study is to describe a new genus and species of Chaperiidae found in early Miocene formations of the provinces of Santa Cruz and Chubut, Argentina.

GEOLOGICAL SETTING

The marine Neogenic sedimentary units of Argentina extend along the Atlantic coast of Patagonia, between the provinces of Río Negro and Tierra del Fuego. Among the various outcrops on the coast representing this segment of geological time, the Miocene units are particularly interesting due to their high diversity of macroinvertebrates. The Chenque and Monte León Formations, separated by ~500 km, outcrop in the provinces of Chubut and Santa Cruz, respectively (Fig. 1). The former is exposed in Punta del Marqués, near the city of Comodoro Rivadavia (Cuitiño *et al.*, 2015) while, the latter, is mainly located at the Parque Nacional Monte León (Parras and Griffin, 2009; Parras *et al.*, 2012).

The Chenque and Monte León formations are partially contemporary units originated in a relatively low-energy, shallow marine environment (Cuitiño *et al.*, 2015; del Río *et al.*, 2018). Among the macroinvertebrate fauna represented in these units, the Bryozoa is one of the most abundant and best-preserved phyla. Cenozoic bryozoans in the Patagonian region were initially studied by Ortmann (1900, 1902) and Canu (1904, 1908, 1911), and, more recently, by Pérez *et al.* (2015a,b; 2018) and López-Gappa *et al.* (2017, 2018).

Based on the isotopic analysis of Sr^{87}/Sr^{86} , ages of 19.6 to 17 Ma and 17.9 Ma (Burdigalian) were obtained for the base of the Chenque Formation (Cuitiño *et al.*, 2015) and the top of the Monte León Formation (Parras *et al.*, 2012), re-

spectively. Further information on the fossil associations and the geological setting of these stratigraphic units can be found in Bellosi (1990), Paredes and Colombo (2001), Cuitiño *et al.* (2015) and Carmona *et al.* (2008).

Another sedimentary unit between Punta del Marqués and Monte León is the Puesto del Museo Formation (Panza, 1998). Although it contains fossil macroinvertebrates, it is mainly known as 'Piedra Museo', an archaeological site that confirms early human activity in the Patagonian region (Miotti, 1992). This formation, currently under study (Gómez-Peral *et al.*, in prep.), is characterized by a ~20 m-thick homogeneous succession of friable, cross-bedding grainstones.

METHODS

Measurements were taken with a micrometer eyepiece under a Zeiss stereomicroscope. Colonies were coated with gold/palladium and images were obtained using a SEM



Figure 1. Map of study area and localities mentioned in the text: Punta del Marqués, Puesto del Museo and Parque Nacional Monte León.

(Phillips XL-30) at Museo Argentino de Ciencias Naturales. **Institutional abbreviations.** Museo de La Plata “Francisco P. Moreno”, La Plata, Province of Buenos Aires (MLP). Museo Egidio Feruglio, Trelew, Province of Chubut (MEF). Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Ciudad Autónoma de Buenos Aires (MACN).

SYSTEMATIC PALEONTOLOGY

Phylum BRYOZOA Ehrenberg, 1831
Class GYMNOLEAEMATA Allman, 1856
Order CHEILOSTOMATA Busk, 1852
Family CHAPERIIDAE Jullien, 1888

Genus *Aluis* gen. nov.

Type species. *Aluis spinetta* sp. nov., by monotypy.

Derivation of name. The name chosen for the new genus and species honours the memory of the Argentine musician and composer Luis Alberto Spinetta (1950–2012).

Diagnosis. Colony bilaminar. Zooids separated by crenulated margins. Occlusor laminae well developed. Cryptocyst extensive, coarsely granular, with one pair of processes disto-laterally to the opesia. Gymnocyst, oral spines and avicularia absent. Ovicell globular, recumbent on the cryptocyst of the following zooid. Communication between zooids by pore plates.

Remarks. In addition to *Aluis* gen. nov., the only other genus of Chaperiidae without avicularia and oral spines is *Exallozoon* Gordon, 1982 (Tab. 1). The latter, however, is characterized by the negligible development of the cryptocyst, which is extensive in the new genus.

TABLE 1 – The genera of the Chaperiidae: morphological features, mainly based on their type species

Genus	Colony growth form	Cryptocyst	Gymnocyst	Occlusor laminae/arch	Oral spines	Avicularia	Ovicell
<i>Aluis</i> gen. nov.	Erect, bilaminar	Extensive	Absent	Well developed	Absent	Absent	Globular
<i>Amphiblestrella</i> Prud'homme, 1961	Encrusting or erect cylindrical	Well developed	Absent	Fused in an arch	Absent	Interzooidal	Immersed
<i>Bryochaperia</i> Zágorsek, 2001	Erect, columnar	Well developed	Not developed	Occlusor muscle scars	Absent	Adventitious	Endozoecial
<i>Catenariopsis</i> Maplestone, 1899	Uniserial	Well developed	Extensive	Fused centrally	Present	Absent	Present
<i>Chaperia</i> Jullien, 1888	Encrusting, unilaminar	Extensive	Absent	Well developed	Present	Absent	Absent
<i>Chaperiopsis</i> Uttley, 1949	Encrusting, unilaminar	Narrow	Present proximally	Poorly developed	Present	Adventitious	Hood-like
<i>Clipeochaperia</i> Uttley and Bullivant, 1972	Encrusting	Narrow	Reduced	Weakly developed	Present	Adventitious, vicarious	Subimmersed
<i>Exallozoon</i> Gordon, 1982	Encrusting, unilaminar	Negligible	Reduced	Moderately developed	Absent	Absent	Prominent
<i>Exostesia</i> Brown, 1948	Erect, cellariiform	Present	Obscured by avicularia	Arch complete	Present	Adventitious	Small, cap-like
<i>Icelozoon</i> Gordon, 1982	Uniserial	Well developed	Broad, smooth	Well developed	Present	Absent	Hood-like
<i>Larnacicus</i> Norman, 1903	Encrusting, unilaminar	Extensive	Negligible	Well developed	Present	Interzooidal	Prominent
<i>Notocoryne</i> Hayward and Cook, 1979	Erect, claviform	Broad	Reduced, indistinct	Stout distal arch	Present	Adventitious	Spherical
<i>Patsyella</i> Brown, 1948	Encrusting, unilaminar	Extensive	Not apparent	Vertical ridges on distal wall	Absent	Interzooidal	Immersed
<i>Pyrichaperia</i> Gordon, 1982	Encrusting, multilaminar	Well-developed	Reduced	Weakly developed	Present	Absent	Prominent

Aluis spinettai sp. nov.

Figures 2–3, Table 2

Type material. Holotype MLP 36145. Paratypes, 4 fragments, MLP 36146–9. Monte León Formation.

Other material. MPEF-PI 6513, two fragments, Chenque Formation.

Geographic and stratigraphic occurrence. ‘Cabeza de León’ (50° 21’ 25.38” S; 68° 53’ 5.88” W), a locality within Parque Nacional Monte León, Province of Santa Cruz, in the Punta Entrada Member of the Monte León Formation (early Miocene). Punta del Marqués (45° 56’ 47.44” S; 67° 33’ 13.75” W), Province of Chubut. Chenque Formation. Poorly preserved fragments of this species were also observed

among the bioclasts composing the rock in the basal levels of the Puesto del Museo Formation (47° 53’ 48.45” S; 67°51’ 49.56” W; Panza, 1998; Gómez-Peral *et al.*, in prep.).

Diagnosis. Colony erect, bilaminar, anastomosing. Occlusor laminae well-developed, subparallel. Opesia wider than long. Cryptocyst extensive. Gymnocyst absent. Ovicell globular, recumbent on the cryptocyst of the following zooid. Oral spines and avicularia absent.

Description. Colony erect, bilaminar, anastomosing. In some instances, supplementary layers grow upon the older ones. Autozooids robust, hexagonal, ordered in quincunx (Fig. 2.1), well delimited by crenulated sutures (Fig. 2.2 inset) extending almost to the base of the zooid, longer than wide (length-to-width ratio: ~1.2). Opesia sunken in the middle

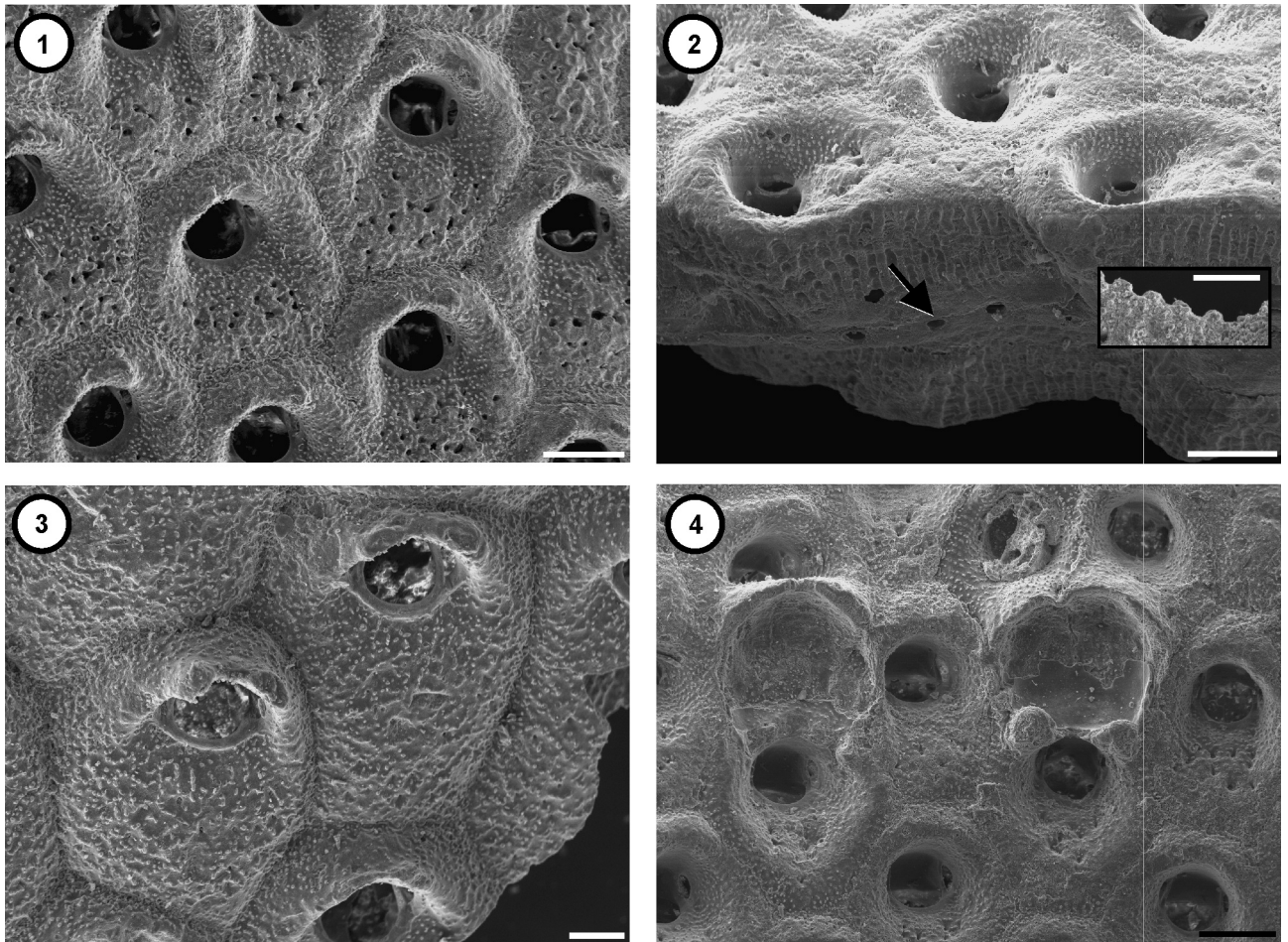


Figure 2. 1–4, *Aluis spinettai* gen. et sp. nov.; 1, Holotype, general aspect (MLP 36145); 2, Paratype (MLP 36148), lateral view of a bilaminar fragment. The crenulated margin extends almost towards the base of the zooid. The arrow shows one pore plate. **Inset:** Paratype (MLP 36148), detail of the crenulated margin; 3, Paratype (MLP 36146), zooids from a supplementary layer showing conspicuous disto-lateral processes. Note the coarsely granular cryptocyst; 4, Paratype (MLP 36147), two incomplete ovicells and fertile zooids with well-developed disto-lateral processes. Note the incised ovicell before a zooidal row bifurcation. Scale bars= 200 μ m (1, 2, 4), and 100 μ m (3, inset).

TABLE 2 – Measurements (mm) of *Aluis spinettai* gen. et sp. nov. (n = 10) from Monte León Formation

	Zooid length	Zooid width	Opesia length	Opesia width
Mean	0.65	0.57	0.16	0.24
Minimum	0.57	0.52	0.14	0.22
Maximum	0.73	0.61	0.18	0.26
Standard Deviation	0.05	0.03	0.01	0.01

of the zooid, wider than long, its length representing about 24% the length of the zooid. Occlusor laminae well developed, subparallel, slightly converging towards the distal margin of the opesia. Cryptocyst extensive, coarsely granular, depressed towards the opesia, pierced by minute, rounded or irregular pores scattered throughout the frontal surface, except around the opesia, with one pair of disto-lateral processes located distally to the opesia. The granules of the cryptocyst tend to be arranged in vertical series around the opesia (Fig. 2.2). Zooids from the supplementary layers growing upon the bilaminar colony have well-developed distal processes (Fig. 2.3). Gymnocyst absent. Communication between zooids by pore plates in the base of the lateral walls (Fig. 2.2). Oral spines and avicularia absent. Ovicell globular, recumbent on the cryptocyst and almost reaching the proximal margin of the opesia of the following zooid (Fig. 2.4). The maternal zooid usually shows well-developed disto-lateral processes. The base of the ovicell appears incised when preceding a bifurcation of zooidal rows (Fig. 2.4). The ovicelled zooids do not display sexual dimorphism, *i.e.* the size and proportions of the opesia are similar to those of the remaining zooids. Zooids with the opesia occluded by calcification are occasionally seen (Fig. 3.1); their frontal surfaces are pierced by scattered pores. Ancestrula and early astogeny not seen.

Remarks. In some areas of the colony, we observed drill holes piercing the frontal surface (Fig. 3.2–3) made by an unknown but presumably small predator. The circular holes drilled in the cryptocyst are similar to those described by Wilson and Taylor (2006) in Recent colonies of *Microporella hyadesi* (Jullien, 1888), from the Southwest Atlantic and in North American Devonian hederellids. In the present case, however, they were not patched by the regeneration of new

skeleton, as in *M. hyadesi*. There are 1–4 per zooid (Fig. 3.2–3), and their diameter is fairly constant (around 40–60 μm) and with straight margins. They occur in different positions, mainly laterally and proximally to the opesia, but not along the distal zooidal margin.

As all the ovicells of *A. spinettai* were broken or incomplete, we ignore further details about their frontal surface. They are recumbent on the frontal surface of the next zooid and seem to be hyperstomial.

Most species of Chaperiidae have encrusting colonies. Bilaminar, anastomosing colonies are not common, but some cases are known in southern species of *Chaperiopsis*, such as *C. bilaminata* (Waters, 1898) from South Africa, *C. columella* (Brown, 1952) from the New Zealand Oligocene, *C. multifida* (Busk, 1884) from South Africa and the Kermadec Ridge (see Gordon, 1984), *C. paulensis* (Kluge, 1914) from Saint Paul Island, and *C. splendida* Gordon, 1986 from New Zealand. According to Brown (1952), colonies of *Patsyella dentata* (Waters, 1887) may be encrusting, unilamellar or bilamellar.

The zooids of *A. spinettai* gen. et sp. nov. from Punta del Marqués (Chenque Formation) (Fig. 3.4) were identical, although slightly larger, to those of the Monte León Formation (length: 0.65–0.81 mm, SD: 0.04, width: 0.54–0.63 mm, SD: 0.03).

The type material of *Chaperia laticella* Canu, 1908 consists of two colonies encrusting a brachiopod shell (MACN-Pi No. 1917). Canu's species differs from *Aluis spinettai* gen. et sp. nov. in being encrusting and lacking crenulated sutures and distal protuberances. The occlusor laminae are oblique and fused together towards the distal margin of the opesia. The spaces for the passage of the occlusor muscles are narrower than in *A. spinettai*. The opesia is somewhat pyriform and relatively large, its length representing about 48% of the length of a zooid. The shape of the zooids is variable and usually wider than long (length-to-width ratio: ~0.8).

Canu (1908) found two other species of Chaperiidae in the Miocene material from Patagonia. The specimen identified by Canu (1908) as *Chaperia acanthina* (MACN-Pi No. 1916) is an encrusting colony on the same shell as *C. laticella*. Its state of preservation is poor, preventing its identification at the specific level. Canu's (1908) material recorded as *Chaperia galeata* (MACN-Pi No. 1915) is a well-preserved

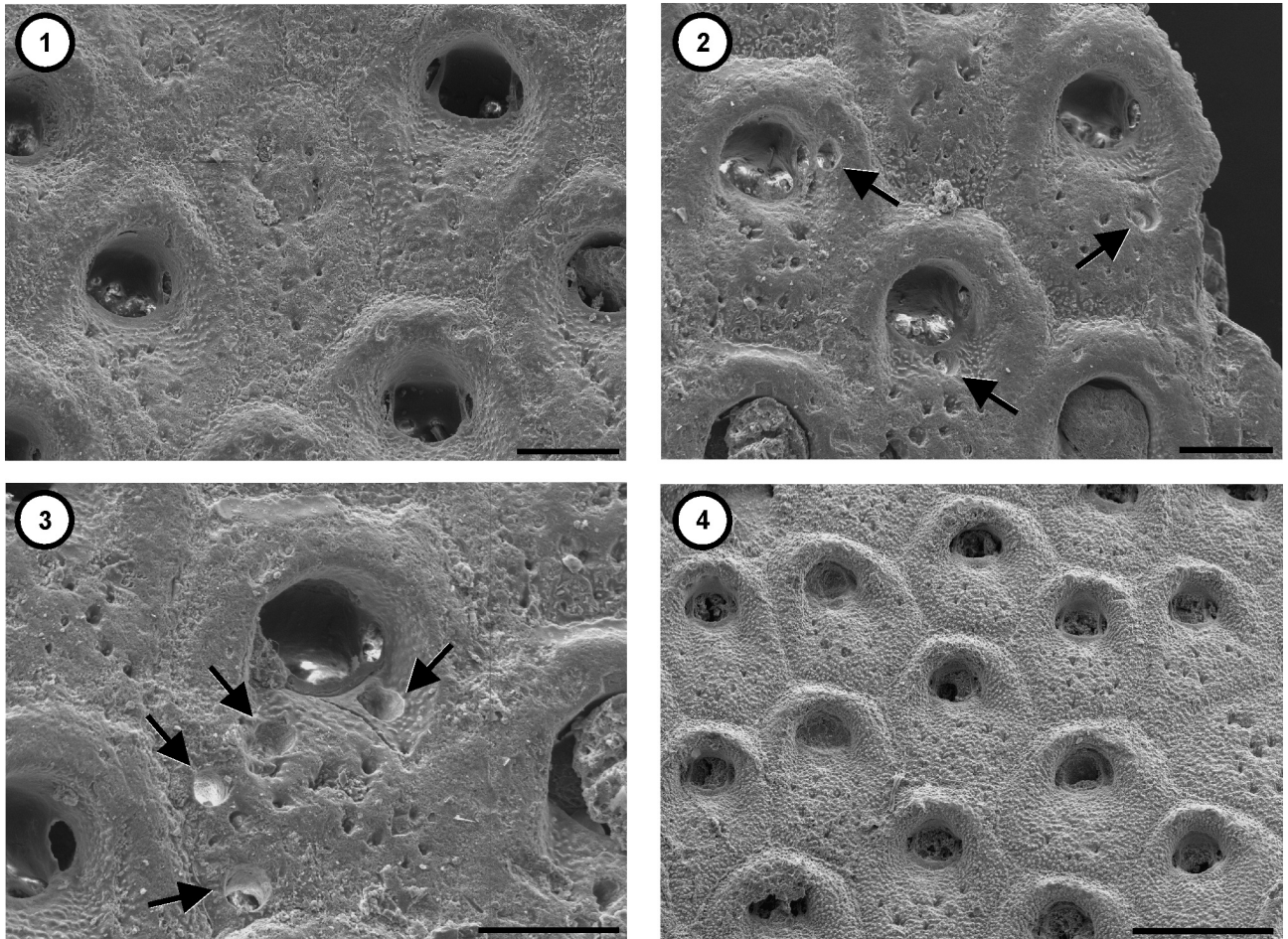


Figure 3. 1–4, *Aluis spinettai* gen. et sp. nov.; 1, Paratype (MLP 36147), zooid occluded by calcification; 2, Paratype (MLP 36149), three zooids with one drill hole each (shown by arrows); 3, Paratype (MLP 36149), detail of one zooid with four drill holes (pointed by arrows); 4, General aspect of a specimen from Chenque Formation (MPEF-PI 6513). Scale bars= 200 μ m (1–3) and 500 μ m (4).

colony of a species of *Chaperiopsis* encrusting an oyster. Its zooids have one pair of adventitious avicularia proximal to the opesia. The ovicell is hood-like, with a narrow transverse fenestra and an associated avicularium distal to it. The occlusor laminae are small and scarcely visible in frontal view. The cryptocyst is narrow. Spine bases are preserved in the zooid disto-lateral corners.

DISCUSSION

The paleogeographic distribution of *Aluis spinettai* gen. et sp. nov. spans more than 500 km along the southern Atlantic coast of South America. Together with *Melychocella biperforata* Pérez *et al.*, 2018, *M. flammula* (Canu, 1908) and *Aspidostoma incrustans* Canu, 1908 (see Pérez *et al.*, 2018), this new chaperiid suggests a biostratigraphic correlation

between the upper levels of the Monte León Formation and the lower levels of the Chenque Formation during the early Miocene. *Aluis spinettai* gen. et sp. nov. has a stratigraphic distribution ranging from at least ~19 to 17 Ma (Burdigalian, early Miocene; Parras *et al.*, 2012; Cuitiño *et al.*, 2015).

Hayward and Thorpe (1988) described 16 species of *Chaperiopsis* based on extensive collections gathered during British surveys to Antarctica, the Scotia Arc and the Patagonian Shelf. All of them are encrusting and spinose while most have sessile or pedunculate avicularia. On the other hand, the living species of Chaperiidae inhabiting warm-temperate waters off the Brazilian coast belong to *Chaperia* [*Chaperia acanthina* (see Marcus, 1955), *C. brasiliensis* Vieira *et al.*, 2010, and *C. taylori* Ramalho and Calliari, 2015]. The material recorded as *Chaperia acanthina* var. *polygonia* Kluge,

1914 by López Gappa and Lichtschein (1988) for the continental shelf off the Province of Buenos Aires (Argentina) may prove to be conspecific with *C. taylori*.

Aluis spinettai gen. et sp. nov. shows an interesting morphological convergence with some South American Miocene species of *Aspidostoma* and, particularly, with *Aspidostoma tehuelche* Pérez *et al.*, 2018, a species hitherto only found in the Chenque Formation. Both species have erect, bilaminar colonies, crenulated zooidal margins, a pair of protruding processes distal to the opesia, a depressed central area in the middle of the frontal surface, a coarsely granular cryptocyst pierced by scattered pores, and the occasional presence of zooids occluded by frontal calcification. However, *A. spinettai* gen. et sp. nov. differs from *A. tehuelche* in the presence of occlusor laminae and in the absence of a quadrangular process in the proximal margin of the opesia.

Aluis gen. nov. is the fourth exclusively fossil genus of the Chaperiidae. The living representatives of the family in the southwest Atlantic do not seem to be related to *A. spinettai* gen. et sp. nov.

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