

CALLOCHITON MONTELEONENSIS N. SP., FIRST RECORD OF POLYPLACOPHORA (MOLLUSCA) FROM THE NEOGENE OF ARGENTINA

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ABSTRACT—A new species of chiton is described from early Miocene deposits of the Monte León Formation, in Santa Cruz Province, Argentina. *Callochiton monteleonensis* n. sp. clearly differs from known fossil and Recent species of the southwestern Atlantic because the central area of its intermediate valves has a stepped appearance, in which each step is marked by a longitudinal rib. It is similar to *Callochiton kapitiensis* Mestayer, 1926, a Recent species from New Zealand. Biogeographic implications are discussed. This is the first record of a polyplacophoran from Neogene deposits of Argentina.

INTRODUCTION

Fossil mollusks have been recorded in Argentine Cenozoic deposits since the first half of the nineteenth century (e.g., Ortmann, 1902; Sowerby, 1846; Philippi, 1887; Pilsbry, 1897; Ihering, 1897, 1899, 1904, 1907; Feruglio, 1937; among others). More recently, the mollusk faunas from Patagonia have been revised by several authors (Camacho and Fernández, 1956; Rossi de García, 1959; Rossi de García and Levy, 1977; Zinsmeister, 1981; Pastorino, 1989; Griffin, 1990, 1991; Griffin and Hunicken, 1994; del Río, 1992, 1994, 1997, 2002; del Río and Camacho, 1998; del Río and Martínez Chiappara, 1998, and references therein). Most previous work was focused on bivalves and gastropods, while minor groups of mollusks such as scaphopods, polyplacophorans and nautiloids remained relatively less known. The scarcity of Polyplacophora in the fossil record may be explained by the fact that these organisms live in high-energy environments. Chances of preservation in these environments are reduced, and the organisms living in them presently found in the fossil record have been normally transported into settings with better chances of preservation. This transport is usually damaging to the shells and these may show evidence of taphonomic processes affecting them before final burial (Gordillo, 2007; Gordillo and Schwabe, 2009; Puchalski and Johnson, 2009). Other causes for its minor fossil representation are the low relative abundance of this Class—which contrasts with those for Bivalvia and Gastropoda—if it can be assumed that it was similar to the present. The increased shell solubility given by the porous nature of its shell microstructure due to aesthetes and aesthetes channels (Gordillo, 2007) is another factor responsible for the low diversity in fossil assemblages. In addition, polyplacophoran shells are unique in that they are made up of eight articulated valves. These valves are independent and normally fall apart shortly after death of the animal. Therefore, when these organisms are finally found in the rocks, they are mostly represented by isolated valves, which often go unnoticed. Puchalski et al. (2008) pointed out this bias in the record of fossil chitons, which is incomplete, sporadic, and geographically limited. The current database comprises enough information to discern diversity patterns throughout geologic time, but whether the patterns are real or artifacts of sampling inadequacy remains to be investigated.

Cenozoic rocks in Patagonia occur at many localities and include stratigraphic units spanning the entire Cenozoic from the early Paleocene to Holocene, albeit unevenly represented. The rocks involved are rich in fossils although a preservation bias towards calcitic hard parts is obvious in most units. Shells of a calcitic nature such as oysters, pectinids, epitoniids, muricids, brachiopods, bryozoans and barnacles are far more abundant than those originally aragonitic, as in the case of polyplacophoran valves, which are normally preserved as rather poor calcitic replacements or by molds. There are exceptions, however, and one of them is the Monte León Formation, a Miocene unit from which the material described herein was collected.

Darwin (1846) recorded the presence of marine fossils in this area for the first time. He believed that the sediments containing these fossils from Santa Cruz were exposed continuously along the Atlantic coast from the mouth of the Río Negro down to Santa Cruz and he called these sediments “Great Patagonian Formation” following d’Orbigny’s “*Tertiaire patagonien*” (d’Orbigny, 1842). The pioneering work of Ameghino (1906) and Ihering (1896, 1897, 1899, 1907, 1914), together with the work carried out by Hatcher (1897) and Ortmann (1902), laid out the bases for subsequent interpretations on the geological framework of the area. Ameghino (1896, 1906) believed that the sediments exposed around the mouth of the Santa Cruz River could be separated into two distinct units: a marine unit of sandstone and tuffaceous sandstone overlain by mainly non-marine mammal-bearing sediments. The first he divided into two “pisos,” i.e., “Juliense” and “Leonense.” The non-marine unit he divided into “Piso Santacruzense,” comprising tuffs and tuffaceous sandstones with mammals and overlying the “Piso Superpatagoniense,” a series of loose marine sandstones with an abundant molluscan fauna. Ihering, who described the mollusks contained in these units, supported in general Ameghino’s views, with some minor discrepancies. However, Hatcher, who also carried out geological investigations in this area, strongly disagreed with Ameghino and Ihering. In this he counted with the full support of Ortmann, whom he had given the fossils he collected to describe. Neither Hatcher nor Ortmann agreed with Ameghino and Ihering on the existence of the “Juliense,” “Leonense” and “Superpatagoniense,” as they noted no difference in their faunal composition. The reasons for this probably lie in the

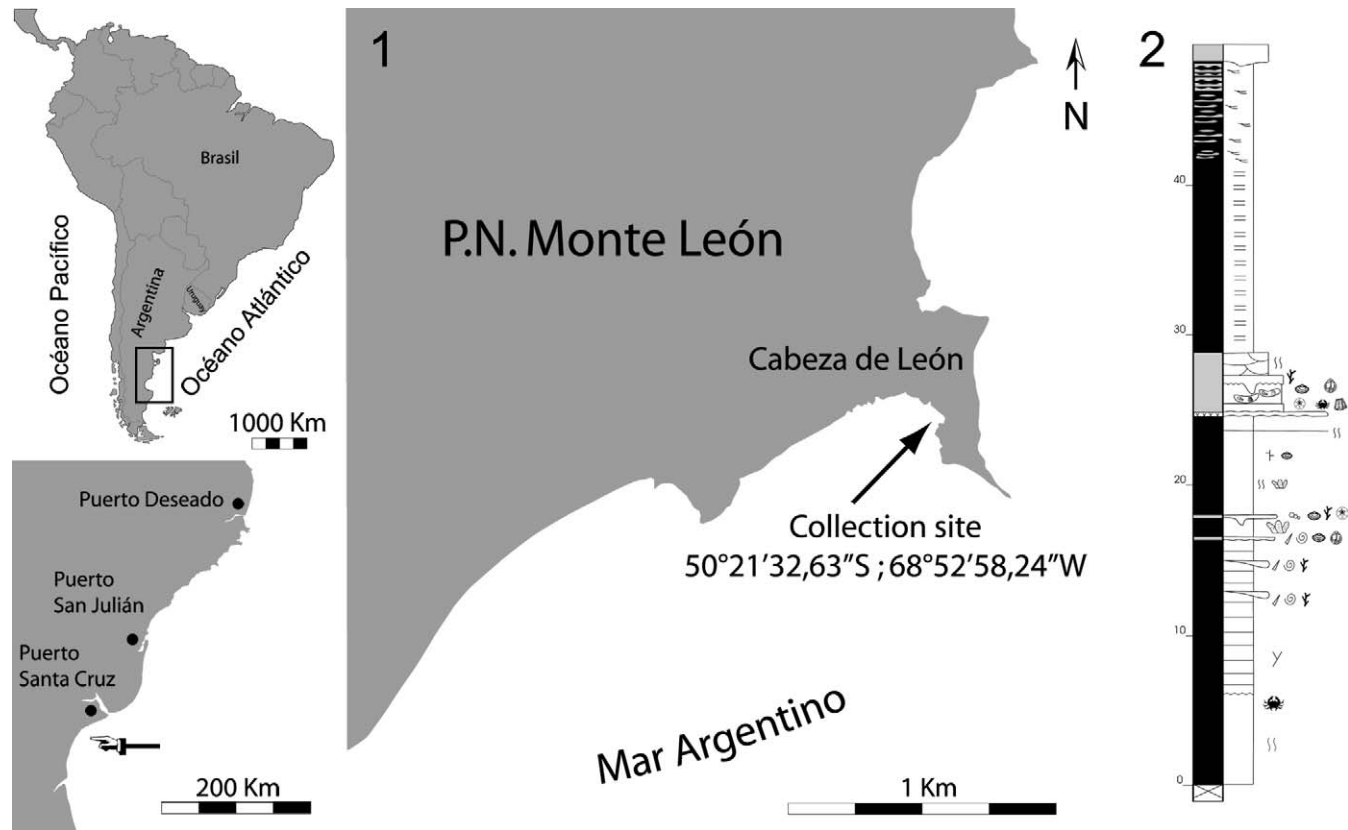


FIGURE 1—1, Map of Monte León area; 2, schematic profile of the locality with the studied section indicated.

fact that Hatcher visited the localities and collected the material himself, while Ameghino and Ihering never visited this part of Patagonia and relied on collections assembled by other authors. An account on the stratigraphic framework of the localities considered can be found in Zinsmeister (1981).

The material described here comes from the Monte León Formation, as described by Bertels (1970, 1980), from beds placed at the top of her Punta Entrada Member. The locality is in the Monte León area (Fig. 1.1), and the material was found in loose or very poorly cemented sandstone constituting the top of the cliff just south of the Monte León beach. They were also associated with abundant and well preserved megafauna, such as bivalves, gastropods, brachiopods, echinoids, decapods and balanoids. A schematic section of the locality is given in Figure 1.2.

The age of the bearing sediments has also been a matter of great controversy ever since they were first mentioned in the literature. According to Bertels (1970, 1975) the Monte León Formation ranges between Chattian and Rupelian, based on foraminifers. Nández (1990), also based on the foraminifer content, suggested a late Oligocene–early Miocene age for the Monte León Formation. Barreda and Palamarzuck (2000) considered it early Miocene based on palynological data.

From a stratigraphic point of view, the fossil chitons from Argentina are restricted to Holocene deposits exposed along the coast. Farinati (1995) published the first record of fossil Polyplacophora from the Quaternary of Bahía Blanca in Buenos Aires province. More recently, these mollusks were recorded from Holocene terrace-deposits of Tierra del Fuego (Gordillo, 2007; Gordillo and Schwabe, 2009). The specimens

described herein are the earliest representatives of the group in the Cenozoic of this part of South America.

Fossil species of *Callochiton* were recorded from the Paleogene and Quaternary (Eocene–Pleistocene) of Europe (Rochebrune, 1883; Sulc, 1934), and also from Miocene to Pleistocene rocks in New Zealand and Australia (Ashby, 1929; Ashby and Cotton, 1939). The only records of fossil *Callochiton* in the American continent were published by Gordillo and Schwabe (2009) and Candel et al. (2009), who reported *C. puniceus* (Gould, 1846), an extant species from the Holocene of Tierra del Fuego.

The purpose of this contribution is to describe a new species of *Callochiton* based on material collected from the early Miocene Monte León Formation exposed along the coast within the boundaries of the Monte León National Park, in Santa Cruz Province, Argentina. Its paleobiogeographic affinities with other living and fossil species of this genus are discussed, as well as the possible implications of its occurrence in rocks of this age in Patagonia. This record constitutes the first Neogene chiton from South America,

MATERIALS AND METHODS

The material was collected from the Monte León Formation (early Miocene) Santa Cruz Province (S 50°21'32", W 68°52'58") (Fig. 1.1). Approximately three kilograms of sediment were dried overnight in an electric heater and then hydrogen peroxide and detergent were added. The resulting loose sediment was sieved under tap water flow in a serial 2,000/1,000/500 μm sieve. Finally, the material obtained was dried and observed under stereoscopic microscope in order to separate the valves from the abundant fossil material contained in the rock (mostly mollusks, bryozoans, barnacles

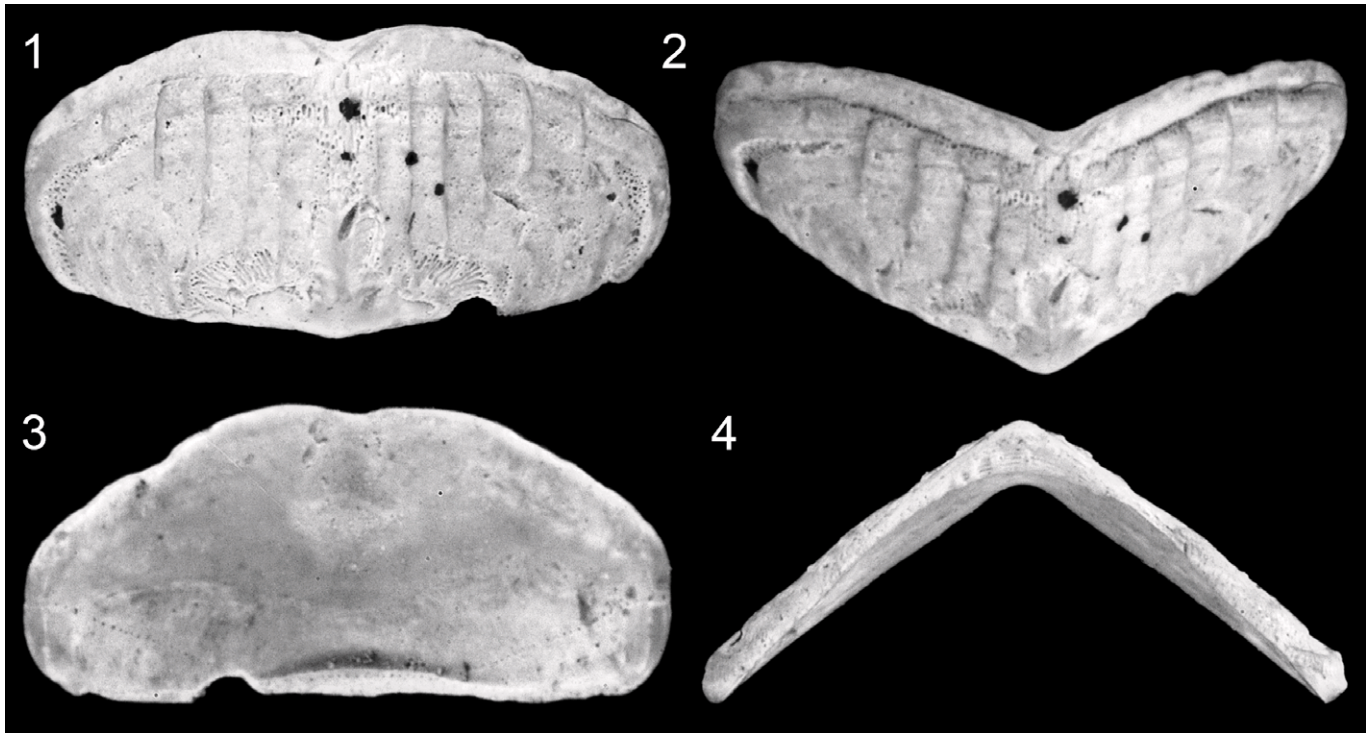


FIGURE 2—Holotype of *Callochiton monteleonensis* n. sp. (MLP 23213), intermediate valve, $\times 11$: 1, dorsal; 2, obliquely dorsal; 3, ventral; 4, front view.

and echinoderms), whether as whole specimens or fragments. Morphological terminology follows Kaas and Van Belle (1985a), while taxonomic arrangement follows Sirenko (2006).

The following museum materials were studied in order to compare with the species here described: *Callochiton bouveti*, holotype, East of Bouvet Island (S 54°29.3', E 3°49') in 567 m depth (ZMHU 59952); *C. puniceus*, holotype, Orange Harbour, Chile (USNM 5803); *C. kapitensis*, off West side of Kapiti Island, S 40°49', E 174°55', in 80 m depth (MNZ 145535); *C. steinenii*, Puerto Madryn, Chubut, Argentina (MLP 24094); *C. puniceus*, Puerto Deseado, Santa Cruz, Argentina (MACN-In 17766); Punta Arenas, Chile (MACN-In: 12396, 12397, 12398, 12399, 12487, 13129).

Acronyms used here are: MACN=Museo Argentino de Ciencias Naturales "Bernardino Rivadavia," Buenos Aires; MLP=Museo de La Plata; MNZ=Te Papa Tongarewa Museum of New Zealand; USNM=United States National Museum of Natural History, Smithsonian Institution, Washington, D.C.; and ZMHU=Museum für Naturkunde der Humboldt Universität zu Berlin.

SYSTEMATIC PALEONTOLOGY

Order CHITONIDA Thiele, 1910

Suborder CHITONINA Thiele, 1910

Superfamily CHITONOIDEA Rafinesque, 1815

Family CALLOCHITONIDAE Plate, 1901

Genus *CALLOCHITON* Gray, 1847

CALLOCHITON MONTELEONENSIS n. sp.

Figure 2.1–2.4

Diagnosis.—Central area of intermediate valve bearing longitudinal complete ribs, side slope stepped, lateral area with scattered pustules. Apophyses wide, short, rounded, connected by a sinus, eaves spongy, slit rays present. Dorsal elevation 0.43–0.47.

Description.—Length of intermediate valve about half the width (5.4 mm \times 2.7 mm), side slopes straight (Fig. 2.4),

anterior margin concave at the jugum, convex on the pleural area, narrowing from half of pleural area toward the sides, side margin truncated, posterior margin about to straight, apices slightly conspicuous, not carinated (Fig. 2.1), lateral areas hardly raised (Fig. 2.2), elevation (height/width) 0.43–0.47.

Central area tegmentum of intermediate valves bearing longitudinal complete ribs (about 7 on each side) weakening toward the jugum, but not shortening nor fading (Fig. 2.1). On the inner side of the rib the tegmentum is higher than the outer side, thus forming steps (Fig. 2.2). Lateral area of intermediate valves bearing cylindrical pustules, irregularly arranged (Fig. 2.1).

Apophyses short, very wide, regularly rounded, connected across the jugum by a lamina, resulting in a sinus, slit formula ?-1-?, eaves spongy, slit rays present, connected with each other by a line of pores on the underfolded jugal tegmentum (Fig. 2.3).

Etymology.—The name refers to the type locality, Monte León.

Type.—Holotype (MLP 23213): intermediate valve, and paratype (MLP 23214): 3 complete and 2 incomplete intermediate valves. Monte León National Park (S 50°21'29", W 68°52'58"), Santa Cruz Province, Argentina. Monte León Formation, early Miocene.

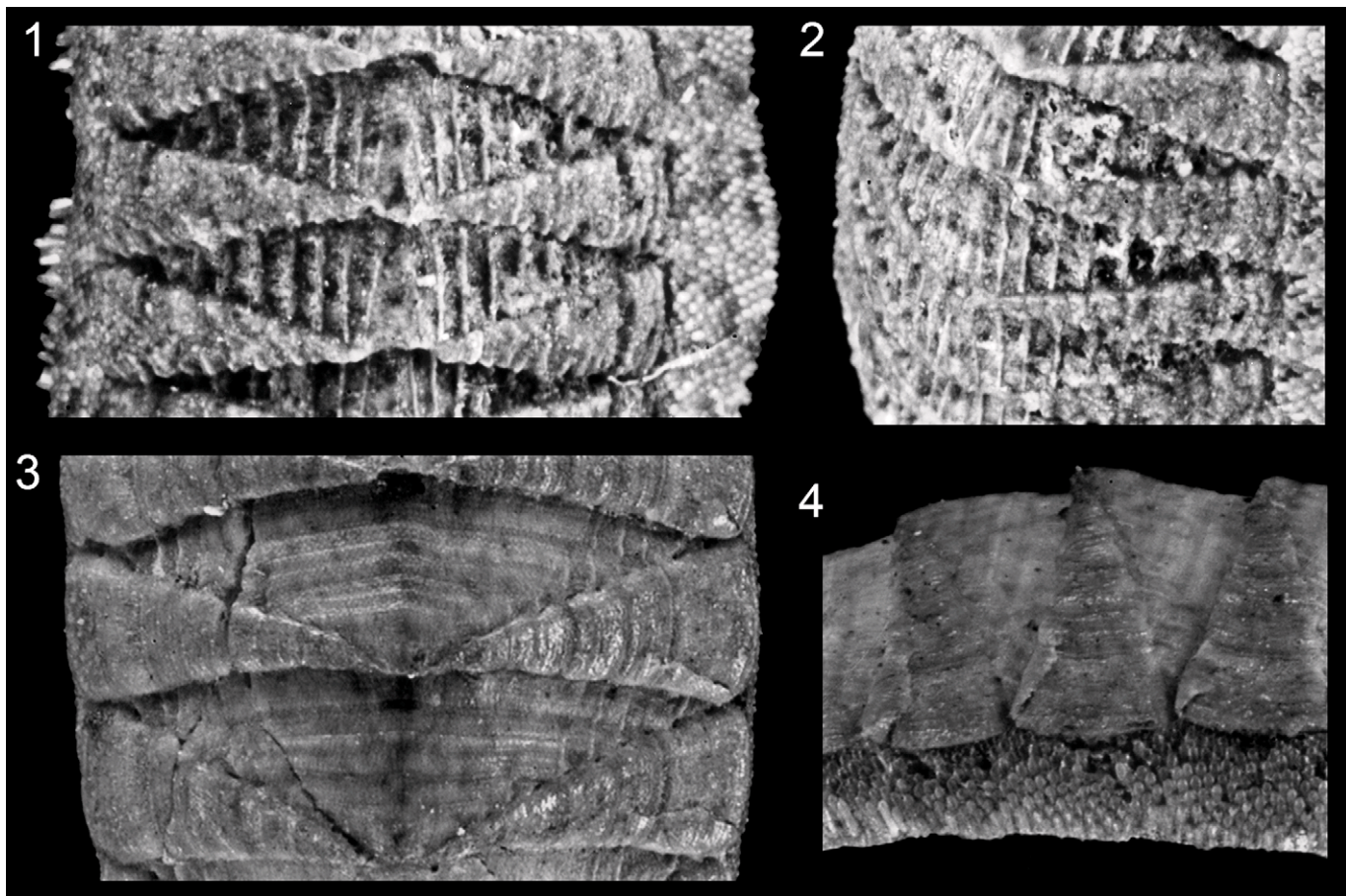
Occurrence.—Only known from the type locality.

Material examined.—Only known from the type material.

Discussion.—*Callochiton monteleonensis* n. sp. is comparable with the Recent and fossil species of the family Callochitonidae living in the southwestern Atlantic, New Zealand and Antarctica (see Table 1). The most conspicuous morphological feature that clearly segregates *C. monteleonensis* from most of the other species of the family is the presence of longitudinal complete ribs all over its tegmentum, rendering a stepped appearance (Fig. 2.2). Although those ribs are present in some other species, they are obliquely arranged as in

TABLE 1—Comparative analysis of the primary observable morphological features between *Callochiton monteionensis* n. sp. and extant and fossil species of the family Callochitonidae distributed in southwestern Atlantic, New Zealand, Antarctica and subantarctic islands.

Species	Tegmentum ribs	Conspicuousness of valve apice	Front slope of head valve	Distribution
<i>C. puniceus</i>	Almost longitudinal, shortening towards the center of the valve, absence at the jugum	Inconspicuous	Straight	Southwestern Atlantic and Southeastern Pacific. Quaternary to Recent
<i>C. bouveti</i>	Diagonal, only presents on pleural area, without shortening	Conspicuous, acute	Concave	Bouvet, Malvinas (Falkland), S. Shetland, S. Orkney, S. Georgia Iss. and Palmer Archipelago. Recent
<i>C. steinenii</i>	Absent	Inconspicuous, Acute on intermediate valves	Slightly concave	South Georgia and Antarctica. Recent
<i>C. gaussi</i>	Absent	-	-	Antarctica. Recent
<i>C. crocinus</i>	Absent	More or less conspicuous, acute	Straight	Australia and New Zealand. Recent
<i>C. empleurus</i>	Absent	More or less conspicuous, acute	-	New Zealand. Pleistocene - Recent.
<i>C. sulculatus</i>	Absent	Conspicuous, acute	-	New Zealand. Recent
<i>C. mortenseni</i>	Absent	Inconspicuous, Acute on intermediate valves	-	New Zealand. Recent
<i>C. kapitiensis</i>	Longitudinal, absent on jugal area	Inconspicuous	-	Kapiti Island, New Zealand. Recent
<i>C. perscrutandus</i>	Absent	Inconspicuous	-	New Zealand. Recent
<i>C. oligosulculatus</i>	Absent	Conspicuous, more or less acute	-	New Zealand
<i>C. chattonensis</i>	Longitudinal, subgranulose, absent at jugum	Inconspicuous	-	New Zealand. Late Oligocene
<i>Eudoxochiton nobilis</i>	Absent	Inconspicuous	Convex	New Zealand. Pleistocene - Recent
<i>C. monteionensis</i> n. sp.	Longitudinal, present along the whole central area. Giving a stepped appearance.	Inconspicuous	-	Monte León Formation (Santa Cruz, Argentina). Lower Miocene

FIGURE 3—*Callochiton kapitiensis* (MNZ 145535), $\times 8.5$: 1, dorsal; 2, obliquely dorsal view of intermediate valves; holotype of *Callochiton puniceus* (USNM 5803), $\times 12$: 3, dorsal; 4, lateral view of intermediate valves.

Callochiton bouveti Thiele, 1906, a subantarctic and antarctic Recent species, incomplete as in *Callochiton puniceus*, and/or absent on the jugal area as in *Callochiton chattonensis* Ashby, 1929, *Callochiton kapitensis* Mestayer, 1926 (Fig. 3.1) and *C. puniceus* (Fig. 3.3).

Callochiton puniceus, a living species from the southwestern Atlantic and southeastern Pacific—also recorded in the Quaternary of Tierra del Fuego, Argentina (Gordillo and Schwabe, 2009)—has pleural longitudinal ribs that become shorter toward the jugum (Fig. 3.4). A similar feature is also observed in *C. chattonensis*, a fossil species from the late Oligocene of New Zealand, which has no ribs on the jugum; furthermore, its ribs are subgranulose. These features contrast those of *C. monteionensis*, a species bearing longitudinal ribs of equal length on the whole central area.

Callochiton kapitensis from New Zealand waters is the morphologically closest species (Fig. 3.1, 3.2). Its dorsal ribs are similar to those of *C. monteionensis* but these are stepped on the latter (Figs. 2.2, 3.2). In addition, the intermediate valves are clearly different since the lateral area in the intermediates of *Callochiton kapitensis* is strongly elevated and has several concentric growth ridges (Fig. 3.1, 3.2) while in *C. monteionensis* the lateral area is hardly elevated and bears only scattered pustules (Fig. 2.1, 2.2).

CONCLUSIONS

This is the first record of Polyplacophora from Argentine Neogene deposits, although not the oldest one. Hoare and Sabattini (2000) described *Asketochiton chubutensis* from the Permian of northern Patagonia, a form not related with the new species here described. Unquestionably belonging to *Callochiton*, this Patagonian record of the genus reveals an unusual paleobiogeographic pattern since it resembles *Callochiton kapitensis*, an extant species from New Zealand. Living *Callochiton* species occur in the west Pacific Ocean, around Australia, the Indian Ocean, the northeastern Atlantic, Mediterranean Sea, southwestern Atlantic, Antarctica and subantarctic islands. It is represented by a number of species, all of them clearly distinguishable from each other.

Living and fossil species of *Callochiton* from Patagonia and Antarctica show significant differences (see Table 1). The extant species from New Zealand appears to be different from the Cenozoic fossil chitons from Australasia (Van Belle, 1981; Kaas and Van Belle 1985a, 1985b, 1987, 1990, 1994, 1998, 2006) but strikingly similar to the Patagonian Miocene species. This fact, coupled with the morphological conservatism shown by polyplacophoran species, elicits questions concerning the paleobiogeographic history of this group.

Inhabiting hard substrates, chitons show a relatively low dispersal potential. Larval life-span is unknown for most species. Smith (1966) mentioned from a few days to little more than a week, so it seems unlikely that they could cross vast oceanic distances by themselves. The occurrence of these two very similar species in Patagonia and New Zealand—albeit separated by a considerable period of time—could be yet another example among mollusks showing a similar paleobiogeographic pattern. Other mollusk groups show this kind of disjunct distribution in Cenozoic marine rocks of the southern hemisphere (Beu et al., 1997 and references therein). Such patterns could be related to the changing paleogeographic and paleoceanographic configurations following the final dismemberment of Gondwana during the Late Cretaceous. The opening of Drake Passage and the consequent onset of the circumantarctic current, and/or the existence of a transantarctic corridor (Casadío et al., 2010), may have played

a crucial role in limited faunal exchange of marine organisms between landmasses in the southern ocean. In addition to larval dispersal in those groups with planktotrophic larvae, rafting could also have played an important role in trans-oceanic dispersions, as suggested for modern members of the faunas of southern South America and New Zealand (Gordillo, 2006; Helmuth et al., 1994; Waters and Roy, 2004). If dispersion of chitons across oceanic distances did actually occur during the Cenozoic then rafting appears the most likely method given the life habits of these organisms.

Limited knowledge of the real distribution of deep water chitons is another plausible explanation for the apparent disjunct distribution of those similar species (Schwabe, 2008). New technologies are now available to improve sampling at great depth so this hypothesis is expected to be tested soon.

Further research is needed to fully ascertain the stratigraphic distribution of *Callochiton* in New Zealand and Patagonia in order to establish the exact biostratigraphic distribution of the species involved, and the true nature of the similarities among them. Only then will it be possible to determine when in the Cenozoic the migration of this group of polyplacophorans occurred between these two areas.

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