Zootaxa 4338 (1): 051–084
http://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4338.1.3
http://zoobank.org/urn:lsid:zoobank.org:pub:398F004C-B562-415B-916D-DBA32EF0F88E

Systematics of the family Carditidae (Bivalvia: Archiheterodonta) in the Cenozoic of Argentina

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Abstract

The systematics of the Family Carditidae is currently poorly elucidated. This paper reviews the Eocene to Pleistocene carditids from Patagonia and Entre Ríos Province (Argentina). Twelve species are described and illustrated and the presence of the genera *Cyclocardia* Conrad, *Pleuromeris* Conrad, *Scalaricardita* Sacco, *Fasciculicardia* Maxwell and *Purpurocardia* Maxwell in southern South America is discussed. The genus *Scalaricardita* is documented for the first time in South America. Two new genera, *Darwinicardia* gen. nov. and *Kolmeris* n. gen. are proposed for the species '*Venericardia*' *patagonica* (Sowerby) and '*V.*' *tehuelchana* (Ihering), respectively, and one new species, *Cyclocardia dalek* sp. nov., is described.

Key words: Neogene, Paleogene, Patagonia, Biostratigraphy, *Venericardia*

Introduction

The Carditidae Férussac, 1822, comprises a large family of bivalves distributed worldwide and ranging from Devonian to Recent (Chavan 1969), becoming a highly diversified group in the Paleogene (Cossmann & Pissarro 1904; Cossmann & Peirot 1912; Gardner & Bowles 1939; Heaslip 1968). Based on molecular analysis, it has been placed in the clade Archiheterodonta, the sister group of true heterodont bivalves (Giribet 2008; Bieler *et al.* 2014).

Although highly diversified, its phylogenetic relationships remain obscure and its systematic and taxonomy is still poorly understood (González & Giribet 2014). Many fossil carditids have been placed in the genera *Cardita* Bruguière, 1792, or *Venericardia* Lamarck, 1801, and an exhaustive revision of the group could indicate that its generic composition is under-estimated.

The first record of Patagonian fossil carditids is *Cardita patagonica* Sowerby, 1846, from the fossil shells collected by Ch. Darwin during his voyage aboard the H.M.S. Beagle. At the end of 19th and the beginning of the 20th centuries many other authors mentioned or described species from many Patagonian locations, including them in *Cardita* or *Venericardia* (Ihering 1899, 1907; Ortmann 1899, 1902; Borchert 1901; Steinmann & Wilckens 1908). Detailed studies focused on specific groups such as planicostate carditids (Gardner & Bowles 1939; Camacho & Fernández 1956; Rossi de García *et al.* 1980, Pérez *et al.* 2017a), Patagonian Danian taxa (Petersen 1946; Masiuk 1967; Pérez & del Río, in press.) or Neogene representatives of the family (del Río 1986). Twenty five species have been described up to now, all of them included either in *Venericardia* Lamarck, 1801, *Pleuromeris* Conrad, 1867, *Cyclocardia* Conrad, 1867, *Purpurocardia* Maxwell, 1969, or *Neovenericor* Rossi de García, Levy & Franchi, 1980. The genus *Neovenericor* has been recently revised by Pérez *et al*. (2017a). The aim of the present research is to carry out an exhaustive systematic revision of the upper Oligocene to Pleistocene species from Argentina in order to increase our knowledge of the group around the southernmost tip of South America.

Accepted by N. Malchus: 8 Sept. 2017; published: 24 Oct. 2017

Material

Carditids studied herein include new material from collections and revisions of Museum material (see below). Shells were recorded from Cenozoic marine rocks exposed over 2200 km along the Atlantic coast (Patagonia), exposures from Punta Arenas (Chile) and from Neogene rocks exposed on the left bank of the Paraná River (Fig. 1). For a full list of species and their stratigraphic ranges see Table 1. Preservation of fossils is quite good in all exposures, except for Las Coloradas (Santa Cruz Province), and early ontogenetic shell stages are visible in many specimens.

TABLE 1. Stratigraphic occurrence of carditid material examined.

Species	Occurrence	Age	Repositories
Cyclocardia cannada	Cañadón de los Artilleros, Pan de Azúcar, Playa La Mina, and Gran Bajo de San Julián (San Julián Formation), Las Cuevas, Yegua Quemada, Monte Entrada and Punta Quilla (Monte León Formation) and Cardiel Lake ('Centinela' Formation)	Upper Oligocene–Lower Miocene	MACN-Pi, CPBA, PRI
Cyclocardia compressa	Living from Valparaíso (Chile) to Burwood Bank (South Atlantic Ocean) (Güller & Zelaya, 2013) and fossil from Santa Cruz Province (Ihering 1907; Pastorino 2000; Aguirre *et al.* 2005).	Pleistocene–Recent	BNHM, MACN-Pi
Cyclocardia dalek	Playa La Mina (San Julián Formation), Yegua Quemada, Monte Observación and mouth of Santa Cruz River (Monte León Formation)	Upper Oligocene–Lower Miocene	MACN-Pi
Cyclocardia nortensis	Punta Norte and Cerro Prismático (Puerto Madryn Formation)	Upper Miocene	CPBA, MLP
Darwinicardia patagonica	Playa La Mina, Gran Bajo de San Julián and Puerto San Julián (San Julián Formation), Cabo Tres Puntas and Punta Nava (San Julián Formation), Las Cuevas, Yegua Quemada, Monte Entrada and Punta Quilla (Monte León Formation), Sección 30 (Carmen Silva Formation), Cerro Cabeza Papagayo (Chenque Formation) and Barranca Final (Barranca Final Formation)	Upper Oligocene–Upper Miocene	BHNM, SGO.Pi, MACN-Pi, CIRGEO-PI, MLP, CPBA
Fasciculicardia sp.	La Paz (Paraná Formation)	Upper Miocene	MACN-Pi
Kolmeris tehuelchana	Terraces of Cerro Laciar	Lower Pliocene	MACN-Pi, PRI
Pleuromeris fueguina	Sierra Carmen Silva, El Castillo, Sección Avilés (Carmen Silva Formation)	Middle Miocene	PZ-NHRM Mo, MACN-Pi, CIRGEO-PI, CPBA
Pleuromeris sulcolunularis	Bajo de las Flechas, Pan de Azúcar (San Julián Formation), Cabo Tres Puntas (San Julián Formation), Monte Entrada, Punta Quilla and Punta Guanacos (Monte León Formation)	Upper Oligocene–Lower Miocene	MACN-Pi, PRI
Purpurocardia elegantoides	Cerro Castillo (Man Aike Formation), Estancia Cancha Carreras (Río Turbio Formation) and Punta Arenas (Loreto Formation, Chile)	Middle Eocene–Upper Eocene	PRI, CIRGEO-PI, MLP
Purpurocardia leonensis	Cerro Prismático (Puerto Madryn Formation)	Upper Miocene	CPBA
Scalaricardita camaronesia	Camarones (Camarones Formation)	Lower Miocene	MACN-Pi
Scalaricardita laciarina	Surroundings of Cerro Laciar	Lower Pliocene	MACN-Pi

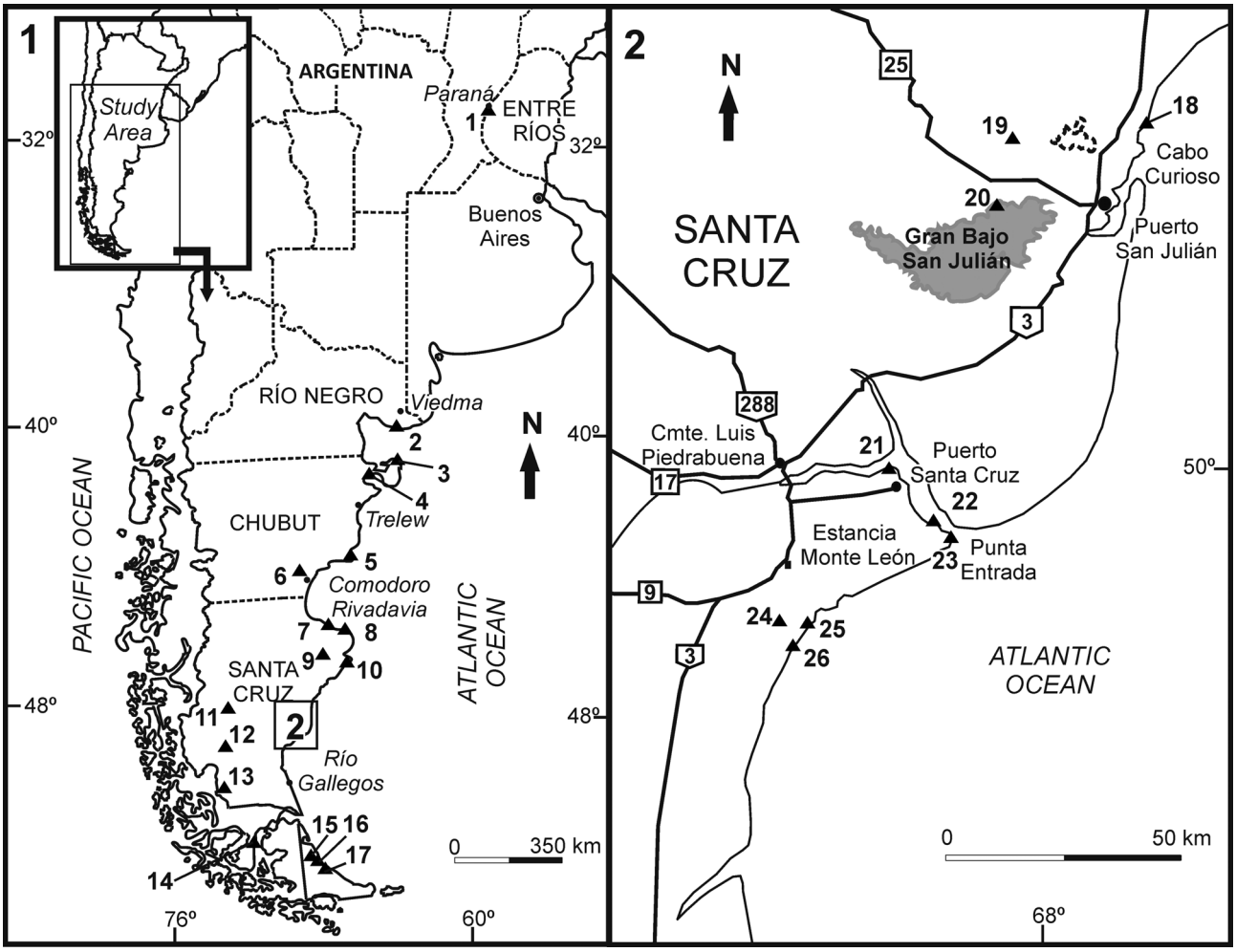

FIGURE 1. **(1)** Provenance of studied fossil. **(2)** Expanded area from 1. Fossiliferous sites at Gran Bajo San Julián and Santa Cruz River and surrounding areas. 1= La Bajada, 2= Barranca Final, 3= Punta Norte, 4= Cerro Prismático, 5= Camarones, 6= Cerro Cabeza Papagayo, 7= Punta Nava, 8= Cabo Tres Puntas, 9= Terraces of Cerro Laciar, 10= Punta Guanacos, 11= Las Coloradas, 12= Cerro Castillo, 13= Cancha Carreras, 14= Punta Arenas, 15= Sección 30, 16= Sección Avilés, 17= El Castillo, 18= Playa La Mina, 19= Cañadón de los Artilleros, 20= Pan de Azúcar, 21= Cañadón Misioneros, 22= Punta Quilla, 23= Monte Entrada, 24= Monte Observación, 25= Las Cuevas, 26= Yegua Quemada. Enclosed area in 1 corresponds to enlarged map in 2.

Repositories. The studied material is housed in the Cátedra de Paleontología of the Universidad de Buenos Aires, Argentina (CPBA), Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Ciudad Autónoma de Buenos Aires, Argentina (MACN-Pi and CIRGEO-PI), Museo de La Plata, Buenos Aires, Argentina (MLP), Museo de Historia Natural, Santiago, Chile (SGO.Pi). Palaeontological Research Institution, Ithaca, United States of America (PRI), Natural Museum of Natural History, Smithsonian Institution of Washington D.C., United States of America (USNM.Mo), The Natural History Museum of London, United Kingdom (BNHM), and at the Naturhistoriska Riksmuseet of Stockholm, Sweden (PZ-NRM.Mo).

Terminology. Abbreviations in synonymy lists and open nomenclature follow the proposals of Matthews (1973) and Bengtson (1988):

asterisk (*): indicates the fist publication of the taxon,
period (.): indicates a new synonymy proposed here,
letter v: represents material checked in this work,
letter p: means '*in partim*',
italized *year*: indicates mentions without illustrations.

The abbreviatures RV and LV indicate right valve and left valve, respectively. Length and height indications follow Heaslip (1968). The morphological terminology for carditids agrees with that proposed by Verastegui (1953) and Heaslip (1968) which fit the morphological terminology for bivalves of Cox (1969). These authors described the tripartite (='*fasciculate*' of Maxwell 1969) sculpture as radiating costae with a central cord flanked by paracostal ribs. The counter-part to this particular sculpture is called 'entire', and comprises radial ribs without paracostal ribblets.

Terms such as 'carditids', 'venericardids', 'planicostates' and 'alticostates' are used with the phylogenetical meaning proposed by Harris (1919), Gardner and Bowles (1939) and Heaslip (1968). 'Carditids' refer to *Cardita*-related taxa and 'venericardids' to *Venericardia*-related ones. 'Planicostates' include a lineage of venericardids with large shells, flat and smooth radial ribs, and long cardinal teeth while 'alticostates' include species with small valves, tripartite and strongly sculptured radial ribs, and short cardinal teeth.

Biostratigraphy. Carditids are well-represented in the Patagonian molluscan assemblages reaching their maximum diversity during the Danian and early–middle Miocene and becoming a minor component of faunas since the late Miocene. From exposures containing Patagonian molluscan assemblages, Del Río (1988) defined the '*Aequipecten*' *paranensis* Biozone for the upper Miocene. Later del Río (2004) recognized five molluscan assemblages for these marine sedimentary deposits: 1) *Panopea sierrana-Parinomya patagonensis* (PP) (upper Oligocene); 2) *Jorgechlamys centralis-Reticulochlamys borjasensis* (JR) (upper Oligocene–lower Miocene); 3) *Reticulochlamys zinsmeisteri-Struthiolarella patagoniensis-Pleuromeris cruzensis* (RSP) (lower Miocene); 4) *Pseudoportlandia glabra-Antimelatoma quemadensis* (PA) (lower Miocene); 5) *Nodipecten* sp.-*Venericor abasolensis-Glycymerita camaronesia* (NVG) (uppermost lower Miocene to lowermost middle Miocene). The different procedences of carditid species studied here are listed below:

Eocene. Studied material comes from the Man Aike Formation (middle Eocene) exposed at Cerro Castillo (Camacho *et al.* 2000), the Río Turbio Formation (middle to lower upper Eocene) at Cancha Carreras (Griffin 1991), and from the Loreto Formation (uppermost Eocene) in the environs of Punta Arenas (Chile) (Ojeda 2012) (Fig. 1.1). *Purpurocardia elegantoides* (Ortmann, 1899) is a poorly represented component of the fossil faunas in these units.

Upper Oligocene. Species are from the San Julián Formation, a unit exposed in the Gran Bajo San Julián (Bajo de las Flechas and Pan de Azucar localities) and Puerto San Julián area (Cañadón de los Artilleros and Playa La Mina) (Fig. 1.2) (Santa Cruz Province). We studied the species *Cyclocardia cannada* (Ihering, 1907), *C. dalek* n. sp., *Darwinicardia* n. gen. *patagonica* (Sowerby, 1846) and *Pleuromeris sulcolunularis* (Ihering, 1907). Lithological sections containing the studied material were described by del Río & Camacho (1998) and Erdmann *et al.* (2008). Carditids are associated with *Zygochlamys geminata* (Sowerby, 1846), *Crassostrea hatcheri* Ihering, 1899, '*Turritella*' *patagonica* (Sowerby, 1846), *Cirsotrema rugulosa* (Sowerby, 1846), *Neilo ortmanni* Erdmann & Morra, 1985, *Pholadidea patagonica* Philippi, 1887, and *Iheringiella patagonensis* (Desor, 1847), which comprise the PP Molluscan Assemblage defined by del Río (2004). At the Cañadon de los Artilleros section, del Río (2004) recognized the PA Molluscan Assemblage.

Lower Miocene. *Darwinicardia* n. gen. *patagonica* and *Pleuromeris sulcolunularis* are recorded in the Miocene strata of the Santa Julián Formation exposed at Punta Nava and Cabo Tres Puntas (Fig. 1.1) (Santa Cruz Province) (del Río 2004). These species are associated with *Neilo ornata* Sowerby, 1846, *Cucullaria*? *darwini* Philippi, 1887, *Limopsis insolita* Sowerby, 1846, *Crassostrea hatcheri*, *Zygochlamys geminata*, *Jorgechlamys centralis* (Sowerby, 1846), *Ameghinomya darwini* (Philippi, 1887), *Penion subrecta* (Ihering, 1899), and *Miomelon gracilior* (Ihering, 1897), which are part of the JR Molluscan Assemblage (del Río 2004).

The Monte León Formation exposed at the mouth of the Santa Cruz River (Punta Quilla, Cañadón Misioneros and Monte Entrada), at about 50 km south of the mouth of that river (Yegua Quemada, Las Cuevas and Monte Observación) (Fig. 1.2) (del Río & Camacho 1998) and at Punta Guanacos, a fossil locality south of the city of Puerto Deseado (Casadío & Griffin 2009) (Fig. 1.1), yield abundant specimens of *Cyclocardia cannada*, *C. dalek* n. sp., *Darwinicardia* n. gen. *patagonica*, and *Pleuromeris sulcolunularis* belonging to the RSP and PA Molluscan Assemblages (del Río 2004).

Some specimens of *C. cannada* come from Las Coloradas, a sedimentary section assigned to the 'Centinela' Formation (Fig. 1.1), correlatable with nearby exposures dated by Parras *et al.* (2008) as Lower Miocene. Recently, Cuitiño & Scasso (2010) indicated that the name of Centinela Formation is not valid and proposed a new name (Estancia 25 de Mayo Formation) for its type strata. Since there are no new revisions of other outcrops, we use the name 'Centinela' Formation for Las Coloradas section.

The species *Darwinicardia* n. gen. *patagonica* is also present in the Chenque Formation exposed at Cerro Cabeza Papagayo (Chubut Province) (Fig. 1.1), where it is associated with *Limopsis insolita*, *Atrina magellanica* (Ihering, 1907), *Cubitostrea* sp., *Jorgechlamys centralis* and *Pteromyrtea crucialis* (Ihering, 1907) which comprises the JR Molluscan Assemblage (del Río 2004).

Middle Miocene. The species *Scalaricardita camaronesia* (Ihering, 1907) is contained in rocks of the Camarones Formation exposed near the town of Camarones (Camacho 1974) (Chubut Province), and associated with *Glycymerita camaronesia* (Ihering, 1907), *Abra patagonica* (Ihering, 1907), *Crassatella kokeni* (Ihering, 1899), *Calliostoma camaronesia* (Ihering, 1907) and *Turritella hauthali* Ihering, 1907, which comprise the NVG Molluscan Assemblage (del Río 2004).

The southernmost exposures of middle Miocene age correspond to the Carmen Silva Formation (Malumián & Olivero 2006), where *Pleuromeris fueguina* (Steinmann & Wilckens, 1908) and *Darwinicardia* n. gen. *patagonica* have been recorded along with *Neilo doellojuradoi* Malumián, Camacho & Gorroño, 1978, *Arca* sp., *Ameghinomya camachoi* Pérez, del Río & Nielsen, 2013, *Retrotapes fuegoensis* del Río, 1997, *Turritella sylva* Ihering, 1907, *Miomelon castilloensis* del Río & Martínez, 2006, and *Struthiolarella desenstriata* (Ihering, 1897) in fossil-bearing beds at El Castillo and Sección Avilés (Tierra del Fuego) (Fig. 1.1)

Upper Miocene. Carditids are poorly represented in the Puerto Madryn and Paraná formations. In the former, the species *Cyclocardia nortensis* (del Río, 1986) and *Purpurocardia leonensis* del Río, 1986, come from Punta Norte and Cerro Prismático (del Río 1992; Scasso *et al.* 2001) (Chubut Province) (Fig. 1.1). In the latter, *Fasciculicardia* sp. is recorded in La Bajada (Aceñolaza 2000; Pérez 2013) (Entre Ríos Province) (Fig. 1.1). In both formations, Del Río (1988) recognized the '*Aequipecten*' *paranensis* Biozone. Specimens of *Darwinicardia* n. gen. *patagonica* also come from the Barranca Final Formation exposed along the northern coast of the San Matías Gulf (Palazzesi *et al.* 2014) (Río Negro Province) (Fig. 1.1).

Lower Pliocene. *Kolmeris* n. gen. *tehuelchana* (Ihering, 1907) and *Scalaricardita laciarina* (Feruglio, 1954) are reported from post-Miocene marine fossiliferous deposits in Santa Cruz Province described by Feruglio (1933) and from the surroundings of Cerro Laciar, near Puerto Deseado city, recently dated as lower Pliocene by del Río *et al.* (2013) (Fig. 1.1).

Upper Pleistocene. Shells of *Cyclocardia compressa* (Reeve, 1843) have been studied by Ihering (1907) from hills on the north side of the Deseado River and from the surroundings of Puerto San Julián (Santa Cruz Province). Feruglio (1933; 1950) included these strata in his Terrace System III and IV, respectively.

According to the biostratigraphic frame shown in Figure 2, *Cyclocardia cannada* proves to be the most extended species, being present from the upper Oligocene to lower Miocene. *Cyclocardia dalek* n. sp. shares the same stratigraphic range but is not present in the JR assemblage. *Pleuromeris sulcolunularis* ranges from the lowermost to middle lower Miocene and *Darwinicardia* n. gen. *patagonica* from the lower to upper Miocene. The Patagonian *Darwinicardia* n. gen. is restricted to the Miocene whereas it occurs in the Eocene in Europe (by *D. angusticostata*).

The upper Miocene '*Aequipecten*' *paranensis* Biozone contains three carditid species: '*Cyclocardia*' *nortensis*, *Purpurocardia leonensis* and *Fasciculicardia* sp. The presence of '*C.*' *nortensis* represents the youngest record of the '*awamoensis*' group of Beu & Maxwell (1990).

The genus *Purpurocardia* appears in the Eocene (*P. elegantoides*) in Patagonia but ranges from the lower Miocene to Recent in Australia and New Zealand (Maxwell 1969; Beu & Maxwell 1990). Instead, *Fasciculicardia* has an Eocene–Miocene range in New Zealand (Maxwell 1969) but arrives to South America in the late Miocene, and may be a Cenozoic disperser according to Beu *et al.* (1997).

Kolmeris n. gen., represented also in upper Pliocene outcrops from New Zealand, may be another Cenozoic disperser with a South American origin. The genera *Pleuromeris* and *Scalaricardita* are present in Miocene rocks from North America and Europe, respectively (Gardner 1943; Janssen ad Moerdijk 2004), showing a maximum diversity in the Pliocene. Both genera are present in Patagonia in lower to middle Miocene rocks and *Scalaricardita* is also present in upper Pliocene deposits. These records coincide with the world record of both taxa. The only fossil carditid that ranges into Recent times is *Cyclocardia compressa* (Güller & Zelaya 2013), and this is the only carditid species in Quaternary deposits.

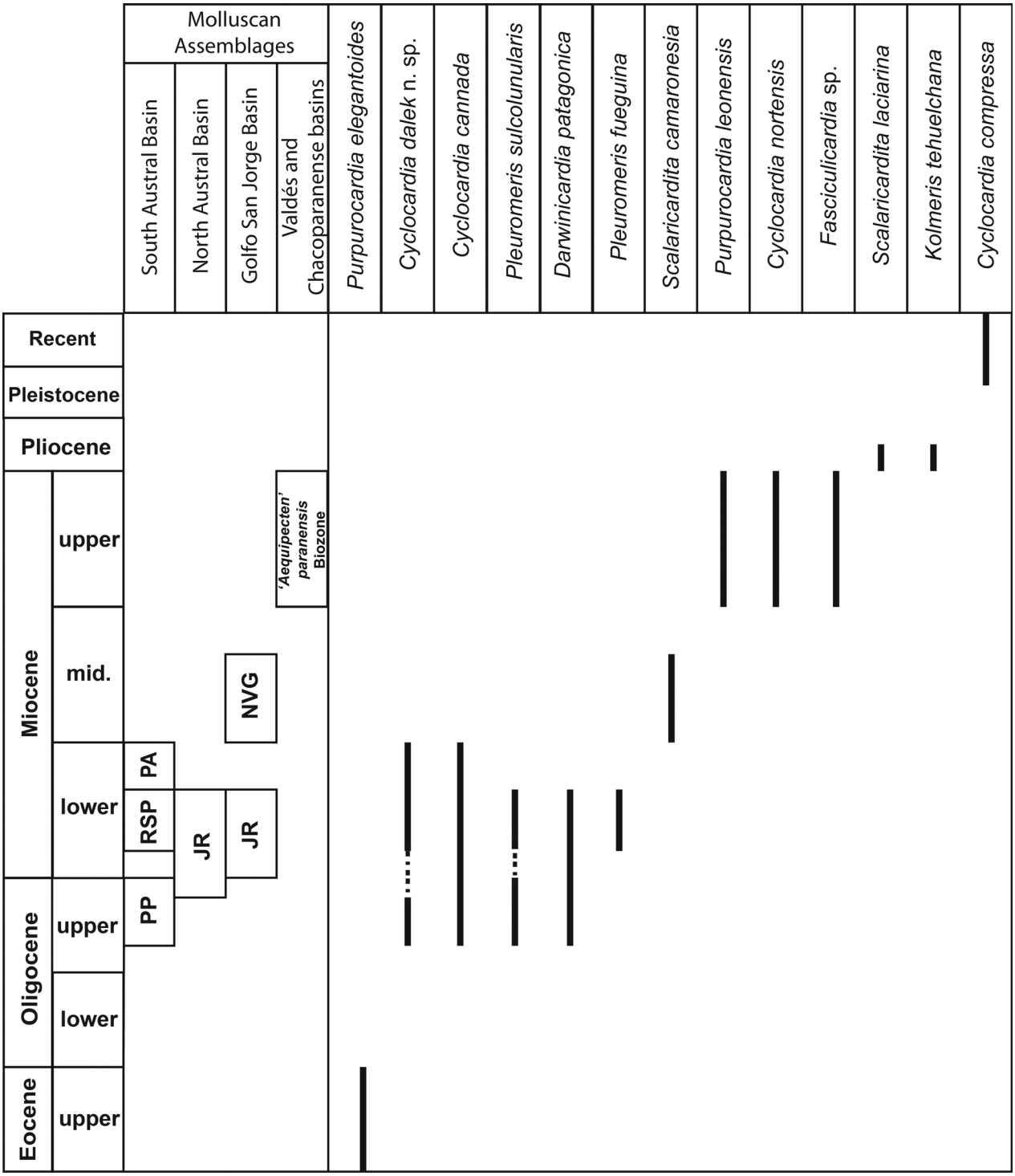

FIGURE 2. Stratigraphic distribution of studied carditid species including Cenozoic molluscan assemblages of Patagonia (del Río 1988, 2004). Abbreviations in the text.

Systematics

Order Archiheterodonta Giribet, 2008

Family Carditidae Férussac, 1822

Remarks. Some authors only recognize a few genera such as *Venericardia* Lamarck, 1801, and *Cardita* Bruguière,

1792, and a large number of subgenera (e.g. *Claibornicardia* Stenzel & Krause, 1957, *Venericor* Stewart, 1930, *Megacardita* Sacco, 1899); however, some of those taxa are ranked as genera by other authors (for comparisons of different approaches see Sacco 1899; Dall 1903; Chavan 1969; Moore 1992, McClure & Lockwood 2015). As the use of subgenera implies closer phylogenetic relationship within each group than between these groups (Dubois 1982), we will regard all supraspecific groups as genera, discarding *a priori* any phylogenetic inferences until a thorough phylogenetic study of the family is carried out.

Chavan (1969) outlined a classification with seven subfamilies mainly based on shell outline and hinge morphology. As a result, members of the venericardids of Harris (1919), Gardner & Bowles (1939) and Heaslip (1968) were indistinctly included in the subfamilies Carditamerinae, Venericardiinae or Carditesinae. In this paper, we reject Chavan's (1969) approach because it ignores the phylogenetic proposals by Harris (1919) and Heaslip (1968). A comparison among genera discussed in the text is presented in Table 2.

Genus *Cyclocardia* Conrad, 1867

Type species. *Cardita borealis* Conrad, 1831 (pl. 8, fig. 1) (subsequent designation by Stolickza, 1871). Pleistocene–Recent, Northwest Atlantic Ocean.

Diagnosis. Carditid with thick shell, subcircular outline and convex dorsal margin. Umbo rounded. Right anterior tooth small, middle tooth very curved, broad and thick. Left anterior tooth large and posterior tooth strong and very curved. External sculpture of 15 to 27 entire and smooth radial ribs, that are low and covered by small subcircular or subrectangular nodes. Periostracum coarse and hirsute in living species.

Included species. *Cyclocardia* is an Eocene to Recent cosmopolitan genus that includes more than a hundred species (Maxwell 1969; Coan 1977; Stilwell & Zinsmeister 1992; Kafanov *et al.* 2001; Huber 2010; Güller & Zelaya 2013).

Remarks. Conrad (1867) highlighted that this genus was characterized by a thick shell with a coarse periostracum, generally smooth radial ribs and strongly inclined posteriorly hinge teeth. Subsequently, Stewart (1930) indicated that *Cyclocardia* has grooved hinge teeth, but that character is not found in all species.

According to Heaslip (1968), *Cyclocardia* has some convergent characters with planicostate carditids, such as the development of a thick shell with low and smooth radial ribs, and pointed out that the sculpture of juvenile specimens is similar to alticostate carditids, inferring that *Cyclocardia* could have originated within this group.

The most ancient records of *Cyclocardia* are represented by the Eocene *C. mesembria* Stilwell & Zinsmeister, 1992 (Marambio Island, La Meseta Formation, Antarctica), *C. steinekei* Clark & Dunham, 1946 (El Carmen District, unnamed formation, Colombia), *C. otatsumei* Uozomi, 1955 (Hokkaido, Wakkanabe Formation, Japan), *C. ezoensis* (Takeda, 1953) and *C. hamiltonensis* (Clark, 1932) (Kamchatka, Aluginskaya Formation, Russia) and by *C. caumontiensis* (Cossmann & Pisarro, 1904) (Paris Basin, France).

Cyclocardia is represented by four Patagonian species (*C. cannada*, *C. dalek* n. sp., *C. nortensis* and *C. compressa*) and is the most diverse carditid genus in the region. According to the large amount of intraspecific variability on this genus, Huber (2010) proposed the existence of at least three subgenera within *Cyclocardia*. As already discussed by Maxwell (1969), New Zealand representatives may belong to a different lineage or genus (see '*C.*' *nortensis* below).

Cyclocardia cannada (Ihering, 1907)

Figure 3.1–3

.1902 *Cardita patagonica* Sowerby—Ortmann, p. 128, pl. 26, figs. 8a–c.
v*1907 *Venericardia cannada* Ihering, p. 287, pl. 10, figs. 71a–f.
.*1907 Venericardia camaronesia* var. *cruzensis* Ihering, p. 285.
v*2004 Pleuromeris cannada* (Ihering)—del Río, p. 1102, Appendix 1–2.
v.*2004 Pleuromeris cruzensis* (Ihering)—del Río, figs. 10.11, 10.12, Appendix 1–2.

Type specimen. Holotype MACN-Pi 344, one left valve from Cañadón de los Artilleros (Santa Cruz Province, San Julián Formation).

TABLE 2. Comparisons among genera mentioned in the text.

Genera	*Cyclocardia*	*Darwinicardi*a n. gen.	*Fasciculicardia*	*Kolmeris* n. gen.	*Pleuromeris*	*Purpurocardia*	*Scalaricardita*
Size	30 – 70 mm	30 – 70 mm	30 – 60 mm	<30 mm	<30 mm	30 – 60 mm	<30 mm
Outline	Subcircular with convex dorsal margin	Subtriangular	Subcircular	Subtriangular with convex dorsal margin	Subtriangular	Subcircular to subrectangular with posterior margin slightly truncated	Subtriangular to subcircular
Umbo	Rounded	Large and recurved	Rounded	Subcentrally	Subcentrally	Anteriorly	Small and subcentrally
Lunule	Small and flat	Medium-sized and deep	Small, vertical or inclined forward	Large, flat and elongate	Large and broad	Small and prominent	Long and flat
Right teeth	Anterior small, middle very curved, broad and thick	Anterior curved	Anterior weak, middle prominent and curved, posterior large and narrow	Middle small and slightly inclined posteriorly	Middle triangular and broad	Anterior triangular, middle prominent and triangular, posterior narrow and almost straight	Middle triangular and broad
Left teeth	Anterior large, posterior strong and very curved	Anterior broad	Anterior small, short and triangular, posterior elongate, narrow and slightly curved	Anterior large and vertical	Anterior straight	Anterior short and triangular, posterior elongate, narrow and slightly curved	Anterior straight
Radial Ribs	15 to 27 smooth and low ribs	22 to 26 poorly-tripartite and high ribs with subtriangular transverse section	26 to 32 moderately tripartite high and sharp ribs	9 to 15 low, smooth and flat ribs widening towards the central region	11 to 12 ribs	21 to 28 poorly-tripartite ribs with subelliptic transverse section	23 to 27 wide ribs
Comarginal sculpture	Small subcircular or subrectangular nodes	Small subcircular nodes	Serrated nodes	Absent	Present	Subrectangular nodes	Closely-spaced subrectangular nodes
Intercostal spaces	Narrow	Wide	Wide	Wide	Narrower than ribs	Narrower than ribs	Sometimes reduced to a very narrow groove

Other material. MACN-Pi 344–348, 5772, 5778–5780; CPBA 9373, PRI.66848 (lectotype of *Venericardia camaronesia* var. *cruzensis*) (35 left valves, 68 right valves and one articulated shell).

Diagnosis. Shell with rounded anterior and posterior margins. Posterior area faint, defined by 5–6 radial ribs. Umbo placed near to anterior third of valve length. Lunule shallow. Right anterior tooth very reduced and middle tooth triangular with broad base. Left anterior tooth triangular and broad. Radial ribs (23 to 27) smooth or with weakly developed nodes, transverse section of ribs subelliptic.

Description. Shell small to medium-sized with subcircular outline; anterior, posterior and ventral margins rounded; dorsal margin slightly convex; posterior area faint and defined by 5–6 radial ribs slightly narrower than the remainder. Umbo placed at anterior third of valve length. Lunule small, shallow, flat, longer than wide and bounded from remaining surface of shell by a groove.

Right valve hinge with asymmetrically concave ventral edge; very small and laminar anterior tooth, straight, inclined forward; middle tooth triangular, with broad base, inclined posteriorly, slightly concave anterior and flat posterior sides, and higher towards apex on lateral view; posterior tooth very thin, slightly curved and shorter than middle tooth. Left valve hinge with a straight ventral edge; anterior tooth triangular, elongate, wide, straight, slightly inclined posteriorly, higher towards base on lateral view, with flat anterior and posterior sides; posterior tooth elongate, high, wide and inclined posteriorly.

External sculpture of 23 to 27 wide and low radial ribs with subelliptic transverse section, smooth or covered with weakly developed nodes; narrow intercostal spaces with triangular transverse section. Pallial line one- fifth of total valve height. Inner ventral margin strongly crenulated; crenulations subrectangular, truncated, covering entire margin.

Remarks. Specimens of *C. cannada* display strong variation in shell outline and sculpture. While the outline varies from slightly subtriangular juvenile to subcircular adult shell, the sculpture can also vary from smooth radial ribs with weakly developed nodes.

Ihering (1907) placed this species in *Venericardia* Lamarck, 1801. Later, del Río (2004) placed it in *Pleuromeris* Conrad, 1867, but the small shell with subcircular outline, entire radial ribs and wide hinge teeth in *C. cannada* allow its inclusion in *Cyclocardia*.

Ihering (1907) also introduced *Venericardia camaronesia* var. *cruzensis* based on specimens illustrated by Ortmann (1902, pl. 36, figs. 8a–o) from the mouth of Santa Cruz River (Monte León Formation, Santa Cruz Province). However, Ortmann's specimens (1902) belong in *C. cannada* according to their outline, external sculpture and hinge features. For this reason, *Venericardia camaronesia* var. *cruzensis* is here considered a junior synonym of *C. cannada*.

We include in this species valves from Lago Cardiel (lower Miocene, 'Centinela' Formation) and extend the geographic range of the taxon.

Cyclocardia cannada belongs in *Cyclocardia* because the shell has the umbo placed near to anterior third of valve length, wide hinge teeth with the right anterior tooth small, right middle tooth curved and broad and left anterior tooth large, and because it has 23 to 27 wide and low radial ribs.

Cyclocardia cannada resembles *C. granulata* (Say, 1824) (Miocene–Pleistocene of USA) (Ward & Blackwelder 1987: pl. 15, figs. 4–7) because of its outline and size. However, the former species has rounded posterior and anterior margins, a more reduced right anterior tooth, a more triangular and broader left anterior tooth, and the radial ribs have a subelliptic transverse section, being covered by weakly developed nodes.

Cyclocardia cannada shares with *C. moniliata* (Dall, 1902) (Recent, Brazil) (Huber 2010: p. 253) the presence of rounded anterior and posterior margins and hinge features. The first species has a larger shell, a posterior area, shallow lunule and radial ribs lacking nodes and with subelliptic a transverse section.

***Cyclocardia compressa* (Reeve, 1843)**

Figure 3.4–6

*1843 *Cardita compressa* Reeve, pl. 9, fig. 46.
1850 Cardita (*Actinobolus*) *procera* Gould, p. 416.3.
v*1907 Venericardia procera* (Gould)—Ihering, p. 425.
1933 *Venericardia procera* (Gould)—Feruglio, p. 107, pl. 9, figs. 5–8.
1964 Cyclocardia compressa (Reeve)—Dell, p. 190.

2000 Cyclocardia compressa (Reeve)—Pastorino, p. 156
2005 Venericardia procera (Gould)—Aguirre *et al.*, p. 25, table B1
2013 *Cyclocardia compressa* (Reeve)—Güller & Zelaya, p. 203–205, figs. 1a–m, 9a.

Type specimens. Syntypes BNHM 1967582, three articulated shells from Valparaíso (Chile) and 'Río Negro' (Argentina).

Other material. MACN-Pi 363–364 (12 left and 15 right valves).

Diagnosis. Small-sized shell (less than 30 mm in length) laterally compressed. Radial ribs (15 to 17) wide, intercostal spaces half as wide as radial ribs (modified from Reeve 1843: pl. 9).

Description. Shell small with subcircular outline, laterally compressed; anterior and ventral margins rounded, posterior margin slightly convex and straight and dorsal margin long. Umbo placed near to middle of the valve length. Lunule small, deep, flat, longer than wide and bounded from remaining surface of shell by a groove.

Right valve hinge with very concave ventral edge; anterior tooth very small, slightly inclined posteriorly; middle tooth triangular, with broad base, very inclined posteriorly, concave anterior and almost convex posterior sides; posterior tooth slightly curved, as long as middle tooth. Left valve hinge with straight ventral edge; anterior tooth large, triangular, wide, straight, slightly inclined forwards with flat anterior and posterior sides; posterior tooth elongate, wide, high and inclined posteriorly.

External sculpture of 16 to 17 very low and entire smooth radial ribs with subelliptic transverse section, becoming obsolete towards ventral margin; shallow intercostal spaces up to half-width of radial ribs with subtriangular transverse section; last 5 to 6 posterior radial ribs narrower than the remainder, delimiting a very faint posterior zone. Pallial line one-fifth of total valve height. Inner ventral margin strongly crenulated; crenulations subrectangular, truncated, covering entire margin to ventral edge of posterior adductor muscle scar.

Remarks. *Cyclocardia compressa* was described by Reeve (1843) from Valparíso (Chile) and *Cardita* (*Actinobolus*) *procera* by Gould (1850) from 'Río Negro, Patagonia'; both species were synonymized by Dell (1964). Ihering (1907) mentioned its presence in 'Pampean' horizons of Puerto San Julián and Deseado River. Other Pleistocene mentions in the region were Aguirre *et al.* (2005) for Bustamante Bay (Chubut Province) and Pastorino (2000) for an unspecified locality of Río Negro Province.

Aguirre *et al.* (2005) proposed that *C. compressa* had migrated from Patagonia to Northern waters during the late Pleistocene or Holocene, but there are not Recent records of this species in Brazil (Ríos 1994) or along the coast of Buenos Aires Province (Castellanos 1967).

Cyclocardia compressa differs from *C. borealis* by having a smaller and more compressed shell, less numerous radial ribs and narrower intercostal spaces.

Cyclocardia dalek new species

Figure 3.7–9, 11

1907 *Venericardia elegantoides* (Ortmann)—Ihering, p. 284, pl. 14, fig. 98b.

Derivation of name. The specific name refers to Daleks, main villains of the "Doctor Who" TV series, characterized by an armour with prominent circles, similar to the nodular external sculpture of this species.

Type specimens. Holotype MACN-Pi 5770, one left valve. Paratypes MACN-Pi 5771, four right and three left valves. All from Playa La Mina (Santa Cruz Province, San Julián Formation).

Other material. MACN-Pi 355; PRI.66396–66397, 66399 and 66407 (20 left and 31 right valves).

Diagnosis. Shell with subcircular to subtriangular outline. Right anterior tooth in contact with lunular margin. Left valve hinge with slightly concave ventral edge. Radial ribs (21 to 24) wide with well-developed nodes; intercostal spaces narrow and shallow with subrectangular transverse section.

Description. Shell small to medium-sized with subcircular to subtriangular outline; posterior, anterior and ventral margins rounded, dorsal margin slightly convex and elongate. Umbo placed at anterior third of the valve length. Lunule small, shallow, flat, longer than wide and bounded from remaining surface of shell by a groove.

Right valve hinge with slightly concave ventral edge; anterior tooth very small and laminar, straight, inclined forward, in contact with lunular margin; middle tooth triangular, with broad base, inclined posteriorly, slightly concave anterior and flat posterior sides, and higher towards apex on lateral view; posterior tooth thin and slightly

curved. Left valve hinge with slightly concave ventral edge; anterior tooth triangular, elongate, wide, straight, slightly inclined posteriorly, higher towards base on lateral view, with flat anterior and posterior sides; posterior tooth elongate, high and inclined posteriorly.

External sculpture of 21 to 24 wide and low radial ribs with a subelliptic transverse section and covered with well-developed subcircular to subrectangular nodes; narrow and shallow intercostal spaces with a subrectangular transverse section; last 5 or 6 posterior radial ribs narrower than the remainder. Pallial line reaching between one-quarter and one-fifth of total valve height. Inner ventral margin strongly crenulated; crenulations subrectangular, truncated, covering entire margin.

Remarks. Ortmann (1899) described *Cardita elegantoides* based on six shells collected by J. Hatcher from Punta Arenas (upper Eocene, Loreto Formation, Chile). He later also considered material from Monte Observación and the mouth of the Santa Cruz River (lower Miocene, Monte León Formation, Santa Cruz Province) as belonging in that species (Ortmann 1902: pl. 26, figs. 5b–c). However, Ihering (1907) stated that material illustrated by Ortmann from the Santa Cruz River actually belongs to a different species. But, rather than proposing a new name for the Santa Cruz River material, he proposed *Venericardia sylva* for shells from Punta Arenas (Ortmann 1902; pl. 26, fig. 5a). This single valve is the holotype of *C. elegantoides* (PRI.66394) designated by Ortmann (1899) and, therefore, *V. sylva* is a junior synonym of *C. elegantoides*. In this revision we agree with the criteria used by Ihering and propose a new species name for the Santa Cruz specimens. Ihering (1907) also mentioned shells of Ortmann's species from Cañadón de los Artilleros (MACN-Pi 354) but this material is apparently lost.

Cyclocardia dalek n. sp. belongs in *Cyclocardia* because of the rounded umbo, entire, low and wide radial ribs and its broad hinge teeth with a very small right anterior tooth and a strongly curved right middle tooth.

Cyclocardia dalek n. sp. differs from *C. cannada* by having a subcircular to subtriangular outline, more pronounced hinge teeth, right anterior tooth in contact with lunular margin, left hinge with concave ventral edge, less and wider radial ribs covered by well-developed nodes.

Cyclocardia dalek n. sp. can be separated from *C. granulata* (Say, 1824) (Miocene–Pleistocene of USA) (Ward & Blackwelder 1987: pl. 15, figs. 4–7) by having more pronounced hinge teeth, left hinge with slightly concave ventral edge, less radial ribs with more strongly developed nodes.

'*Cyclocardia*' *nortensis* (del Río, 1986)

Figure 3.10, 12–13

v*1986 *Venericardia nortensis* del Río, p. 115, pl. 1, fig. 3.
v1994 *Venericardia* ('*Cyclocardia*') *nortensis* (del Río)—del Río, p. 104–105, pl. 1, fig. 10.

Type specimens. Holotype CPBA 13242, one left valve. Paratype CPBA 13247, one right valve. All from Punta Norte (Chubut Province, Puerto Madryn Formation).

Other material. CPBA 9326, 13223–13241, 13243–13246, 13248–13273, MLP 1883 (26 left valves, 43 right valves and one articulated shell).

Diagnosis. Umbo placed at the anterior third of valve. Right anterior tooth vertical or inclined posteriorly. Left anterior tooth triangular, thin, in contact with lunular margin. Radial ribs (21 to 22) covered by weakly developed nodes subrectangular in cross-section and separated by intercostal spaces with subrectangular transverse section (modified from del Río 1986: p. 115).

Description. Shell medium-sized with subcircular outline; anterior and ventral margins rounded, posterior margin slightly truncated and dorsal margin very convex. Umbo placed at anterior third of valve length. Lunule small, deep, flat, vertical or slightly inclined posteriorly, longer than wide, separated by a groove with sculpture of fine commarginal growth lines.

Right valve hinge with asymmetrically concave ventral edge; anterior tooth very small and laminar, straight, vertical or slightly inclined posteriorly; middle tooth triangular, with broad base, very curved, inclined posteriorly, slightly concave anterior and convex posterior sides; posterior tooth thin and slightly curved. Left valve hinge with straight ventral edge; anterior tooth small, thin, triangular, elongate, inclined posteriorly, in contact with lunular margin and higher towards apex in lateral view; posterior tooth elongate, narrow and inclined posteriorly.

External sculpture of 21 to 24 wide and entire radial ribs, low, with subelliptic transverse section, becoming obsolete towards ventral margin, covered with weakly developed and subrectangular nodes; narrow and shallow

intercostal spaces with subrectangular transverse section. Pallial line one-fifth of total valve height. Inner ventral margin strongly crenulated; crenulations subrectangular, truncated, covering entire margin to ventral edge of posterior adductor muscle scar, vanishing from here.

Remarks. Del Río (1986) related '*Cyclocardia*' *nortensis* to the New Zealand '*awamoensis*' group (Maxwell 1969; Beu & Maxwell 1990) and may thus represent a lineage separate from *Cyclocardia* s.s. (Maxwell 1969). It shares with that group the posteriorly truncated shell, prominent umbo, small lunule and radial ribs becoming obsolete towards the ventral margin.

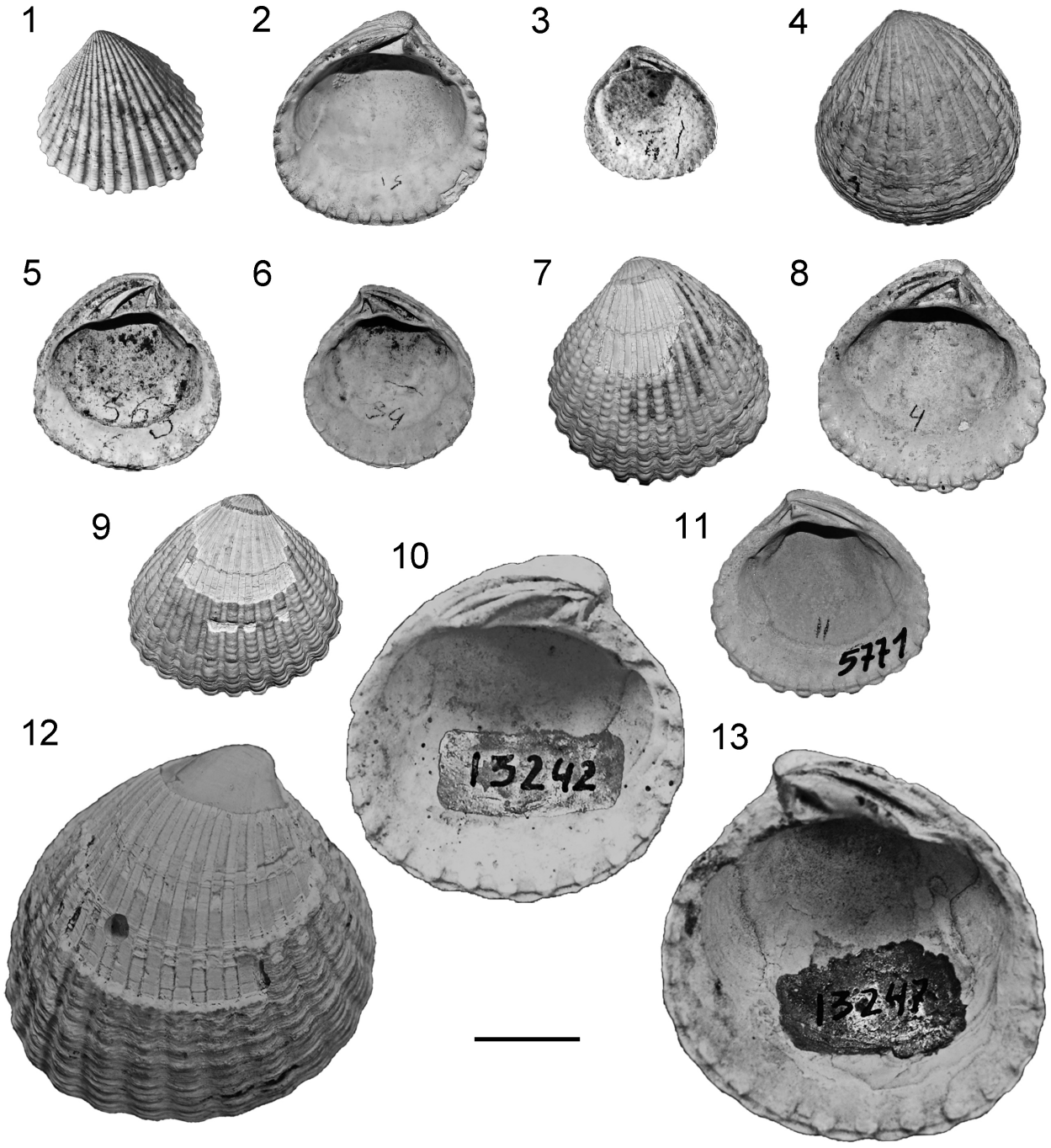

FIGURE 3. **(1–3)** *Cyclocardia cannada* (Ihering, 1907). **1,** LV, Holotype MACN-Pi 344, from Cañadón de los Artilleros. **2,** LV, MACN-Pi 344, from Cañadón de los Artilleros. **3,** RV, MACN-Pi 348, from Yegua Quemada. **(4–6)** *Cyclocardia compressa* (Reeve, 1843). **4,** LV, MACN-Pi 363, from Puerto Deseado. **5,** LV, MACN-Pi 363, from Puerto Deseado. **6,** RV, MACN-Pi 363, from Puerto Deseado. **(7–9, 11)** *Cyclocardia dalek* n. sp. from Playa La Mina. **7,** LV, Holotype MACN-Pi 5770. **8,** LV, Holotype MACN-Pi 5770. **9,** RV, Paratype MACN-Pi 5771. **11,** RV, Paratype MACN-Pi 5771. **(10, 12–13)** '*Cyclocardia*' *nortensis* (del Río, 1986), from Punta Norte. **10,** LV, Holotype CPBA 13242. **12,** RV, Paratype CPBA 13247. **13,** RV, Paratype CPBA 13247. Scale bar represents 10 mm.

'*Cyclocardia*' *nortensis* differs from '*C.*' *awamoensis* (Harris, 1897) (lower Miocene, New Zealand) (Beu & Maxwell 1990: pl. 17, figs. h,i) by having a smaller shell, umbo placed at the anterior third of valve length, lunule more vertical, left anterior tooth thinner, more numerous radial ribs with nodes weakly developed and intercostal spaces narrower and with subrectangular transverse section.

'*Cyclocardia*' *nortensis* can be separated from '*C.*' *christei* (Marwick, 1929) (upper Oligocene, New Zealand) (Beu & Maxwell 1990: pl. 10, figs. g, i) by having a smaller shell, left anterior tooth more triangular, thinner and in contact with the lunular margin. Also, its intercostal spaces have a subrectangular transverse section.

'*Cyclocardia*' *nortensis* differs from '*C.*' *marama* Maxwell, 1969 (upper Oligocene, New Zealand) (Maxwell 1969: pl. 3, figs. 35–37) by having a more rounded umbo placed at the anterior third of valve length, left anterior tooth in contact with lunular margin and radial ribs covered by weakly developed nodes.

'*Cyclocardia*' *nortensis* can be distinguished from '*C.*' *pseutella* (Marwick, 1929) (upper Oligocene, New Zealand) (Marwick 1929: figs. 29, 31) by its smaller shell, lunule more vertical, left anterior tooth in contact with lunular margin and a smaller number of radial ribs separated by intercostal spaces with subrectangular transverse section.

Genus *Darwinicardia* new genus

Type species. *Cardita patagonica* G. B. Sowerby I, 1846 (pl. 2, fig. 17). San Julián, Monte León, Carmen Silva and Barranca Final formations, upper Oligocene–upper Miocene, Argentina.

Diagnosis. Carditid with subtriangular outline and recurved umbo. Posterior area defined by a change in convexity starting from the sixth rib. Right valve hinge with ventral edge 'V'-inverted shaped. Right anterior tooth curved and left anterior tooth broad. External sculpture of 22 to 26 tripartite and high radial ribs with subtriangular transverse section covered with small subcircular nodes. Radial rib tips raising above crenulations on internal view.

Included species. *Darwinicardia angusticostata* (Deshayes, 1824) (Eocene, Paris Basin, France).

Derivation of name. The name honours Charles Darwin, who collected the first specimen of the type species, followed by the suffix '-*cardia*', that means 'heart' (in reference to its outline when viewed anteriorly); the suffix is often used for carditid genera.

Remarks. This new genus is placed along with the members of the alticostate group of carditids (Harris 1919; Heaslip 1968), which are characterized by the presence of tripartite radial ribs usually covered with nodes, scales or tubercles and narrow hinges.

Darwinicardia resembles *Glyptoactis* Stewart, 1930 (type species *Venericardia hadra* Dall, 1903, Miocene of Florida, USA) (Heaslip 1968: pl. 27–29) by having a similar outline and sculpture. However, *Darwinicardia* has a stronger and rectangular left anterior tooth, higher radial ribs with weaker paracostal ribs separated by wider intercostal spaces with a subtriangular transverse section.

Darwinicardia differs from *Venericardia* Lamarck, 1801 by its subtriangular outline, umbo more convex and recurved, a larger lunule, a smaller number of higher radial ribs with weaker paracostal ribs separated by wider intercostal spaces and covered by smaller comarginal nodes.

The shell outline and external sculpture of *Darwinicardia* resemble those of *Fasciculicardia* Maxwell, 1969 (type species *Venericardia subintermedia* Suter, 1917: lower–middle Miocene of New Zealand) (Maxwell 1969: pl. 23, fig. g) but the new genus has a right anterior tooth with a very convex anterior side, a stronger left anterior tooth, a larger lunule and a smaller number of radial ribs, standing out from crenulations on internal view.

Darwinicardia can be distinguished from *Cardites* Link, 1807 (type species *Chama antiquata* Linnaeus, 1758; Miocene–Recent of Europe and North Africa) by having a right anterior tooth, higher tripartite radial ribs standing above crenulations on internal view and separated by wider intercostal spaces.

Darwinicardia differs from *Cardiocardita* Anton, 1839 (type species *Cardita ajar* Bruguière, 1792; Recent, West Africa) by having a more clearly subtriangular outline, umbo more convex and recurved, a larger lunule, a right valve hinge with 'V'- shaped ventral edge, and higher radial ribs with weaker paracostal ribs separated by wider intercostal spaces.

We also include in this new genus the species *Venericardia angusticostata* Deshayes, 1825 (=*V. granulata* Defrance, 1828) (Eocene, Paris Basin, France). Pacaud & Le Renard (1995) placed the species in *Venericardia*. However, the subtriangular outline, convex umbo, the posterior area defined by a change in convexity starting from

the sixth rib, the right valve hinge with a 'V'- shaped ventral edge, the strong and rectangular left anterior tooth and the 22 to 23 tripartite and high radial ribs covered by small subcircular nodes and intercostal spaces with transverse section places this species in the new genus *Darwinicardia*.

***Darwinicardia patagonica* (Sowerby, 1846)**
Figure 4.1–10

v*1846 *Cardita patagonica* Sowerby: p. 251, pl. 2, fig. 17.
.1887 *Cardita inaequalis* Philippi: p. 167, pl. 37, fig. 5.
1897 Cardita patagonica Sowerby—Ihering, p. 244–245.
1897 Cardita inaequalis Philippi—Ihering, p. 245.
1899 Cardita pseudopatagonica Ihering, p. 16.
1900 Cardita inaequalis Philippi—Ortmann, p. 380.
v1902 *Cardita volckmanni* Philippi—Ortmann, p. 126–127, pl. 26, figs. 7a–d.
v1902 *Cardita inaequalis* (Philippi)—Ortmann, p. 127–128, pl. 26, figs. 6.
v1907 *Venericardia patagonica* (Sowerby)—Ihering, p. 283–284, pl. 10, fig. 67a–b.
1907 Venericardia inaequalis (Philippi)—Ihering, p. 284.
1907 Venericardia pueyrredona Ihering, p. 286–287.
1978 *Cardiocardita inaequalis* (Philippi)—Malumián *et al*., p. 275, pl. 3, fig. 5.
1995 *Venericardia inaequalis* (Philippi)—del Río, p. 110, fig. 8: 1–5.
v*2004 Fasciculicardia inaequalis* (Philippi)—del Río, p. 2004, Appendix 1–2.
2008 *Fasciculicardia patagonica* (Philippi)—Griffin & Nielsen, p. 277, pl. 13, figs. 6–7.

Type specimens. Syntype BHNM-L 27955-6, right and left valves from 'Santa Cruz' (Santa Cruz Province, Monte León Formation).

Other material. SGO.Pi 469 (holotype of *Cardita inaequalis*); MACN-Pi 357–359, 362, 365 (holotype of *Cardita pseudopatagonica*), 3578, 3583, 3602, 3611, 5768–5769, 5781–5782, 5803; CIRGEO-PI 2358, 2370, 2831, 2856, 2888; CPBA 6543, 8639–8640, 9328, 9364, 9373, 15946–15949, 15942–15960; MLP 1837, 1838, 10507, 18334; PRI.66324, 66402–66403, 66405–66406, 66408–66410, 66702 (116 left valves, 126 right valves, six articulated shells, 22 internal and one external moulds).

Diagnosis. Dorsal margin slightly convex with a pronounced slope from beaks to posterior end. Umbo large. Lunule deep and separated by a deep groove from remaining surface of shell. Radial ribs (23 to 26) lower and less developed towards ventral margin.

Description. Shell medium-sized, thick, subtriangular; anterior and ventral margins rounded; dorsal and posterior margins slightly convex, dorsal margin sharply sloping from beaks to posterior end; posterior area defined by a change in convexity starting from the sixth rib. Umbo large, convex, recurved, placed at anterior third of the valve length. Lunule medium-sized, deep and sharply separated by an incised groove from remaining surface of shell.

Right valve hinge with a 'V'- shaped ventral edge below middle tooth; anterior tooth very small and curved, inclined posteriorly with broad base and with convex anterior and concave posterior sides; middle tooth triangular, inclined posteriorly, with broad base, slightly concave anterior and gently convex posterior sides, and higher towards apex on lateral view; posterior tooth thin and slightly curved. Left valve hinge with a slightly concave ventral edge; anterior tooth strong, large, rectangular, inclined posteriorly, with slightly concave anterior and straight posterior sides; posterior tooth elongate, curved with broad base and acute apex.

External sculpture of 23 to 26 high and tripartite radial ribs, with triangular transverse section and lower and less developed towards ventral margin; central costal cord covered with aligned nodes of subcircular transverse section; poorly developed smooth paracostal ribs, narrower than central cord; wide intercostal spaces with triangular transverse section; first six posterior ribs narrower and lower than the remainder. Pallial line at a quarter of total valve height. Inner ventral margin strongly crenulated; crenulations subrectangular, truncated, covering entire margin to top of posterior adductor muscle scar. Radial rib tips reaching above crenulations on internal view.

Remarks. *Darwinicardia patagonica* is one of the most common carditids recorded in the Patagonian Neogene and was the first to be described. Sowerby (1846) described and illustrated shells collected by Charles Darwin from Miocene beds at the mouth of the Santa Cruz River (Monte León Formation, Santa Cruz Province).

Philippi (1887) introduced *Cardita inaequalis* based on an internal cast coming from the same locality as Darwin's specimens. He distinguished *C. inaequalis* by its smaller and less convex shell and its less pronounced umbo. Later, Ortmann (1900, 1902) separated those species by the better developed commarginal nodes in *C. inaequalis*. Ihering (1907) suggested that both species could be synonyms, an idea endorsed by Malumián *et al.* (1978), del Río (1995; 2004) and Griffin & Nielsen (2008). Del Río (1995) suggested sexual dimorphism within this species, which was supported by a morphometric geometrical analysis carried out by Pérez *et al.* (2017b).

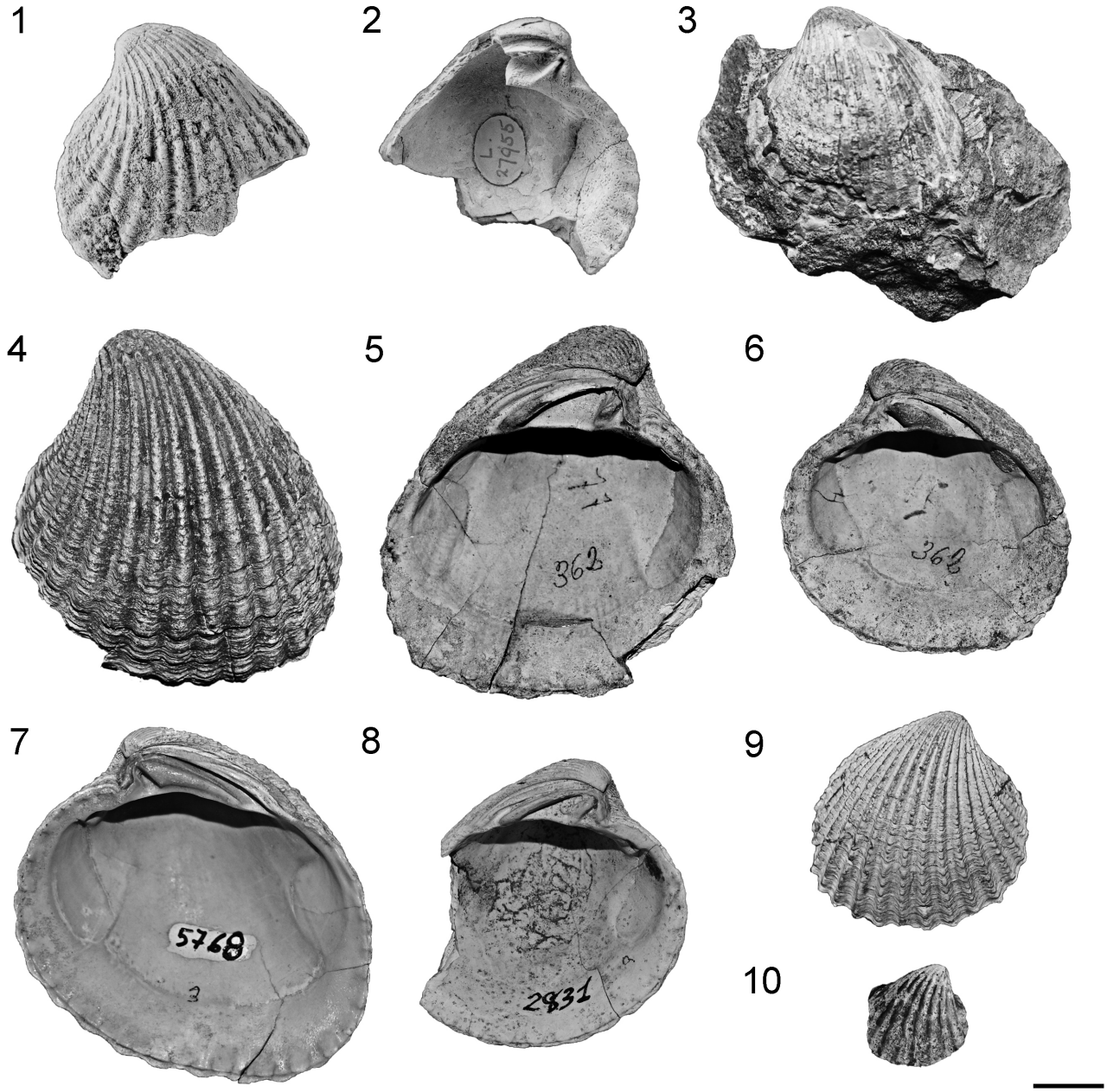

FIGURE 4. *Darwinicardia patagonica* (Sowerby, 1846). **1,** LV, Syntype BNHM-L 27955-6, from "Santa Cruz". **2,** LV, Syntype BNHM-L 27955-6, from "Santa Cruz". **3,** LV, Holotype of *Cardita inaequalis* SGO.Pi 469, from "Santa Cruz". **4,** LV, MACN-Pi 362, from Las Cuevas. **5,** LV, MACN-Pi 362, from Las Cuevas. **6,** RV, MACN-Pi 362, from Las Cuevas. **7,** RV, CPBA 15948, from Punta Quilla. **8,** LV, CIRGEO-PI 2831, from Sección 30. **9,** RV, MACN-Pi 5768, from Playa La Mina. **10,** Internal mould of RV, PRI.66400, from Lago Pueyrredon (=*Venericardia pueyrredona* Ihering, 1907). Scale bar represents 10 mm.

This species was initially known from the lower Miocene of the mouth of Santa Cruz River (Ihering 1897, 1907; Ortmann 1900, 1902) and middle Miocene of Tierra del Fuego (Malumián *et al.* 1978), but new records expand its stratigraphical and geographica range into the lower Miocene of Chubut (Cerro Cabeza Papagayo, lower Chenque Formation) and the late Miocene of northern Patagonia (Barranca Final Formation, Río Negro Province).

Darwinicardia patagonica can be separated from *D. angusticostata* (Eocene, France) by having a less convex and steeply sloping dorsal margin, larger umbo, a deeper lunule, a higher number of radial ribs that are less pronounced towards ventral margin.

Genus *Fasciculicardia* Maxwell, 1969

Type species. *Venericardia subintermedia* Suter, 1917 (p. 74) (by original designation). lower–middle Miocene of New Zealand.

Diagnosis. Shell small to medium-sized with a subcircular outline. Lunule small, vertical or inclined forward. Right anterior tooth weak; middle tooth prominent and curved; posterior tooth large and narrow. Left anterior tooth small, short and triangular; posterior elongate, narrow and slightly curved. External sculpture of 26 to 32 high, sharp, moderately wide tripartite radial ribs, flanked by very smooth paracostal ribs, and covered by serrated nodes. Third and fourth posterior radial ribs stronger than the rest. Tubular nodes distally opened in posterior area (modified from Maxwell 1969: 173).

Included species. *F. acanthodes* (Suter, 1917) (middle Eocene, New Zealand), *F.*? *allophyla* (Maxwell, 1992) (middle–upper Eocene, New Zealand), *F. bartrumi* (Fleming, 1950) (middle Eocene, New Zealand), *F. benhami* (Fleming, 1950) (Oligocene, New Zealand and Australia), *F. faceta* (Suter, 1917) (upper Oligocene, New Zealand), *F. gracilicostata* (Tenison-Woods, 1877) (lower Miocene, Australia), *F. healyi* (Fleming, 1950) (middle Eocene, New Zealand), *F. janjukiensis* (Chapman & Singleton, 1927) (Oligocene, Australia), *F. latissima* (Tate, 1886) (Oligocene, Australia), *F. nuntia* (Marwick, 1928) (lower Eocene, New Zealand and Australia), *F. scabrosa* (Tate, 1886) (Oligocene, Australia), *F. polynema* (Tate, 1886) (lower–middle Miocene, Australia).

Remarks. According to Maxwell (1969), the sculpture is the main morphological character of *Fasciculicardia* species. Beu (2006) considered it a subgenus of *Glyptoactis* Stewart, 1930, but this genus has a more subrectangular outline, a lower number of wider radial ribs and more developed paracostal ribs. The genus is widely distributed from the Eocene–Miocene interval of Australia and New Zealand (Beu & Maxwell 1990).

Fasciculicardia sp.

Figure 5.1–2

.1942 *Venericardia paranensis* Borchert—Wahnish de Carral Tolosa, p. 575, pl. 1, figs. 4a–b.
.vp1991 *Venericardia* (*Purpurocardia*?) *paranensis* Borchert—del Río, p. 60, fig. 6, fig-text 20.

Studied material. MACN-Pi 361b (one left valve).

Remarks. Del Río (1991) described two left valves from the Ihering Collection as *V.* (*P*?) *paranensis* from La Paz. The two shells have different sculptures and del Río interpreted them as different ontogenetic stages of a single species. However, both valves are of similar size. The first one (MACN-Pi 361b) is characterized by a small and nearly vertical lunule, very small left anterior tooth inclined posteriorly, left posterior tooth elongate and narrow, 26 high sharp radial ribs with subtriangular transverse sections, more pronounced towards anterior margin, no paracostal ribs, narrow and serrated nodes, small tubular spines along posterior margin and very wide intercostal spaces with 'U'-shaped transverse sections. These characters agree with *Fasciculicardia* and allow this species to be assigned to *Fasciculicardia* sp. The incompleteness of the shells prevents comparison with other *Fasciculicardia* species. Wahnish de Carral Tolosa (1942) described a small specimen of *Venericardia paranensis* (Borchert, 1901) from the Monte Veloz perforation ("Entrerriense" horizons, upper Miocene, Buenos Aires Province) that could be considered as belonging to *Fasciculicardia* sp.

The other specimen described by del Río (1991) (MACN-Pi 361a) belongs to the planicostate carditid *Neovenericor paranensis* (Borchert, 1901) (Pérez *et al.* 2017a).

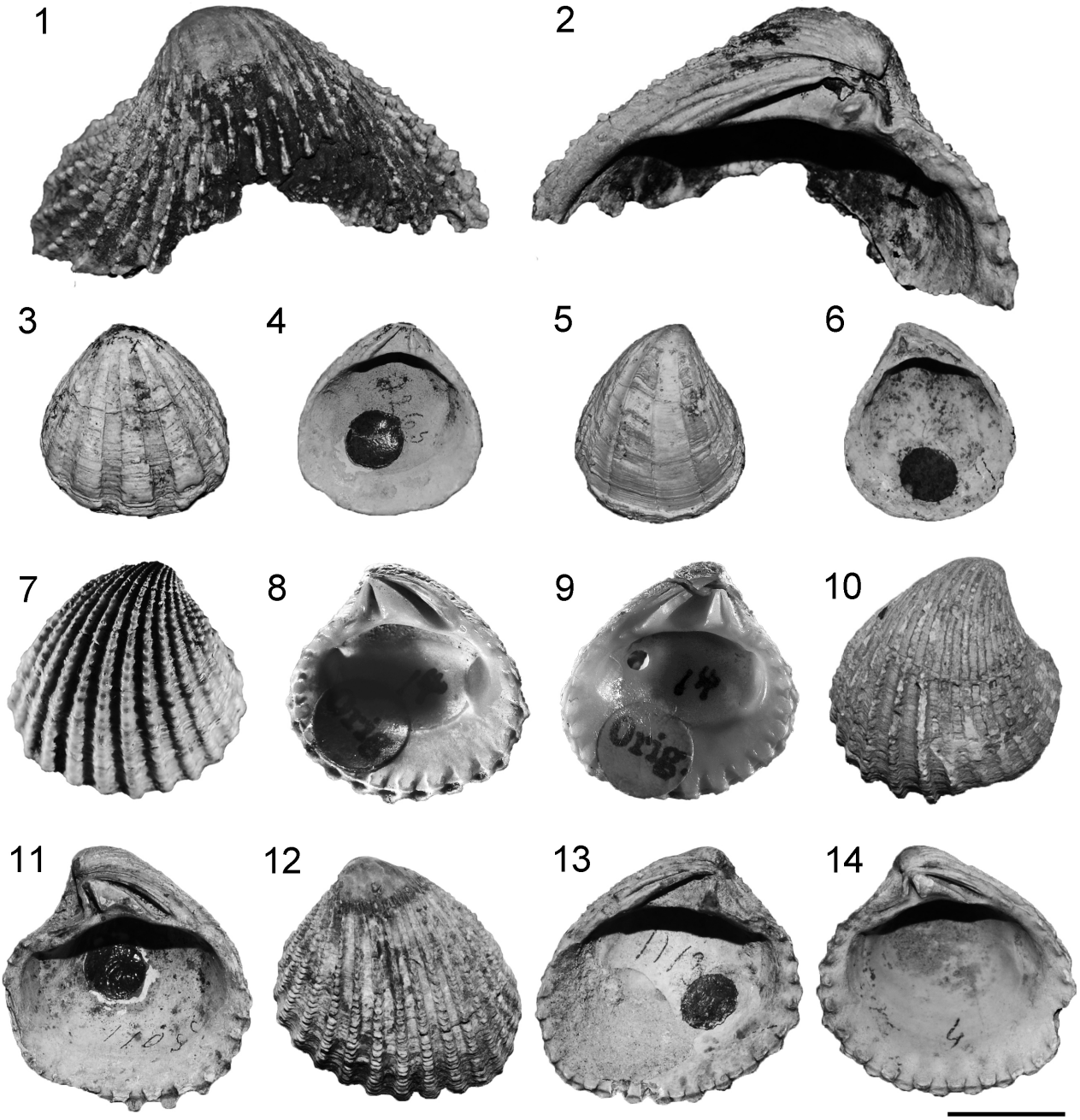

FIGURE 5. **(1–2)** *Fasciculicardia* sp., from La Bajada. **1,** LV, MACN-Pi 361b. **2,** LV, MACN-Pi 361b. **(3–6)** *Kolmeris tehuelchana* (Ihering, 1907), from Terraces of Cerro Laciar. **3,** LV, Holotype MACN-Pi 371. **4,** LV, Holotype MACN-Pi 371. **5,** RV, MACN-Pi 353. **6,** RV, MACN-Pi 353. **(7–9)** *Pleuromeris fueguina* (Steinmann & Wilckens, 1908), from Sierra Carmen Silva. **7,** RV, Holotype PZ-NHRM Mo. 117903. **8,** RV, Holotype PZ-NHRM Mo. 117903. **9,** LV, Holotype PZ-NHRM Mo. 117903. **(10–14)** *Pleuromeris sulcolunularis* (Ihering, 1907). **10,** RV, Holotype MACN-Pi 367, from Bajo de las Flechas. **11,** RV, Holotype MACN-Pi 367, from Bajo de las Flechas. **12,** LV, Paratype MACN-Pi 366, from Cabo Tres Puntas. **13,** LV, Paratype MACN-Pi 366, from Cabo Tres Puntas. **14,** RV, MACN-Pi 5774, from Monte Entrada. Scale bar represents 10 mm.

Genus *Kolmeris* new genus

Type species. *Venericardia tehuelchana* Ihering, 1907 (pl. 16, figs 107a–b). Surroundings of Cerro Laciar (Feruglio 1954), lower Pliocene, Santa Cruz, Argentina.

Diagnosis. Carditid with small (less than 30 mm in length) and high shell with subtriangular outline and a

convex dorsal margin. Left anterior tooth large and vertical, right middle tooth small and slightly inclined posteriorly. External sculpture of 9 to 15 low, smooth and flat radial ribs, widening towards the central region of the valve with wide intercostal spaces.

Included species. *Venericardia* (*Pleuromeris*) *marshalli* Marwick, 1924 (upper Pliocene–Recent, Petane Clays, New Zealand), *Pleuromeris murdochi* Powell, 1938 (upper Pliocene, Castle Point, New Zealand), *Pleuromeris paucicostata* Laws, 1940 (upper Pliocene–Recent, Nukumaru, New Zealand).

Derivation of name. From '*kol*' (Aonikenk, original language of the Aonikenk or Tehuelche's people, early inhabitants of Santa Cruz Province) that means 'seashell', and '*-meris*', a common suffix employed for small carditids and which probably comes from Latin word '*maris*' that means 'from the sea'.

Remarks. *Kolmeris* n. gen. shares characters with *Pleuromeris* and *Pteromeris* Conrad, 1862 (type species *Cardita perplana* Conrad, 1841; Pliocene–Recent of North Atlantic Ocean) (Gardner 1943: pl. 13, figs 6–9) such as their small and subtriangular shell, pointed umbo, large lunule, right middle tooth being triangular and vertical and a sculpture of usually less than 20 wide radial ribs.

The new genus can be separated from *Pleuromeris* by having a higher shell with convex dorsal margin, less pointed umbo, a larger right anterior tooth and fewer, lower and wider radial ribs not covered by nodes. It can be distinguished from *Pteromeris* by the absence of the typical recurved and anteriorly directed umbo that characterizes this genus, the presence of a smaller right middle tooth and straight left posterior tooth, and by the development of wider intercostal spaces.

Kolmeris differs from *Coripia* de Gregorio, 1885 (type species *Cardita unidentata* Basterot, 1825; Pliocene–Recent of Northeast Atlantic Ocean and Mediterranean Sea) (Pras 2013: pl. 1, figs 4–7) and *Miodontiscus* Dall, 1903 (type species *Miodon prolongatus* Carpenter, 1863; Pliocene–Recent of North Pacific) (Moore 1992: pl. 5, figs 12–14, 16) by having a subcentrally placed straight umbo, and ribs separated by wider intercostal spaces.

Kolmeris can be distinguished from *Cyclocardia* Conrad, 1867 (type species *Cardita borealis* Conrad, 1831; Pleistocene–Recent, Northwest Atlantic Ocean) (Huber 2010: p. 253) by having a smaller and subtriangular shell, with larger right anterior tooth, vertical left anterior tooth, and shell surface sculptured by fewer radial ribs.

Kolmeris differs from *Scalaricardita* Sacco, 1899 (type species *Cardita scalaris* Sowerby, 1825; lower Miocene–upper Pliocene of Europe) (Janssen & Moerdijk 2004: fig. 4) by having a more convex dorsal margin, fewer and smooth radial ribs with wider intercostal spaces.

We include three New Zealand species in *Kolmeris*: *Pleuromeris murdochi* (Powell 1938: pl. 39, fig. 6) (upper Pliocene, Castle Point Formation), *Pleuromeris paucicostata* (Laws 1940: figs 7–8) (upper Pliocene–Recent, Nukumaru Beds) and *Venericardia* (*Pleuromeris*) *marshalli* (Marwick 1924: pl. 16, figs 1–2) (upper Pliocene–Recent, Petane Clays). These species share with *K. tehuelchana* the same outline, the straight right anterior tooth, the right middle tooth slightly inclined posteriorly, and 9 to 15 wide radial ribs separated by wide intercostal spaces. As the New Zealand species are not older than Nukumaruan (upper Pliocene, 2–1.2 Ma sensu Haywick *et al.* 1991); *K. tehuelchana* (lower Pliocene) becomes the oldest member of the genus.

***Kolmeris tehuelchana* (Ihering, 1907)**

Figure 5.3–6

v*1907 *Venericardia tehuelchana* Ihering, p. 412–413, pl. 16, figs 107a–b.
v.1907 *Venericardia dalli* Ihering, p. 413, pl. 16, figs 108a–d.
1914 *Venericardia tehuelchana* Ihering—Ihering, p. 45.
v.1933 *Venericardia dalli* Ihering—Feruglio, p. 96, pl. 8, figs 4–7.
v1933 *Venericardia tehuelchana* Ihering—Feruglio, p. 96, pl. 8, figs 1–3.
1996 Venericardia tehuelchana Ihering—Parodiz, p. 273.

Type specimens. Holotype MACN-Pi 371, one left valve from Terraces of Cerro Laciar (Feruglio, 1954) (Santa Cruz Province). Paratypes MACN-Pi 371, nine left and eight right valves from Terraces of Cerro Laciar (Feruglio, 1954) (Santa Cruz Province).

Other material. MACN-Pi 353 (Holotype of *Venericardia dalli*), 2214, 6334; PRI.66711 (83 left valves and 100 right valves).

Diagnosis. Shells with long dorsal margin with a pronounced slope. Left anterior tooth elongate. Radial ribs

(13 to 15) with subrectangular transverse section, increasing in width towards ventral margin, stacking towards posterior and anterior margins. Intercostal spaces with subrectangular transverse section.

Description. Shell small-sized (maximum size of 16 mm), subtriangular, higher than long; posterior margin rounded forming a slight angle with ventral one, dorsal margin convex and long nearly vertical, descending in a strong slope, ventral and anterior margins rounded. Umbo pointed, placed at centre of valve length. Lunule large, flat, elongate, demarcated by a deeply incised groove.

Right valve hinge with concave ventral edge; anterior tooth very small, thin, short, straight, inclined anteriorly, with concave anterior side; middle tooth triangular, slightly inclined posteriorly, with straigth anterior side and higher towards apex on lateral view; posterior tooth very thin and slightly curved. Left valve hinge with a concave ventral edge; elongate anterior tooth, triangular, straight, with straight anterior and posterior sides; posterior tooth elongate and straight.

External sculpture of 13 to 15 entire and low radial ribs of triangular transverse section, widening towards ventral margin; shallow intercostal spaces of subrectangular transverse section, narrower than radial ribs; ribs stacking and narrowing towards anterior and posterior sides with 3 to 6 radial ribs, leaving 3 to 6 wide radial ribs at central region. Pallial line one-fourth of total valve height. Inner ventral margin strongly crenulated, crenulations subrectangular, truncated covering entire margin.

Remarks. Ihering (1907) described *Venericardia dalli* from the same locality as *K. tehuelchana*, with the only major difference being the number of stacked radial ribs on the valve flanks, four in *V. dalli* and six in *K. tehuelchana*. By observing many specimens of *K. tehuelchana*, we found the number of stacked ribs ranged from three to six. *Venericardia dalli* is considered synonymous with *K. tehuelchana*, therefore.

Kolmeris tehuelchana can be distinguished from *K. murdochi* (Powell, 1938) (upper Pliocene, New Zealand) by having a more pronounced sloping dorsal margin, a longer left anterior tooth and fewer radial ribs that are stacked on the flanks.

Kolmeris tehuelchana and *K. paucicostata* (Laws, 1940) (Pliocene–Recent, New Zealand) has a shell of similar outline and size, but the Patagonian species has a longer left anterior tooth and more radial ribs that are stacked on its flanks.

Kolmeris tehuelchana differs from *K. marshalli* (Marwick, 1924) (upper Pliocene–Recent, New Zealand) by having a higher number of radial ribs that are stacked on the flanks and ribs that are wider towards the ventral margin.

Genus *Pleuromeris* Conrad, 1867

Type species. *Pleuromeris decemcostata* Conrad, 1867 (p.12) (by original designation). Yorktown, Waccamaw, Choctawhatchee, Caloosahatche, Chowan River, James City and Tamiani formations, lower Pliocene-lower Pleistocene of Florida and North Calorina, United States of America (USA) (revised herein).

Diagnosis. Carditid with small shell (less than 30 mm in length) and a subtriangular outline. Umbo subcentral. Lunule large and broad. Right middle tooth triangular and broad. External sculpture of 11 to 22 radial ribs covered with nodes, with subtriangular transverse section.

Included species. *P. acaris* Dall, 1903 (Miocene–Pliocene, Jamaica, Panama, Trinidad and Tobago and Venezuela), *P. archaenepeanensis* Chapman & Crespin, 1928 (lower Pliocene, Australia), *P. auroraensis* Ward & Blackwelder, 1987 (Pliocene–Pleistocene, North Carolina), *P. armilla* (Dall, 1903) (Recent, USA), *P. benthicola* Powell, 1937 (Recent, New Zealand), *P. conradiana* Gabb, 1881 (Pliocene, Costa Rica), *P. finlayi* (upper Pliocene–lower Pleistocene, New Zealand), *P. fueguina* (middle Miocene, Argentina), *P. hectori* Powell, 1938 (upper Pliocene–lower Pleistocene, New Zealand), *P. instata* Laws, 1944 (Miocene, New Zealand), *P. kapuensis* (Marwick, 1931) (upper Miocene–lower Pliocene, New Zealand), *P. koruahinensis* (Bartrum & Powell, 1928) (lower Pliocene, New Zealand), *P. latiuscula* Powell, 1937 (Recent, New Zealand), *P. micella* Olsson & McGinty, 1958 (Recent, Caribbean Sea), *P. otamateaensis* Laws, 1944 (lower Miocene, New Zealand), *P. pecten* Tate, 1886 (Miocene, Australia), *P. prolutea* (Marwick, 1929) (upper Oligocene, New Zealand), *P. scitula* Dall, 1903 (early Miocene, Florida), *P. scituloides* Olsson, 1941 (Pliocene, Florida), *P. sulcolunularis* (Ihering, 1907) (upper Oligocene–lower Miocene, Argentina), *P. tellia* Dall, 1903 (lower Miocene, Florida), *P. tridentata* (Say, 1826) (upper Pliocene–Recent, USA and Caribbean Sea), *P. ultima* Dell, 1956 (lower Miocene, Florida), *P. volckmanni*

(Philippi, 1887) (Miocene, Chile), *P. waitorana* Laws, 1940 (upper Pliocene, New Zealand), *P. zelandica* (Deshayes, 1854) (lower Pliocene–Recent, New Zealand).

Remarks. According to Conrad (1867) and Dall (1903), the main characters of *Pleuromeris* are the small size and subtriangular outline, sculptured with 11 to 22 radial ribs covered by nodes, and the presence of a triangular and broad right middle tooth. This genus has a wide geographic distribution and was recorded by Conrad (1867) in the Pleistocene–Recent of southeastern North America, and by Dall (1903) in lower Miocene strata of that region. Later, Powell (1937; 1938) mentioned *Pleuromeris* from the Pliocene and Recent of New Zealand and Darragh (1970) from the Miocene and Pliocene of Australia. Other South American records correspond to '*Cardita*' *volckmanni* (Philippi, 1887) (Miocene, Chile), assigned to *Pleuromeris* because of its subtriangular outline and radial ribs with nodes. Del Río (2004) included in *Pleuromeris* four species described by Ihering (1907): '*Venericardia*' *sulcolunularis*, '*V.*' *cannada*, '*V.*' *cruzensis* and '*V.*' *camaronesia*. The last three species are placed in different genera in this work ('*V.*' *cannada* and '*V.*' *cruzensis* in *Cyclocardia*, and '*V.*' *camaronesia* in *Scalaricardita*).

Dall (1903) indicated the presence of '*Pleuromeris*' *parva* (Lea, 1833) from the Eocene of the USA but this species is better placed in *Rotundicardia* Heaslip, 1968, because of its subcircular shell with tripartite radial ribs.

Pleuromeris sanmartini Klappenbach, 1970, was described from the Recent of Uruguay, but this species has a posteriorly-placed umbo and wide and smooth radial ribs that are typical of *Pteromeris* Conrad, 1862.

***Pleuromeris fueguina* (Steinmann & Wilckens, 1908)**

Figure 5.7–9

v*1908 *Cardita elegantoides* var. *fueguina* Steinmann & Wilckens, p. 39–41, pl. 3, figs 5a–c, pl. 4, figs 2a–b.
1978 *Pleuromeris elegantoides* (Ortmann)—Malumián *et al.*, p. 275, pl. 4, figs 6–8.

Type specimens. Holotype PZ-NHRM Mo. 117903, right and left valves from Sierra Carmen Silva (Tierra del Fuego Province, Carmen Silva Formation).

Other material. MACN-Pi 2619, 3747, 3748, CIRGEO-PI 2382, 2877, CPBA 9349 (35 left valves, 30 right valves, three articulated shells and one internal mould).

Diagnosis. Shell slightly convex with slightly recurved umbo. Lunule flat. Left anterior tooth narrow and inclined posteriorly. Low radial ribs (18 to 21).

Description. Shell small-sized (less than 30 mm in length), slightly convex, subtriangular; dorsal and ventral margins straight and posterior and anterior ones slightly rounded. Umbo large, rounded, slightly recurved, placed between first and second anterior third of valve length. Lunule large, flat, vertical, bounded from remaining surface of shell by an incised groove.

Right valve hinge with slightly concave ventral edge below middle tooth; anterior tooth small, thin, short, straight, with concave anterior and convex posterior sides, in contact with the lunular margin; middle tooth triangular, inclined posteriorly, with very broad base, with slightly concave anterior and gently convex posterior sides, and higher towards apex on lateral view; posterior tooth thin and slightly curved. Left valve hinge with slightly concave ventral edge; elongate anterior tooth, triangular, slightly inclined posteriorly, with straight anterior and posterior sides and higher towards apex on lateral view; posterior tooth elongate, narrow, and slightly curved.

External sculpture of 18 to 21 entire radial ribs, low, narrow with triangular transverse section, widening towards ventral margin; covered with closely-spaced nodes with subrectangular to subquadrate transverse section; wide 'V'-shaped intercostal spaces of . Pallial line one-fifth of total valve height. Inner ventral margin strongly crenulated, crenulations subrectangular, truncated, covering entire margin to posterior adductor muscle scar.

Remarks. The original *Cardita elegantoides* Ortmann, 1899, from the Eocene of the Loreto Formation in Chile, is here described under *Purpurocardia*. Steinmann & Wilckens (1908) introduced *P. fueguina* as a variety of this species, pointing out that illustrations provided by Ortmann (1902, pl. 26, fig. 5a) show differences between the specimens from Santa Cruz and Tierra del Fuego. Ortmann illustrated the holotype of *C. elegantoides* from Punta Arenas, and of other shells collected in the Santa Cruz River area on plate 26, figures 5b–c (herein described as *Cyclocardia dalek* n. sp.).

Pleuromeris fueguina is placed in this genus because of its small-sized shell with subtriangular outline, large and wide lunule, broad right middle tooth and the development of 18 to 21 radial ribs covered with nodes.

The species can be distinguished from *P. decemcostata* by the development of a flat lunule, left anterior tooth inclined posteriorly and a higher number of radial ribs.

It is separated from *P. tridentata* by having a larger and less recurved umbo, narrower and inclined posteriorly left anterior tooth and a higher number of radial ribs.

Pleuromeris fueguina differs from *P. zelandica* by its more convex shell, more recurved umbo and left anterior tooth inclined posteriorly.

***Pleuromeris sulcolunularis* (Ihering, 1907)**
Figure 5.10–14

v*1907 *Venericardia sulcolunularis* Ihering, p. 285–286, pl. 10, fig. 70a–f.
1996 Venericardia sulcolunularis Ihering—Parodiz p. 271.
v*2004 Pleuromeris sulculonularis* (Ihering)—del Río, Appendix 1–2.

Type specimens. Holotype MACN-Pi 367, right valve from Bajo de las Flechas (Santa Cruz Province, San Julián Formation). Paratype MACN-Pi 366, two left, three right valves and an articulated shell from Cabo Tres Puntas (Santa Cruz Province, San Julián Formation).

Other material. MACN-Pi 368–370, 5773–5777, PRI.66398 (16 left valves, 18 right valves, and two articulated shells).

Diagnosis. Shell thick and very convex with very recurved umbo. Lunule very deep and strongly concave, delimited by a deep groove. Left anterior tooth broad and inclined posteriorly. High radial ribs (18 to 20) separated by wide intercostal spaces.

Description. Shell small-sized (less than 30 mm in length), thick, subtriangular; dorsal and ventral margins straight and posterior and anterior margins slightly rounded. Umbo large, rounded, very recurved, placed between first and second anterior third of the valve length. Lunule large, strongly concave, vertical, very deep, demarcated by an incised groove from remaining surface of shell.

Right valve hinge with a concave ventral edge below middle tooth; anterior tooth small, thin, short, straight, with concave anterior and convex posterior sides, in contact with the lunular margin; middle tooth triangular, inclined posteriorly, with broad base, slightly concave anterior and gently convex posterior sides, higher towards apex on lateral view; posterior tooth thin and slightly curved. Left valve hinge with a slightly concave ventral edge; anterior tooth strong, broad, triangular, slightly inclined posteriorly, with straight anterior and posterior sides and higher towards apex on lateral view; posterior tooth elongate, broad, and slightly curved.

External sculpture of 18 to 20 entire radial ribs, high, narrow, with triangular transverse section, widening towards ventral margin; covered with closely-spaced nodes of subrectangular transverse section; intercostal spaces as wide as radial ribs with 'V'-shaped transverse section. Pallial line one-fifth of total valve height. Inner ventral margin strongly crenulated; crenulations subtriangular, truncated, covering entire margin to posterior adductor muscle scar.

Remarks. Ihering (1907) and Parodiz (1996) placed this species in *Venericardia*, and del Río (2004) in *Pleuromeris* without discussion. Because of its small-sized shell, subtriangular outline, large and wide lunule, wide right middle tooth and the presence of 18 to 20 radial ribs, *P. sulcolunularis* should be assigned to *Pleuromeris*.

Ihering (1907) stated that *P. sulcolunularis* is related to *P. volckmanni* (Frassinetti & Covacevich 1995; pl. 1, figs 10–17, Miocene, Navidad Formation, Chile) but it differs from the Chilean species by having a less recurved umbo, more concave and deeper lunule and narrower intercostal spaces.

Pleuromeris sulcolunularis can be distinguished from *P. decemcostata*, the type species of the genus (Gardner 1943, pl. 13, figs 1–4, lower Pliocene–lower Pleistocene, USA), by its thicker and more convex shell, a more concave lunule, left anterior tooth inclined posteriorly and by having a higher number of radial ribs.

Pleuromeris sulcolunularis differs from *P. tridentata* (Say, 1826) (Conrad 1838, pl. 43, fig. 11, Pliocene–Recent, USA) by the presence of more convex shell with a larger and recurved umbo, a concave instead of a flat lunule, left anterior tooth broader and inclined posteriorly and a higher number of radial ribs set apart by wider intercostal spaces.

Pleuromeris sulcolunularis can be separated from *P. zelandica* (Deshayes, 1854) (Huber 2010, p. 255, lower Pliocene–Recent, New Zealand) because of its more convex shell, larger and more recurved umbo, deeper and more concave lunule and left anterior tooth inclined posteriorly.

This species can be distinguished from *P. fueguina* (Steinmann & Wilckens, 1908) by having a deeper and more concave lunule, broader left anterior tooth and taller radial ribs.

Genus *Purpurocardia* Maxwell, 1969

Type species. *Cardita purpurata* Deshayes, 1854 (pl. 17, figs. 12–13) (by original designation). Pliocene–Recent of New Zealand, Recent of Australia.

Diagnosis. Carditid with small to medium-sized shell (between 30 and 60 mm in length), subcircular to subrectangular outline and posterior margin slightly truncated. Lunule small and prominent. Right valve hinge with a sinuous ventral edge. Right anterior tooth triangular; middle prominent, triangular, wide and ventrally concave; posterior tooth narrow and almost straight. Left anterior tooth short and triangular; posterior tooth elongate, narrow and slightly curved. External sculpture of 21 to 28 tripartite radial ribs, moderately wide with subelliptic transverse section, poorly developed paracostal ribs, intercostal spaces narrower than ribs (modified from Maxwell 1969: 174).

Included species. *P. beata* (Marwick, 1928) (upper Miocene?–lower Pliocene, New Zealand), *P. elegantoides* (Ortmann, 1899) (Eocene, Argentina and Chile), *P. haskelli* (Fleming, 1950) (lower Pliocene, New Zealand), *P. leonensis* del Río, 1986 (upper Miocene, Argentina), *P. lilliei* (Fleming, 1943) (lower–upper? Pliocene, New Zealand), *P. penerectangularis* (Bartrum & Powell, 1928) (lower Miocene, New Zealand), *P. perscrupulosa* (Marwick, 1932) (lower–middle Miocene, New Zealand), *P. reigna* (Powell, 1933) (Recent, New Zealand), *P. southlandica* (Fleming, 1955) (upper Miocene, New Zealand), *P. titirangiensis* (Marwick, 1943) (upper Pliocene–Pleistocene, New Zealand), *P. urutiensis* (Marwick, 1926) (upper Miocene, New Zealand), *P. waikohuensis* (Marwick, 1926) (upper Miocene, New Zealand).

Remarks. According to Maxwell (1969), the main characters of *Purpurocardia* are a subcircular or subrectangular shell, smaller than 40 mm, sculptured with 21 to 28 tripartite and wide radial ribs with subelliptic transverse section and poorly developed paracostal ribs. This author restricted the genus to the lower Miocene–Recent interval of New Zealand and Recent of Australia, but del Río (1986) mentioned it for the late Miocene of Argentina, a record that subsequently wen unnoticed (Beu & Maxwell1990; Beu 2006). We include here in *Purpurocardia* the species *P. elegantoides* (Ortmann, 1899) from Eocene rocks of Santa Cruz and Chile, the oldest record of the genus.

Reichler (2010) mentioned *Purpurocardia* sp. from the Saladar Member of the Gran Bajo del Gualicho Formation (lower–middle Miocene, Río Negro Province) based on two valves. These specimens have subquadrate outlines, strong teeth and 21 entire radial ribs and we can assign it to young specimens of the planicostate *Neovenericor austroplata* (Gardner & Bowles, 1939) (Pérez *et al.* 2017a).

Purpurocardia elegantoides (Ortmann, 1899)

Figure 6.1–5

v**1899 Cardita elegantoides* Ortmann, p. 428.
1902 *Cardita elegantoides* Ortmann—Ortmann, p. 125–126, pl. 26, figs. 5a–c.
.1907 *Venericardia sylva* Ihering, p. 346–347, pl. 24, figs. 98a–b.
v2000 *Venericardia elegantoides* (Ortmann)—Camacho *et al*., p. 68–69, figs. 3m–o.
2012 Cardita elegantoides Ortmann—Ojeda, p. 125.

Type specimen. Holotype PRI.66394, right valve from Punta Arenas (Tierra del Fuego Province, Loreto Formation, Chile).

Other material. PRI.66395; CIRGEO-PI 2276; MLP 26811 (8 left valves and 11 right valves).

Diagnosis. Shell small-sized (less than 30 mm in length) with subrectangular outline. Posterior area defined by six to seven radial ribs narrower than the remainder. Umbo large. Lunule very convex. Right valve hinge with slightly defined sinuous ventral edge. Left anterior tooth slightly inclined posteriorly. External sculpture of 22 to 23 radial ribs, paracostal ribs very reduced, intercostal spaces with 'U'-shaped transversal section.

Description. Shell small-sized with subrectangular outline in anterior-posterior direction; dorsal margin

straight and gently sloping, posterior margin slightly truncated, ventral and anterior margins smooth and rounded. Umbo large, rounded, placed near anterior third of the valve length. Lunule small, very convex, prominent and weakly separated by a groove from remaining surface of shell.

Right valve hinge with a slightly sinuous ventral edge; small, triangular, narrow, short and straight anterior tooth; middle tooth very broad, inclined posteriorly, with broad base, ventrally concave with flat anterior and gentle convex posterior sides, and higher towards apex on lateral view; posterior tooth narrow and straight. Left valve hinge with a straight ventral edge; anterior tooth strong, broad, triangular, slightly inclined posteriorly; posterior tooth elongate, narrow and curved.

External sculpture of 22 to 23 tripartite radial ribs, short, wide, with subelliptic transverse section; covered with very low nodes of subrectangular transverse section; very reduced paracostal ribs; wide intercostal spaces with 'U'-shaped transverse section. Pallial line one-fifth of total valve height. Inner ventral margin strongly crenulated; crenulations subtriangular, truncated, covering entire margin to upper tip of posterior adductor muscle scar.

Remarks. Ortmann (1899) introduced *Cardita elegantoides* based on six shells collected by J. Hatcher in Punta Arenas (Eocene, Loreto Formation, Chile). Later, Ortmann (1902) mentioned this species from Monte Observación and mouth of Santa Cruz River (lower Miocene, Monte León Formation, Santa Cruz Province). As stated above, Ihering (1907) proposed a new name for the specimens from Tierra del Fuego but including the holotype of *C. elegantoides*. Therefore, this new name is a junior synonym of *C. elegantoides*. Recently, Ojeda (2012) revised Hatcher's fossil localities and assigned an upper Eocene age to the Loreto Formation with (Otero *et al.* 2012).

Purpurocardia elegantoides is placed in *Purpurocardia* by its subrectangular outline, slightly truncated posterior margin, small lunule, right valve hinge with a slightly sinuous ventral edge, triangular, broad and ventrally concave right middle tooth, short and triangular left anterior tooth and 22 to 23 wide radial ribs with very reduced paracostal ribs.

Purpurocardia elegantoides can be distinguished from *P. purpurata* (Deshayes, 1854) (Beu 2006: pl. 18, figs. B, D, E) by having a strongly defined posterior area, larger umbo, more convex lunule, less pronounced sinuosity of right hinge ventral edge, slightly inclined posteriorly instead vertical left anterior tooth and low number of radial ribs.

Purpurocardia elegantoides differs from *P. perscrupulosa* (Marwick, 1932) (Beu & Maxwell 1990: pl. 17, figs. d, e) (lower–middle Miocene, New Zealand) by having a smaller shell, a more convex lunule, slightly inclined posteriorly left anterior tooth, lower number of radial ribs and more reduced paracostal ribs.

Purpurocardia elegantoides can be separated from *P. beata* (Marwick, 1928: figs. 48 and 50) (upper Miocene–upper Pliocene, New Zealand) and *P. titirangiensis* (Marwick, 1943) (=*Venericardia martini* Marwick, 1928: figs. 52–53) (upper Pliocene–lower Pleistocene, New Zealand) by its smaller shell, subrectangular outline in anterior-posterior direction, lower number of radial ribs and intercostal spaces with 'U'-shaped transverse section.

Purpurocardia elegantoides differs from *P. urutiensis* (Marwick, 1926: pl. 75, figs. 1 and 3) (upper Miocene, New Zealand) by a posterior area with narrower radial ribs, more convex lunule, left anterior tooth inclined posteriorly instead of vertically and wider intercostal spaces.

***Purpurocardia leonensis* del Río, 1986**

Figure 6.6–9

v*1986 *Venericardia* (*Purpurocardia*) *leonensis* del Río, p. 114, pl. 1, fig. 2.
v1994 *Venericardia* (*Purpurocardia*) *leonensis* del Río—del Río, p. 102–104, pl. 1, figs. 8–9.

Type specimen. Holotype CPBA 11651, right valve. Paratypes CPBA 11652, 12921 and 12926. All from Cerro Prismático (Chubut Province, Puerto Madryn Formation).

Other material. CPBA 11653–11656, 12922–12925, 12927–12929, 13583–13585 (four left valves and 10 right valves).

Diagnosis. Shell medium-sized with subcircular outline. Posterior area defined by smooth convexity change. Umbo small and pointed. Right anterior tooth very small and strongly inclined posteriorly. Left anterior tooth strongly inclined posteriorly. External sculpture of 24 to 26 high radial ribs.

Description. Shell medium-sized with subcircular to subquadrate outline; dorsal margin slightly convex, gently sloping, posterior margin truncated with a strongly marked angle between it and posterior margin, ventral and anterior margins rounded. Posterior area defined by a smooth change in convexity. Umbo small, pointed, placed near to anterior third of the valve length. Lunule small, convex, prominent and separated by a groove from remaining surface of shell.

Right valve hinge with sinuous ventral edge; anterior tooth small, triangular, narrow, curved and inclined posteriorly; middle tooth very broad and triangular, inclined posteriorly, with broad base, ventrally concave with slightly concave anterior and convex posterior sides, and higher towards apex on lateral view; posterior tooth narrow and straight. Left valve hinge with almost straight ventral edge; anterior tooth strong, broad, triangular and strongly inclined posteriorly; posterior tooth elongate, narrow and curved.

External sculpture of 24 to 26 tripartite radial ribs, high, wide, with a subelliptic transverse section; covered with well-developed nodes of subrectangular transverse section; very reduced paracostal ribs; wide 'V'-shaped intercostal spaces with . Pallial line one-fifth of total valve height. Inner ventral margin strongly crenulated; crenulations subtriangular, truncated, running along entire margin up to upper tip of posterior adductor muscle scar.

Remarks. This is a relatively rare species which has only been recorded from Cerro Prismático (Puerto Madryn Formation). The presence of a subcircular shell outline, truncated posterior margin, prominent lunule, sinuous right hinge ventral edge, triangular right middle tooth broad and ventrally concave, 25 to 26 wide radial ribs with reduced paracostal ribs allow to confirm the assignment of this species to *Purpurocardia*.

Purpurocardia leonensis can be distinguished from *P. purpurata* (Deshayes, 1854) (Beu 2006: pl. 18, figs. B, D, E) by having a shell with subcircular outline and more developed posterior area, smaller and pointed umbo, left anterior tooth inclined posteriorly instead of vertical, and higher radial ribs.

Purpurocardia leonensis differs from *P. perscrupulosa* (Marwick, 1932) (Beu & Maxwell 1990: pl. 17, figs. d, e) (lower–middle Miocene, New Zealand) by its subcircular outline, more developed posterior area, left anterior tooth inclined posteriorly, and lower number of radial ribs.

Purpurocardia leonensis shares with *P. beata* (Marwick, 1928: figs. 48 and 50) (upper Miocene–upper Pliocene, New Zealand) and *P. titirangiensis* (Marwick, 1943) (=*Venericardia martini* Marwick, 1928: figs. 52–53) (upper Pliocene–lower Pleistocene, New Zealand) the subcircular outline, but the Patagonian species has a smaller shell with smaller umbo, right anterior tooth more inclined posteriorly and a lower number of radial ribs.

Purpurocardia elegantoides differs from *P. southlandica* (Fleming, 1955: fig. 1.11 and 1.12) (upper Miocene, New Zealand) by subcircular outline, more developed posterior area, and smaller umbo.

This species can be distinguished from *P. elegantoides* by having larger shells with subcircular outline, less defined posterior area, smaller umbo and a higher number of radial ribs.

Genus *Scalaricardita* Sacco, 1899

Type species. *Venericardia scalaris* J. de C. Sowerby, 1825 (pl. 490, fig. 3) (by original designation), upper Miocene-Pliocene of the Vienna Basin, Italy and Poland; Pliocene of North Sea Basin.

Diagnosis. Carditid with subtriangular to subcircular outline. Small umbo. Lunule long and flat. Right middle tooth triangular and broad, left anterior tooth straight. External sculpture of 23 to 27 wide radial ribs, covered by closely-spaced subrectangular nodes with wide intercostal spaces sometimes reduced to a very narrow groove.

Included species. *S. camaronesia* (Ihering, 1907) (lower Miocene, Argentina), *S. compacta* (Tate, 1886) (middle Miocene, Australia), *S. laciarina* (Feruglio, 1954) (lower Pliocene, Argentina), *S. miniscula* (Bartrum & Powell, 1928) (upper Pliocene, New Zealand) and *S. subcompacta* (Chapman & Crespin, 1928) (lower Pliocene, Australia).

Remarks. Sacco (1899) erected the genus in order to separate *Venericardia scalaris* from *Miodontiscus* Dall, 1903, and *Coripia* de Gregorio, 1885; which comprise very small-sized Cenozoic carditids from Italy. Sacco also indicated that *Scalaricardita* has a smaller shell with less circular outline, less convex dorsal margin, more pronounced radial ribs with subrectangular instead of subrounded nodes, provided with smaller and less curved right middle tooth and less curved right posterior tooth. Sacco (1899) mentioned that *V. scalaris* could be related to *Cyclocardia* Conrad, 1867 by similarities in outline and shell sculpture, and later Dall (1902; 1903) and Thiele (1935) suggested a possible synonymy between *Scalaricardita* and *Cyclocardia*. *Scalaricardita* can be separated

from *Miodontiscus* and *Coripia*, by having a more rounded shell with subcentrally placed umbo, less radial ribs with subrectangular nodes and narrower intercostal spaces.

Scalaricardita differs from *Pleuromeris* Conrad, 1867 (type species *P. decemcostata* Conrad, 1867; Pliocene–Pleistocene of USA) by having a less triangular outline and a higher number of radial ribs separated by narrower intercostal spaces.

The genus is represented in the Miocene and Pliocene of Europe by the type species (Sacco 1899; Glibert & Van der Poel 1970; Raffi *et al.* 1985; Studencka 1986; Janssen & Moerdijk 2004) and Australia (Darragh, 1970) by *S. compacta* (Tate, 1886) (Mudy Creek Formation, middle Miocene) and *S. subcompacta* (Chapman & Crespin, 1928) (Sorrento Bore, lower Pliocene). *Pleuromeris miniscula* Bartrum & Powell, 1928 (Kaawa Creeks Beds, upper Pliocene, New Zealand) may be belongs to *Scalaricardita* since it has a subcircular outline, umbo subcentrally placed, and by having 22 radial ribs with subrectangular nodes and very narrow intercostal spaces.

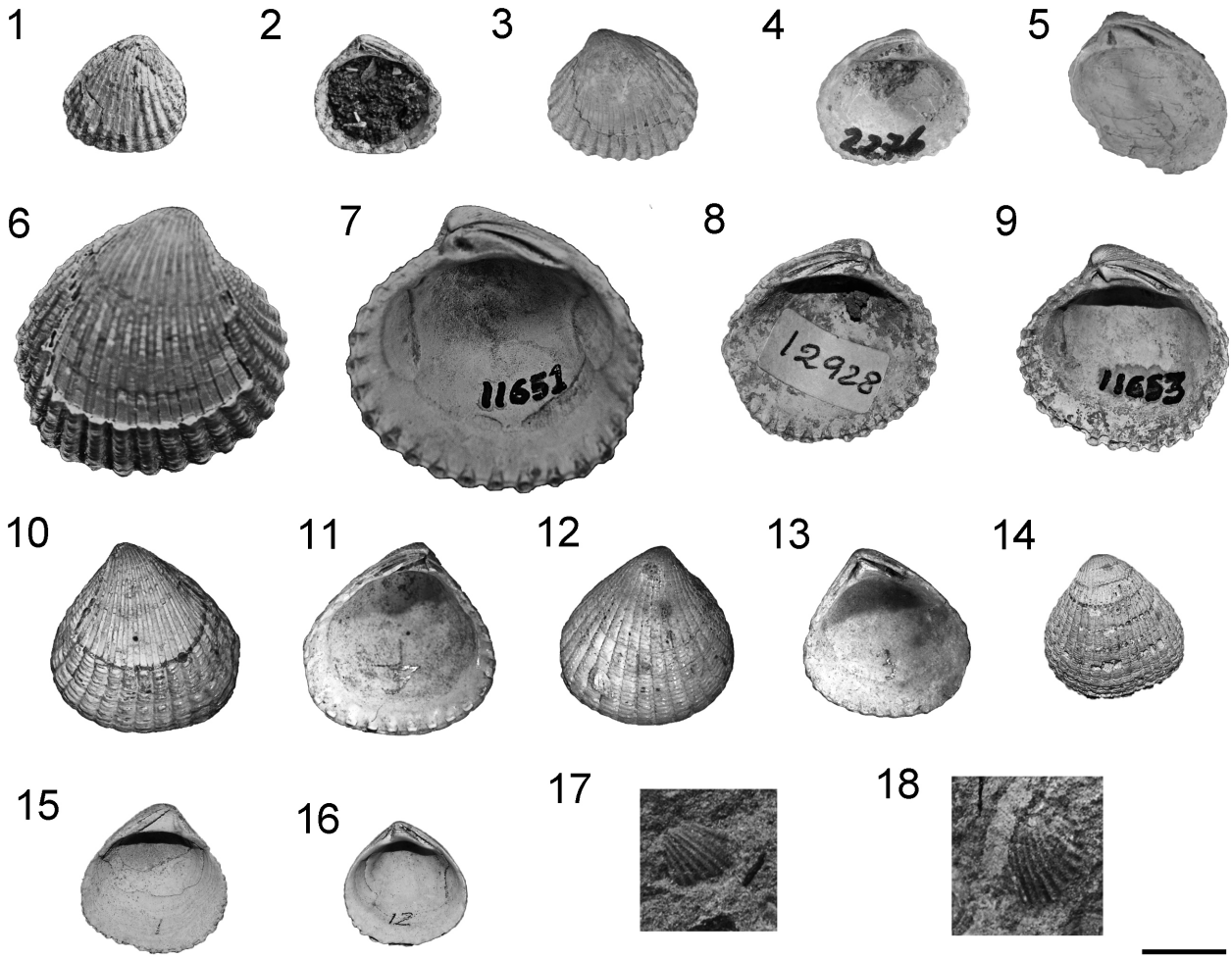

FIGURE 6. **(1–5)** *Purpurocardia elegantoides* (Ortmann, 1899). **1,** RV, Holotype PRI.66394, from Punta Arenas. **2,** RV, Holotype PRI.66394, from Punta Arenas. **3,** LV, CIRGEO-PI 2276, from Cerro Castillo. **4,** LV, CIRGEO-PI 2276, from Cerro Castillo. **5,** RV, CIRGEO-PI 2276, from Cerro Castillo. **(6–9)** *Purpurocardia leonensis* del Río, 1986, from Cerro Prismático. **6,** RV, Holotype CPBA 11651. **7,** RV, CPBA 11651. **8,** LV, CPBA 12928. **9,** RV, CPBA 11653. **(10–13)** *Scalaricardita camaronesia* (Ihering, 1907), from Camarones. **10,** LV, Holotype MACN-Pi 349. **11,** LV, Holotype MACN-Pi 349. **12,** External view of right valve, Paratype MACN-Pi 349. **13,** RV, Paratype MACN-Pi 349. **(14–16)** *Scalaricardita laciarina* (Feruglio, 1954), from Terraces of Cerro Laciar. **14,** LV, MACN-Pi 2214. **15,** LV, MACN-Pi 2214. **16,** RV, MACN-Pi 2214. **(17–18)** *Pleuromeris*? sp. (=*Venericardia* sp.), from Estancia Arroyo. **17,** Internal moulds of LV, CPBA 15637. **18,** Internal mould of RV, CPBA 15637. **(18)**. Scale bar represents 10 mm for 1–9, 14–16, 5 mm for 10–13 and 15 mm for 17–18.

***Scalaricardia camaronesia* (Ihering, 1907)**
Figure 6.10–13

1902 *Cardita patagonica* Sowerby—Ortmann, p. 128, pl. 36, figs 8a–c.
v*1907 *Venericardia camaronesia* Ihering, p. 285, pl. 10, figs 69a, d.
v*2004 Pleuromeris camaronesia* (Ihering)—del Río, Appendix I and II.

Type specimens. Holotype MACN-Pi 349, one left valve from Camarones (Chubut Province, Camarones Formation). Paratypes MACN-Pi 349, 78 right and 98 left valves from Camarones (Chubut Province, Camarones Formation).

Diagnosis. Shell very small (around 10 mm in length) with a subtriangular outline, dorsal and posterior margins straight. Umbo nearly anteriorly placed. Right middle tooth very broad. Radial ribs (23 to 25) with constant width along the whole valve.

Description. Shell small-sized, outline subtriangular; posterior margin slightly truncated with gentle angle between it and ventral margin, dorsal margin slightly convex with pronounced slope from beaks to posterior end, ventral and anterior margins rounded. Umbo placed between middle and anterior third of valve length. Lunule large, elongate, flat and shallow, bounded from remaining surface of shell by an incised groove.

Right hinge with concave ventral edge below middle tooth; anterior tooth very small, short, elongate, inclined forward, in contact with lunular margin; middle tooth triangular, inclined posteriorly with broad base, with straight anterior and slightly convex posterior sides, higher towards base on lateral view; posterior tooth very thin and straight. Left hinge with slightly curved ventral edge; anterior tooth elongate, triangular, high, slightly inclined forward with straight anterior and posterior sides; posterior tooth elongate, straight, as high as anterior one.

External sculpture of 23 to 25 entire radial ribs, low, with constant width along the whole valve with subelliptic transverse section; covered with small subrectangular and closely-spaced and very strong nodes; very narrow and very shallow intercostal spaces with subtriangular transverse section, sometimes reduced to a groove. Pallial line placed about a quarter of total valve height. Inner ventral margin strongly crenulated, crenulations subrectangular, truncated, covering entire margin.

Remarks. Ihering (1907) introduced this species based on shells collected in Camarones, stating that valves described by Ortmann (1902) from the Santa Cruz River area as *Cardita patagonica* Sowerby could be representatives of *Venericardia camaronesia*. However, as discussed below, the specimen described by Ortmann (1902: pl. 36, figs 8a–c) belongs to *Cyclocardia cannada* (Ihering, 1907), and *S. camaronesia* turns out to be a species restricted to the Camarones Formation.

The subtriangular outline, small and subcentrally placed umbo, large and flat lunule, 23 to 27 entire and wide radial ribs with closely-spaced subrectangular nodes and narrow intercostal spaces place this species in *Scalaricardita*.

S. camaronesia was placed by Ihering (1907) in the genus *Venericardia* Lamarck, 1801, but the European genus has a larger umbo, the hinge has an anterior tooth inclined posteriorly, a narrow right middle tooth and shell is sculptured by more numerous tripartite radial ribs. Del Río (2004) placed this species in *Pleuromeris*, but this genus has a more triangular outline, fewer radial ribs covered by more widely spaced nodes and separated by wider intercostal spaces.

Scalaricardita camaronesia differs from *S. compacta* (Tate 1886: pl. 2, fig. 13) by its more triangular outline, straight posterior margin and more anteriorly placed umbo.

Scalaricardita camaronesia can be distinguished from *S. subcompacta* (Ludbrook 1954: pl. 2, figs 5 and 8) by having umbos more anteriorly placed, dorsal and posterior margins straight and a wider right middle tooth.

The Patagonian species can be distinguished from *S. miniscula* (Bartrum & Powell 1928: fig. 12) by having straight posterior margin, more numerous and lower radial ribs with a homogenous width over the entire valve.

***Scalaricardita laciarina* (Feruglio, 1954)**
Figure 6.14–16

v1933 *Venericardia* n.f. Feruglio, p. 96, figs. 8–11.
*1954 *Venericardia laciarina* Feruglio, p. 10–11, pl. 1, figs 5a–b, 6a–b, pl. 2, figs. 1–4a,b, 5–6.

Material studied. MACN-Pi 2213 (nine left valves and five right valves).

Diagnosis. Shell with subtriangular outline. Umbo subcentrally. Lunule faintly defined. Left anterior tooth large. External sculpture of 25 to 27 low radial ribs more conspicuous towards anterior margin.

Description. Shell small-sized (maximum size of 17 mm) with subtriangular outline, posterior margin slightly truncated forming a gentle angle as it meets the ventral one, dorsal margin straight and elongate sloping pronouncedly from beaks to posterior end, ventral and anterior margins rounded. Umbo placed near centre of the valves. Lunule small, narrow, flat, shallow and weak.

Right hinge with a concave ventral edge; anterior tooth very small, elongate, short, inclined forward, in contact with lunular margin; middle tooth triangular, small, inclined posteriorly base broad and with straight anterior and slightly posterior sides, higher towards base on lateral view; posterior tooth very thin and straight, extending to the apex of middle tooth. Left hinge with slightly curved ventral edge; anterior tooth triangular, elongate, high, inclined forward with straight anterior and posterior sides; posterior tooth elongate, wide and straight.

External sculpture of 25 to 27 entire radial ribs, low and wide, slightly wider towards ventral marginwith subelliptic transverse section covered with subrectangular and small closely-spaced and barely noticeable nodes; shallow and narrow intercostal spaces with subtriangular transverse section. Pallial line placed about a quarter of total valve height. Inner ventral margin strongly crenulated, crenulations subrectangular, truncated, covering entire margin.

Remarks. Feruglio (1933, 1954) described and illustrated specimens of this carditid recorderd in Cerro Laciar (lower Pliocene, Santa Cruz Province) but that type material was not available to the authors. However, the Feruglio collection housed at the MACN hosts 12 valves belonging in *S. laciarina*.

Scalaricardita laciarina is assigned to *Scalaricardita* because of its subtriangular shell with slightly truncated posterior margin, a triangular and wide right middle tooth, 23 to 27 low and wide radial ribs covered by subrectangular, elongate and closely-spaced nodes and narrow intercostal spaces.

Scalaricardita laciarina can be distinguished from *S. scalaris* (Janssen & Moerdijk 2004: figs. 4a–b) by having a larger shell, subcentrally placed umbo, less-defined lunule, larger left anterior tooth, more pronounced anterior radial ribs and wider intercostal spaces.

Scalaricardita laciarina differs from *S. compacta* (Tate 1886: pl. 2, fig. 13) by having more subtriangular shell with more prominent and subcentrally placed umbo.

Scalaricardita laciariana can be separated from *S. subcompacta* (Ludbrook 1954: pl. 2, figs. 5 and 8) by a more subtriangular shell with subcentrally placed umbo and larger right anterior tooth.

This species differs from *S. miniscula* (Bartrum & Powell 1928: fig. 12) by having more subtriangular shell and more radial ribs.

Scalaricardita laciarina differs from *S. camaronesia* by having a larger shell, less anteriorly placed umbo and narrower right middle tooth.

[Figure 3]

Other records of Carditidae

There are other mentions of Cenozoic Carditidae, some of them currently in open nomenclature or referred to incomplete shells. Herein, we describe and discuss two of these records.

Venericardia sp. (Buatois & Camacho, 1993). (Fig. 6.17–18; CPBA 15637). Buatois & Camacho described this taxon from Estancia Arroyo (lower Eocene, Leticia Formation, Tierra del Fuego Province) (=Rio Claro Formation from Camacho 1967) based on two small-sized triangular internal moulds with more than 12 radial ribs with intercostal spaces as wide as the radial ribs. The characters of the specimens are very poor and we assign them with doubts to the genus *Pleuromeris* Conrad, 1867.

Venericardia pueyrredona Ihering, 1907. (Fig. 4.10; PRI.66400–66401). This species was introduced by Ihering based on an illustration provided by Ortmann (1902: pl. 26, fig. 6) of a carditid from rocks of the 'Centinela' Formation exposed in the Lago Pueyrredon area (Santa Cruz Province). Ihering (1907) highlighted the subquadrate outline of this shell, with a marked angle between dorsal and posterior margins. The material studied by Ortmann (deposited in the Paleontological Research Institute) is an incomplete internal mould with the umbonal portion of the valve preserved. The strong angle appreciated by Ihering (1907) is due to incompleteness of the

shell. Characters such as convexity of umbo, and the number and size of radial ribs allow us to assign this mould to *Darwinicardia* n. gen. *patagonica* (Sowerby, 1846).

Discussion and conclusions

Previous to this systematic revision, the Argentinian Cenozoic carditids were assigned to the genera *Venericardia* (Ihering 1907), *Pleuromeris* (Malumián *et al.* 1978), *Cyclocardia* (del Río 1986), *Purpurocardia* (del Río 1986, 1991) and *Fasciculicardia* (del Río 2004; Griffin & Nielsen 2008). The systematic revision carried out herein allowed the confirmation of the presence of all these taxa except *Venericardia*. *Pleuromeris* is represented by two species (*P. sulcolunularis* and *P. fueguina*), instead of the five previously listed by del Río (2004). Conversely, *Cyclocardia* is a more diverse genus than previously thought, being represented by '*C.*' *nortensis*, *C. compressa*, *C. cannada* and *C. dalek* n. sp. The stratigraphic range of *Purpurocardia* goes back to the middle Eocene with the addition of *P. elegantoides*. Del Río (2004) and Griffin & Nielsen (2008) placed '*V.*' *patagonica* in *Fasciculicardia*, but in our revision this genus is only represented by an incomplete shell (*Fasciculicardia* sp.) from the Paraná Formation. For the upper Oligocene–middle Miocene '*V.*' *patagonica* a new genus is erected, i.e. *Darwinicardia* n. gen., which also includes the European species *D. angusticostata*. The genus *Scalaricardita* is mentioned for the first time in South America and includes two species, i.e. the early Miocene *S. camaronesia* and the early Pliocene *S. laciarina*. These records of *Scalaricardita* agree with the world stratigraphic range for the genus, restricted to the Miocene–Pliocene interval (Darragh 1970; Janssen & Moerdijk 2004). A second new genus (*Kolmeris* n. gen.) is proposed for the species *K. tehuelchana*, from Pliocene marine terraces near Cerro Laciar. This new genus also includes three Pliocene species from New Zealand. No species of *Venericardia sensu stricto* are present in Cenozoic Patagonian outcrops.

The number of species in Argentinean carditid assemblage is lower than previously supposed (del Río, 2004) because several species are no longer valid because they are synonyms to other species (*V. dalli*, *P. cruzensis*, *F. inaequalis* and *V. sylva*). A different situation occurs with the generic diversity of the group that increased with the inclusion of *Scalaricardita*, *Kolmeris* n. gen. and *Darwinicardia* n. gen. According to Huber (2010), the Carditidae are one of the most neglected families of bivalves. For example, the genus *Venericardia* is a highly diversified taxon represented by more than 50 Recent and several fossils species (Huber 2010), but many of these assignments were never reviewed. Therefore, the generic diversity of carditids could be under-estimated, in contrast with the specific diversity.

The confused taxonomic status of *Cardita elegantoides* is now resolved. This name is restricted to Ortmann's species (Ortmann 1899), while the specimens that Ihering assigned to it (Ihering 1907) now belong in *Cyclocardia dalek* n. sp.

Excluding planicostate and Paleocene carditids, 12 species of this family are described from Cenozoic rocks of Argentina: *Pleuromeris sulcolunularis*, *P. fueguina*, *Kolmeris tehuelchana*, *Scalaricardita camaronesia*, *S. laciarina*, *Cyclocardia cannada*, *C. dalek* n. sp., *C. compressa*, '*C.*' *nortensis*, *Darwinicardia patagonica*, *Purpurocardia elegantoides* and *P. leonensis*.

Acknowledgements

The authors are indebted to the curators who facilitated access to collections: M. Longobucco (MACN-Pi and CIRGEO-PI, Buenos Aires), M. Tanuz (CPBA, Buenos Aires), C. Salazar (SGO.Pi, Santiago), A. Riccardi (MLP, La Plata) and C. Frazén (PZ-NRM, Stockholm). We wish to thank M. Munt (BNHM, London), J. Simes (TM, GNS Science, Wellington), T. Trnski (AK, Auckland), W. Blom (AK, Auckland), H. Schlumpf (AK, Auckland), J. Pacaud (MNHM, Paris), P. Schuchert (GMNH, Geneva) and L. Cavin (GMNH, Geneva) for providing photographs of New Zealand and European fossil material. We thank M. Griffin (MLP, La Plata) for providing photographs of the holotype of *C. patagonica*, F. Medina (FCEN-UBA, Buenos Aires) for supplying us with stratigraphic information of Lago Cardiel fossils, P. Picasso for improving the English, and M. Álvarez (MACN-Pi, Buenos Aires) and M. B. Santelli (MACN-Pi, Buenos Aires) for their assistance the figures. We also thank the editor N. Malchus, the reviewer P. Valentich-Scott and an anonymous reviewer for their constructive comments.

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