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Bivalves from the Chilean Fjords Region: Knowns and unknowns*

Marina Güller[1] and Diego G. Zelaya[2]

[1]Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Av. Ángel Gallardo 470 (C1405DJR), Buenos Aires, Argentina

[2]Departamento de Biodiversidad y Biología Experimental, Facultad de Ciencias Exactas y Naturales – UBA, Ciudad Universitaria, Pab. 2, Lab. 31 (C1428EHA), Buenos Aires, Argentina

Correspondence, Marina Güller: mguller@macn.gov.ar

Abstract: The Chilean Fjords Region has been regarded as one of the most complex coastal systems of the world, with a high level of mollusk diversity. Contradictorily, bivalves from this region have been recently considered both well and insufficiently known. This study critically evaluates the current state of knowledge on bivalves from the Chilean Fjords Region, by combining information coming from previously published literature, the study of material housed at museum collections, and new data coming from recently collected material. Although a total of 223 species appear listed in the literature for the area, only 81 valid species have documented records, the remaining corresponding to *nomina dubia/nuda*, synonyms, misidentifications, species complexes or species which were listed for the area, but based on unknown sources. The present study makes evident that, after more than two centuries the knowledge on bivalve diversity from the Chilean Fjords Region still remains at its first stages.

Key words: Diversity, Bivalvia, Chile

The southern coastal and shelf area of Chile is characterized by the presence of numerous fjords, originated as a consequence of the advance and retraction of the ice during the last glacial maximum (Pleistocene), and the subsequent flooding of the glacial valleys by the sea (Hervé *et al.* 2010, Soto 2010). Due to this peculiar physiognomy, the area is known as the "Chilean Fjords Region" (CFR). In addition to the glacial events the area was also modeled by several tectonic processes, such as the uplift of the Andes ridge, which originated numerous islands, islets, gulfs and channels, and the preponderance of steep, rocky shores and the presence of great depths near the coast (Coronato *et al.* 1999, Hromic *et al.* 2006, Försterra 2010). These processes turned the CFR into one of the most intricate systems in the world (Brattström and Johanssen 1983, Palma and Silva 2004).

Hydrologically, the CFR is under the incidence of the West Wind Drift (a low temperature and salinity sub-Antarctic superficial water mass) that reaches the west coast of South America, between 40–48°S (Camus 2001, Thiel *et al.* 2007) (Fig. 1). At this point, it divides into two main branches: the Perú-Chilean Current, an oceanic flux heading northwards, and the Cape Horn Current, that flows south-eastwards towards the Atlantic Ocean, influencing the southern part of the CFR. This latter current gives origin to a coastal branch that heads north parallel to the Chilean coast: the Fjords Current (Fernández *et al.* 2000, Camus 2001). The northern part of the CFR is mainly under the influence of this latter current, which enters the area as a consequence of tide oscillation and circulation induced by density fluctuations (Sobarzo Bustamante 2010). Inside the fjords, this sub-Antarctic water mass is mixed with freshwater coming from river input, glacial melting and rain, resulting in the so called "Subantarctic Modified Water", which shows extremely local hydrological conditions (Fernández *et al.* 2000, Camus 2001).

The aim of this contribution is to critically evaluate the current state of knowledge on bivalves from the Chilean Fjords Region, with view to providing a baseline for new biogeographic and taxonomic studies.

Previous studies on bivalves from the CFR

The first descriptions of bivalves from the CFR were performed by the cleric-naturalist Giovanni Ignazio Molina, who in 1782 described five Chilean species of bivalves. The 19th century was the beginning of a series of international exploratory campaigns to South America, in which Chilean bivalves were included. In this context, John Edward Gray

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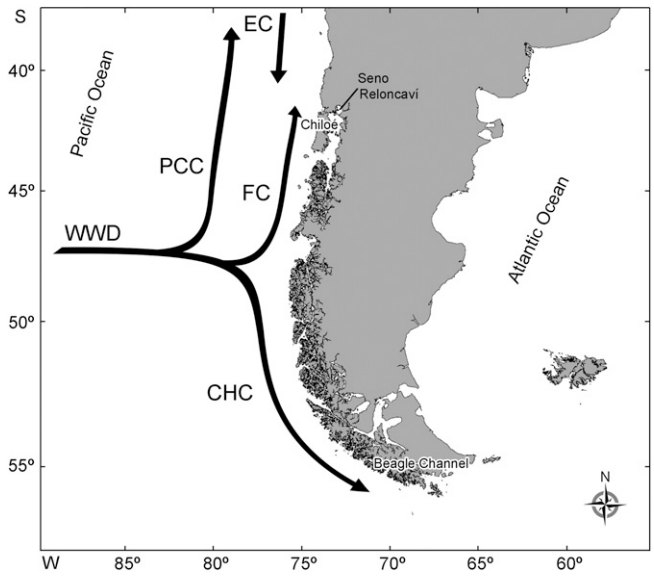

Figure 1. Humboldt Current System. (CHC, Cape Horn Current; EC, Equatorial Current; WWD, West Wind Drift; PCC, Perú-Chilean Current; FC, Fjords Current).

(1828, 1837) studied the mollusks collected in Chile and housed at the collections of the British Museum; and captain Philip Parker King (1832) described the mollusks collected between 1826 and 1830 by the H.M.S. *Beagle* and *Adventure* expeditions.

Between 1822 and 1831, Hugh Cuming – a shell collector – resided in Valparaíso (central Chile); during these years, he made important collections of mollusks along the Chilean coast. In 1831, when Cuming returned to England, he made available these collections to George Brettingham Sowerby I and Lovell Augustus Reeve who, based on this material, described several new species (G. B. Sowerby I 1833a, 1833b, 1833c, 1834a, 1834b, 1835a, 1835b, 1835c, Reeve 1843). Between 1828 and 1841, the French botanist Claudio Gay, made numerous sampling trips along Chile, collecting specimens of almost all zoological groups, among them the mollusks, which were studied by H. Hupé (1854). Another great contribution to the knowledge of Chilean bivalves was made by Rudolf Amandus Philippi. His contribution to the group started in Germany, when he obtained a position as professor at the industrial lyceum of Kassel (Philippi 1844a, 1844b, 1845). Then, in 1851, Philippi moved to Chile, where he continued to study the local fauna, and described several new species (Philippi 1858, 1868, 1893).

Between the end of the 19th and the beginning of the 20th centuries, the studies on Chilean bivalves had a new impulse, due to the information arising from the H.M.S. *Alert*, the Swedish and German expeditions, and the U.S.S. *Albatross*. Edgar Allan Smith (1881), Walter Stempell (1899), and Dall (1908a) were responsible for studying the mollusks from these expeditions, respectively. By the middle of the 20th century, two new expeditions brought new insights to the knowledge of Chilean bivalve diversity: the *Lund University Chile Expedition*, performed between 1948 and 1949, between 41° and 54°S (bivalves studied by Soot-Ryen (1957, 1959)) and the *Royal Society Expedition to Southern Chile*, which between 1958 and 1959 obtained samples from Chiloé (42°S) and Wellington (49°S) islands; the mollusks collected during this expedition were studied by Dell (1971).

In 1995, the Comité Oceanográfico Nacional de Chile (CONA), started a program of scientific study of the Chilean austral sea, called "CIMAR" ("Cruceros de Investigación Marina en Áreas Remotas). As part of this program, 17 cruises were performed along the Chilean coast, resulting in valuable and novel physical and biological information; four of these cruises (CIMAR 7, 8, 10 and 12), provided valuable information on the bivalve fauna: the CIMAR 7, performed from Boca del Guafo (43°39′18″S) to estero Elefantes (46°28′88″S); CIMAR 8 from Boca del Guafo (43°40′57″S) to Ana Pink (45°50′09″S); CIMAR 10 from seno Reloncaví (41°31′S) to Boca del Guafo (43°49′S); and CIMAR 12 from seno Reloncaví (41°33′ S) to Boca del Guafo (43°49′S). These cruises obtained samples of bivalves from 146 sites in total, which were studied by Osorio *et al.* (2003, 2005, 2006), Osorio and Reid (2004), Cárdenas *et al.* (2008), Valdovinos *et al.* (2008) and Ramajo and Osorio (2010). Complementary information of mollusks from estero Elefantes and Laguna San Rafael was given by Reid and Osorio (2000). The most abundant and conspicuous bivalve species from the CFR were also considered in the illustrated identification guide "Marine Benthic Fauna of Chilean Patagonia" (Zelaya 2010).

Simultaneously to the above mentioned contributions, there were a series of catalogs / check-lists that compiled the information available (at different times) on Chilean bivalves, or that included this fauna in the context of the study of the fauna from a wider area. Among them should be mentioned the contributions by Hupé (1854, on Chilean mollusks), Carcelles and Williamson (1951, on Magellanic mollusks), Bernard (1983, Eastern Pacific Ocean bivalves), Osorio and Bahamonde (1970, Chilean bivalves), Ramírez-Bohme (1993, Chilean bivalves) and Valdovinos (1999, Chilean mollusks).

MATERIALS AND METHODS

All published records on the distributional ranges, systematics and taxonomy on the Recent bivalve fauna from the southern coast and shelf of Chile, from the northernmost part of Seno Reloncaví (41°23′S) to the western mouth of Beagle Channel (55°S) (excluding the inner part of the Beagle

Channel as well as the Magellan Strait) were critically compiled. This compilation included all the publications listed in the section "Previous studies on bivalves from the CFR", as well as the original description of all the species reported from the area. Additional information comes from: Aldea and Troncoso (2008), Aldea and Valdovinos (2005), Aldea *et al.* (2002), Ashton (2007), Buroker *et al.* (1983), Castellanos (1971), Castilla and Guiñez (2000), Castilla *et al.* (2005), Cazzaniga (1994), Chaparro *et al.* (1993), Coan (1988, 1997, 1999, 2000), Dall (1890, 1901, 1908b, 1909), del Rio (1997), Dell (1964, 1972, 1990), Dijkstra and Köhler (2008), Dijkstra and Marshall (2008), d'Orbigny (1834–1847), Grau (1959), Güller and Zelaya (2011, 2013), Hanley (1860), Holmes *et al.* (2005), Huber (2010), Jonkers (2003), Knudsen (1970), Lamy (1906, 1912, 1922, 1931, 1934), Letelier *et al.* (2003), Linse (1997, 2002), Linse and Brandt (1998), Malchus (2006), Marincovich (1973), Marshall (2002), Nielsen and Valdovinos (2008), Ó Foighil *et al.* (1999), Osorio (2002), Osorio *et al.* (1983), Pastorino and Bagur (2011), Pérez *et al.* (2013), Petit (2009), Philippi (1860), Rabarts and Whybrow (1979), Ramorino (1968), Riveros Zuñiga and González Reyes (1950), Signorelli and Alfaya (2014), Signorelli and Pastorino (2011), Simone (2009), Simone and Penchaszadeh (2008), Smith (1885), Stuardo (1960, 1962), Tarifeño *et al.* (2012), Toro and Aguila (1996), Toro and González (2009), Toro *et al.* (2005), Trovant *et al.* (2014), Turner (1966), Urban and Campos (1994), Villarroel and Stuardo (1998), Waloszek (1984), Zagal and Hermosilla (2001), Zelaya (2009), and Zelaya and Ituarte (2004, 2006, 2013).

With view to evaluating the reliability of the currently published information on the CFR bivalve fauna, bibliographic information was contrasted / supplied with new samples coming from 92 sampling stations, obtained from the intertidal to 260 m depth, and the study of the collections of the Museo Nacional de Historia Natural (MNHN), Santiago de Chile; Museo de Zoología de la Universidad de Concepción (MZUC), Concepción; Museo de La Plata (MLP), La Plata; Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (MACN), Buenos Aires; and the Natural History Museum of Los Angeles County (LACM), Los Angeles. The collections of the MNHN and MZUC are the repository of the mollusks collected during the CIMAR cruises.

A list of all nominal species mentioned from the CFR is provided in Appendix 1 (DOI: 10.4003/006.033.0218.s1). The order of families follows Carter *et al.* (2011), and within each family, species are arranged alphabetically. Due to the few studies dealing with revision of Chilean bivalves, a number of taxonomic problems arise when performing such compilation: 1) in some cases it is not possible at present to determine if different nominal species actually comprise different taxa or correspond to intraspecific variants. These taxa are herein referred to as "**species complexes**". 2) The occurrence of some species in the CFR appears unlikely; these species are considered as "**doubtful**". Records from the CFR that have been reassigned to another species in previous studies or herein, are labeled "**misidentification**" (note that the term applies only to CFR records not implying species synonymy). Other nominal species reported for the CFR are currently considered synonyms, *nomina nuda* or *nomina dubia*. By excluding the synonyms, *nomina nuda* / *dubia*, misidentifi cations, species complexes and doubtful species, all other taxa included in the Appendix 1 (DOI: 10.4003/006.033.0218.s1) are regarded either as "**documented**" species (those having precise information on the site of collection) or "**mentioned**" species (if the source of the record is unknown, but its presence is plausible). Only the former are considered in the analyses performed in the results section.

For the distributional analysis, the CFR was divided into 0.5° latitudinal ranges. Documented records for each species at each latitudinal range are indicated in Appendix 2 (DOI: 10.4003/006.033.0218.s1). Previous published records with no indication of geographic coordinates were georeferenced by using external evidence (Sources: Chilean National Weather Service and/or Google Earth). Two species have been only previously recorded from "Chiloé" (*Sphenia hatch-eri* Pilsbry, 1899 and *Petricola dactylus* G.B. Sowerby I, 1823). These species were therefore classifi ed as "documented", but due to the extension of this island, their record could not be properly georreferenced. Only information coming from natural populations was considered. Consequently, *Crassostrea gigas* (Thunberg, 1793) was excluded for being a cultured species in Chile, for which the presence of natural populations in the CFR is not yet documented. Further infor-mation on the new records here provided will be published in a subsequent contribution.

RESULTS

A total of 223 nominal species of bivalves appear listed in the bibliography as present in the CFR (Appendix 1; DOI: 10.4003/006.033.0218.s1). However, the presence of only 79 of these species is documented up to now. The re-maining species correspond either to *nomina dubia/nuda* (3 species), synonyms (46 species), misidentifi cations (9 spe-cies), "species complexes" (30 species), "doubtful" (28 spe-cies) or "mentioned" (28 species) taxa.

As part of this study, material belonging to 58 species from the CFR was personally examined. This material provides new latitudinal records for 46 species, including the finding of four species here reported for the first time in this area: *Cyclopecten multistriatus* Linse, 2002, previously known from the Beagle Channel; *Thyasira patagonica* Zelaya, 2010, previously known from the Magellan Strait and Beagle

Channel; *Limatula chilensis* Campusano, Ruz and Oliva, 2012, previously only known from the type locality at Punta Coloso (23°45′S 70°28′W); and *Hiatella meridionalis* (d'Orbigny, 1846) previously known from the southwestern Atlantic (Simone and Penchaszadeh, 2008). The records of *Thyasira patagonica* are based on the previous (mis)identification of "*Thyasira*" *magellanica* Dall, 1901, by Cárdenas *et al.* (2008: fig. 6.81).

The present study also allows confirmation of the presence of *Gaimardia bahamondei* Osorio and Arnaud, 1984, and *Mulinia byronensis* Gray, 1837, in the area. These species had been previously listed for the CFR, but until now had no published documented records in the area. The distribution of eight other species is here extended, either southwards (*Dermatomya chilensis* Dall, 1908, *Cumingia mutica* G. B. Sowerby I, 1833, *Semele solida* (Gray, 1828), *Ostrea chilensis* Philippi in Küster, 1844, *Brachidontes granulatus* (Hanley, 1843) and *Philobrya brattstromi* Soot-Ryen, 1957) or northwards (*Ennucula eltanini* Dell, 1990 and *Gaimardia trapesina* (Lamarck, 1819)).

Taking into account the above mentioned new findings, the present diversity of bivalves from the CFR accounts for a total of 85 species with documented records (Table 1).

When considering the type locality of the species with documented records in the CFR, it becomes evident that most of the species have been described from Chilean Pacific waters (50.6% of the total) or adjacent areas (Magellan Strait: 14.5%, Beagle Channel: 9.6%, Argentina: 9.6%, Perú: 2.4%); a few species were described from an imprecise (*e.g.*, "Southern South America") or unknown locality (7.2%); and the remaining 6.0% correspond to species described from Antarctic waters, sub-Antarctic islands or even Europe (Fig. 2). Out of the species described from the Chilean Pacific waters, the number described from the CFR is similar to those described from northern and central Chile (*i.e.*, north of Seno Reloncaví).

The species with documented records in the CFR have mostly been described during two periods: 1817–1854 (37 species) and 1875–1912 (27 species) (Fig. 3). After 1912, descriptions of new species became only sporadic, with four new taxa in 1957, and ten more species from 1984 to date. It is interesting to note that the ten new species described in the last 30 years, correspond to small-sized species (< 10 mm maximum length). However, as mentioned before, only 27% of the species with documented records in the CFR were described from this area (Fig. 2). When considering the date of the first documented record in the CFR for each of these species (instead of the date of description of the species), a considerable delay between the time of description of a particular species and the finding of such species in the CFR becomes evident (Fig. 3). The first documented record dates from 1782, corresponding to a species described from the CFR (*Pholas chiloensis* Molina, 1782) and, until 1832, this was the only species known from the area. Between 1832 and 1958, the presence of 41 species (about 50% of those currently documented for the area) was documented. Since 1959, the differences between the description and findings curves becomes even more notorious, evidenced by an abrupt and extended increase in the number of recorded species described from other areas. In fact, 48% of the species currently documented from the CFR were first reported during this period (Fig. 3).

With the only exception of five species (*Nucula pseudoexigua* Villarroel and Stuardo, 1998, *Cyclopecten subhyalinus* (Smith, 1885), *Cyamiocardium dahli* Soot-Ryen, 1957, *Mysella cahuelmensis* Güller and Zelaya, 2012, and *Dermatomya chilensis* Dall, 1908), all other taxa also appear reported outside the CFR either at northern Chile, the Magellan Strait, the Beagle Channel, or the southwestern Atlantic. However, the "endemic" condition of these species should be taken with caution, because they have been either recently described, they are small-sized species (not frequently sampled in the adjacent areas) or were collected at great depths (a habitat not well-sampled in these areas). In fact, the only known record for these species comes from their original description.

The latitudinal analysis of species diversity shows a contrasting scenario when considering the distributional ranges of the species and when considering the documented records. In the first case, almost all latitudinal ranges show a similar species richness (between 48 and 65 species), and 61% of the species appear as widely distributed along the CFR (*i.e.*, encompassing more than 10° latitude). In the second case, species richness is consistently lower at any latitudinal range and, in addition, a heterogeneous pattern becomes evident when comparing different latitudes (Fig. 4). In this case, only eight 0.5° latitudinal ranges show more than 20 species with documented records, and only two latitudinal ranges have more than 30 species each. The highest species richness appears at 41.5–42.5°S, 45.0–45.5 and 50.0–50.5°S, and the species richness is abruptly reduced between 47.0–47.5°S, 49.5–50.0°S and 50.5–51.0°S, where only one, two and three species (respectively) have been recorded.

Contrasting the previously published literature with the new information arising from this study, it becomes evident that our knowledge on the species richness of some particular areas is considerably increased (Fig. 4). This fact is particularly evident between 42.0–42.5°, and 50.0–50.5° from where 19 and 11 species (respectively) are found for the first time.

DISCUSSION

This study makes evident that the currently available literature greatly overestimates the species richness of

Table 1. Species of bivalves with documented records in the CFR. ("*", species for which material from the CFR was personally studied). References concerning the description of these species are listed in Appendix 1 (DOI: 10.4003/006.033.0218.s1).

SOLEMYIDAE
Acharax patagonica (Smith, 1885)*
NUCULIDAE
Ennucula eltanini Dell, 1990*
Ennucula grayi (d'Orbigny, 1846)*
Ennucula puelcha (d'Orbigny, 1842)*
Nucula falklandica Preston, 1912*
Nucula pisum G. B. Sowerby I, 1833*
Nucula pseudoexigua Villarroel and Stuardo, 1998*
NUCULANIDAE
Nuculana cuneata (G. B. Sowerby I, 1833)
Propeleda cf. *longicaudata* (Thiele, 1912)*
MALLETIIDAE
Malletia magellanica (Smith, 1875)*
NEILONELLIDAE
Neilonella sulculata (Couthouy in Gould, 1852)*
SAREPTIDAE
Yoldia cf. *eightsii* (Couthouy in Jay, 1839)
Yoldiella chilenica Dall, 1908*
Yoldiella indolens Dall, 1908*
PHASEOLIDAE
Silicula patagonica Dall, 1908
TINDARIIDAE
Tindaria virens Dall, 1890*
LIMOPSIDAE
Limopsis hirtella Mabille and Rochebrune in Rochebrune and Mabille, 1889
PHILOBRYIDAE
Philobrya brattstromi Soot-Ryen, 1957*
Philobrya crispa Linse, 2002
MYTILIDAE
Aulacomya atra (Molina, 1782)*
Brachidontes granulatus (Hanley, 1843)*
Choromytilus chorus (Molina, 1782)*
Mytilus chilensis Hupé in Gay, 1854*
Mytilus galloprovincialis Lamarck, 1819*
Perumytilus purpuratus (Lamarck, 1819)*
CRENELLIDAE
Crenella magellanica Linse, 2002
LIMIDAE
Acesta patagonica Dall, 1902*
Limatula chilensis Campusano, Ruz and Oliva, 2012*
Limea pygmaea (Philippi, 1845)
OSTREIDAE
Ostrea chilensis Philippi in Küster, 1844*
PECTINIDAE
Austrochlamys natans (Philippi, 1845)*
Zygochlamys patagonica (King, 1832)*
PROPEAMUSSIIDAE
Cyclopecten multistriatus Linse, 2002*
Cyclopecten subhyalinus (Smith, 1885)
Delectopecten gelatinosus (Mabille and Rochebrune in Rochebrune and Mabille, 1889)*
LUCINIDAE
Lucinoma lamellata (Smith, 1881)*
UNGULINIDAE
Diplodonta inconspicua Philippi, 1845*
THYASIRIDAE
Adontorhina pisum (Dall, 1908)*
Conchocele? fuegiensis (Dall, 1890)
Parathyasira magellanica (Dall, 1901)*
Thyasira patagonica Zelaya, 2010*
ASTARTIDAE
Astarte longirostra d'Orbigny, 1842
CARDITIDAE
Cyclocardia compressa (Reeve, 1843)*
Cyclocardia velutina (Smith, 1881)*
CONDYLOCARDIIDAE
Carditella naviformis Reeve, 1843*
Carditella tegulata (Reeve, 1843)*
Carditopsis flabellum (Reeve, 1843)*
GALEOMMATIDAE
Waldo cf. *digitatus* Zelaya and Ituarte, 2013
LASAEIDAE
Mysella cahuelmensis Güller and Zelaya, 2012*
Mysella mabillei (Dall, 1908)
NEOLEPTONIDAE
Neolepton concentricum (Preston, 1912)
Neolepton hupei Soot-Ryen, 1957
VENERIDAE
Ameghinomya antiqua (King, 1832)*
Leukoma thaca (Molina, 1782)
Retrotapes exalbidus (Dillwyn, 1817)*
Retrotapes lenticularis (G. B. Sowerby I, 1835)*
Tawera elliptica (Lamarck, 1818)*
Petricola dactylus G. B. Sowerby I, 1823*
CYAMIIDAE
Cyamiocardium dahli Soot-Ryen, 1957*
Reloncavia chilenica (Soot-Ryen, 1957)
TELLINIDAE
Macoma inornata (Hanley, 1844)*
PSAMMOBIIDAE
Gari solida (Gray, 1828)*
SEMELIDAE
Cumingia mutica G. B. Sowerby I, 1833*
Semele solida (Gray, 1828)*
SOLECURTIDAE
Tagelus dombeii (Lamarck, 1818)*
PHARIDAE
Ensis macha (Molina, 1782)*
MACTRIDAE
Darina solenoides (King, 1832)
Mulinia byronensis Gray, 1837*
Mulinia edulis (King, 1832)*
Mulinia exalbida Gray, 1837*

Table 1. (Continued)

MESODESMATIDAE
Mesodesma donacium (Lamarck, 1818)*
MYIDAE
Sphenia hatcheri Pilsbry, 1899
GAIMARDIIDAE
Gaimardia bahamondei Osorio and Arnaud, 1984*
Gaimardia trapesina (Lamarck, 1819)*
HIATELLIDAE
Hiatella meridionalis (d'Orbigny, 1846)*
PHOLADIDAE
Nettastoma darwinii (G. B. Sowerby II, 1849)
Pholas chiloensis Molina, 1782*
Xylophaga globosa G. B. Sowerby I, 1835
TEREDINIDAE
Bankia martensi (Stempell, 1899)*
CUSPIDARIIDAE
Cuspidaria cf. *infelix* Thiele, 1912*
Cuspidaria patagonica (Smith, 1885)
Luzonia chilensis (Dall, 1890)
VERTICORDIIDAE
Policordia radiata (Dall, 1889)
POROMYIDAE
Dermatomya chilensis Dall, 1908*
Dermatomya cf. *mactroides* Dall, 1889

bivalves from the CFR, as previously suggested by Kiel and Nielsen (2010). According to this study, out of the 223 nominal species of bivalves listed from this area only 81 species are valid and have documented records (including two species documented here by first time for the area). Other 54 species listed from the CFR are valid taxa, well-known from other geographic areas, but with no documented (or at least published) records in the CFR, to confirm their actual occurrence in the area. This fact suggests either that there could be a bulk of unpublished information (with the material not housed at the main local repositories) or that these taxa were subjectively listed from this area, due to their occurrence in the "vicinity" of the CFR. However, considering the distributional ranges of these species, 28 of them are here regarded as improbably present in the CFR (species reported as "doubtful" in the Appendix 1) (DOI: 10.4003/006.033.0218.s1). The inclusion of the remaining 88 nominal species in the CFR arises in a number of taxonomic problems, such as the usage of different names to refer to the same species (synonyms), the wrong usage of names (misidentifi cations), and the exis-tence of several "species complexes", for which it is diffi cult at present to determine with precision their local (*e.g.*, *Pandora* Bruguière, 1797) or even worldwide (*e.g.*, *Lasaea* Brown, 1827, *Kellia* Turton, 1822) species richness. Our preliminary studies suggest that several species within these "complexes" could be synonyms; consequently, we preferred to be conservative and exclude these taxa from the present analyses, given that their inclusion (as done in previous studies) would artificially increase the actual local species richness.

Miloslavich *et al*. (2011), regarding the diversity of Chilean marine invertebrates as a whole, considered this fauna as well-known, and particularly the mollusks as one of the groups with "the best state of taxonomic knowledge". This statement is not surprising when considering that the mollusk fauna of Chile had been previously considered as "relatively well known", according to the European standards of the mid-19th century (Reid and Osorio 2000). The fact that only 14/4 new species of bivalves have been described in the last 100/10 years (respectively) from the CFR, also seems in accordance with this interpretation, by suggesting that the description curve of new species could be reaching a plateau. However, this is far from being true, at least for the CFR, where the low number of new species described in the last years seems to be reflecting the low number of systematic and taxonomic studies performed on the bivalve fauna from this area. In fact, only four particular groups of bivalves (Pectinidae: Waloszek 1984, Protobranchia: Villarroel and Stuardo 1998, Mactridae: Signorelli and Pastorino 2011, and Carditoidea: Güller and Zelaya 2013) were systematically addressed in the last 30 years; and similar revisions are still missing for several other groups (among them, the members of the "species complexes", recognized in the

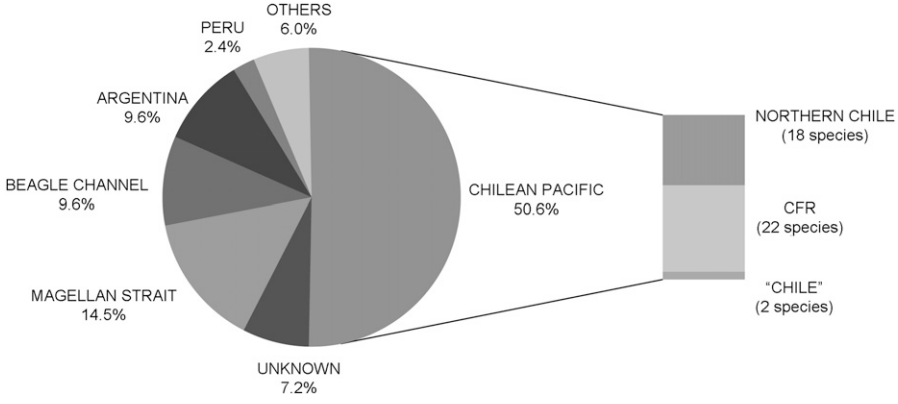

Figure 2. Site of description of the species with documented records in the CFR.

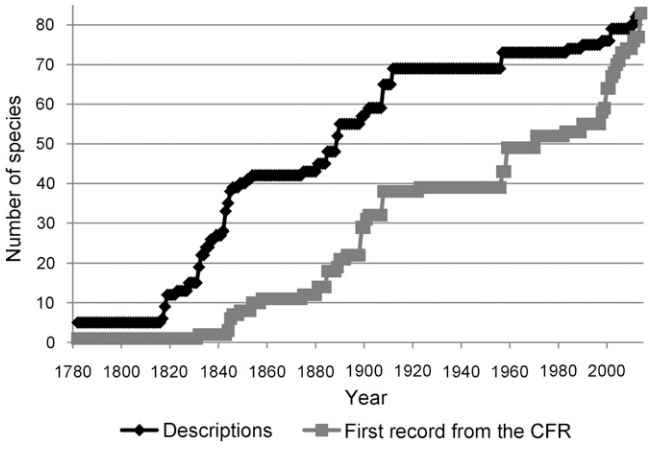

Figure 3. Cumulative number of species present in the CFR, along the years. (Black line, considering date of description of the species; Gray line, considering the first documented record in the CFR).

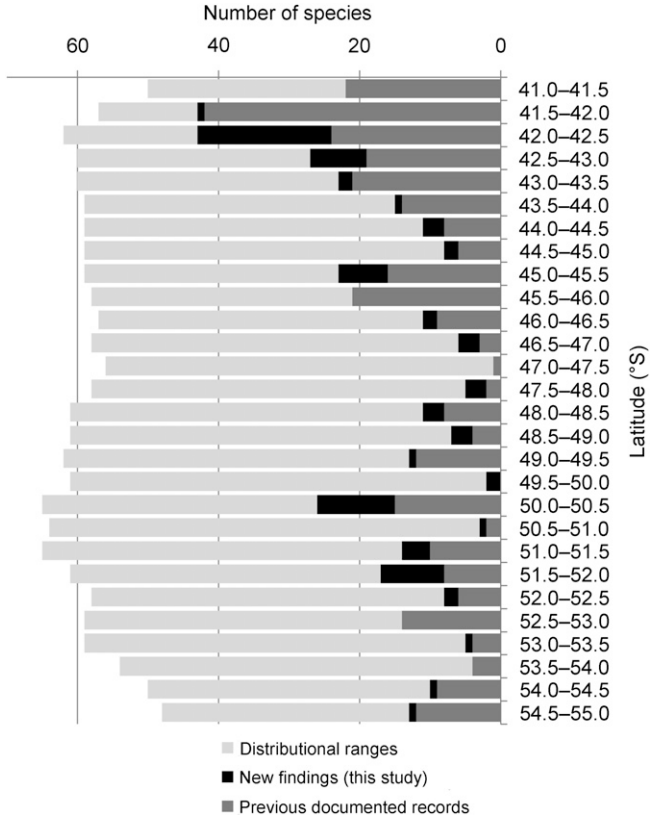

Figure 4. Number of species with documented records in the CFR, at each 0.5° latitudinal range, according to distributional ranges and documented records (previous and new findings).

Appendix 1) (DOI: 10.4003/006.033.0218.s1). Furthermore, the history of bivalve knowledge in the CFR shows that every new sampling performed in the area resulted in the fi nding of species previously unknown (or at least not docu-mented) from this area, and new distributional records for already known species. This is evident in the last 55 years on the basis of the results of the *Lund University Expedition*, the *Royal Society Expedition to Southern Chile*, the CIMAR cruises, and the material sampled as part of this study. In these cases, the increase in the number of species was not originated in the description of new species but in the docu-mentation in the CFR of species previously described from other (usually adjacent) areas. These new fi ndings suggest greater changes in the species richness known at any lati-tude. In this regard, Valdovinos (1999) reported the maxi-mum species diversity at 45°S, by considering continuous distributional ranges for the species. This maximum of spe-cies richness greatly differs with the results arising from the present study, where the greater diversity was found be-tween 41.5 and 42.5°S when considering documented re-cords. In addition, according to distributional ranges, 61% of the species appear as widely distributed along the CFR (*i.e.*, extending for more than 10° latitude); However, this study, makes evident that most species only have a few iso-lated records in the area, and only 11 species have docu-mented records in more than 10 latitudinal ranges. Also interesting to note is the extremely low number of species currently known from some particular areas, such as 47.0–47.5°S, 49.5–50.0°S and 50.5–51.0, which correspond to ar-eas of diffi cult access (such as the north and south Chilean ice fi elds).The above mentioned scenario makes evident that the knowledge on the species richness from the CFR is still at its first stages. Consequently, any ecological result of this fauna, such as the "increase in the number of species towards higher latitudes, south of 42°S" reported by Valdovinos *et al.* (2003), and posteriorly discussed by Kiel and Nielsen (2010), should be taken, at least, with caution.

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LITERATURE CITED

Aldea, C. and J. S. Troncoso. 2008. Systematics and distribution of shelled molluscs (Gastropoda, Bivalvia and Scaphopoda) from the South Shetland Islands to the Bellingshausen Sea, West Antarctica. *Iberus* **26**: 43–117.

Aldea, C., J. Olave and C. Valdovinos. 2002. Descripción de la concha de *Cumingia mutica* Sowerby, 1833 (Bivalvia, Semelidae) de la costa chilena. *Boletín de la Sociedad de Biología de Concepción* **73**: 77–82. [In Spanish].

Aldea, C. and C. Valdovinos. 2005. Moluscos del intermareal rocoso del centro-sur de Chile (36°-38°S): Taxonomía y clave de identificación. *Gayana* **69**: 364–396. [In Galician].

Ashton, T. 2007. *A Field Guide to Molluscs of Northern Chile*. S. I. Native Marine,[place of publication not stated].

Bernard, F. R. 1983. Catalogue of the living Bivalvia of the Eastern Pacific Ocean: Bering Strait to Cape Horn. *Canadian Special Publication of Fisheries and Aquatic Sciences* **61**: 1–102.

Brattström, H. and A. Johanssen. 1983. Ecological and regional zoogeography of the marine benthic fauna of Chile. *Sarsia* **68**: 289–339.

Buroker, N. E., P. Chanley, H. J. Cranfield, and P. Dinamani. 1983. Systematic status of two oyster populations of the genus *Tiostrea* from New Zealand and Chile. *Marine Biology* **77**: 191–200.

Camus, P. A. 2001. Biogeografía marina de Chile continental. *Revista chilena de Historia Natural* **74**: 587–617.[In Spanish].

Carcelles, A. R. and S. I. Williamson. 1951. Catálogo de los moluscos marinos de la Provincia Magallánica. *Revista Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"*, Zoología **2**: 225–383. [In Spanish].

Cárdenas, J., C. Aldea, and C. Valdovinos. 2008. Chilean marine Mollusca of northern Patagonia collected during the CIMAR-10 Fjords cruise. *Gayana* **72**: 31–67.

Carter, J. G., C. R. Altaba, L. C. Anderson, R. Araujo, A. S. Biakov, A. E. Bogan, D. C. Campbell, M. Campbell, C. Jin-hua, J. C. W. Cope, G. Delvene, H. H. Dijkstra, F. Zong-jie, R. N. Gardner, V. A. Gavrilova, I. A. Goncharova, P. J. Harries, J. H. Hartman, M. Hautmann, W. R. Hoeh, J. Hylleberg, J. Bao-yu, P. Johnston, L. Kirkendale, K. Kleemann, J. Koppka, J. Kříž, D. Machado, N. Malchus, A. Márquez-Aliaga, J. P. Masse, C. A. McRoberts, P. U. Middelfart, S. Mitchell, L. A. Nevesskaja, S. Özer, J. Pojeta, Jr., I. V. Polubotko, J. M. Pons, S. Popov, T. Sánchez, A. F. Sartori, R. W. Scott, I. I. Sey, J. H. Signorelli, V. V. Silantiev, P. W. Skelton, T. Steuber, J. B. Waterhouse, G. L. Wingard, and T. Yancey. 2011. A synoptical classification of the Bivalvia (Mollusca). *Paleontological Contributions* **4**: 1–47.

Castellanos, Z. A. 1971. Los *Chlamys* más comunes del Mar Argentino. *Neotropica* **17**: 55–65. [In Spanish].

Castilla, J. C. and R. Guiñez. 2000. Disjoint geographical distribution of intertidal and nearshore benthic invertebrates in the Southern Hemisphere. *Revista Chilena de Historia Natural* **73**: 585–603.

Castilla, J. C., M. Uribe, N. Bahamonde, M. Clarke, R. Desqueyroux-Faúndez, I. Kong, H. Moyano, N. Rozbaczylo, B. Santelices, C. Valdovinos, and P. Zavala. 2005. Down under the southeastern Pacific: Marine non-indigenous species in Chile. *Biological Invasions* **7**: 213–232.

Cazzaniga, N. J. 1994. A concern for grammar: The name of the Magellanic mussel (Bivalvia: Mytilidae). *Malacological Review* **27**: 110.

Chaparro, O. R., R. J. Thompson, and J. E. Ward. 1993. *In vivo* observations of larval brooding in the Chilean oyster, *Ostrea chilensis* Philippi, 1845. *Biological Bulletin* **185**: 365–372.

Coan, E. V. 1988. Recent eastern Pacific species of the bivalve genus *Semele*. *The Veliger* **31**: 1–42.

Coan, E. V. 1997. Recent species of the genus *Petricola* in the Eastern Pacific (Bivalvia: Veneroida). *The Veliger* **40**: 298–340.

Coan, E. V. 1999. The eastern Pacific species of *Sphenia* (Bivalvia: Myidae). *The Nautilus* **113**: 103–120.

Coan, E. V. 2000. The eastern Pacific recent species of the bivalve genus *Gari* (Tellinoidea: Psammobiidae), with notes on western Atlantic and fossil taxa. *Malacologia* **42**: 1–29.

Coronato, A., M. Salemme, and J. Rabassa. 1999. Palaeoenvironmental conditions during the early peopling of Southernmost South America (Late Glacial-Early Holocene, 14-8 ka B.P.). *Quaternary International* **53/54**: 77–92.

Dall, W. H. 1890. Scientific results of explorations by the U.S. Fish Commission steamer "Albatross" N° 7. Preliminary report on the collection of Mollusca and Brachiopoda obtained in 1887/8. *Proceedings of the United States National Museum* **12**: 219–362, pls. 5–14.

Dall, W. H. 1901. Synopsis of the Lucinacea and of the American species. *Proceedings of the United States National Museum* **23**: 779–833, pls. 38–42.

Dall, W. H. 1908a. Reports on the dredging operations off the West coast of Central America to the Galápagos, to the West coast of Mexico, and in the Gulf of California and reports on the scientific results of the expedition to the Eastern Tropical Pacific. Reports on the Mollusca and Brachiopoda. *Bulletin of the Museum of Comparative Zoology Harvard* **43**: 205–487, 222 pls.

Dall, W. H. 1908b. A revision of the Solenomyacidae. *The Nautilus* **22**: 1–2.

Dall, W. H. 1909. Report on a collection of shells from Peru, with a summary of the marine Mollusca of the Peruvian zoological province. *Proceedings of the United States National Museum* **37**: 147–294, pls. 120–128.

del Río, C. J. 1997. Cenozoic biogeographic history of the eurythermal genus *Retrotapes*, new genus (subfamily Tapetinae) from Southern South America and Antárctica. *The Nautilus* **10**: 77–93.

Dell, R. K. 1964. Antarctic and sub-Antarctic Mollusca: Amphineura, Scaphopoda and Bivalvia. *Discovery Reports* **33**: 93–250.

Dell, R. K. 1971. The marine mollusca of the Royal Society Expedition to Southern Chile, 1958-59. *Records of the Dominion Museum* **7**: 155–233.

Dell, R. K. 1972. Notes on nomenclature of some Mollusca from Antarctica and southern South America. *Records of the Dominion Museum* **8**: 21–42.

Dell, R. K. 1990. Antarctic Mollusca with special reference to the fauna of the Ross Sea. *Bulletin of the Royal Society of New Zealand* **27**: 1–311.

Dijkstra, H. H. and F. Köhler. 2008. An annotated catalogue of Recent Pectinoidea (Mollusca, Pectinidae, and Propeamussiidae) type

material in the Museum of Natural History, Humboldt University, Berlin. *Zoosystema Evolution* **84**: 31–44.

Dijkstra, H. H. and B. A. Marshall. 2008. The Recent Pectinoidea of the New Zealand region (Mollusca: Bivalvia: Propeamussidae, Pectinidae and Spondylidae). *Journal of Molluscan Research* **28**: 1–88.

d'Orbigny, A. D. 1834–1847, *Voyage dans l' Amerique Meridionale,* Vol. 5. Bertrand and Strasbourg, Levraul, Paris. [In French].

Fernández, M., E. Jaramillo, P. A. Marquet, C. A. Moreno, S. A. Navarrete, F. P. Ojeda, C. Valdovinos, and J. A. Vásquez. 2000. Diversity, dynamics and biogeography of Chilean benthic nearshore ecosystems: An overview and guidelines for conservation. *Revista Chilena de Historia Natural* **73**: 797–830.

Försterra, G. 2010. Aspectos ecológicos y biogeográficos de la región de los fiordos chilenos. *In*: V. Häussermann and G. Försterra, eds., *Guía de Identificación Ilustrada de la Fauna Marina Bentónica de la Patagonia Chilena*. Nature in Focus, Santiago, Chile. Pp. 61–76. [In Spanish].

Grau, G. 1959. *Pectinidae of the Eastern Pacific*. Allan Hancock Pacific Expeditions, Vol. 23. The University of Southern California Press, Los Angeles.

Gray, J. E. 1828. *Spicilegia Zoologica. Original Figures and Short Systematic Descriptions of New and Unfigured Animals.* Part. 1. Treüttel, Würtz and Co., and W. Wood, London.

Gray, J. E. 1837. A synoptical catalogue of the species of certain tribes of genera of shells contained in the collection of the British Museum. *The Magazine of Natural History* (new series) **1**: 370–376.

Güller, M. and D. G. Zelaya. 2011. On the generic allocation of "*Aligena*" *pisum* Dall, 1908. *Malacologia* **53**: 373–378.

Güller, M. and D. G. Zelaya. 2013. The families Carditidae and Condylocardiidae in the Magellan and Perú-Chile provinces (Bivalvia: Carditoidea). *Zootaxa* **3682**: 201–239.

Hanley, S. 1860. Monograph of the family Nuculidae, forming the Lamarckian genus *Nucula*. *In*: G. B. Sowerby II, ed., *Thesaurus Conchyliorum*; *or Monographs of the Genera of Shells,* Vol. 3. London. Pp. 105–168, pls. 226–230.

Hervé, F., D. Quiroz, and P. Duhart. 2010. Principales aspectos geológicos de la región de los fiordos chilenos. *In*: V. Häussermann and G. Försterra, eds., *Guía de Identificación Ilustrada de la Fauna Marina Bentónica de la Patagonia Chilena*. Nature in Focus, Santiago, Chile. Pp. 30–42. [In Spanish].

Holmes, A. M., P. G. Oliver, and J. Sellanes. 2005. A new species of *Lucinoma* (Bivalvia: Lucinoidea) from a methane gas seep off the southwest coast of Chile. *Journal of Conchology* **38**: 673–681.

Hromic, T., S. Ishman, and N. Silva. 2006. Benthic foraminiferal distributions in Chilean fjords: 47°S to 54°S. *Marine Micropaleontology* **59**: 115–134.

Huber, M. 2010. *Compendium of Bivalves. A Full-color Guide to 3.300 of the World's Marine Bivalves. A Status on Bivalvia After 250 Years of Research*. ConchBooks, Hackenheim, Germany.

Hupé, L. 1854. Fauna Chilena. Moluscos. *In*: C. Gay, ed., *Historia Física y Política de Chile*. Zoología 8, Maulde and Renou, Paris. Pp. 1–499, Atlas II, Pls. 1–14. [In Spanish].

Jonkers, H. A. 2003. Late Cenozoic-Recent Pectinidae (Mollusca: Bivalvia) of the Southern Ocean and neighbouring regions. *Monographs of Marine Mollusca* **5**: 1–125.

Kiel, S. and S. V. Nielsen. 2010. Quaternary origin of the inverse latitudinal diversity gradient among southern Chilean mollusks. *Geology* **38**: 955–958.

King, P. 1832. Description of the Cirripedia, Conchifera and Mollusca in a collection formed by the officies of HMS Adventure and Beagle employed between the years 1826 and 1830 in surveying the southern coast of South America including the Strait of Magallans and the coast of Tierra del Fuego. *Zoological Journal* **5**: 332–349.

Knudsen, J. 1970. *The Systematics and Biology of Abyssal and Hadal Bivalvia. Reprinted from Galathea Report volume 11*. Danish Science Press, Copenhagen, Denmark.

Lamy, É. 1906. Lamellibranches recueillis per l'Expedition Antarctique Francaise du Dr. Charcot. *Bulletin du Museum National d'Histoire Naturelle de Paris* **12**: 44–52. [In French].

Lamy, É. 1912. Revision des *Limopsis* vivants du Muséum d'Histoire Naturelle de Paris. *Journal de Conchyliologie* **60**: 108–137. [In French].

Lamy, É. 1922. Révision des Carditacea vivants du Muséum d'Histoire Naturelle de Paris. *Journal de Conchyliologie* **66**: 289–368. [In French].

Lamy, É. 1931. Revision des Limidae vivants du Muséum d'Histoire Naturelle de Paris. *Journal de Conchyliologie* **74**: 245–269. [In French].

Lamy, É. 1934. Révision des Pandoridae vivants du Muséum d'Histoire Naturelle de Paris. *Journal de Conchyliologie* **78**: 95–125. [In French].

Letelier, S., M. A. Vega, A. M. Ramos, and E. Carreño. 2003. Base de datos del Museo Nacional de Historia Natural: Moluscos de Chile. *Revista de Biología Tropical* **51**: 33–137 + Appendixes. [In Spanish].

Linse, K. 1997. Distribution of epibenthic Mollusca from the Chilean Beagle Channel. *Berichte zur Polarforschung* **228***:* 1–130.

Linse, K. 2002. *The shelled Magellanic Mollusca: With Special Reference to Biogeographic Relations in the Southern Ocean. Theses Zoologicae*, Vol. 34. A.R.G Gantner Verlag KG, Ruggell, Lichtenstein.

Linse, K. and A. Brandt. 1998. Distribution of epibenthic mollusca on a transect through the Beagle Channel (Southern Chile). *Journal of the Marine Biological Association of the United Kingdom* **78**: 875–889.

Malchus, N. 2006. Amended description of the arcoid bivalve *Philobrya brattstromi* Soot-Ryen, 1957, from Chile. *The Nautilus* **120**: 8–14.

Marincovich, L., Jr. 1973. Intertidal mollusks of Iquique, Chile. *Natural History Museum Los Angeles County Science Bulletin* **16**: 1–49.

Marshall, B. A. 2002. Authorship and date of publication of *Ostrea chilensis* Philippi in Küster, 1844 (Bivalvia: Ostreidae). *The Nautilus* **116**: 66–67.

Miloslavich, P., E. Klein, J. Díaz, C. Hernández, G. Bigatti, L. Campos, F. Artigas, J. Castillo, P. E. Penchaszadeh, P. E. Neill, A. Carranza, M. V. Retana, J. M. Díaz de Astarloa, M. Lewis, P. Yorio, M. L. Piriz, D. Rodríguez, Y. Yoneshigue-Valentin, L. Gamboa, and

A. Martín. 2011. Marine biodiversity in the Atlantic and Pacific coasts of South America: Knowledge and gaps. *PLoS ONE* **6**: e14631.

Molina, J. I. 1782. *Ensayo Sobre la Historia Natural de Chile*. Maule, Santiago, Chile. [In Spanish].

Nielsen, S. N. and C. Valdovinos. 2008. Early Pleistocene mollusks of the Tubul Formation, South-Central Chile. *The Nautilus* **122**: 201–216.

Ó Foighil, D., B. A. Marshall, T. J. Hilbish, and M. A. Pino. 1999. Trans-Pacific range extension by rafting in inferred for the flat oyster *Ostrea chilensis. Biological Bulletin* **196**: 122–126.

Osorio, C. 2002. *Moluscos Marinos en Chile. Especies de Importancia Económica*. Facultad de Ciencias, Universidad de Concepción, Concepción, Chile. [In Spanish].

Osorio, C. and N. Bahamonde. 1970. Lista preliminar de Lamellibranchios de Chile. *Boletín del Museo Nacional de Historia Natural* **31**: 185–256. [In Spanish].

Osorio, C. and D. Reid. 2004. Moluscos marinos intermareales y submareales entre la Boca del Guafo y estero Elefantes, sur de Chile. *Investigaciones Marinas, Valparaiso* **32**: 71–89. [In Spanish].

Osorio, C., D. Frassinetti, and E. Bustos. 1983. Taxonomy and morphometry of *Venus antiqua antiqua* King & Broderip, 1835 (Mollusca, Bivalvia, Veneridae). *Tethys* **11**: 57–66.

Osorio, C., R. Peña, L. Ramajo, and N. Garcelón. 2003. *Estudio de la diversidad de moluscos bentónicos en los fiordos del sur de Chile*. Resultados del Crucero CIMAR 8 Fiordos. Comité Oceanográfico Nacional, Valparaíso. [In Spanish].

Osorio, C., R. Peña, L. Ramajo, and N. Garcelón. 2006. Malacofauna bentónica de los canales oceánicos del Sur de Chile (43°-45°S). *Ciencia y Tecnología del Mar* **29**: 103–114. [In Spanish].

Osorio, C., D. Reid, and L. Ramajo. 2005. Moluscos en los canales del sur de Chile entre la Boca del Guafo y estero Elefantes (CIMAR 7 Fiordos). *Ciencia y Tecnología del Mar* **28**: 91–98. [In Spanish].

Palma, S. and N. Silva. 2004. Distribution of siphonophores, chaetognaths, euphausiids and oceanographic conditions in the fjords and channels of southern Chile. *Deep-Sea Research II* **51**: 513–535.

Pastorino, G. and M. Bagur. 2011. The genus *Sphenia* Turton, 1822 (Bivalvia: Myidae) from shallow waters of Argentina. *Malacologia* **54**: 431–435.

Pérez, D. E., C. J. del Rio, and S. N. Nielsen. 2013. Sistemática y filogenia del género *Ameghinomya* Ihering, 1907 (Bivalvia: Chioninae) del Cenozoico de Argentina y Chile. *Ameghiniana* **50**: 354–374. [In Spanish].

Petit, R. E. 2009. George Brettingham Sowerby, I, II & III: Their conchological publications and Molluscan taxa. *Zootaxa* **2189**: 1–218.

Philippi, R. A. 1844a. *Pecten*. *Abbildungen und Beschreibung neuer oder wenig gekannter Conchylien* **1**: 99–102, pl. 1. [In German].

Philippi, R. A. 1844b. *Cytherea*. *Abbildungen und Beschreibungen neuer oder wenig gekannter Conchylien* **1**: 149-150, pl. 141. [In German].

Philippi, R. A. 1845. Diagnosen einiger neuen Conchylien. *Archiv für Naturgeschichte* **1**: 50–71. [In German].

Philippi, R. A. 1858. Breves descriptiones Molluscorum quorundam terrestrium et marinorum Chilensium. Bericht über die Sitzungen der naturforschenden Gesellschaft zu Halle. *Abhandlungen der Naturforschenden Gesellschaft zu Halle* **4**: 21–24. [In Latin].

Philippi, R. A. 1860. *Viage al desierto de Atacama hecho de orden del gobierno de Chile en el verano 1853-54*. Librería de Eduardo Anton, Halle, Germany. [In Spanish].

Philippi, R. A. 1868. Conchylia nova potissimum magellanica. *Malakozoologishe Blätter* **15**: 222–226. [In German].

Philippi, R. A. 1893. Las especies chilenas del género *Mactra*. *Anales del Museo Nacional de Chile* (Primera sección - Zoolojía): 5–12, 13 pls. [In Spanish].

Rabarts, I. W. and S. Whybrow. 1979. A revision of the Antarctic and Subantarctic members of the genus *Yoldia* Moller, 1842 (Bivalvia: Nuculanidae). *Journal of Natural History* **13**: 161–183.

Ramajo, L. and C. Osorio. 2010. Riqueza, abundancia y patrones espaciales de moluscos desde el Estero Reloncaví (43°33'S) a la Boca del Guafo (43°49'S), sur de Chile. *Ciencia y Tecnología del Mar* **33**: 57–65. [In Spanish].

Ramírez-Bohme, J. 1993. *Moluscos de Chile*. Vol. 4, Bivalvia. Author's edition, Santiago de Chile.

Ramorino, L. 1968. Pelecypoda del fondo de la Bahía de Valparaíso. *Revista de Biología Marina* **13**: 176–285. [In Spanish].

Reeve, L. A. 1843. Monograph of the genus *Cardita. Conchologia Iconica; or, Illustrations of the Shells of Molluscous Animals* **1**: 9 pls.

Reid, D. and C. Osorio. 2000. The shallow-water marine mollusca of the Estero Elefantes and Laguna San Rafael, southern Chile. *Bulletin of the Natural History Museum of London* (Zoology) **66**: 109–146.

Riveros-Zuñiga, F. and J. González Reyes. 1950. Catálogo descriptivo de venéridos chilenos. *Revista de Biología Marina* **2**: 117–160. [In Spanish].

Signorelli, J. H. and J. E. F. Alfaya. 2014. *Panopea abbreviata* (Bivalvia: Hiatellidae) in the southwestern Atlantic Ocean, taxonomic revision and anatomy. *Malacologia* **57**: 279–293.

Signorelli, J. H. and G. Pastorino. 2011. Revision of the Magellanic Mactridae Lamarck, 1809 (Bivalvia: Heterodonta). *Zootaxa* **2757**: 47–67.

Simone, L. R. L. 2009. Comparative morphology among representatives of main taxa of Scaphopoda and basal Protobranch Bivalvia (Mollusca). *Papéis Avulsos de Zoologia* **49**: 405–457.

Simone, L. R. L. and P. E. Penchaszadeh. 2008. Redescription of *Hiatella meridionalis* d'Orbigny, 1846 (Mollusca, Bivalvia, Hiatellidae) from Argentina. *Papéis Avulsos de Zoologia* **48**: 119–127.

Smith, E. A. 1881. Zoological collections made during the survey of HMS "Alert" IV. Mollusca and molluscoidea. *Proceedings of the Zoological Society of London* **1881**: 22–44, pls. 3–5.

Smith, E. A. 1885. Report on the Lamellibranchiata collected by HMS Challenger during the years 1873-76. *Report on the Scientific Results of the Voyage of HMS Challenger*, Zoology **13**: 1–341, 325 pls.

Sobarzo Bustamante, M. 2010. La región de los fiordos de la zona del Sur de Chile: Aspectos oceanográficos. *In*: V. Häussermann and G. Försterra, eds., *Guía de Identificación Ilustrada de la Fauna Marina Bentónica de la Patagonia Chilena*. Nature in Focus, Santiago, Chile. Pp. 53–60. [In Spanish].

Soot-Ryen, T. 1957. Preliminary diagnoses of new genera and species of Pelecypods from Chile. *Astarte* **16**: 1–5.

Soot-Ryen, T. 1959. Reports of the Lund University Chile Expedition 1948-1949. 35. Pelecypoda. *Lunds Universitets Ärsskrift* (2) **55**: 1–86.

Soto, M. V. 2010. Geografía de la región de los fiordos chilenos. *In*: V. Häussermann and G. Försterra, eds., *Guía de Identificación Ilustrada de la Fauna Marina Bentónica de la Patagonia Chilena*. Nature in Focus, Santiago, Chile. Pp. 43–52. [In Spanish].

Sowerby, G. B., I. 1821–1834. *The genera of recent and fossil shells, for the use of students, in conchology and geology*. London. [Published in 42 numbers. For complete collation see Petit, 2006, Archives of Natural History **33**: 71–89.].

Sowerby, G. B., I. 1833a. *Nucula*. *In*: G. B. Sowerby, ed., *The Conchological Illustrations, or Coloured Figures of all the Hitherto Unfigured Recent Shells.* Parts 14–16. Pls. 1–24 [two plates numbered 24]

Sowerby, G. B., I. 1833b. [Descriptions of new species of shells from the collection formed by Mr. Cuming on the western coast of South America, and among the islands of the southern Pacific Ocean.] *Proceedings of the Committee of Science and Correspondence of the Zoological Society of London* **Part II for 1832**: 194–202.

Sowerby, G. B., I. 1833c. [Characters of new species of shells from the collection formed by Mr. Cuming on the western coast of South America and among the islands of the South Pacific Ocean.] *Proceedings of the Zoological Society of London* **1833**: 34–38.

Sowerby, G. B., I. 1834a. [Characters of new species of shells collected by Mr. Cuming on the western coast of South America and among the islands of the South Pacific Ocean.]. *Proceedings of the Zoological Society of London* **1834**: 46–47.

Sowerby, G. B., I. 1834b. [Characters of new species of shells contained in the collection formed by Mr. Cuming on the western coast of South America and among the islands of the South Pacific Ocean.] *Proceedings of the Zoological Society of London* **1834**: 87–89.

Sowerby, G. B., I. 1835a. [Characters of new species of shells contained in the collection of Mr. Cuming.] *Proceedings of the Zoological Society of London* **1835**: 21–23.

Sowerby, G. B., I. 1835b. [Characters of new species of shells contained in Mr. Cuming's collection.] *Proceedings of the Zoological Society of London* **1835**: 41–47.

Sowerby, G. B., I. 1835c. [Characters of previously undescribed species of shells contained in the collection of Mr. Cuming.] *Proceedings of the Zoological Society of London* **1835**: 109–110.

Stempell, W. 1899. Die Muscheln der Sammlung Plate (Systematische Ubersicht.). *Zoologischen Jahrbüchern* (**Supplement 4**): 217–250, pl. 12. [In German].

Stuardo, J. 1960. La familia Glycymeridae (Bivalvia) en Chile. *Revista de Biología Marina* **10**: 133–142. [In Spanish].

Stuardo, J. 1962. Sobre el género *Limopsis* y la distribución de *L. jousseaumei* (Mabille y Rochebrune, 1889) (Mollusca: Bivalvia). *Gayana* **6**: 5–11. [In Spanish].

Tarifeño, E., R. Galleguillos, A. Llanos-Rivera, D. Arriagada, S. Ferrada, C. B. Canales-Aguirre, and M. Seguel. 2012. Erroneous identification of the mussel, *Mytilus galloprovincialis* (Lamarck 1819) as the species, *Mytilus chilensis* (Hupe 1854) in the Bay of Concepcion, Chile. *Gayana* **76**: 167–172.

Thiel, M., E. C. Macaya, E. Acuña, W. E. Arntz, H. Bastias, K. Brokordt, P. A. Camus, J. C. Castilla, L. R. Castro, M. Cortés, C. P. Dumont, R. Escribano, M. Fernandez, J. A. Gajardo, C. F. Gaymer, I. Gomez, A. E. González, H. E. González, P. A. Haye, J. E. Illanes, J. L. Iriarte, D. A. Lancellotti, G. Luna-Jorquera, C. Luxoro, P. H. Manriquez, V. Marín, P. Muñoz, S. A. Navarrete, E. Perez, E. Poulin, J. Sellanes, H. Hito Sepúlveda, W. Stotz, F. Tala, A. Thomas, C. A. Vargas, J. A. Vasquez, and J. M. Alonso Vega. 2007. The Humboldt Current System of northern and central Chile. Oceanographic processes, ecological interactions and socioeconomic feedback. *Oceanography and Marine Biology: An Annual Review* **45**: 195–344.

Toro, J. E. and P. R. Aguila. 1996. Genetic differentiation of populations of the oyster *Ostrea chilensis* in southern Chile. *Aquatic Living Resources* **9**: 75–78.

Toro, J. E. and C. P. González. 2009. La estructura genética de la ostra chilena (*Ostrea chilensis* Philippi, 1845) en poblaciones naturales del sur de Chile, basada en análisis con marcadores RAPDs. *Revista de Biología Marina y Oceanografía* **44**: 467–476. [In Spanish].

Toro, J. E., J. A. Ojeda, A. M. Vergara, G. C. Castro, and A. C. Alcapán. 2005. Molecular characterization of the Chilean blue mussel (*Mytilus chilensis* Hupe 1854) demonstrates evidence for the occurrence of *Mytilus galloprovincialis* in southern Chile. *Journal of Shellfish Research* **24**: 1117–1121.

Trovant, B., J. M. (Lobo) Orensanz, D. E. Ruzzante, W. Stotz, and N. G. Basso. 2014. Scorched mussels (Bivalvia: Mytilidae: Brachidontinae) from the temperate coasts of South America: Phylogenetic relationships, trans-Pacific connections and the footprints of Quaternary glaciations. *Molecular Phylogenetics and Evolution* **82**: 60–74.

Turner, R. D. 1966. *A Survey and Illustrated Catalogue of the Teredinidae.* Harvard University, Museum of Comparative Zoology, Cambridge, Massachusetts.

Urban, H. J. and B. Campos. 1994. Population dynamics of the bivalves *Gari solida, Semele solida* and *Prothothaca thaca* form a small bay in Chile at 36°S. *Marine Ecology Progress Series* **115**: 93–102.

Valdovinos, C. 1999. Biodiversidad de moluscos chilenos: Base de datos taxonómica y distribucional. *Gayana* **63**: 111–164. [In Spanish].

Valdovinos, C., S. A. Navarrete, and P. A. Marquet. 2003. Mollusk species diversity in the Southeastern Pacific: Why are there more species towards the pole? *Ecography* **26**: 139–144.

Valdovinos, C., J. Cárdenas, C. Aldea, M. Azócar, P. Pedreros, and M. Henríquez. 2008. Biodiversidad marina en el norte de la provincia magallánica (43°49′-41°32′S): Composición y patrones especiales de diversidad de moluscos submareales. *Ciencia y Tecnología del Mar* **31**: 109–121. [In Spanish].

Villarroel, M. and J. Stuardo. 1998. Protobranchia (Mollusca: Bivalvia) chilenos recientes y algunos fósiles. *Malacologia* **40**: 113–229. [In Spanish].

Waloszek, D. 1984. Variabilität, Taxonomie un Verbreitung von *Chlamys patagonica* (King & Broderip, 1832) und Anmerkungen

zu weiteren *Chlamys*-Arten von der Südspitze Süd-Amerikas (Mollusca, Bivalvia, Pectinidae). *Verhandlungen des Naturwissenschaftlichen Vereins in Hamburg* **27**: 207–276. [In German].

Zagal, C. and C. Hermosilla. 2001. *Guía de Invertebrados Marinos del Litoral Valdiviano*. Quebecor World Chile, Santiago, Chile. [In Spanish].

Zelaya, D. G. 2009. The genera *Thyasira* and *Parathyasira* in the Magellan region and adjacent Antarctic waters (Bivalvia: Thyasiridae). *Malacologia* **51**: 271–290.

Zelaya, D. G. 2010. Bivalvia. *In*: V. Häussermann and G. Försterra, eds., *Guía de Identificación Ilustrada de la Fauna Marina Bentónica de la Patagonia Chilena*. Nature in Focus, Santiago, Chile. Pp. 425–454. [In Spanish].

Zelaya, D. G. and C. Ituarte. 2004. The genus *Neolepton* Monterosato, 1875 in southern South America (Bivalvia: Neoleptonidae). *Journal of Molluscan Studies* **70**: 123–137.

Zelaya, D. G. and C. Ituarte. 2006. Redescription of two Antarctic species of *Cuspidaria*: *C. concentrica* Thiele, 1912 and *C. minima* (Egorova, 1993) (Bivalvia: Cuspidariidae). *The Veliger* **48**: 170–177.

Zelaya, D. G. and C. F. Ituarte. 2013. Two new species of *Waldo* Nicol, 1966 from sub-Antarctic waters (Bivalvia: Galeommatoidea). *Marine Biology Research* **9**: 776–784.

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