

Article

Annotated Checklist and Latitudinal Distribution of Freshwater Bivalves from Chile

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Abstract

Freshwater bivalves are a poorly represented but biogeographically informative component of Chilean inland waters. Their distribution offers a useful framework for evaluating latitudinal gradients, historical biogeography, and the southern limits of non-marine molluscs in South America. Here, we present a georeferenced synthesis and annotated checklist of Chilean freshwater bivalves based on 90 occurrence records compiled from the literature and associated datasets. The records comprise 12 species in three genera: *Diplodon*, *Euglesa* and *Sphaerium*, belonging to Hyriidae and Sphaeriidae. *Diplodon chilensis* was the most frequently recorded species, with 52 records and a latitudinal range from approximately 30.5° S to 46.6° S. By contrast, the southernmost records were represented by sphaeriine clams, especially *Euglesa magellanicum* from Laguna El Salto, Isla Navarino, at approximately 55.0° S. Other high-latitude records included *Euglesa lebruni* from Punta Arenas, *Sphaerium patagonicum* from Puerto Natales and *Euglesa chilense* from the Aysén Region. The dataset indicates contrasting biogeographical patterns between large-bodied hyriid mussels and small-bodied sphaeriid clams. Whereas *Diplodon* appears mainly associated with central-southern and Patagonian continental freshwater systems, the sphaeriine clams represented in the dataset extend farther south into Magellanic and sub-Antarctic environments. This contrast may reflect differences in dispersal capacity, ecological tolerance, habitat use and historical responses to Quaternary glaciations. The checklist and distributional synthesis provide a baseline for future taxonomic, phylogeographical and conservation studies of Chilean freshwater bivalves.

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1. Introduction

Freshwater bivalves are important components of inland aquatic ecosystems, contributing to water filtration, sediment bioturbation, nutrient cycling, organic matter processing and benthic habitat structure [1]. Despite their ecological relevance, non-marine bivalves remain unevenly documented across the Southern Hemisphere. Most global syntheses and conservation assessments have focused on Northern Hemisphere mussel faunas, whereas

the diversity, taxonomy and distribution of South American freshwater bivalves are still comparatively less integrated in regional and global biogeographical analyses [2–5].

In Chile, freshwater bivalves are represented mainly by Hyriidae and Sphaeriidae. The sphaeriid taxa considered in the present study belong to the subfamily Sphaeriinae, whereas Euperinae is not represented in the compiled dataset [6–8]. These families differ markedly in body size, life-history traits, habitat use and probable dispersal mechanisms. Species of *Diplodon* are comparatively large mussels associated with rivers, lakes and permanent freshwater systems, whereas sphaeriid clams are smaller, often occur in lakes, ponds, wetlands and marginal habitats, and may disperse passively through waterbirds or other vectors.

The taxonomy of Sphaeriinae has undergone substantial revision following molecular phylogenetic studies, which have demonstrated that several traditional generic assignments do not adequately reflect phylogenetic relationships within the group. Consequently, the generic placement of several South American taxa historically assigned to *Pisidium* or *Musculium* requires reassessment under current taxonomic frameworks [6,7].

The Chilean territory provides a natural setting for evaluating the distribution of freshwater bivalves along one of the longest latitudinal gradients in the Southern Hemisphere. Inland waters in Chile extend from arid and semi-arid northern basins to temperate, Patagonian, Magellanic and sub-Antarctic systems [6]. This gradient is particularly useful for identifying northern and southern distributional limits and for comparing the distributional behaviour of large-bodied mussels and small-bodied clams [7].

Previous studies have summarised the taxonomy, ecology and state of knowledge of Chilean freshwater bivalves, including progress and conflicts in their systematics, reproductive biology, karyology, ecology and conservation relevance [6–16]. However, the latitudinal structure of the Chilean fauna and the contrast between Hyriidae and Sphaeriidae have received less explicit attention. In particular, high-latitude records of *Euglesa* and related sphaeriid taxa are biogeographically important because they reach Patagonia, Magallanes and sub-Antarctic environments [8,17,18].

The objective of this study was to provide an annotated and georeferenced synthesis of Chilean freshwater bivalves and to analyse their latitudinal distribution. Specifically, we aimed to: (1) summarise the taxonomic composition of the compiled records; (2) provide an annotated checklist of the species included in the dataset; (3) determine northern and southern latitudinal limits for each species and genus; (4) compare distributional patterns between hyriid and sphaeriine bivalves; and (5) discuss the biogeographical implications of the observed patterns for southern South American inland waters.

2. Materials and Methods

2.1. Dataset and Sources

The analysis was based on a compiled database of Chilean freshwater bivalve occurrence records. The dataset included 90 records and 18 fields containing taxonomic, geographical and bibliographic information. The main variables used in the analysis were family, genus, species, locality, latitude, longitude, altitude and bibliographic reference. The dataset was treated as a literature-derived occurrence compilation rather than as a systematic field survey. Therefore, record frequency should be interpreted as the number of compiled records and not as a direct measure of abundance, population size or sampling effort.

Only records corresponding to inland waters were retained. Marine, strictly estuarine and coastal marine records were excluded when they were not compatible with freshwater or freshwater occurrence. When multiple records corresponded to the same species and locality but came from different bibliographic sources or entries, they were retained as inde-

pendent literature records unless clear duplication was evident. The database was closed before analysis; no additional occurrence records were incorporated after closure (Table S1).

2.2. Taxonomic Treatment

Taxonomic names reported in the original sources were retained to preserve the provenance of each occurrence record. However, the nomenclature used in the present study was standardised according to MolluscaBase, which was adopted as the primary reference for currently accepted names and synonymies. For taxa lacking direct molecular phylogenetic evidence, generic assignments were treated cautiously, and taxonomic uncertainty was explicitly indicated in the annotated checklist. Traditional regional taxonomic treatments [6–8,17,18] were used to trace the historical identification of Chilean taxa, whereas recent molecular phylogenetic studies of Sphaeriinae were considered when evaluating current generic assignments. Within Sphaeriidae, all taxa included in the compiled dataset belong to the subfamily Sphaeriinae; no representatives of Euperinae were present in the analysed records. When the name reported in the original source differed from the currently accepted name, the original name was retained in the database for traceability, whereas the accepted name was used in the analyses and manuscript.

2.3. Data Cleaning and Georeferencing

The database was imported into R (version 4.5.2 (2025-10-31 ucrt)) using the package readxl. Latitude values were inspected before analysis and corrected when evident formatting errors were detected, particularly records in which southern latitudes were written with an initial dot instead of a minus sign. Longitude values were retained in decimal degrees. The coordinates were treated as approximate locality coordinates when they came from bibliographic information rather than from direct GPS measurements. Records with uncertain or potentially inconsistent coordinates should be flagged in the final submitted dataset.

2.4. Descriptive and Spatial Analyses

Species-level summaries were calculated using dplyr. For each species, the number of records, northernmost latitude, southernmost latitude and latitudinal range were estimated. Southernmost records were identified by arranging the dataset by latitude, with more negative values representing higher southern latitudes. Genus-level summaries were also calculated to compare the distributional ranges of *Diplodon*, *Euglesa* and *Sphaerium*.

Occurrence records were converted to spatial objects using sf, with coordinates defined in the WGS84 geographic reference system. A base map of Chile was obtained using rnaturalearth and rnaturalearthdata, and distribution maps were produced using ggplot2 and ggrepel. All analyses were conducted in R [19] using readxl [20], dplyr [21], ggplot2 [22], sf [23], rnaturalearth and rnaturalearthdata [24], and ggrepel [25].

3. Results

3.1. Taxonomic Composition

A total of 90 occurrence records corresponding to 12 freshwater bivalve species were compiled for Chile. The records belonged to two families, Hyriidae and Sphaeriidae. All sphaeriid taxa included in the dataset belonged to the subfamily Sphaeriinae; no representatives of Euperinae were recorded. Sphaeriinae accounted for ten of the twelve species included in the dataset, whereas Hyriidae was represented by two species. By contrast, Hyriidae accounted for most compiled occurrence records because *Diplodon chilensis* alone represented 52 records, equivalent to 57.8% of the database (Table 1).

Table 1. Species composition and number of occurrence records of Chilean freshwater bivalves included in the analysed database.

Species	Family	Number of Records
<i>Diplodon chilensis</i>	Hyriidae	52
<i>Diplodon solidulus</i>	Hyriidae	1
<i>Sphaerium argentinum</i>	Sphaeriidae	8
<i>Sphaerium forbesi</i>	Sphaeriidae	1
<i>Sphaerium lauricochae</i>	Sphaeriidae	1
<i>Sphaerium patagonicum</i>	Sphaeriidae	1
<i>Euglesa chilense</i>	Sphaeriidae	15
<i>Euglesa huillichum</i>	Sphaeriidae	4
<i>Euglesa lebruni</i>	Sphaeriidae	1
<i>Euglesa llanquihuense</i>	Sphaeriidae	3
<i>Euglesa magellanicum</i>	Sphaeriidae	2
<i>Euglesa meierbrooki</i>	Sphaeriidae	1
Total		90

3.2. Annotated Checklist

Family: Hyriidae Swainson, 1840

Genus: *Diplodon* Spix, 1827

Diplodon chilensis (Gray, 1828)

The most frequently recorded species in the dataset. It occurs mainly in central-southern Chile and northern Patagonia, with a compiled latitudinal range of approximately 30.5–46.6° S. Its high frequency reflects both broad distribution and greater historical research attention compared with other Chilean freshwater bivalves.

Diplodon solidulus (R. A. Philippi, 1869)

Represented by a single compiled record near 41.5° S.

Family: Sphaeriidae Deshayes, 1855 (1820)

Subfamily: Sphaeriinae Deshayes, 1855 (1820)

Genus: *Sphaerium* Scopoli, 1777

Sphaerium argentinum (d'Orbigny, 1835)

Represented by eight records between approximately 38.5° S and 41.2° S. The species has been reported from Chilean continental waters and contributes to the regional diversity of small-bodied sphaeriid clams.

Sphaerium forbesi (Philippi, 1869)

Represented by a single northern record at approximately 18.2° S. This record should be interpreted cautiously because it is the northern limit of *Sphaerium* in the analysed dataset.

Sphaerium lauricochae (Philippi, 1869)

Represented by a single record from northern Chile, approximately 21.6° S. Its inclusion indicates the occurrence of *Sphaerium* in arid or high-altitude northern freshwater systems, but final taxonomic validation is recommended.

Sphaerium patagonicum Pilsbry, 1911

Represented by one high-latitude record from Puerto Natales, approximately 51.7° S. This record contributes to the evidence that Sphaeriidae reach Magellanic freshwater environments.

Genus: *Euglesa* Jenyns, 1832

Euglesa chilense (d'Orbigny, 1846)

The most frequently recorded sphaeriid in the dataset, with 15 records and a latitudinal range of approximately 36.6–44.6° S. It represents the widest species-level range among the Chilean sphaeriids included here, excluding the single northern outlier records of other species.

Taxonomic remark. Unlike several other Chilean sphaeriine taxa included in this study, this species has been investigated using molecular phylogenetic data [26]. Its current generic placement was therefore evaluated considering both the molecular evidence and the nomenclatural treatment adopted in MolluscaBase.

Euglesa huillichum Ituarte, 1999

Represented by four records from southern Chile, between approximately 40.6° S and 43.3° S. Its distribution reinforces the importance of temperate and northern Patagonian freshwater systems for sphaeriid diversity.

Taxonomic remark. The generic placement of this species remains uncertain in the context of recent molecular phylogenetic classifications of Sphaeriinae. In the absence of direct molecular evidence supporting its transfer to another genus, the currently recognised combination *Euglesa huillichum* is retained here pending further integrative taxonomic study.

Euglesa lebruni Mabilie, 1884

Represented by one record from Punta Arenas, approximately 53.1° S. Together with *E. magellanicum* and *S. patagonicum*, this species documents the extension of Sphaeriidae into Magellanic inland waters.

Taxonomic remark. The phylogenetic position and generic assignment of this species require further assessment using molecular data. The traditional combination *Euglesa lebruni* is retained here pending an integrative taxonomic revision.

Euglesa llanquihuense Ituarte, 1999

Represented by three records, with a compiled range of approximately 40.6–42.6° S. The species appears associated with southern Chilean freshwater systems.

Taxonomic remark. Although recent molecular phylogenetic studies have substantially revised generic boundaries within Sphaeriinae, the phylogenetic position of this South American species remains insufficiently resolved. We therefore retain the currently recognised combination *Euglesa llanquihuense* pending molecular and integrative taxonomic assessment.

Euglesa magellanicum (Dall 1908)

Represented by two records, including the southernmost occurrence in the dataset: Laguna El Salto, Isla Navarino, approximately 55.0° S. This taxon is central to the biogeographical interpretation of high-latitude sphaeriid distribution.

Taxonomic remark. The generic placement of this species requires further evaluation under the current molecular phylogenetic framework of Sphaeriinae. In the absence of sufficient species-specific molecular evidence supporting assignment to another genus, *Euglesa magellanicum* is retained here provisionally.

Euglesa meierbrooki Kuiper & Hinz, 1983

Represented by a single northern Chilean record at approximately 18.2° S. This record strongly influences the genus-level northern limit of *Euglesa* in the compiled dataset and should be verified in the final database.

Taxonomic remark. The generic placement of this species has not been sufficiently resolved under recent molecular classifications of Sphaeriinae. Accordingly, *Euglesa meierbrooki* is retained provisionally pending species-specific molecular and integrative taxonomic evidence.

3.3. Latitudinal Distribution

The analysed records covered a broad latitudinal gradient from approximately 18.2° S in northern Chile to 55.0° S in the Magallanes Region. The northernmost occurrences corresponded to *Euglesa meierbrooki* and *Sphaerium forbesi* in northern Chile, whereas the southernmost record corresponded to *Euglesa magellanicum* from Laguna El Salto, Isla Navarino, at approximately 55.0° S. *Diplodon chilensis* exhibited the broadest species-level

distribution among frequently recorded taxa, extending from approximately 30.5° S to 46.6° S, equivalent to a range of 16.1 degrees of latitude (Table 2; Figure 1).

Table 2. Northern and southern latitudinal limits of Chilean freshwater bivalve species included in the analysed database.

Species	Records	Northern Limit (°S)	Southern Limit (°S)	Latitudinal Range (Degrees)
<i>Diplodon chilensis</i>	52	30.5	46.6	16.1
<i>Diplodon solidulus</i>	1	41.5	41.5	0.0
<i>Sphaerium argentinum</i>	8	38.5	41.2	2.7
<i>Sphaerium forbesi</i>	1	18.2	18.2	0.0
<i>Sphaerium lauricochae</i>	1	21.6	21.6	0.0
<i>Sphaerium patagonicum</i>	1	51.7	51.7	0.0
<i>Euglesa chilense</i>	15	36.6	44.6	8.0
<i>Euglesa huillichum</i>	4	40.6	43.3	2.7
<i>Euglesa llanquihuense</i>	3	40.6	42.6	2.0
<i>Euglesa magellanicum</i>	2	52.8	55.0	2.2
<i>Euglesa lebruni</i>	1	53.1	53.1	0.0
<i>Euglesa meierbrooki</i>	1	18.2	18.2	0.0

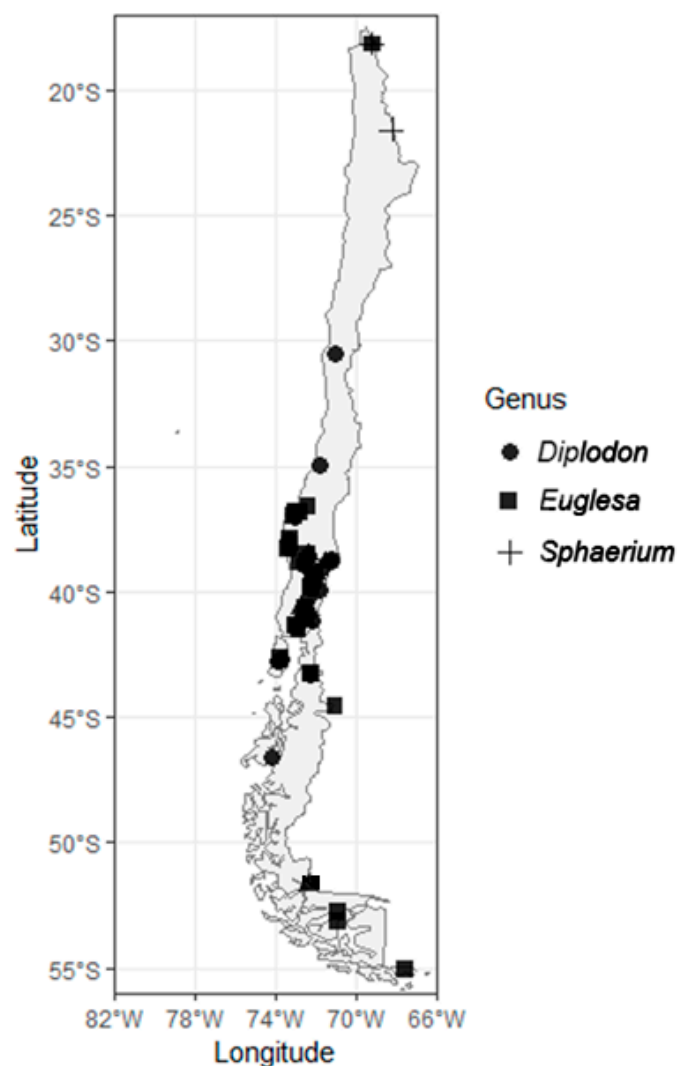


Figure 1. Geographic distribution of freshwater bivalve genera recorded in Chile. Symbols represent occurrence records of *Diplodon*, *Euglesa* and *Sphaerium* along the Chilean latitudinal gradient. This figure should be replaced by a higher-resolution, journal-ready version before final submission.

3.4. Genus-Level Patterns

At the genus level, *Diplodon* accounted for 53 records and two species, whereas *Euglesa* comprised five species and 25 records. *Euglesa* exhibited the broadest genus-level latitudinal distribution, extending from 18.2° S to 55.0° S, although this broad range is strongly influenced by single northern and southern records. *Diplodon* ranged from 30.5° S to 46.6° S, *Sphaerium* from 18.2° S to 51.7° S, and *Euglesa* from 18.2° S to 55.0° S (Table 3).

Table 3. Latitudinal limits and distributional characteristics of freshwater bivalve genera recorded in Chile.

Genus	Species Richness	Records	Northern Limit (°S)	Southern Limit (°S)
<i>Diplodon</i>	2	53	30.5	46.6
<i>Sphaerium</i>	4	11	18.2	51.7
<i>Euglesa</i>	5	25	18.2	55.0

4. Discussion

4.1. Diversity and Composition of Chilean Freshwater Bivalves

Although the analysed fauna is species-poor compared with that reported from larger South American countries, it is biogeographically distinctive because it combines large-bodied hyriid mussels and several small-bodied sphaeriine clams [4]. The dataset also illustrates an important contrast between species richness and record frequency: Sphaeriinae contributed most species, whereas *Diplodon chilensis* dominated the compiled occurrence records.

The prominence of *Diplodon chilensis* in the dataset probably reflects a combination of true ecological distribution, conspicuous body size and stronger historical research attention. Chilean *Diplodon* populations have been studied in relation to reproduction, population dynamics, feeding behaviour, karyology, growth, trophic interactions and conservation [10,12,15,27–36]. In contrast, sphaeriids are small, less conspicuous and more easily overlooked in routine surveys, which may partly explain their lower frequency in compiled records despite higher taxonomic richness.

4.2. Contrasting Latitudinal Patterns

The most relevant biogeographical result is the contrast between the dominant but less austral distribution of *Diplodon* and the higher-latitude reach of the sphaeriine clams represented in the dataset [6]. *Diplodon chilensis* showed the broadest range among individual species with many records, but its southern limit in the dataset was approximately 46.6° S [7]. By contrast, the sphaeriine clams represented in the dataset reached Magellanic and sub-Antarctic environments, including *Euglesa magellanicum* at Isla Navarino, approximately 55.0° S [18]. However, these genus-level patterns should be interpreted cautiously because the phylogenetic position of several Chilean sphaeriine species has not yet been adequately resolved using molecular data.

This pattern suggests that southern distributional limits differ substantially among Chilean freshwater bivalve lineages [6,7]. Large freshwater mussels appear mainly associated with continental temperate and Patagonian freshwater systems, where permanent habitats and hydrographic connectivity are more favourable [2,6]. Small-bodied sphaeriids, in contrast, can occur in isolated, cold and high-latitude freshwater habitats. Their small size, short generation time, ecological flexibility and potential for passive dispersal may facilitate persistence in environments where large unionoid mussels are absent [7].

4.3. Biogeographical Implications for Southern South America

Patagonia, Tierra del Fuego and Isla Navarino are key areas for understanding the historical biogeography of freshwater organisms in southern South America [37,38]. These regions were strongly affected by Quaternary glaciations and subsequent post-glacial landscape reorganisation. The occurrence of *Euglesa magellanicum*, *Euglesa lebruni* and *Sphaerium patagonicum* in Magellanic and sub-Antarctic freshwater environments suggests that sphaeriid clams may be useful model organisms for studying high-latitude persistence, post-glacial colonisation and dispersal in southern inland waters [18].

The interpretation proposed here should be treated as a working biogeographical hypothesis rather than as a definitive reconstruction. The compiled dataset is literature-derived and is affected by uneven sampling effort among regions, taxa and habitat types. Northern and southern range limits based on single records require particular caution and should be validated through taxonomic revision, specimen examination, updated georeferencing, and, where appropriate, integrative molecular analyses [38,39]. In particular, the generic placement of several Chilean sphaeriine taxa traditionally assigned to *Pisidium* remains insufficiently resolved under current molecular phylogenetic frameworks, highlighting the need for integrative morphological and molecular revision. In particular, the generic placement of several Chilean sphaeriine taxa traditionally assigned to *Pisidium* remains insufficiently resolved under current molecular phylogenetic frameworks, highlighting the need for integrative morphological and molecular revision.

4.4. Conservation and Research Implications

Freshwater bivalves are sensitive to habitat degradation, eutrophication, sediment alteration, hydrological regulation and water pollution [3]. In Chile, *Diplodon* species have particular conservation relevance because they are large, long-lived and associated with permanent freshwater habitats that are increasingly affected by land-use change and water management [7]. Sphaeriids, although smaller and less conspicuous, may provide important information on isolated wetlands, high-latitude systems and poorly explored inland waters [8].

The present checklist highlights the need for updated field surveys, specimen-based taxonomic confirmation, molecular analyses and public deposition of occurrence data. Future studies should prioritise poorly sampled northern systems, Patagonian waters, Magellanic wetlands and sub-Antarctic freshwater habitats. Integrating morphology, molecular data and standardised georeferenced records will be essential for resolving taxonomic uncertainty and improving conservation assessments of Chilean freshwater bivalves.

5. Conclusions

The freshwater bivalve fauna of Chile comprises a relatively small number of recorded species but exhibits clear biogeographical structure along the country's extensive latitudinal gradient. *Diplodon chilensis* was the dominant species in terms of compiled occurrence records and showed the widest range among frequently recorded taxa. However, the sphaeriine clams represented in the dataset reached the greatest southern distributional limits, with *Euglesa magellanicum* from Isla Navarino representing the southernmost record in the database. This contrast between Hyriidae and Sphaeriidae suggests that body size, life-history traits, habitat requirements and dispersal capacity may shape freshwater bivalve distributions in southern South America. The revised checklist and georeferenced synthesis provide a baseline for future taxonomic, phylogeographical, ecological and conservation studies of Chilean freshwater bivalves.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/d18090518/s1>, Table S1: A compiled database of Chilean freshwater bivalve occurrence records.

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