| Palaeontographica Abt. A | 265 | Lfg. 1-4 | 1-119 | Stuttgart, Juni 2002 |
|---|---|---|---|---|

# Early Jurassic bivalves of Argentina Part 3: Superfamilies Monotoidea, Pectinoidea, Plicatuloidea and Dimyoidea

## Bivalven aus dem unteren Jura von Argentinien Teil 3: Die Überfamilien Monotoidea, Pectinoidea, Plicatuloidea und Dimyoidea

## Bivalvos del Jurásico inferior de Argentina Parte 3: Superfamilias Monotoidea, Pectinoidea, Plicatuloidea y Dimyoidea

by

SUSANA ESTER DAMBORENEA

With 11 plates, 47 figures and 3 tables in the text

This paper is a contribution to:
IGCP Project 322, "Correlation of Jurassic Events in South America"
IGCP Project 458, "Triassic-Jurassic boundary events"

### Zusammenfassung

Die vorliegende Arbeit ist der dritte Teil der sich mit der Taxonomie, Phylogenie und Biogeographie der Bivalven aus dem Unter Jura von Argentinien befaßt. 25 Arten und 19 Gattungen der Familien Monotidae, Oxytomidae, Asoellidae, Propeamussiidae, Entoliidae, Pectinidae, Terquemiidae, Plicatulidae, Placunopsidae und Dimyidae werden bearbeitet. *Entolium mapuche* und *Terquemia andina* sind neu. Das Material wurde aus 56 Aufschlüssen in den Provinzen San Juan, Mendoza, Neuquén und Chubut feinstratigraphisch aufgesammelt.

*Kolymonectes* wird wegen des fehlenden Ctenoliums und der anscheinend stark entwickelten kalzitisch-prismatischen Außenschicht zu den Propeamussiidae gestellt. Nähere Beziehungen deuten sich auch zwischen *Radulonectites* und *Camptonectes* und zwischen *Ochotochlamys* und der *Hyalopecten*-Gruppe der Pectinidae an. Die Trennung von *Harpax* und *Plicatula* s.s. wird an Hand von Schloß, Ligament und Schalenkonvexität bestätigt.

Biogeographisch sind 10 Arten quasi-weltweit verbreitet. Die anderen 15 sind südpazifisch. Eine Art war bisher nur von Neu Seeland bekannt: *Agerchlamys wunschae* (MARWICK). Andere Arten stehen süd-pazifischen Arten nahe: *Otapiria pacifica* COVACEVICH & ESCOBAR, *Otapiria neuquensis* DAMBORENEA, *Asoella asapha**(LEANZA), *Entolium mapuche* n. sp. und *Harpax rapa* (BAYLE & COQUAND). Die restlichen Arten sind bislang nur von Südamerika bekannt. Mehrere davon gehören zu ehemals für boreal gehaltenen Gattungen, die wahrscheinlich aber eine bipolare Verbreitung besitzen und die im Unter Jura im „australen Bereich" vorkommen. Den schon in der Trias vorkommenden Monotidae höherer Breitengrade gesellten sich im frühen Jura Pectinidae, Oxytomidae und Plicatulidae zu. Im östlichen

---

Author's address: Dr. S. E. DAMBORENEA, Departamento Paleontología Invertebrados, Museo de Ciencias Naturales de La Plata, Paseo del Bosque s/n, 1900 La Plata, Argentina

0375-0442/02/0265/0001 $ 58.50

Pazifik wird die Grenze zwischen tethydischem und australem Bereich durch eine Bivalven-Mischfauna in Zentral Argentinien und Chile angezeigt. Seltene „australe" Vertreter sind noch in Nord-Chile und Peru vorhanden.

Die regionale Biostratigraphie des Unter Jura mit Hilfe von Pectinaceen in relativ küstenferner Fazies wird unter Einbeziehung von fünf Assemblage-Zonen für Argentinien und Chile diskutiert.

Schlüsselwörter: Bivalvia – Unter Jura – Argentinien – Systematik – Biostratigraphie

## Resumen

Esta revisión de los monotáceos, pectináceos, dimyaceos y plicatuláceos del Jurásico Inferior fue realizada sobre la base de extensas colecciones personales en unas 56 localidades de las provincias de San Juan, Mendoza, Neuquén y Chubut del centro-oeste argentino. También se revisó material de varias colecciones de museos. La estratigrafía se basó en los amonites encontrados en las mismas secciones o en localidades cercanas. Se describen 25 especies de bivalvos pertenecientes a 19 géneros de las familias Monotidae, Oxytomidae, Asoellidae, Propeamussiidae, Entoliidae, Pectinidae, Terquemiidae, Plicatulidae, Placunopsidae y Dimyidae. Se proponen las nuevas especies *Entolium mapuche* y *Terquemia andina*. Las demás especies se refieren a taxa ya conocidos. Se discuten las afinidades de cada uno de los taxa tratados.

El género *Kolymonectes* es referido a la familia Propeamussiidae por carecer de ctenolio y porque se infiere posee una capa externa calcítica prismática muy desarrollada. De ese mismo modo, nuevas evidencias indican estrechas afinidades entre los géneros *Radulonectites* y *Camptonectes* y entre *Ochotochlamys* y el grupo de *Hyalopecten* entre los pectínidos. El género *Harpax* es revalidado y distinguido de *Plicatula* s.s. por diferencias en detalles de la charnela, convexidad relativa de las valvas y ligamento.

Diez de las especies son referidas a taxa tradicionalmente considerados "Tethyanos", pero que en realidad poseen una distribución casi cosmopolita, aún a nivel específico. Las demás especies pertenecen a grupos típicamente sud-pacíficos.

Se discute la zonación bioestratigráfica regional del Jurásico Temprano elaborada sobre la base de la distribución vertical de los pectináceos en facies de costa afuera. Esta incluye cinco Biozonas de Asociación que han sido reconocidas en Argentina y Chile: *Agerchlamys wunschae* (Marwick) es conocida en Nueva Zelanda, mientras que otras, como *Otapiria pacifica* Covacevich & Escobar, *Otapiria neuquensis* Damborenea, *Asoella asapha* (Leanza), *Entolium mapuche* n. sp. y *Harpax rapa* (Bayle & Coquand) también están relacionadas con especies de estirpe pacífica. Las restantes especies están hasta el momento regionalmente restringidas al sur de América del Sur. Algunas de ellas pertenecen a géneros que fueron previamente considerados como típicos de regiones boreales pero cuya distribución aparece ahora como bipolar, definiendo un Dominio biogeográfico Austral para el Jurásico Temprano. Este Dominio está caracterizado por los Monotidae, que ya estaban presentes en el Triásico, a los cuales se agregaron en el Jurásico Temprano algunos Pectinidae, Oxytomidae y Plicatulidae. En la región sud-andina el límite entre los dominios Austral y Tethyano está representado por una franja de faunas mixtas en Argentina y Chile centrales. Más al norte (Chile septentrional y Perú) se advierten muy pocos elementos australes, en tanto la influencia tethyana es más evidente.

Palabras claves: Bivalvia – Jurásico inferior – Argentina – Sistemática – Bioestratigrafía

## Summary

This revision of Early Jurassic monotacean, pectinacean, plicatulacean and dimyacean bivalves is based on museum material and extensive own collections from 56 localities in the provinces of in western Argentina. The ammonites from the same or nearby sections provided the key to the stratigraphy. 25 species of bivalves belonging to 19 genera are systematically described. They belong to the families Monotidae, Oxytomidae, Asoellidae, Propeamussiidae, Entoliidae, Pectinidae, Terquemiidae, Plicatulidae, Placunopsidae and Dimyidae. The new species *Entolium mapuche* and *Terquemia andina* are proposed. All other species are referred to previously known taxa. The systematic affinities of each taxon are discussed.

The genus *Kolymonectes* is placed in the family Propeamussiidae on account of the absence of ctenolium and the inferred presence of an extensive outer prismatic calcitic layer. Similarly, new evidence now points to a close relationship of *Radulonectites* to *Camptonectes* and of *Ochotochlamys* to the *Hyalopecten* group of pectinids. The genus *Harpax* is re-validated and distinguished from *Plicatula* s.s. by differences in hinge details, relative convexity of valves and ligament.

Ten of the species are referred to taxa generally regarded as "Tethyan" but which in fact have an almost cosmopolitan distribution, even at the species level. The other species belong to distinct South Pacific stocks, one of them has been described from New Zealand: *Agerchlamys wunschae* (Marwick), others, such as *Otapiria pacifica* Covacevich & Escobar, *Otapiria neuquensis* Damborenea, *Asoella asapha* (Leanza), *Entolium mapuche* n. sp. and *Harpax rapa* (Bayle & Coquand) are closely related to South Pacific species, the rest are regionally restricted to southern South America up to now. Some of these belong to genera which were previously thought to be typical to Boreal regions, but their distribution appears now to be bipolar, characterizing an Early Jurassic Austral Realm. To the high latitude Monotidae, already present in the Triassic, certain Pectinidae, Oxytomidae and Plicatulidae were added in the Early Jurassic. Along the East Pacific, the boundaries between Austral and Tethyan Realms lie in the Andean region. An area with mixed bivalve faunas is present in central Argentina and Chile. Further north (northern Chile and Peru) there are very few (if any) Austral elements and the Tethyan influence is more evident.

The regional biostratigraphical zonation of the Lower Jurassic based on the vertical ranges of pectinaceans in relatively off-shore facies is discussed, including five Assemblage Zones which have been recognized in Argentina and Chile.

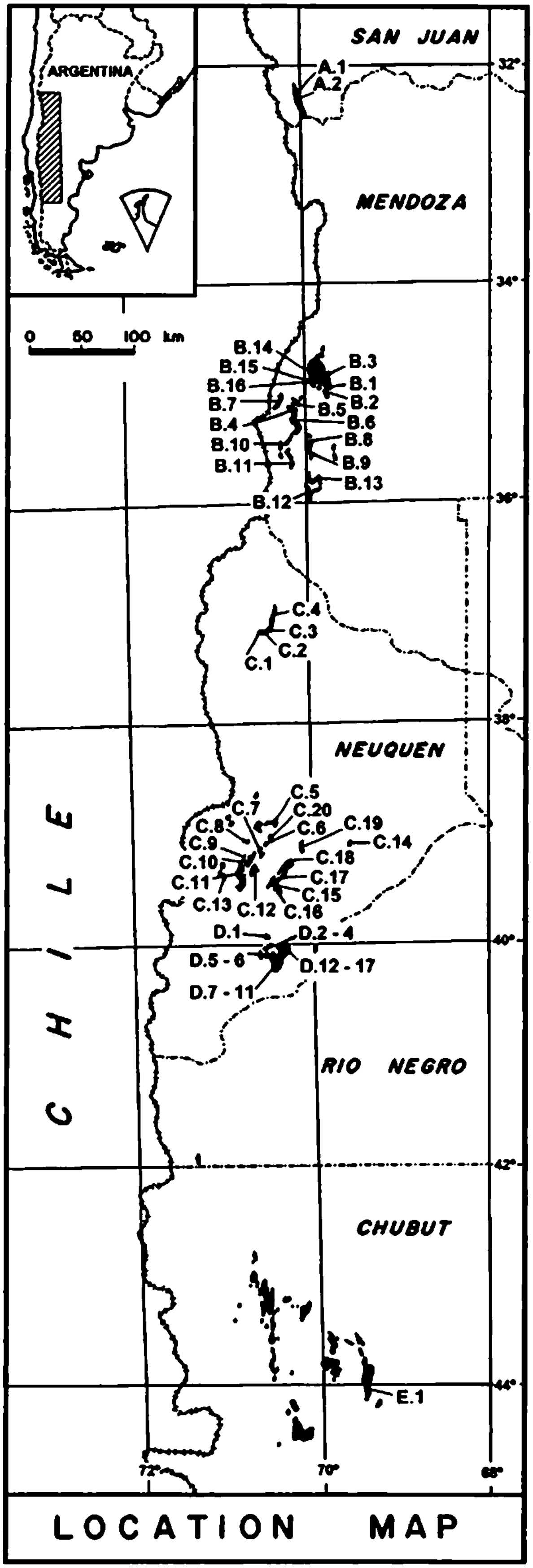
Key words: Bivalvia – Lower Jurassic – Argentina – Systematics – Biostratigraphy

## Contents

## Introduction

Early Jurassic bivalve faunas from Argentina are as rich and diverse as those from other parts of the world. Nevertheless, this group of molluscs remained neglected for a long time and just until recently there were only poor collections available. Consequently, extensive collections were made with the purpose of revising their systematics and also their geographical and stratigraphical distributions. The field work, which was carried out between 1973 and 1996, was planned to cover as many localities as possible in the so-called Neuquén Basin (San Juan, Mendoza and Neuquén provinces) of western Argentina (Text-fig. 1). Most type localities of species described by previous authors were thus examined. On the whole, about 850 samples of megainvertebrates were taken at 56 localities (Table 1). Most of these samples are accurately located in the 28 measured sections and, as all the shelly fauna was collected, the ammonites from the same or nearby sections provided the key to the stratigraphy (Riccardi 1984, Riccardi et al. 1988, 1991). Although very limited personal collecting was done in Lower Jurassic deposits from Rio Negro and Chubut provinces, material from those regions was also analysed.

Most of the stratigraphical framework and the revision of Superfamilies Nuculanoidea, Arcoidea, Mytiloidea, Pinnoidea, Pterioidea, Monotoidea and part of Pectinoidea was already published as parts 1 and 2 of this monograph (Damborenea 1987a, 1987b) and in Riccardi et al. (1988, 1991). The purpose of this part is



Text-fig. 1. Location map.

Table 1. Localities mentioned in text. See location map in Text-fig. 1. Reference to sample numbers used in text can be found in the papers listed in this table.

| Name of locality | Geographic situation | Located in map or described | Section figured |
|---|---|---|---|
| A.1: Quebrada Honda | 32°13'S, 70°01'W | *(2)* : 29 | |
| A.2: Arroyo La Laguna | 32°17'S, 70°02'W | *(2)* : 29-32<br>*(6)* : 210-221<br>*(7)* : 302-308 | *(2)* t-fig. 2(2)<br>*(3)* fig. 1(8)<br>*(6)* fig. 3<br>*(7)* fig. 2<br>*Here*, t-fig. 2 |
| B.1: Puesto Araya | 34°57'S, 69°43'W | *(2)* : 32-33 | *(2)* t-fig. 3(1)<br>*(5)* fig. 2-D |
| B.2: Cerro La Brea | 34°59'S, 69°43'W | *(2)* : 33 | |
| B.3: Arroyo La Manga | 34°49'S, 69°41'W | *(2)* : 33 | |
| B.4: Portezuelo Ancho | 35°06'S, 70°07'W | *(2)* : 34 | *(2)* t-fig. 3(4) |
| B.5: Arroyo del Portezuelo Ancho | 35°06'S, 70°06'W | *(2)* : 34 | *(2)* t-fig. 3(5)<br>*Here*, t-fig. 2 |
| B.6: Rio Salado | 35°12'S, 70°07'W | *(2)* : 35 | |
| B.7: Arroyo Santa Elena | 35°08'S, 70°35'W | *(2)* : 35 | |
| B.8: Arroyo Serrucho | 35°26'S, 69°55'W | *(2)* : 35-36 | *(2)* t-fig. 3(8)<br>*Here*, t-fig. 2 |
| B.9: Cerro Puchenque | 35°29'S, 69°55'W | *(2)* : 36-37 | *(2)* t-fig. 3(9) |
| B.10: El Infiernillo | | *(2)* : 38 | |
| B.11: Cerro Tricolor | 35°31'S, 70°11'W | *(2)* : 38 | *(2)* t-fig.3(11)<br>*(3)* fig. 1(9)<br>*(8)* fig. 2<br>*Here*, t-fig. 2 |
| B.12: Arroyo Poti Malal | 35°57'S, 69°59'W | *(2)* : 39 | *(2)* t-fig.3(12)<br>*(8)* fig. 2 |
| B.13: Arroyo Chacayco | 35°49'S, 69°50'W | *(2)* : 39 | |
| B.14: Arroyo Malo | 34°50'S, 69°54'W | *(5)* fig. 1 | *(5)* fig. 2-A<br>*Here*, t-fig. 2 |
| B.15: Arroyo El Pedrero | 34°51'S, 69°52'W | *(5)* fig. 1 | *(5)* fig. 2-B |
| B.16: Arroyo Las Chilcas | 34°54'S, 69°47'W | *(5)* fig. 1 | *(5)* fig. 2-C<br>*Here*, t-fig. 2 |
| C.1: Southern Cordillera del Viento | 37°16'S, 70°34'W | *(2)* : 40-41 | *(2)* t-fig. 4(1)<br>*Here*, t-fig. 2 |
| C.2: Arroyo Lista Blanca | 37°16'S, 70°33'W | *(2)* : 41 | |
| C.3: Arroyo Chacay Melehue | 37°16'S, 70°31'W | *(2)* : 41 | *(2)* t-fig. 4(3)<br>*Here*, t-fig. 2 |
| C.4: Arroyo Ñiraico | 37°04'S, 70°26'W | *(2)* : 41 | |
| C.5: Arroyos del Gringo y Los Toldos | 38°56'S, 70°29'W | *(2)* : 42 | |
| C.6: Arroyo Pichi Picún Leufú | 39°07'S, 70°30'W | *(2)* : 42 | |
| C.7: Vuta Picún Leufú | 39°11'S, 70°33'W | *(2)* : 42-43 | *(2)* t-fig. 4(7)<br>*Here*, t-fig. 2 |
| C.8: Arroyo Puruvé Pehuén | 39°10'S, 70°40'W | *(2)* : 43 | |
| C.9: Arroyo Lonqueo | 39°14'S, 70°41'W | *(2)* : 43 | *(2)* t-fig. 4(9) |
| C.10: Espinazo del Zorro | 39°16'S, 70°39'W | *(2)* : 43 | *(2)* t-fig.4(10) |
| C.11: Arroyo Llao-Llao | | *(2)* : 44 | |
| C.12: Mallín de La Piedra | 39°17'S, 70°35'W | *(2)* : 44 | *(3)* fig. 1(14)<br>*Here*, t-fig. 2 |
| C.13: Rahue-Aluminé | 39°20'S, 70°56'W | *(2)* : 44 | |

Table 1. (continued).

| **Name of locality** | **Geographic situation** | **Located in map or described** | **Section figured** |
|---|---|---|---|
| C.14: Cerro Granito | 39°09'S, 69°34'W | *(2)*: 45 | *(2)* t-fig.4(14)<br>*(3)* fig. 1(12) |
| C.15: Arroyo Lapa | 39°23'S, 70°25'W | *(2)*: 45-46 | *(2)* t-fig.4(15)<br>*(3)* fig. 1(16)<br>*Here*, t-fig. 2 |
| C.16: Estancia Charahuilla | 39°25'S, 70°25'W | *(2)*: 46 | |
| C.17: Cerro Keli-Mahuida | | *(1)*: 47 | |
| C.18: Los Molles | | *(2)*: 45 | |
| C.19: Puente Picún Leufú | | *(1)*: 45-47<br>*(2)*: 45 | *(1)* fig. 2 |
| C.20: Arroyo Ñireco | 39°03'S, 70°33'W | *(2)*: 42 | |
| D.1: South of Estancia Santa Isabel | 39°58'S, 70°28'W | *(2)*: 47 | *(1)* fig. 2<br>*(2)* t-fig. 5(1) |
| D.2: Carrán Curá | 40°01'S, 70°20'W | *(2)*: 47-49 | *(2)* t-fig. 5(2) |
| D.3: Salitral Grande | 40°03'S, 70°21'W | *(2)*: 49 | *(2)* t-fig. 5(3) |
| D.4: Arroyos Los Chilenos-Los Pantanos | 40°05'S, 70°19'W | *(2)*: 49 | |
| D.5: North of Sañicó | 40°05'S, 70°25'W | *(2)*: 49-50 | |
| D.6: NW of Puesto Manqueú | 40°07'S, 70°23'W | *(2)*: 50 | |
| D.7: Subida a Sañicó | 40°09'S, 70°22'W | *(2)*: 50 | *(2)* t-fig. 5(7)<br>*(4)* fig. 3 |
| D.8: Cerro Grande | 40°08'S, 70°23'W | *(2)*: 50 | |
| D.9: SW of School No 27 | 40°09'S, 70°21'W | *(2)*: 50 | |
| D.10: Cerro Corona | 40°10'S, 70°21'W | *(2)*: 50 | *(1)* fig. 2 |
| D.11: Cerro Mesa | 40°08'S, 70°21'W | *(2)*: 51 | |
| D.12: Cerro Del Vasco | 40°09'S, 70°18'W | *(2)*: 51 | *(2)* t-fig.5(12)<br>*(4)* fig. 3<br>*Here*, t-fig. 2 |
| D.13: Cañadón La Pintada | 40°08'S, 70°17'W | *(2)*: 51 | |
| D.14: Cerro Del Vasco/ Cerro Roth | 40°09'S, 70°17'W | *(2)*: 51-52 | *(2)* t-fig.5(14) |
| D.15: South of Cerro Roth | 40°08'S, 70°16'W | *(2)*: 52-53 | *(1)* fig. 2<br>*(2)* t-fig. 5(15)<br>*(4)* fig. 3 |
| D.16: Cerro Roth | 40°07'S, 70°16'W | *(2)*: 53 | |
| D.17: Cañadón Los Chilenos | 40°04'S, 70°17'W | *(2)*: 53 | |
| E.1: Cañadón Cerro Negro | 44°05'S, 69°35'W | *(9)*: 45 | *(9)*: fig. 4 |

References

*(1)* Ballent 1987
*(2)* Damborenea 1987a
*(3)* Damborenea 1989
*(4)* Damborenea et al. 1975
*(5)* Riccardi et al. 1988, 1991
*(6)* Volkheimer et al. 1978a
*(7)* Volkheimer et al. 1978b
*(8)* Westermann and Riccardi 1982
*(9)* Robbiano 1971

to continue the analysis of other groups of bivalves with a similar approach. At the same time, this work includes the first description of Hettangian and early Sinemurian bivalves from Argentina.

An earlier version of this paper was presented as a Ph. D. thesis at the University College of Swansea, University of Wales, Great Britain (DAMBORENEA 1991). It is a contribution to IGCP Project 322, "Correlation of Jurassic Events in South America" and IGCP Project 458, "Triassic-Jurassic boundary events".

## Previous research

Specific references will be discussed at length in the systematic part of this monograph. A brief summary of the previous literature on early Jurassic bivalves from Argentina was provided by DAMBORENEA (1987a). Some palaeogeographical (DAMBORENEA & MANCEÑIDO 1979, 1988, 1992, DAMBORENEA 1989, 1992, 1993a, 1996) and biostratigraphical (RICCARDI et al. 1990, DAMBORENEA et al. 1992, DAMBORENEA, 1993b, 1994) approaches have been published since. Only recently Hettangian and Lower Sinemurian bivalves from Argentina were discovered and preliminary figured (RICCARDI et al. 1988, 1991).

The brachiopods from the same sections were studied by MANCEÑIDO (1978, 1981, 1983, 1991) and the microfossils by BALLENT (1987, 1990, 1992, 1994). The ammonites have been determined by A. C. RICCARDI, who is currently studying them.

## Geology

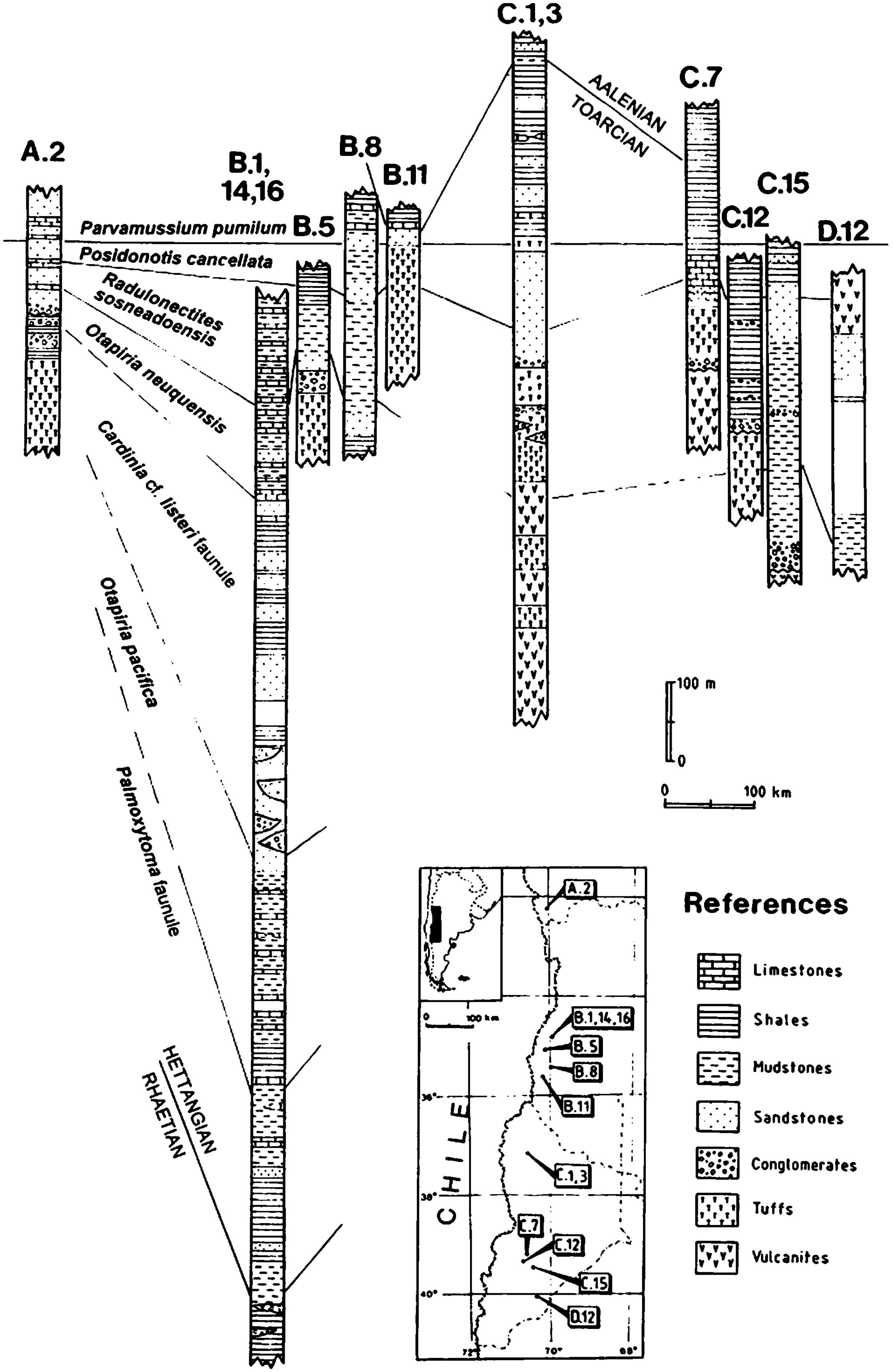
A detailed account on the geology of the fossiliferous localities of the material described here has already been provided in DAMBORENEA (1987a) and RICCARDI et al. (1988, 1991), where the exact location of each sample and a summary of the previous geological knowledge of each region can be found (see Text-fig. 1 and Table 1 here).

Early Jurassic marine deposits are known in Argentina from around 32° S in San Juan Province to about 45° S in Chubut Province, in two marine basins which may be called Neuquén and Patagonian (Text-fig. 1). Not surprisingly, along these 1400 km they exhibit a great variation in lithological characteristics. Unfortunately, most of the areas have only been very superficially studied from the geological point of view and the knowledge on their sedimentology and facies distribution is, with some exceptions (GULISANO & PANDO 1981), patchy and still preliminary. Some general views and different interpretations about the historical development of the Neuquén Basin during the Jurassic can be found in DIGREGORIO (1972, 1978), DIGREGORIO & ULIANA (1980), GULISANO (1981), GULISANO et al. (1984), RICCARDI & GULISANO (1992), RICCARDI et al. (1993), LEGARRETA et al. (1993), GULISANO & GUTIÉRREZ PLEIMLING (1995a, 1995b), ALVAREZ (1996b), LO FORTE (1996) and LEGARRETA & ULIANA (1996). A summary of the Jurassic of central-western Patagonia (Chubut Province) can be found in LESTA & FERELLO (1972) and LESTA et al. (1980). RICCARDI (1983 and in RICCARDI & DAMBORENEA 1993) provided a comprehensive synthesis of the previous knowledge about the Jurassic of Argentina and Chile and compiled a very thorough reference list on the subject. Consequently, only a general up-dated overview of the geology of Lower Jurassic marine deposits of the Cuyan Basin will be outlined here.

Earliest Jurassic sedimentation occurred within a series of semi-isolated depocentres related to Triassic NNW oriented troughs (ULIANA & BIDDLE 1988, LEGARRETA & ULIANA 1996).

In most places of the Argentinian Main Cordillera, except in the Atuel river region, the Lower Jurassic rests unconformably on vulcanites referred to the Triassic (Text-fig. 2). Furthermore, the volcanic activity continued at most places during at least the early Jurassic and almost everywhere the tuffaceous or volcanoclastic component in marine sediments is high. All early Jurassic marine sediments were included in the Cuyan subcycle of the "Jurassic" sedimentary cycle by GROEBER (1946 and in GROEBER et al. 1953) and the Araucanic Synthem by RICCARDI & GULISANO (1992).

The earliest marine Lower Jurassic in Argentina is known to occur only in the Atuel river area, Mendoza Province (B.14 in Text-figs. 1 and 2; RICCARDI et al. 1988, 1991, 1993). The oldest Jurassic sediments from that region bear an ammonite fauna equivalent to the Planorbis Zone and rest conformably on at least 300 m of marine turbidites of late Triassic age (RICCARDI et al. 1997). This represents the easternmost extension of the



Text-fig. 2. Selected sections of Lower Jurassic marine deposits in western Argentina showing distribution of bivalve biozones. For location see Text-fig. 1 and Table 1.

Hettangian sea in the southern Andes and at the same time is the only Argentinian area where the Triassic–Jurassic boundary occurs within a marine clastic sedimentary sequence. The whole Hettangian succession in the Atuel river region comprises about 175 m of mudstones and siltstones, some of them probably of turbiditic origin, in which the abundance and variety of the shelly fauna increases upwards (see Text-fig. 2).

During late Triassic–earliest Jurassic times, other regions were covered by volcanic or volcanoclastic rocks, thus making their stratigraphical study very difficult.

During most of the Sinemurian the marine sediments were still restricted to the neighbourhood of the Atuel river (see Text-fig. 2), but during the latest Sinemurian–early Pliensbachian the initial depocentres coalesced and the sea developed a wide embayment which extended eastwards and covered most of the Neuquén Province. In many places conglomerates, sandstones or tuffs can be found at the base of the marine sequence. These continental sediments fill in local topographic depressions and thus the marine sediments rest either on them or directly on the Triassic vulcanites. Where the former margins of that embayment are now exposed, such as in the Piedra Pintada region in southern Neuquén, the normal marine sediments interfinger with fluvial red beds, tuffs, volcanic breccias, alluvial-fan conglomerates and stromatolitic limestones (Gulisano & Pando 1981).

Palaeogeographic reconstructions of the Neuquén basin for different time intervals are available (Riccardi et al. 1992, Legarreta et al. 1993, Gulisano & Gutiérrez Pleimling 1995a, 1995b, Legarreta & Uliana 1996).

Whereas the basin fringe was dominated by coarse clastic rocks, the marine sequence in the central part of the embayment comprises mainly black shales and limestones, with local episodes of turbiditic sedimentation (for example at Espinazo del Zorro) and storm-deposits (for example at Arroyo Serrucho and Arroyo del Portezuelo Ancho). Within this general development, the basinal successions are also locally punctuated by submarine volcanism, and by shallower water accumulations.

Early Jurassic deposits are followed by Middle Jurassic sediments with no major break or hiatus in the Neuquén Basin.

## Terminology and measurements

Each fossiliferous locality is given a letter-number symbol that is used throughout the text (see Table 1 and Text-fig. 1). The numbers in brackets that are given after catalogue numbers represent field sample numbers. Their location in the stratigraphical sections was given in Damborenea (1987a) and Riccardi et al. (1988, 1991).

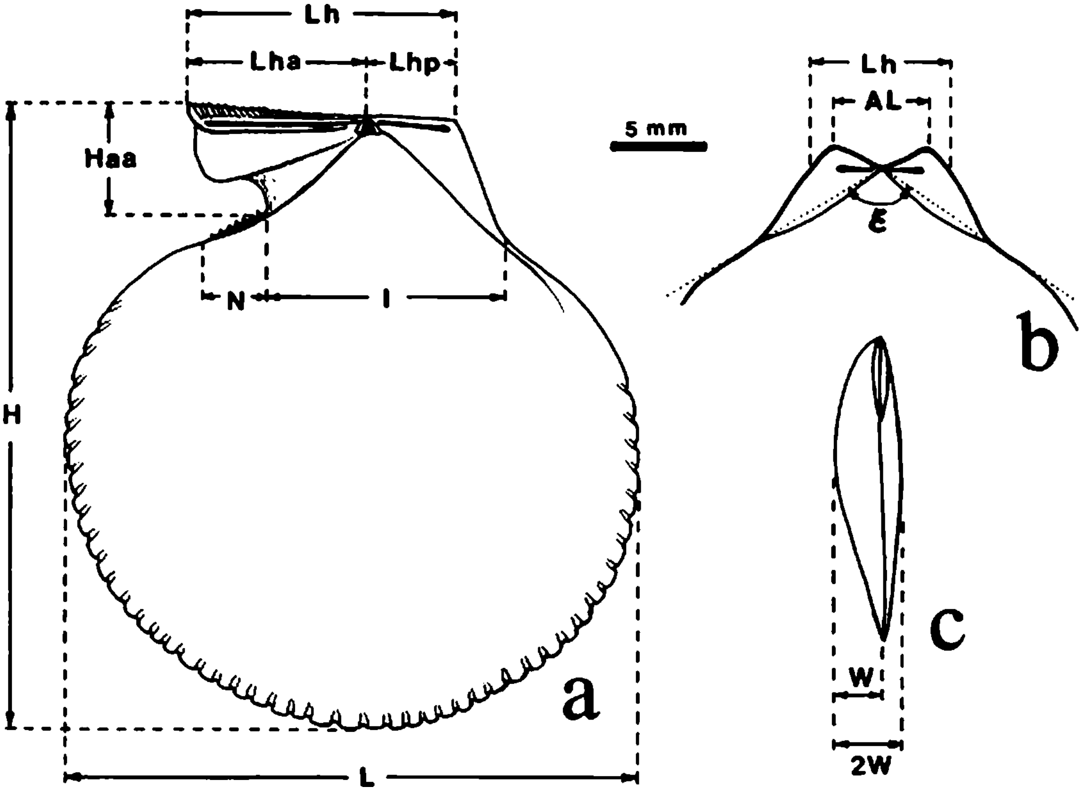
The morphological terms used in this work are those listed and defined by Cox et al. (1969) and by Waller (1984) and Newell & Boyd (1995) for pectinoideans. Measurements (see Text-fig. 3) were made using a pair of vernier calipers (accurate to 0.1 mm). In order to facilitate comparisons, the mode of preservation of each measured specimen (S = shell present; IM = internal, EM = external, or CM = composite moulds) and the nature of the material (LV = left, RV = right, or BV = both valves) is indicated in the tables. Measurements are recorded in mm. In addition to the numerical data, scatter diagramms have been plotted for certain species.

Other abbreviations used throughout the text are as follows: L = length; H = height; W = width or inflation of single valves; 2W = width or inflation of both valves together; Lh = length of the hinge-line; Lha = length of the anterior portion of the hinge-line; Lhp = length of the posterior portion of the hinge-line; Haa = height of anterior auricle; N = depth of byssal notch; AL = separation of auricular dorsal apices in Entoliidae (in this group this measurement is different from Lh) and I = intersinal distance.

Angular measurements are accurate to the nearest degree: $\alpha$ = angle between the dorsal and anterior margins of the shell; $\beta$ = angle between the dorsal and posterior margins; $\varepsilon$ = umbonal angle in pectinoideans. Other angular measurements used in special cases are explained in the text.

Shell size is said to be small (less than 2 cm long), medium (between 2 and 5 cm long) or large (more than 5 cm long).

The morphological terms employed for the description of ornament in pectinoideans are mainly based on Waller (1972a) and Newell & Boyd (1995): costae are radial ribs limited to the exterior of the shell, riblets is used when the costae are fine and sinuous, while plicae are radial corrugations affecting most of the thickness of the shell and its ventral margin and forming interlocking folds on shell margin. The general term ribs is used only when the distinction between costae and plicae is not possible.



Text-fig. 3. Measurements used throughout the text. For abbreviations see "Terminology and Measurements". a – Inner view of right valve of *Agerchlamys wunschae* (MARWICK) based on MLP 23655; b – inner view of *Entolium disciforme* (SCHÜBLER); c – lateral view of *Camptonectes* cf. *auritus* (SCHLOTHEIM).

The discussion of suprageneric groupings is beyond the scope of this study except where necessary to explain generic assignments.

The synonymy lists were prepared according to the indications given by MATTHEWS (1973) to indicate the degree of confidence in allocation of each entry. They include only published records.

The use of open nomenclature follows the guide-lines given by BENGTSON (1988).

## Repositories

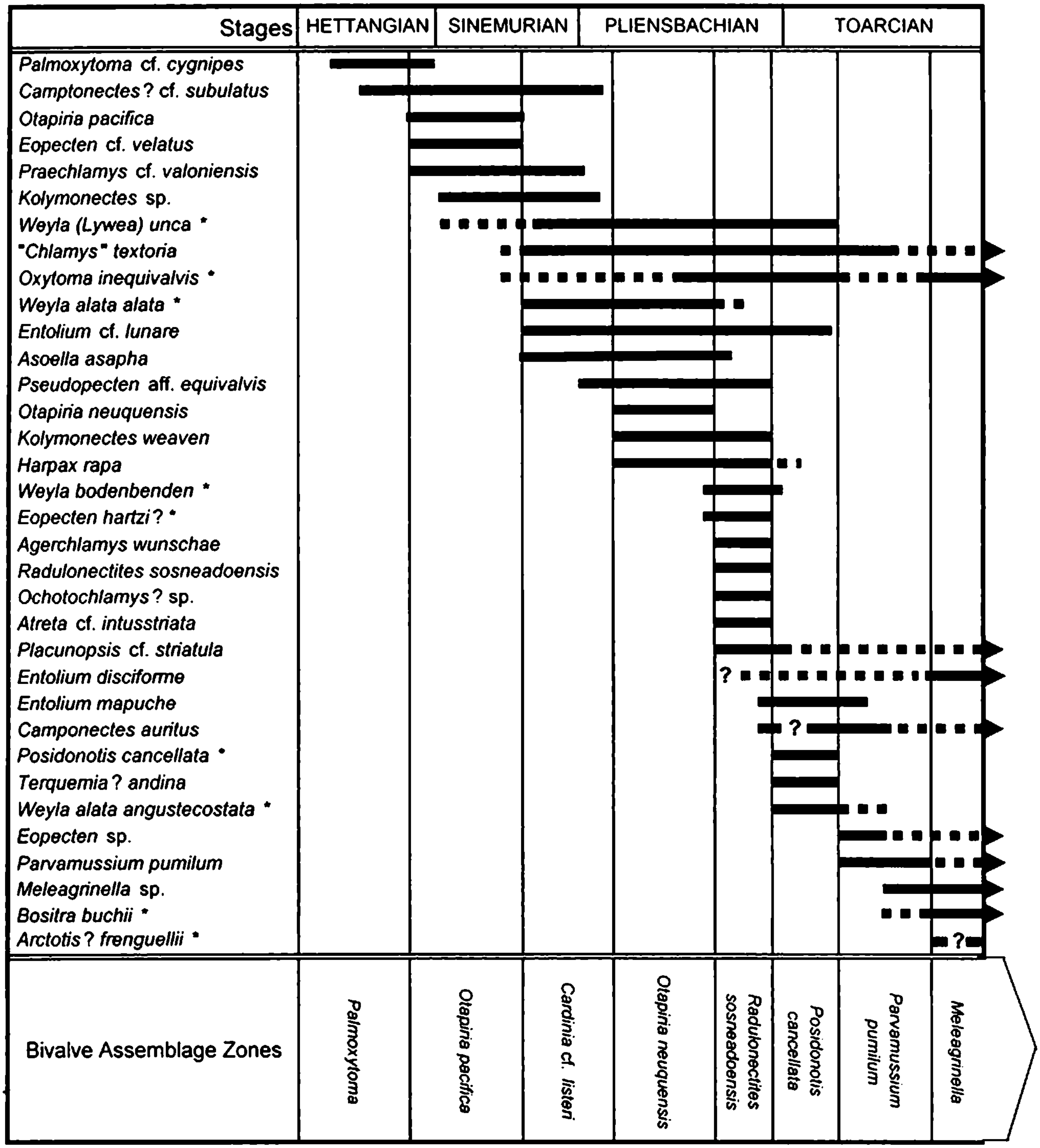
The specimens studied are deposited in the following collections under the catalogue numbers listed in the text and the figure captions:

| | |
|---|---|
| AU: | Department of Geology, University of Auckland, Auckland, New Zealand. |
| BMNH: | British Museum (Natural History), Cromwell Road, London SW7 5BD, Great Britain. |
| BMW: | The Burke Memorial Washington State Museum, DB10, University of Washington, Seattle, Washington 98195, United States. |
| CPBA: | Facultad de Ciencias Exactas y Naturales (Departamento de Geología), Universidad de Buenos Aires, Ciudad Universitaria, Pabellón 2, 1428 Buenos Aires, Argentina. |
| DNGM: | Servicio Geológico Nacional de Argentina, Avenida Santa Fe 1548, 1060 Buenos Aires, Argentina. |
| MACN: | Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires. |
| MLP: | Museo de Ciencias Naturales de La Plata (División Paleozoología Invertebrados), Paseo del Bosque, 1900 La Plata, Argentina. |
| NHMB: | Naturhistorisches Museum Basel, CH-4051 Basel, Augustinergasse 2, Switzerland. |
| NZGS: | New Zealand Geological Survey, Lower Hutt, New Zealand. |
| OU: | Department of Geology, Otago University, Dunedin, New Zealand. |
| SGOPI: | Museo Nacional de Historia Natural, Santiago de Chile, Chile. |
| SMNHL: | Staatliches Museum für Naturkunde, Zweigstelle, Arsenalplatz 3, D-71638 Ludwigsburg, Germany. |
| USNM: | United States National Museum of Natural History, Washington D.C. 20560, United States. |

The author's collection is entirely deposited at the La Plata Museum (MLP).

## Biostratigraphy

One of the conclusions of this work is a clear picture of the stratigraphical distribution of the revised species (Text-fig. 4). Furthermore, a biostratigraphical zonation of the Argentinian Lower Jurassic based on the vertical ranges of bivalves in relatively off-shore facies was proposed (Damborenea in Riccardi et al. 1990, Damborenea 1993b, 1994; Table 2 here). This includes five Assemblage Zones and three faunules which are now widely recognized in Argentina (Damborenea et al. 1992, Leanza 1993, Alvarez 1996a, 1996b) and Chile



Text-fig. 4. Range chart of Early Jurassic monotoidean, pectinoidean, plicatuloidean and dimyoidean bivalves from western Argentina. For local zonation see Table 2. Only species revised by the author are included.

and perhaps even in Perú and Colombia – Ecuador. Their distribution in Argentina is summarized in Text-figs. 2 and 5.

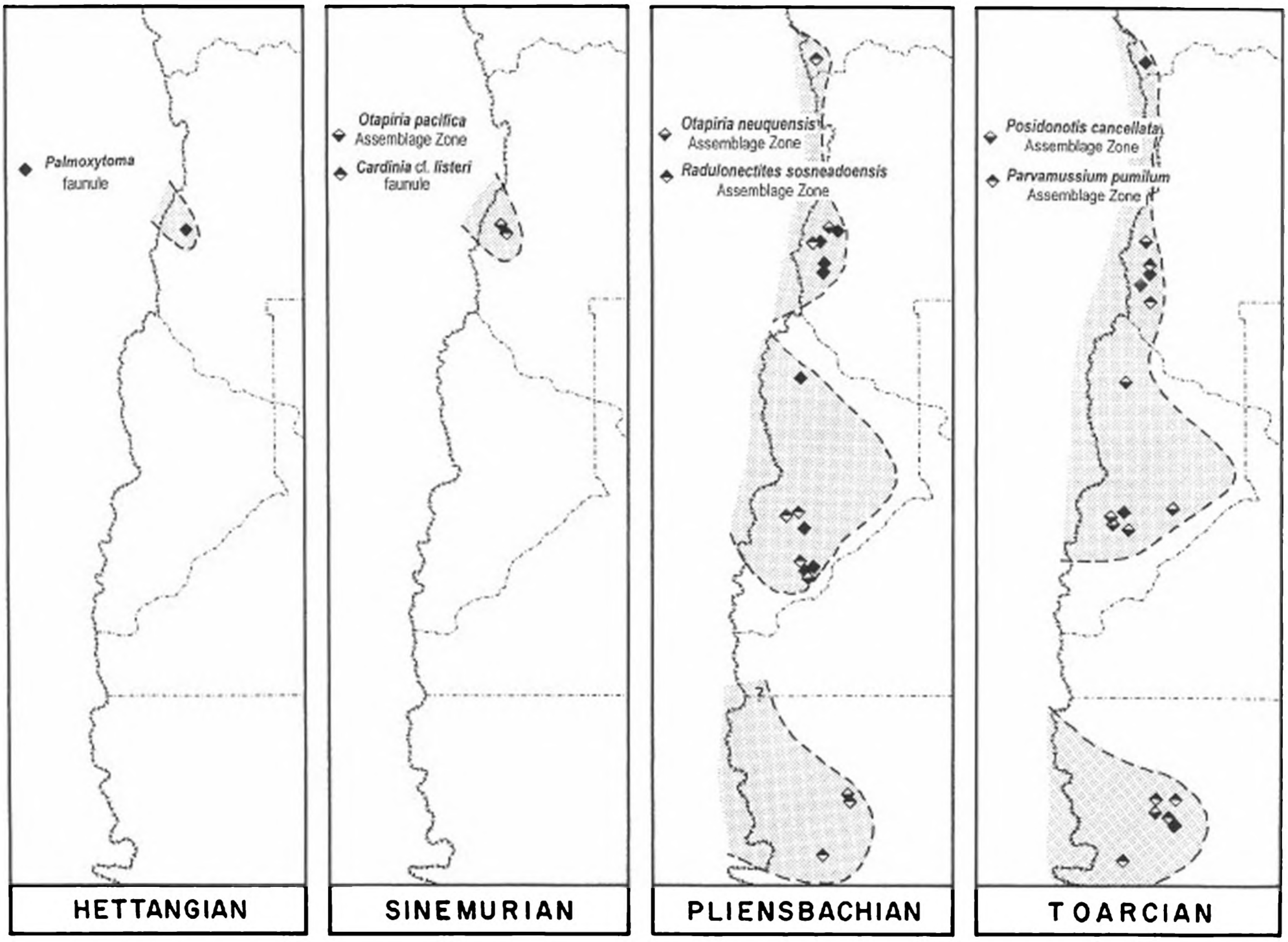
The local age calibration of this scheme is very good, due to the fact that the bivalves were often collected from the same sections and levels which provided the ammonites identified by Riccardi (1984).

Most of these Assemblage Zones, as with those of NE Asia (Polubotko & Repin 1988) are based and named after local species belonging to mainly circum-Pacific genera, such as *Otapiria*, *Radulonectites* and *Posidonotis*. Although this is only a consequence of the fact that correlation tables are commonly based on off-shore species, it makes comparison with other circum-Pacific regions easier. This analysis should not overlook, however, the progressive displacement of local vertical ranges of some of these bivalve taxa with latitude, which is known to occur (see Damborenea 1989 and Aberhan & Pálfy 1996 for *Posidonotis* species).

Unfortunately, our knowledge is not yet detailed enough and hence correlation between circum-Pacific regions is still being done via the independent reference of the local zonations to the European Standard Zonation, thus introducing a certain degree of ambiguity and inaccuracy in the process. Nevertheless, a correlation chart for several circum-Pacific regions has been compiled (Table 3) showing approximate equivalences (Damborenea et al. 1992, Damborenea 1993b, 1994).

## Hettangian – Sinemurian

The knowledge of Hettangian – Sinemurian faunas is still poor and is currently being developed. The following is the bivalve zonation recognized so far.



Text-fig. 5. Geographical distribution of bivalve biozones in western Argentina. Shaded areas represent maximum extension of sea for each time interval.

Table 2. Biozonation of the Early Jurassic of Argentina based on bivalves and its proposed correlation with European and local ammonite biozones. Local ammonite zonation from Riccardi (1984), Riccardi et al. (1988) and Riccardi (pers. comm.).

| STAGES AND SUBSTAGES | | AMMONITES | | BIVALVES |
|---|---|---|---|---|
| | | EUROPE | ARGENTINA | ARGENTINA + CHILE |
| TOARCIAN | U | *Dumortieria levesquei* | *Dumortieria faunule* | *Meleagrinella* faunule |
| | | | *Phlyseogrammoceras tenuicostatum* | |
| | | *Grammoceras thouarsense* | *Phymatoceras* faunule | *Parvamussium* cf. *pumilum* Assemblage Zone |
| | | *Haugia vatiabilis* | | |
| | L | *Hildoceras bifrons* | *Collina chilensis* Zone | |
| | | | *Peronoceras pacificum* Zone | |
| | | | *Peronoceras largaense* Zone | |
| | | *Harpoceras falcifer* | *Dactylioceras hoelderi* Zone | |
| | | *Dactylioceras tenuicostatum* | *D. tenuicostatum chilense* Zone | *Posidonotis cancellata* Ass. Zone |
| | | | *Dactylioceras simplex* Zone | |
| PLIENSBA-CHIAN | U | *Pleuroceras spinatum* | *Fanninoceras* Zone | *Radulonectites sosneadoensis* A.Z. |
| | | *Amaltheus margaritatus* | | |
| | L | *Prodactylioceras davoei* | *Dubariceras* Zone | *Otapiria neuquensis* Ass. Zone |
| | | *Tragophylloceras ibex* | | |
| | | *Uptonia jamesoni* | *Miltoceras* faunule | |
| SINEMURIAN | U | *Echioceras raricostatum* | | |
| | | *Oxynoticeras oxynotum* | | *Cardinia* cf. *listeri* faunule |
| | | *Asteroceras obtusum* | *Epophioceras* faunule | |
| | L | *Caenisites turneri* | *Agassiceras* Zone | *Otapiria pacifica* Ass. Zone |
| | | *Arnioceras semicostatum* | *Vermiceras Zone* | |
| | | *Arietites bucklandi* | | |
| HETTAN-GIAN | | *Schlotheimia angulata* | *Badouxia canadensis* Zone | *Palmoxytoma* faunule |
| | | *Alsatites liasicus* | *Waehneroceras-Schlotheimia* Z. | |
| | | *Psiloceras planorbis* | *Psiloceras* Zone | |

*Palmoxytoma* faunule (Damborenea 1994)

An ill-defined Hettangian bivalve faunule with *Palmoxytoma* cf. *cygnipes* (Riccardi et al. 1988, 1991, Damborenea, 1992, pl. 115, fig. 1; Aberhan 1994, text-fig. 16; Pl. 1, Figs. 6–8 here) and "*Inoceramus*" sp. (Tilmann 1917, Escobar 1980) also contains *Camptonectes*? cf. *subulatus* (Münster) and is associated with ammonites of the *Waehneroceras-Schlotheimia* and *Badouxia canadensis* Ammonite Zones.

*Otapiria pacifica* Assemblage Zone (Damborenea in Riccardi et al. 1990)

An Assemblage Zone characterized by *Otapiria pacifica* Covacevich & Escobar (1979, pl. 1, figs. 1–13; Pl. 1, Figs. 1-3 here) can be recognized from the Lower Sinemurian of Chile and Argentina, ranging from the upper part of the *Badouxia canadensis* Ammonite Zone to the *Agassiceras* Ammonite Zone. It appears to be more or less equivalent to the *Otapiria omolonica* Zone of eastern Russia (Polubotko & Repin 1988, Sey & Kalacheva 1988) and the beds with *O. marshalli* of New Zealand. In Argentina it is present only in the Atuel river region, but has a wider distribution in Chile. In littoral facies, *Quadratojaworskiella* sp. and the first South American *Weyla* may represent a more or less coeval association.

*Cardinia* cf. *listeri* faunule (Damborenea 1994)

A better knowledge of late Sinemurian bivalve faunas will allow the distinction of one or more Assemblage Zones of that age. Between the *Otapiria pacifica* and the *O. neuquensis* Ass. Zones, near-shore bivalve faunas are characterized by *Cardinia* cf. *listeri* (Sow.) (Damborenea in Riccardi et al. 1988, fig. 5.11). This late Sinemurian faunule is relatively rich and marks the local appearance of several long-ranging species, such as *Weyla alata* (v. Buch), *Asoella asapha* (Leanza), *Entolium* cf. *lunare* (Roemer) and "*Chlamys*" *textoria* (Schlotheim).

### Pliensbachian

During the Pliensbachian an especially rich and varied littoral bivalve fauna flourished in the South American Andes, with several species of *Weyla*, *Parallelodon*, *Cucullaea*, *Harpax*, *Jaworskiella*, *Frenguelliella*, *Cardinia*, other pectinids, mytilids, astartids, etc.

Two Assemblage Zones were recognized for the Pliensbachian.

*Otapiria neuquensis* Assemblage Zone (Damborenea in Riccardi et al. 1990)

This zone is well-characterized and has a wide geographical distribution in Argentina, ranging from the upper part of the *Miltoceras* ammonite faunule to the lower portion of the *Fanninoceras* Ammonite Zone, i.e. most of the Lower Pliensbachian. It is characterized by *Otapiria neuquensis* Damborenea (1987b, pl. 6, figs. 1–5; Pl. 1, Figs. 4–5 here), *Palaeoneilo patagonidica* (Leanza), *Asoella asapha*, *Parainoceramus apollo* (Leanza), a local species of *Kalentera*, *Grammatodon costulatus* (Leanza) and *Kolymonectes weaveri* Damborenea. It is present in the Atuel river region, Portezuelo Ancho, Cerro Puchenque–Serrucho, Cordillera del Viento, Arroyo Lapa and Piedra Pintada area. Its presence in Chubut is also probable, since Nullo (1983) listed "*Inoceramus apolo*" (sic) and "*Nuculoma patagonídica*" from the Pampa de Agnia region.

It can be correlated with the *Otapiria tailleuri* beds of Alaska, the *Posidonotis semiplicata* beds of western North America and the *Chlamys tapensis* Zone in northeast Russia (Polubotko & Repin 1988) which contains *Kolymonectes staeschei* (Polubotko).

*Radulonectites sosneadoensis* Assemblage Zone (Damborenea in Riccardi et al. 1990)

This zone covers the remaining part of the *Fanninoceras* Ammonite Zone (latest Lower Pliensbachian and most of the Upper Pliensbachian) and is characterized by *Radulonectites sosneadoensis* (Weaver 1931, pl. 28, fig. 169; Pl. 6, Figs. 12–20 here), *Kolymonectes weaveri* Damborenea and *Eopecten hartzi* (Ros.). It is present in several localities from San Juan to Chubut and it is likewise widespread in Chile. This is roughly equivalent to the *Eopecten viligaensis* plus the *Radulonectites hayamii* Beds of eastern Russia (Polubotko & Repin 1988) and the *R. japonicus* beds of Japan (Hayami 1975, 1985). In certain facies, the pectinid *Agerchlamys wunschae* (Marwick) and *Harpax rapa* (Bayle & Coquand), both characteristic species of the Lower Ururoan of New Zealand, occur also in this assemblage (see Damborenea & Manceñido 1992). At least part of the Pliensbachian material illustrated by Poulton (1991) as *Camptonectes* (*Camptochlamys*) sp. belong to *Radulonectites*, and coeval beds of Russia bear a species of *Harpax* (Polubotko 1968a and Sey 1984) related to *H. rapa* (see discussion in Damborenea 1993a).

### Toarcian

Again knowledge of Toarcian bivalves is still poor and probably more Assemblage Zones could be recognized in the future.

*Posidonotis cancellata* Assemblage Zone (Damborenea in Riccardi et al. 1990)

During the latest Pliensbachian and earliest Toarcian the *Posidonotis cancellata* Assemblage Zone can be recognized, typically with *P. cancellata* (Leanza; Damborenea, 1987b, pl. 14, figs. 1–12) and *Weyla alata angustecostata* (Philippi). It is interesting to note that the subspecies *W. alata angustecostata*, which is such a characteristic fossil of this Assemblage Zone in Argentina, in Chile has been either only recognized in older Pliensbachian beds according to Pérez & Reyes (1994), or not distinguished as a different taxon (Aberhan 1994). This Assemblage Zone spans the *Dactylioceras simplex* + *D. tenuicostatum chilense* Ammonite Zones and is known from Arroyo de Las Vegas (Alvarez 1996a, 1996b), Arroyo La Laguna, Portezuelo Ancho, Cerro Puchenque, Cerro Tricolor, Cordillera de Viento, Vuta Picún Leufú, Arroyo Lonqueo, Cerro Granito, Arroyo Lapa and also from several localities in Chubut. It can be correlated with the lower part of *Meleagrinella substriata* beds of northern Russia and with *Posidonotis dainellii* beds of Japan (Hayami 1985, in Sato & Westermann 1991). In South America *Posidonotis* consistently appears at the Pliensbachian/Toarcian boundary, but beds with *Posidonotis semiplicata* (Hyatt) have a wider stratigraphical range in western North America

Table 3. Correlation chart for the Early Jurassic of Circum-Pacific regions based on bivalve biostratigraphic units.

| | NORTHEAST RUSSIA 1 | FAR-EAST RUSSIA 2 | ALASKA 3 | WESTERN CANADA 4 | WESTERN USA 5 | SOUTH AMERICA 6 | NEW ZELAND 7 | CHINA 8 | JAPAN 9 |
|---|---|---|---|---|---|---|---|---|---|
| TOARCIAN | *Meleagrinella faminaestriata* Beds | *G. borsjaensis* | | | | *Meleagrinella* faunule<br>*Parvamussium pumilum* Assemblage Zone | *I. ururoaensis* | | *P. matsumotoi* |
| | *Meleagrinella substriata* Beds | | | | | *Posidonotis cancellata* A. Z. | | *Astarte* cf. *voltzi* - *Weyla ambongoensis* | *Posidonotis* sp. |
| PLIENSBACHIAN | *Radulonectites hayamii* Beds | *Ochotochl. bureiensis* | | | *L. boechiformis* | *Radulonectites sosneadoensis* A. Z. | *P. martini* | | *Radulonectites japonicus* |
| | *E. villgaensis* Beds | *Palmoxytoma cygnipes* | | | | | | | |
| | *Chlamys tapensis* Beds | *H. spinosus* Beds | *O. tailleuri* | *Posidonotis semiplicata* | *Posidonotis semiplicata* | *O. neuquensis* Assemblage Zone | *Pseudaucella marshalli* | | |
| SINEMURIAN | *O. limaeformis* Z.<br>*"Monotis" inopinata* | *O. limaeformis* Zone | | | | *Cardinia* cf. *listeri* faunule | ? | *Parainoceramus* - *Teinonuculana* | |
| | *O. omolonica* Zone | *O. omolonica* Zone | | | | *O. pacifica* Ass. Z. | *O. marshalli* | | |
| HETTANGIAN | *O. originalis* Beds | | | | | *Palmoxytoma* faunule | | *Hiatella* Ass. | |

REFERENCES

*E.* = *Entolium*
*G.* = *Galinia*
*H.* = *Harpax*
*I.* = *Inoceramus*
*L.* = *Lupherella*
*O.* = *Otapiria*
*P.* = *Parainoceramus*

1. Polubotko and Repin 1988
2. Sey 1984; Sey and Kalacheva 1980; 1985; 1988
3. Imlay 1967
4. Pálfy et al. 1990
5. Imlay 1967
6. Damborenea in Riccardi et al. 1990
7. Marwick 1953a; Speden 1970; Stevens 1978; Stevens and Speden 1978
8. Wang and Sun 1983; Wang 1988
9. Hayami 1960; 1985

(Damborenea 1989, Palfy et al. 1990, Smith et al. 1994, Aberhan & Pálfy 1996). The name *P. cancellata* was synonymized to *P. semiplicata* by Aberhan & Pálfy (1996).

*Parvamussium pumilum* Assemblage Zone (Damborenea in Riccardi et al. 1990)

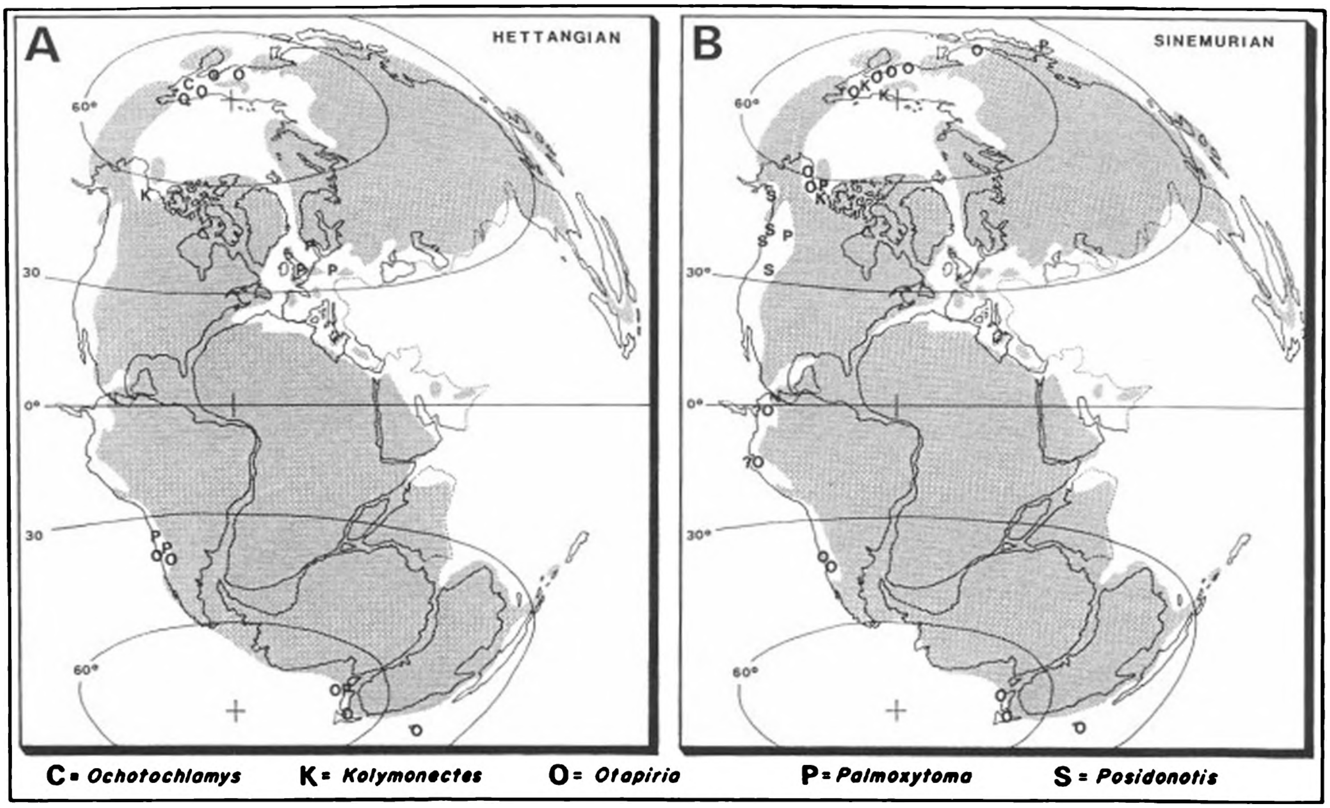
This zone is characterized by the appearance of *Parvamussium* cf. *pumilum* (Lamarck; Pl. 1, Figs. 12–20 here), *Bositra ornati* (Quenstedt) and *Meleagrinella* sp. and extends over most of the Toarcian. This is roughly equivalent to *Meleagrinella substriata* and *M. faminaestriata* beds of northern Russia and the beds with "*Inoceramus*" *ururoaensis* of New Zealand.

*Meleagrinella* faunule (Damborenea 1994)

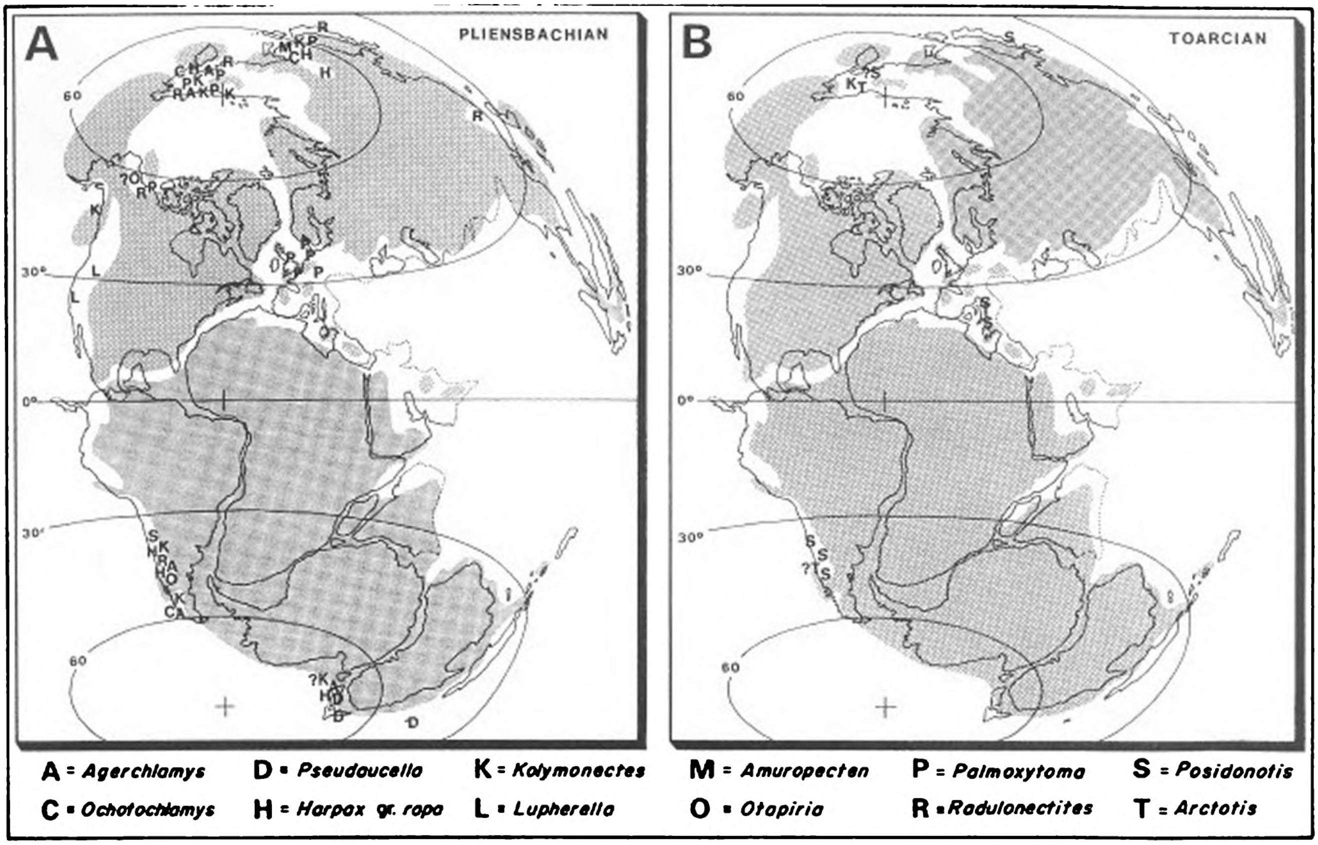
Uppermost Toarcian and Aalenian beds contain a relatively diverse near-shore bivalve assemblage with *Meleagrinella* sp. (Pl. 1, Figs. 9–11 here). Off-shore bivalve faunas for this interval are still imperfectly known but may allow the recognition of more than one biostratigraphical unit. In Russia the first species of *Retroceramus* are used in biostratigraphy (see Sey & Kalacheva 1980, 1988, Polubotko & Repin 1988). In a broad sense, the lowermost Temaikan beds of New Zealand (see Damborenea & Manceñido 1992) and the *Inoceramus* ? *kudoi* Hayami (1960) beds of Japan are probably coeval with the *Meleagrinella* faunule of the Andes.

## Paleogeography

The following palaeobiogeographical analysis is focussed on the taxa described in this paper. Pectinoideans (s.l.) have been used in the northern Hemisphere to recognize palaeogeographic units in the Early Jurassic. They are also the core of data used by Damborenea (1993a) to show that, if the relations of each taxon are adequately



Text-fig. 6. Palaeogeographical distribution of selected bivalve taxa during A: Hettangian, B: Sinemurian. Palaeocontinental reconstruction from Smith & Briden (1977) for the Early Jurassic, hypothetic coast-lines compiled from various sources. Modified from Damborenea & Manceñido 1992.



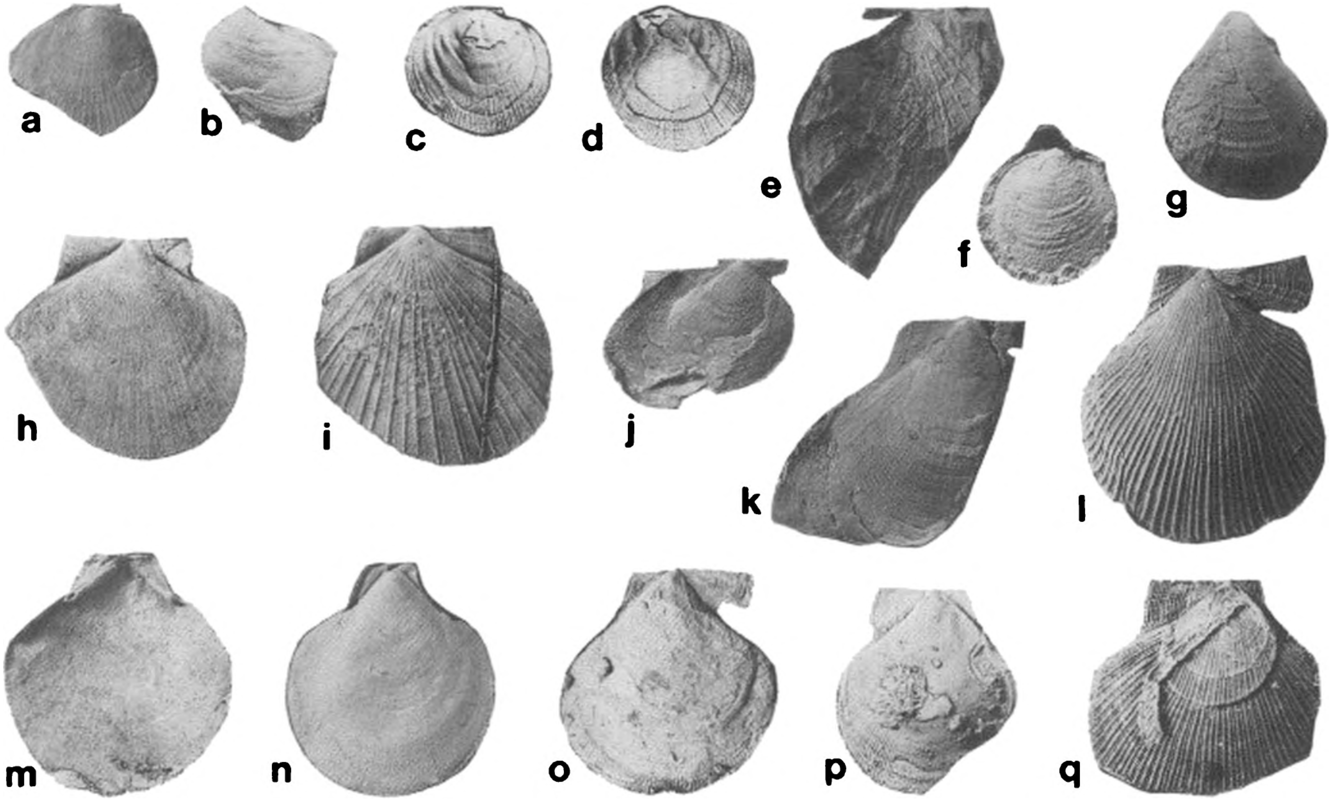
Text-fig. 7. Palaeogeographical distribution of selected bivalve taxa during A: Pliensbachian, B: Toarcian. Palaeocontinental reconstruction from Smith & Briden (1977) for the Early Jurassic, hypothetic coast-lines compiled from various sources. Modified from Damborenea & Manceñido 1992.

evaluated, several species have "Boreal" affinities, challenging previous ideas on the absence of a distinct Austral fauna during the early Jurassic. In the following discussion, palaeolatitudes are referred to broadly as low (< 30°), middle (30°–60°) and high (> 60°) according to the palaeogeographical reconstructions in Smith & Briden (1977).

Crame (1986) suggested that lack of data from the southern Hemisphere seriously distorted palaeobiogeographic interpretations. His arguments, referred to younger faunas, are perfectly relevant to the Early Jurassic as well. Data from Early Jurassic Antarctic faunas are still very fragmentary and will add key arguments to this discussion.

According to their palaeogeographic distribution and relative abundance, Early Jurassic pectinoideans were grouped by Damborenea (1993a, 1996) into the following categories: cosmopolitan, tethyan (low latitude); boreal, austral and bipolar (high latitude); and pacific.

The global Early Jurassic distribution of some of the geographically restricted genera (Damborenea 1993a; also Text-fig. 8 here) indicates that in the Pacific and during the Early Jurassic, according to pectinoideans, East-West faunal differentiation was weaker than the latitudinal one (see Text-figs. 6–7). Hallam's study (1977a) on Jurassic bivalves emphasized East-West differences in the Pacific, with a distinct West American Province as opposed to an East Asian Province and a Southwest Pacific Province. The data used by Hallam have been considerably altered by recent research, especially in eastern Russia, northern Canada, Antarctica and South America. Within the scope of this analysis, only *Lupherella* and *Weyla* could be claimed to be East Pacific forms. *Lupherella boechiformis* (Hyatt) is clearly related to *Otapiria* (could be distinguished as a local subgenus at most; see Damborenea 1987b). The distribution of *Weyla* has been already revised (Damborenea & Manceñido



Text-fig. 8. Some examples of Early Jurassic Monotoidea and Pectinoidea restricted to high latitudes described in this paper. a – *Otapiria neuquensis* Damborenea, MLP 19997, right valve, X 1; b – *Otapiria pacifica* Covacevich & Escobar, MLP 22260, left valve, X 1; c-d – *Arctotis frenguellii* (Damborenea), MLP 10418, right and left valves, X 0.8; e – *Palmoxytoma* cf. *cygnipes* (Young & Bird), MLP 22253, right valve, X 1; f-g – *Asoella asapha* (Leanza), f: MLP 28011, right valve, X 2, g: MLP 28024-a, left valve, X 2; h-i – *Kolymonectes weaveri* Damborenea, MLP 23807, right and left valves, X 1; j-k – *Ochotochlamys* sp., j: MLP 27592, both valves, X 1, k: MLP 27595, right valve, X 1; l, q – *Agerchlamys wunschae* (Marwick), l: MLP 26559-a, right valve, X 1, q: MLP 23656, left valve, X 1; m-n – *Entolium mapuche* n. sp., m: MLP 15536-a, X 1, n: MLP 24869, X 1; o-p – *Radulonectites sosneadoensis* (Weaver), o: MLP 22321, right valve, X 1, p: MLP 6033, left valve, X 1.

1979; 1988) and although this is a typical East Pacific bivalve, the record claimed from the Alazei Plateau, NE Siberia (Polubotko & Repin 1984) cannot be overlooked. The facies in which *Weyla* and other littoral bivalves of the Andean faunas thrive are missing in New Zealand. It is therefore extremely difficult to evaluate the absence of such faunal elements in the south-west Pacific.

Well-defined Austral faunas are admitted for the Permian and the Triassic (cf. Fleming 1962, 1967, Stevens 1980, 1989) and again in the late Jurassic – Cretaceous (cf. Fleming 1967, Kauffman 1973, Stevens 1973, Enay 1980, Crame 1986). For the Early Jurassic, "Maorian" faunas of New Zealand and New Caledonia were repeatedly discussed by New Zealand authors as related to cool or cold water temperature (Marwick 1953b, Fleming 1967, Stevens 1977, 1980, 1989, 1990), but these were understated in global discussions on account of their apparent areal restriction. This is no longer the case and *Pseudaucella* remains the only Early Jurassic strictly Maorian endemic bivalve genus, since others such as *Kalentera* are now known to occur in South America as well (Covacevich et al. 1991; Damborenea 1992, 1993a). Fleming (1975) and Stevens (1980) have already mentioned the occurrence of Maorian elements in other places in southern Gondwana and they pointed out that the Maorian Province could be seen as a remnant of the Triassic and Early Jurassic Palaeoaustral Realm. They nevertheless preferred to retain the term Maorian which helped to emphasize the idea of the isolation of New Zealand at that time.

FLEMING's and STEVENS' ideas, together with the data discussed here, fit quite naturally with the concept of a latitudinally distinct Early Jurassic bivalve fauna, most probably climatically controlled. There are enough arguments to characterize an Early Jurassic Austral Realm, with a Maorian Province (if worth distinguishing) as a subordinate unit (DAMBORENEA 1993a).

Although recognized through the whole Early Jurassic, this Austral Realm is more distinctly characterized in Pliensbachian times than for other Stages (see Text-figs. 6 and 7). Similarly, the first distinct Boreal Jurassic fauna in northern Canada is of Upper Pliensbachian age (POULTON 1991). This may just reflect the higher diversity of bivalve faunas worldwide at that time (and then better known), but other climatic and palaeogeographic factors may have contributed to this picture.

The palaeogeographical position of South America during the Early Jurassic and the availability of outcrops make this part of Gondwana a privileged place to study the transition between Austral and Tethyan benthonic faunas. DAMBORENEA (1996) analyzed the latitudinal distribution of Early Jurassic bivalve species between 22° and 46° S and recognized a wide area of mixed faunas which shifted southwards about 8° to 10° from Hettangian to Toarcian times. This is consistent with a similar latitudinal shift observed in New Zealand (STEVENS 1989).

As CRAME (1986) pointed out for the Late Mesozoic, there are distinct groups of bivalve taxa with clear high latitude affiliations, which can be also recognized in the Early Jurassic (herein) and even earlier. Core high latitude groups within the families Monotidae, Trigoniidae and Kalenteridae are evident since the Late Triassic (FLEMING 1962, 1964, 1987, KOBAYASHI & TAMURA 1983). To these some Pectinidae, Plicatulidae and Oxytomidae are added in the Early Jurassic (DAMBORENEA 1993a; Text-fig. 8 here). This high latitude bipolar core is still noticeable (though weaker) during the Middle Jurassic with the addition of some Inoceramidae (DAMBORENEA 1990), and is well-defined for the Late Jurassic as already discussed by CRAME (1986).

Several high latitude stocks have similar evolutionary histories: their origin can always be traced to Boreal or Austral Triassic groups, they persisted and diversified during the Late Triassic and through the Jurassic of high latitude regions, occasionally spreading to low latitudes, they declined in the Cretaceous and dissappeared by the end of the Mesozoic. This can be best exemplified with the Monotoidea. The origin and history of the four Mesozoic families recognized by BEGG & CAMPBELL (1985) are definitively linked with high palaeolatitudes. Faunas from Mesozoic polar regions (either Boreal or Austral) have a distinct "flavour" given by the abundance and diversity of monotoidean genera: *Hokonuia*, *Sichuania*, *Etalia*, *Asoella*, *Monotis* and *Otapiria* in the Triassic; *Otapiria*, *Asoella*, *Palmoxytoma* and *Pseudaucella* in the Early Jurassic; *Arctotis* and *Praebuchia* in the Middle Jurassic; *Buchia* and *Malayomaorica* in the Late Jurassic; *Praeaucellina*, *Maccoyella* and *Aucellina* in the Cretaceous. Even cosmopolitan genera within this group, such as *Oxytoma* and *Meleagrinella* (CRAME 1996), are more diversified in these regions than in lower latitudes. An open-minded comparison between northern and southern monotoidean groups will certainly improve knowledge on the evolutionary history of this very interesting bivalve group.

Some of these neritic high latitude early Jurassic stocks, notably the Propeamussiidae and some Pectinidae, have close relationships with living deep-sea pectinoideans (DAMBORENEA 1997a). These include *Parvamussium*, which had a wide distribution in the past but is now restricted to deeper waters, *Kolymonectes*, only known from high latitudes (both northern and southern) in the Mesozoic and related to the living deep-sea internally smooth Propeamussiidae, and *Ochotochlamys*, also of antitropical distribution during the Mesozoic and allied to the *Hyalopecten* group of very small deep-sea Pectinidae. This indicates that the origin of some of these deep-sea pectinoideans should be extended at least to the Triassic. As proposed elsewhere (DAMBORENEA 1997a, 1997b) the environmental range of these pectinoideans was restricted or shifted from neritic during the Jurassic to bathyal-abyssal during the Cainozoic, probably as a result of the "Mesozoic Marine Revolution", as proposed for other bivalve groups (HARPER & SKELTON 1993).

# Systematic descriptions

## Class Bivalvia Linné 1758

## Subclass Pteriomorphia Beurlen 1944

## Order Pectinoida Newell & Boyd 1995

### Superfamily Monotoidea Fischer 1887

Begg & Campbell (1985, p. 727) have pointed out that the correct name for the superfamily which includes Monotidae is Monotoidea Fischer 1887 and not Buchioidea Cox 1952 as used by other authors (Waller 1978, Damborenea 1987b). See diagnosis of Superfamily in Carter (1990a) and in Newell & Boyd (1995). Begg & Campbell (1985) and Sha & Fürsich (1994) provided a discussion and illustration of the hinge characters of most genera assigned to this superfamily. Their arrangement of genera within families is followed here.

### Family Monotidae Fischer 1887 (nom. transl. Kittl 1912)

### Genus *Otapiria* Marwick 1935

Type species: *Pseudomonotis marshalli* Trechmann 1923, from the early Jurassic (Aratauran) of New Zealand, by original designation.

For synonymy and comments on systematic affinities and palaeogeographical distribution see Damborenea (1987b, p. 154–156).

This genus is represented in the Jurassic of Argentina by two species with a different biostratigraphical distribution: *Otapiria pacifica* Cov. & Esc. (described below) extends from the latest Hettangian (*Badouxia canadensis* Amm. Z.) to the early Sinemurian (*Vermiceras* Amm. Z.), while *Otapiria neuquensis* Damborenea (1987b) lived from latest Sinemurian (*Miltoceras* faunule) to early Pliensbachian (lower *Fanninoceras* Amm. Z.) times.

The material described as *Otapiria* ? sp. (Damborenea 1987b, p. 159, pl. 6, fig. 6) is now regarded as conspecific with *O. neuquensis* Damborenea. The species originally referred as *O. ? frenguellii* Damborenea (1987b, p. 158-159, pl. 6, figs. 7-8) most probably does not belong to *Otapiria* and could perhaps be related to the genus *Arctotis* Bodylevsky according to its acline suborbicular shape and other morphological characters (Text-fig. 8c-d).

### *Otapiria pacifica* Covacevich & Escobar 1979

(Pl. 1, Figs. 1–3; Text-fig. 8b)

? 1967 *Antiquilina* (sic) aff. *nagatoensis* – Thiele Cartagena, p. 39, Lám. 5, figs. 17–18.
1979 *Otapiria* cf. *tailleuri* – Covacevich & Escobar, p. H171, H172.
1979 *Otapiria* cf. *marshalli* – Covacevich & Escobar, p. H171, H172.
!* v 1979 *Otapiria pacifica* – Covacevich & Escobar, p. H177–182; lám. 1, figs. 1–13; text-figs. 3 a-d.
1979 *Otapiria* aff. *pacifica* – Covacevich & Escobar, p. H183; lám. 1, figs. 14–16; text-figs. 3e-h.
1980 *Otapiria* cf. *tailleuri* – Escobar, p. 50–51; lám. 3, fig. 5.
1980 *Otapiria* cf. *marshalli* – Escobar, p. 51–52; lám. 3, fig. 6.
1980 *Otapiria* sp. – Escobar, p. 52–53; lám. 3, fig. 4.?
1980 *Oxytoma* (*Hypoxytoma*) cf. *substriata* – Escobar, p. 56, lám. 3, fig. 2.
1980 *Otapiria pacifica* – Hillebrandt, lám. 1, figs. 4–5.
v 1988 *Otapiria pacifica* – Riccardi et al., p. C368, lám. 2, figs. 10–13.
v ! 1992 *Otapiria pacifica* – Damborenea, pl. 115, figs. 3–4.
v ! 1992 *Otapiria pacifica* – Damborenea & Manceñido, pl. 1, fig. 2a.

Material: One specimen with both valves together, one left valve of a young specimen, two external moulds of left valves and fragments, all of them from the ridge between Arroyos El Alumbre and Malo, Mendoza (B.14): MLP 22260, 22261 and 22379 (M 1397 and 1722), in sediments ranging in age from the latest Hettangian (*Badouxia canadensis* Zone) to the early Sinemurian (*Vermiceras* Zone).

Doubtfully included in this species are a couple of fragmentary left valves from the same locality: MLP 22380 (M 1708).

Remarks: This species, which is very abundant in Chile, is only represented in Argentina by few specimens. In part this may be due to a more marginal position of the Argentinian localities, since a corresponding decrease in abundance towards littoral areas has been observed in other species of this genus. On the other hand, beds of Hettangian to early Sinemurian age are not widespread in Argentina.

Description: Shell of medium size, sub-circular in young specimens to oblique and posteriorly elongated in adults. Inequivalve, with the left valve more convex than the right. The umbones are anteriorly placed. The greatest inflation of the shell is placed on its anterior half.

Dorsal margin short and straight, posterior margin slightly concave dorsally and then evenly convex, meeting the dorsal at a very obtuse angle. Anterior and ventral margins evenly convex.

The left valve is of moderate inflation and is ornamented by very fine and closely set radial riblets and irregular commarginal folds. On the right valve, which is only slightly inflated, the ornament consists mainly of commarginal folds. The right anterior auricle is not preserved in the available specimens.

Measurements: The only complete specimen (MLP 22261) has the following dimensions: L = 23.80 mm; H = 18.45 mm; 2W = 9.05 mm.

Affinities: The affinities of this species have been extensively discussed by COVACEVICH & ESCOBAR (1979). According to the supraspecific arrangement proposed by DAMBORENEA (1987b, p. 155–156), this species belongs to group (b) which includes *Otapiria limaeformis* (ZAKHAROV) and *O. ussuriensis* (VORONETZ), both very similar to *O. pacifica*. Furthermore, the South American specimens are almost identical in shape, ornament and range of variability, to *O. limaeformis* from the Sinemurian of northeastern Siberia and could even be considered conspecific (see ZAKHAROV 1962, tab. 1, figs. 1–16, text-figs. 2–3; POLUBOTKO 1968b, tab. 4, figs. 1–7, tab. 5, figs. 1–6). A few specimens referred to *O.* cf. *limaeformis* have been described from Sinemurian and Pliensbachian beds in northern Canada (POULTON 1991, pl. 9, figs. 6, 13, 14).

Being a very variable taxon, the material referred to *O.* aff. *pacifica* by COVACEVICH & ESCOBAR (1979) could be easily accomodated within the same species.

*Otapiria pacifica* shows also affinities with some specimens from New Zealand assigned to *O. dissimilis* (COX), although figured specimens have a more prominent radial ribbing on the left valve (MARWICK 1953a, pl. 3, figs. 10–12; SPEDEN & KEYES 1981, pl. 11, figs. 3, 4, 7). The similarity is even greater with specimens from the basal Aratauran of the Kawhia Harbour region, New Zealand, which have an intermediate morphology between *O. dissimilis* and *O. marshalli* (TR.), but which have not been described yet (AU collection).

*Otapiria neuquensis* DAMBORENEA, from younger levels (late Sinemurian – early Pliensbachian) of the same region and other Argentinian localities (DAMBORENEA 1987b, pl. 6, figs. 1–5; 1992, pl. 115, figs. 5–6; Pl. 1, Figs. 4–5 here), differs from *O. pacifica* by a more subcircular shape and a similar ornament on both valves, with stronger and fewer radial riblets.

### *Otapiria neuquensis* DAMBORENEA 1987

(Pl. 1, Figs. 4–5; Text-fig. 8a)

* ! v 1987b *Otapiria neuquensis* – DAMBORENEA, p. 156–158; pl. 6, figs. 1–5.
v 1987b *Otapiria* ? sp. – DAMBORENEA, p. 159; pl. 6, fig. 6.
v ! 1992 *Otapiria neuquensis* – DAMBORENEA, pl. 115, figs. 5–6.
v ! 1992 *Otapiria neuquensis* – DAMBORENEA & MANCEÑIDO, pl. 1, fig. 3a.
1994 *Otapiria neuquensis* – ABERHAN, p. 34–35, pl. 16, figs. 7–9.

Material: To the material described in DAMBORENEA (1987a), the following must be added: an almost complete specimen, seven left valves, four right valves and some fragments, from early Pliensbachian beds (*Miltoceras* and *Dubariceras* Zones) at Puesto Araya (B.1) and Arroyo Las Chilcas (B.16), Mendoza: MLP 16491, 19997, 24259 to 24263, 27824, 27842 (M 352, 361, 1275, 1276, 1423, 1433, 1439 and LANÉS'collection) and from early Pliensbachian beds of Cañadón La Pintada (D.14), Neuquén: MLP 19715 to 19718, 23715.

Remarks: Well preserved material allows the extension of the known geographical range of this species, previously thought to be restricted to southern Neuquén, to include southern Mendoza as well. Whilst in Neuquén this species was found in beds of Pliensbachian (s.l.) age, the new material from Mendoza is clearly restricted to the earliest Pliensbachian, i.e. latest *Miltoceras* (one specimen) and specially *Dubariceras* Zones.

The specimens from Mendoza show a slightly larger mean size than those of Neuquén, but this is thought to be within the range of variability of this species. A few specimens have a more centrally placed umbo, most probably due to post-depositional deformation. Thus the left valve earlier identified as *Otapiria* ? sp.

(Damborenea 1987b, p. 159, pl. 6, fig. 6) is now included in O. *neuquensis*. One bivalved specimen (MLP 19997, Pl. 1, Figs. 5a-c) clearly shows the difference in relative convexity of the valves and the shape of the anterior auricle of the right valve, details not so easily seen in material from Neuquén.

Measurements: Of best preserved specimens, in mm. [1]: number of radial ribs

| Specimen MLP | Material | | L (mm) | H (mm) | W (mm) | [1] |
|---|---|---|---|---|---|---|
| 19997 | IM | RV | 24.0 | 22.0 | 2.0 | 38 |
| 19997 | IM | LV | 24.0 | 22.0 | 5.8 | 43 |
| 24259 | IM | LV | 24.9 | 22.7 | 3.9 | 53 |
| 24260 | IM | RV | 17.4 | 16.7 | 1.2 | 61 |
| 24261 | IM | LV | 19.2 | 15.9 | 3.3 | 59 |
| 24263 | IM | RV? | 18.2 | 16.6 | 2.4 | 54 |
| 27824-a | IM | RV | 35.8 | 37.0 | 4.3 | |
| 27824-b | IM | LV | 27.9 | 25.0 | 2.3 | |

Affinities: Already discussed in Damborenea (1987b). The affinities with *Otapiria marshalli* (Trechmann), from the Aratauran of New Zealand (Trechmann 1923, pl. 15, figs. 6–9; Marwick 1935, figs. 10, 12, 28–32, 34, 35; 1953a, pl. 11, figs. 7–8; Speden & Keyes 1981, pl. 13, figs. 4, 8; Damborenea 1993a, text-fig. 3d) are great, especially with material from North Island of New Zealand, which has generally a smaller size than the material from the type locality in the Hokonui Hills. The Argentinian species also shares with the New Zealand one many details of occurrence, such as the lithological type and associated fauna.

## Family Oxytomidae Ichikawa 1958

There has been considerably controversy regarding the suprafamilial affinities of the Oxytomidae and the subject is still under discussion (see comments in Ichikawa 1958, Begg & Campbell 1985, Crame 1985, 1996, Carter 1990a). Whereas most of these authors refer Oxytomidae to the Monotoidea, Newell & Boyd (1995, p. 76) mention without further discussion that they do not belong there, and Marincovich (1993) places this family within the Pectinoidea. Crame (1985, 1996) focussed his attention on the Oxytomidae and their relationships with other monotoidean families and provided an emended diagnosis for the family (Crame 1996, p. 618).

This family is represented in the Argentinian Early Jurassic by one species of *Oxytoma* already described in Damborenea (1987b, p. 159–168), one of *Palmoxytoma* and one of *Meleagrinella*, both described below.

### Genus *Palmoxytoma* Cox 1961

Type species: *Pecten cygnipes* Young & Bird 1822, from the early Jurassic of Europe, by original designation.

When Cox (1961) named this taxon as a subgenus of *Oxytoma* Meek, he believed it to be restricted to the early Jurassic of Europe. Its type species (or very related ones) had, nevertheless, been also recognized from New Zealand (Trechmann 1923; see also Arkell 1956, p. 453), Canada (Frebold 1957; see also Frebold 1964; 1966; Aberhan 1998) and Japan (Hayami 1959a; 1975) and was later illustrated from northeast Siberia (Polubotko 1968b). The New Zealand record seems to have been overlooked by later authors who analyzed the palaeogeographical distribution of Jurassic bivalves (Hallam 1977a; 1983). It has recently been recorded from Chile (Aberhan 1994).

The Chilean and Australasian occurrences, together with the Argentine one described here, shows that the palaeogeographical distribution of this genus included, at least during the Hettangian, the southern circum-Pacific margins in addition to the well-known northern hemisphere records (Text-figs. 6–7). By Sinemurian and Pliensbachian times *Palmoxytoma* seems to have been restricted to boreal regions, where it is locally abundant and forms conspicuous shell-beds.

As already said (Damborenea 1987b, p. 160) *Palmoxytoma* probably derives from forms like *Oxytoma mojsisovicsi* Teller from the late Triassic of Siberia and Japan (Kobayashi & Ichikawa 1950 under several specific names; see also Hayami 1975, p. 62; Kiparisova et al. 1966, Bychkov et al. 1976).

### *Palmoxytoma* cf. *cygnipes* (Young & Bird 1822)

(Pl. 1, Figs. 6–8; Text-fig. 8c)

cf. 1822 *Pecten cygnipes* Young & Bird, pl. 9, fig. 6.
v 1988 *Palmoxytoma* sp. – Riccardi et al., p. C368, lám. 1, fig. 14.
v 1992 *Palmoxytoma* sp. – Damborenea, pl. 115, fig. 1.
v 1992 *Palmoxytoma* sp. – Damborenea & Manceñido, pl. 1, fig. 1a.
1994 *Oxytoma* (*Palmoxytoma*) cf. *cygnipes* – Aberhan, text-fig. 16.

Material: One specimen with both valves slightly displaced, the right one almost complete, one left valve, three external moulds of left valves and several fragments, from the Hettangian (*Waehneroceras – Schlotheimia* and *Badouxia canadensis* Ammonite Zones) at Arroyo Malo, Mendoza (B.14): MLP 22253, 22378, 27544 to 27545 (M 1394, 1696 and 1784).

The specimen figured by Aberhan (1994, text-fig. 16) from the Hettangian of Quebrada San Juan, Chile, seems to belong here.

Description: Shell of medium size, apparently higher than long, of subcircular shape. Very inequivalve, left valve convex and right valve almost flat, right valve appears to be smaller than matching left valve, probably as a result of the loss of the marginal apron of outer prismatic layer of the shell.

Hinge line straight and long, left umbo prominent and centrally placed, valve acline to slightly opistocline. Right umbo not protruding above hinge-line.

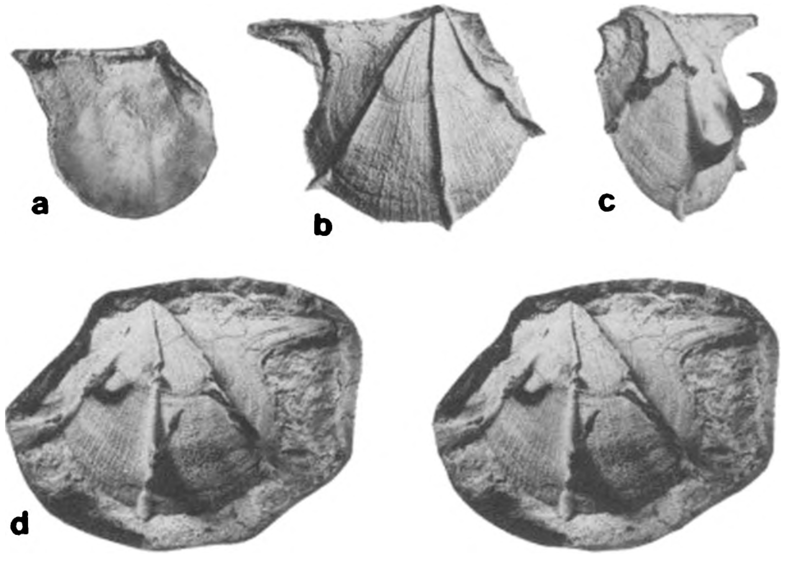
Right valve anterior auricle small but distinct, of sub-rectangular shape, separated from the disc by a very deep byssal notch which reaches almost to the umbones. Posterior auricle not preserved, though its surface is flat and covered by the same kind of faint radial ornament which appears between the primary costae.

Left valve ornamented by (probably five) prominent and narrow radial costae separated by wide areas covered by fine radial and rather irregular lines. The main costae are stronger towards the valve margin, where they project as short digitations.

Right valve with five (or six) radial grooves and fine radial striae between them. The right posterior auricle also bears fine radial lines. The right valve margin is not projected like the left valve.

The inner surface of the valve is smooth except for the major radial costae. Other internal characters unknown.

Measurements: Neither of the specimens is complete enough to take accurate measurements. Specimen MLP 22253 was at least 50 mm long and high, as estimated from the fragmentary valves.



Text-fig. 9. *Palmoxytoma* n. sp., complete specimen with both valves, OU 17810, Otapiri stream, Hokonui Hills, New Zealand X 1. a – Right valve view, internal mould; b – Left valve view, external mould; c – Oblique view, latex cast of left valve; d – Stereopair of latex cast of left valve, showing spines.

Affinities: The Hettangian New Zealand specimens described by TRECHMANN (1923, p. 272, pl. 12, figs. 6, 7) as *Oxytoma* sp. and later referred by ARKELL (1956, p. 453) to *Oxytoma* cf. *cygnipes* (YOUNG & BIRD) are very similar to the Argentinian material and may even be conspecific. The New Zealand specimens show very long spines on the radial ribs of the left valve (DAMBORENEA & MANCEÑIDO 1992, pl. 1, fig. 1b; DAMBORENEA 1993a, fig. 3b; Text-fig. 9 here), which distinguish them from all other previously described species. This character is not seen on the Argentinian specimens probably due to different preservation.

The Argentinian specimens show close affinities with the type species, *Palmoxytoma cygnipes* (YOUNG & BIRD), to which most of the Sinemurian and Pliensbachian material from the northern hemisphere has been referred (YOUNG & BIRD 1822, pl. 9, figs. 4, 6; DUMORTIER 1869, pl. 35, figs. 6–9; PHILLIPS 1871, pl. 8, fig. 13; TATE 1876, p. 370; LUNDGREN 1881, pl. 5, figs. 2-5, as *Avicula magnifica*; WILSON 1948, fig. 5.B; HÖLDER 1953, text-figs. 3, 4; FREBOLD 1957, pl. 16, figs. 1–5; 1964, pl. 5, figs. 3, 4; 1966, pl. 1, figs. 5–6; POLUBOTKO 1968b, pl. 22, figs. 11–12; COX et al. 1969, figs. C.69, 4a-b; CASTELL & COX 1975, pl. 13, fig. 1; SEY 1984, tabl. 16, figs. 9–13; POULTON 1991, pl. 6, figs. 14–16, pl. 11, figs. 14–16; DAMBORENEA 1993a, text-fig. 3a; ABERHAN 1998, pl. 9, figs. 15–19). As seen from the fragmentary material at hand, the size, shape, number of costae and type of ornament betwen costae are almost identical, but the Argentinian material does not show the shape of the posterior auricle and thus the comparison cannot be complete.

The ornament is also very similar to *P. scanica* (LUNDGREN) from the Pliensbachian of Sweden as figured by TROEDSSON (1951, p. 201, pl. 10, fig. 15) and HÖLDER (1953, text-fig. 2) and the Hettangian of Germany (HÖLDER 1953, text-fig. 1) but the left valve umbo is larger and more prominent in the Swedish species.

Though the size and overall shape of the species described here also agree with those of *P. longicostata* (STUTCHBURY) from the lowest Hettangian of Great Britain, the Argentinian specimens do not show the spiny costae and narrow digitations of the left valve margins of this species (cf. ARKELL 1933b, pl. 29, fig. 1; HÖLDER 1953, text-fig. 5). DUMORTIER (1869, p. 294) even included STUTCHBURY's species as a synonym of *P. cygnipes*.

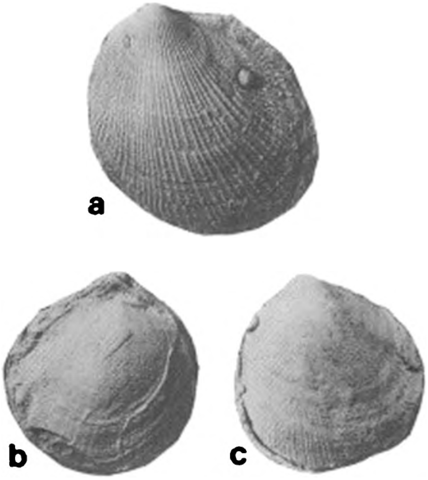
### Genus *Meleagrinella* WHITFIELD 1885

Type species: *Avicula curta* HALL 1852, subsequent designation by COX 1941 (p. 134), Oxfordian of South Dakota, U.S.A. (see Text-fig. 10 here).

Synonyms: *Clathrolima* COSSMANN 1908 (type species *C. lalmenti* COSSMANN 1908)
*Echinotis* MARWICK 1935 (type species *Avicula echinata* SMITH 1817)

The synonymy of this genus has already been discussed by COX (1940, 1941) and DUFF (1978), who also provided a complete diagnosis.

*Meleagrinella*-beds are a common feature in the Andes. The incoming of *Meleagrinella* was thought to mark the base of the Aalenian deposits in the Andes by some authors, but others had mentioned material referable to this genus from older beds (BURCKHARDT 1903, WEAVER 1931, PIATNITZKY 1936). The first appearance of this



Text-fig. 10. Plaster casts of *Meleagrinella curta* (HALL), Oxfordian of South Dakota, U.S.A., X 2. a – Holotype, left valve, USNM 29319; b-c – right and left valve of paratype, USNM 205.

genus in fact denotes the base of one of the sedimentary cycles recognized in the area, varying in age from Toarcian to Aalenian or even Bajocian in different localities and usually associated with coarse calcareous sandstone or shelly beds.

Material from Argentina and Chile was referred either to *Meleagrinella substriata* (Zieten) (Gottsche 1878, 1925, Tornquist 1898, Burckhardt 1900a, 1900b, 1903, Jaworski 1926a, 1926b, Weaver 1931, Piatnitzky 1936) or to *M. echinata* (Smith) (Burckhardt 1903).

Several records of Early Jurassic material from Argentina originally referred to *Pseudomonotis* should also be analyzed. *Pseudomonotis* cf. *interlaevigata* Qu. in Burckhardt (1900a, p. 25) from the Atuel region is, according to the description, an *Oxytoma*, probably *O. inequivalvis* (Sowerby). On the other hand, the records of *Pseudomonotis* cf. *papyria* Qu. in Behrendsen (1891, 1922) and Möricke (1894), from Portezuelo Ancho (Argentina) and Jorquera (Chile) respectively, may rather correspond to a species of *Otapiria*. Yet, no definite opinion can be given without seeing the specimens since this material has not been figured.

Only a brief description of the Argentinian specimens from Early Jurassic beds is given below, as the species is much better represented in Middle Jurassic deposits and a detailed description will be given elsewhere.

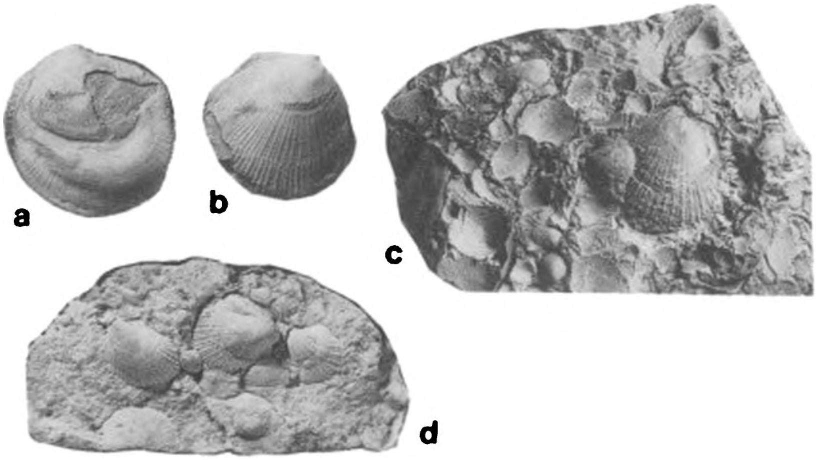
### *Meleagrinella* sp.

(Pl. 1, Figs. 9–11)

1878 *Pseudomonotis substriata* – Gottsche, p. 22; pl. 6, figs. 7–9.
1898 *Pseudomonotis substriata* – Tornquist, p. 164
1900a *Pseudomonotis substriata* – Burckhardt, p. 33; pl. 21, figs. 5, 7; pl. 22, fig. 9.
1900b *Pseudomonotis substriata* – Burckhardt, p. 10; pl. 19, fig. 2.
1903 *Pseudomonotis substriata* – Burckhardt, p. 10–11, 21.
1903 *Pseudomonotis echinata* – Burckhardt, p. 26, pl. 2, figs. 9–10.
1918 *Pseudomonotis substriata* – Groeber, p. 14, 20.
1925 *Pseudomonotis substriata* – Gottsche, p. 253-254; pl. 6, figs. 7–9.
1926a *Pseudomonotis substriata* – Jaworski, p. 154-155.
1926b *Pseudomonotis substriata* – Jaworski, p. 377.
1931 *Pseudomonotis substriata* – Weaver, p. 215, pl. 19, fig. 86.
1936 *Pseudomonotis substriata* – Piatnitzky, p. 103.

Material: About thirty specimens, most of them left valves, from Toarcian beds at Arroyo La Laguna, San Juan Province (A.2): MLP 24998 to 25001. This or a very closely related species becomes very common in Aalenian and Bajocian deposits of the Andes (see Damborenea & Manceñido 1992, pl. 3, fig. 1a; Text-figs. 11a-c here).

Description: Small sub-orbicular shells, inequilateral, very inequivalve. Length and height almost equal or height slightly exceeding length. Left valve more inflated than right valve. Dorsal margin straight, about half of total shell length. Left umbo prominent but narrow, projecting above hinge-line and slightly anterior to mid-length. No left anterior auricle, anterior margin evenly rounded, merging with equally rounded ventral margin.



Text-fig. 11. a-c – *Meleagrinella* sp. from Middle Jurassic deposits of Argentina, X 1. a – MLP 25014, left valve; b – MLP 25015, right valve; c – slab with many specimens, MLP 24874. d – *Meleagrinella* sp. from Temaikan beds of New Zealand, latex cast, X 1, AU 9228.

Posterior margin less rounded. Posterior auricle short, ill-defined and only faintly pointed. Right valve almost flat with very small anterior auricle and small, flat and pointed posterior auricle.

Exterior of left valve ornamented by very narrow and wavy costae of irregular size and unevenly spaced. They are variable in number and are separated by wider interspaces. Sometimes secondary costae are intercalated. In some specimens very faint comarginal lines can also be seen. Right valve with much weaker and fewer radial costae.

Internal characters not seen on Early Jurassic specimens.

Affinities: The Early Jurassic specimens from Argentina can be closely compared with the Toarcian species *Meleagrinella substriata* (ZIETEN) and the Middle Jurassic *M. echinata* (SMITH). These two species have a very wide geographical distribution and their shell characters are very variable. *Meleagrinella substriata* (ZIETEN 1830, pl. 69, fig. 9; GOLDFUSS 1835, pl. 120, figs. 7a-f; QUENSTEDT 1858, pl. 37, figs. 2–3; POLUBOTKO 1968b, pl. 39, figs. 1–2) is very similar to the Argentinian material but has about double number of radial costae. Also *Meleagrinella* sp. from the Sinemurian of Yukon (POULTON 1991, pl. 6, figs. 8–11) has more dense ribbing.

The Bajocian-Callovian species *M. echinata* has a more similar density of ribbing according to figures in POMPECKJ (1901, pl. 15, figs. 1, 4, 7, 11, 15, 19), BORISSJAK (1909, pl. 2, fig. 13), COSSMANN (1915, pl. 4, figs. 3–6), DOUGLAS & ARKELL (1932, pl. 12, fig. 7), COX (1940, pl. 6, figs. 2–7), PETROVA (1947, pl. 12, figs. 8–10) JAITLY (1988, fig. 3) and JAITLY et al. (1995, pl. 17, figs. 15–18). Apart from the records from Argentina listed in the synonymy, other material from the southern Hemisphere has also been referred to this species (TRECHMANN 1923, MARWICK 1935, QUILTY 1978; see DAMBORENEA & MANCEÑIDO 1992, pl. 3, fig. 1b; Text-fig. 11d here).

Ornament is similar in *M. ansparsicosta* POLUBOTKO (1968b, pl. 21, figs. 3–7) from Pliensbachian levels of Russia, but this species has a shorter dorsal margin with a much more pointed left posterior wing. Some Early Jurassic species from Russia referred by PETROVA (1947, pl. 12, figs. 13–19) to *Eumorphotis* have a similar shape and left valve ornament.

The type species of the genus, *M. curta* (HALL) has a comparable size but has more radial ribs and is more prosocline than the Argentinian specimens (see figures in MEEK & HAYDEN 1865, pl. 3, figs. 10a-c; BUTLER et al. 1920, pl. 10, fig. 3; Text-figs. 10a-c here). The small specimens named *Pseudomonotis ferniensis* by McLEARN (1924, pl. 3, figs. 1–4), from the Fernie Formation of western Canada, have a similar shape but have more radial ribs.

*Meleagrinella papyria* (QUENSTEDT) from Sinemurian-Pliensbachian beds of Europe, has a large shell with a well-defined left posterior auricle (QUENSTEDT 1858, pl. 13, figs. 31–32; DUMORTIER 1869, pl. 20, figs. 3–5).

Autecology: This species appears in characteristic shell-beds which have specimens of the whole size-range. *Meleagrinella* shells dominate the assemblages, but a varied benthonic bivalve fauna is also commonly present (pectinids, entolids, trigonids) as well as occasional gastropods and ammonites. This mode of occurrence is similar throughout the very wide geographical range of this bysally attached genus.

## Family Asoellidae BEGG & CAMPBELL 1985

BEGG & CAMPBELL (1985) erected the new family Asoellidae to include Monotoidea with alivincular amphidetic ligament and without accessory hinging structures. CARTER (1990a) CRAME (1996) questioned the assignement of *Aucellina* to this family by the presence of pseudoctenolium in this genus. BEGG & CAMPBELL (1985) regarded *Asoella* TOKUYAMA, *Etalia* BEGG & CAMPBELL and perhaps also *Aucellina* POMPECKJ as belonging to this group. They provided excellent illustrations of the internal characters and a very good comparison with other monotoideans.

*Asoella* and *Etalia* are typically Triassic genera from northern and southern Hemisphere circum-Pacific regions respectively, but the occurrence of species belonging to this group in the Early Jurassic of Austral areas is indicated by unpublished records of *Asoella* sp. from New Zealand (HUDSON 1983) and by the taxon described here.

### Genus *Asoella* TOKUYAMA 1959

Type species: *Eumorphotis* (*Asoella*) *confertoradiata* TOKUYAMA 1959, from the Carnian (or lower Norian) of Japan, by original designation.

TOKUYAMA (1959) referred to his new taxon *Asoella* three species of Middle to Late Triassic age of the northern Hemisphere. These species are characterized by small subcircular inequibiconvex or plano convex shells, with left valves strongly convex and right valves flatter, almost orthocline, with straight dorsal line and right anterior auricle as long as the posterior one, with a shallow byssal notch. The central ligamental pit is triangular and prosocline and the posterior muscle scar is large and rounded.

This genus was referred to the Aviculopectinidae by TOKUYAMA (1959) and COX et al. (1969) and transferred to the Buchioidea (= Monotoidea) by WALLER (1978) on account of the morphology of the right anterior auricle. The closely related genus *Etalia* BEGG & CAMPBELL (1985) was described from older beds (Etalian = ? Anisian) of New Zealand.

Although the ligament characters are not completely seen in the Argentinian material described below, it is assigned to *Asoella* on account of the other shell characters.

### *Asoella asapha* (LEANZA 1942)

(Pl. 9, Figs. 1–15; Text-figs. 8f-g)

vp? 1942 *Cardium asaphum*, LEANZA, p. 195, pl. 19, figs. 1–2.
? 1980 *Cardium asaphum* – LIZUAIN, p. 178.
? 1981 *Cardium asaphum* – HALLER et al., p. 226.
? 1984 *Jurassicardium*? *asaphum* – MANCEÑIDO & DAMBORENEA, p. 425.
v 1996 *Asoella*? sp. — DAMBORENEA, p. 155, 157.
v 1996 "*Jurassicardium*" *asaphum* – DAMBORENEA, p. 155, 157.

Material: Twenty nine left valves, 26 right valves and several fragments, mostly preserved as moulds of isolated valves with fragments of recrystalized shell material. Only three specimens appear to have both valves together. MLP 24983 to 24986, 27823, 27826, 27831, 27906, 28006 to 28027 (M 352, 1263, 1267, 1269, 1271, 1272, 1275, 1415, 1433, 1918, 1958, and LANÉS' collection) from late Sinemurian and early Pliensbachian deposits (upper part of *Epophioceras*, *Dubariceras* and lower part of *Fanninoceras* Ammonite Zones) at Arroyo Las Chilcas and Puesto Araya, Mendoza Province (B.1, B.16). A few specimens from coeval levels in the Piedra Pintada region (D.7, D.9): MLP 6254, 13009, 24982, 28003 to 28005 (M 133, 136, and FRENGUELLI'S collection), where they appear at the lower levels of the *Fanninoceras* Ammonite Zone. This species spans the range of the *Cardinia* cf. *listeri* faunule and *Otapiria neuquensis* Assemblage Zone.

Of the material originally described by LEANZA (1942), only two syntypes could be located at the La Plata Museum collection (MLP 6254 and 13009, left valves), unfortunately, both figured specimens appear to have been lost.

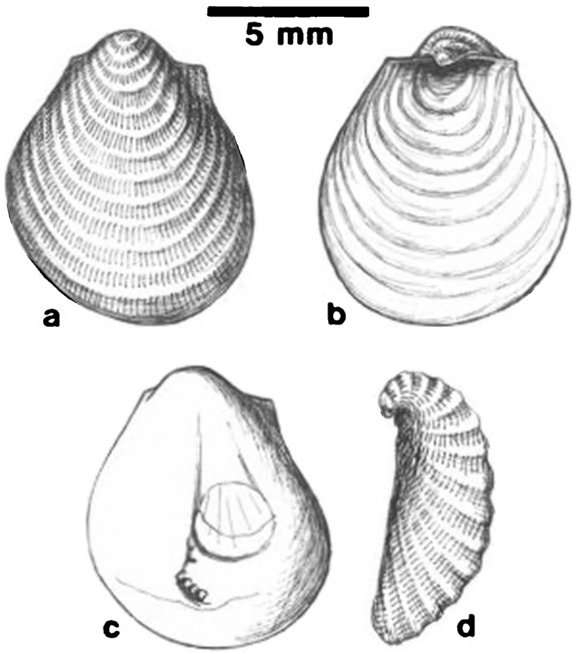
The material from Cerro Piltriquitrón (Chubut Province) identified by LIZUAIN (1980) and HALLER et al. (1981) as *Cardium asaphum* could not be re-located in their collection. It is thus referred here only doubtfully, since it may belong to a true cardiidae species instead (MANCEÑIDO & DAMBORENEA 1984, p. 425).

Description: Small sub-circular shell, nearly orthocline, slightly longer than high. Very inequivalve, convex left valve very inflated and almost circular concave right valve, giving a "gryphaeaoid" appearance to the shell. Dorsal margin straight and long, about half of total shell length, anterior and posterior portions equally long. Broad left valve umbo almost centrally placed, prosogyrous. Anterior and posterior auricles ill-defined and not clearly limited from disc. Anterior and posterior margins meet dorsal line at an obtuse angle. Anterior auricle of left valve merges gradually into anterior margin of disc. Anterior auricle of right valve flat and small, with an apparently shallow byssal notch. Posterior auricles meet posterior margin of disc after a very shallow sinuosity. Anterior, ventral and posterior margins evenly rounded, shell somewhat extended posteriorly in large specimens.

Shell thin. Outer surface differently ornamented on both valves. Left valves have a calcellate appearance, they bear radial threads separated by equally wide intervals which are interrupted regularly by comarginal lines (see LEANZA 1942, pl. 19, fig. 1; and here on Pl. 9, Fig. 8). Right valves have regular comarginal lines only (Pl. 9, Figs. 2–5). Interior of both valves and inner shell margin smooth.

Resilifer triangular and prosocline, centrally placed, with two long triangular areas to each side (Pl. 9, Fig. 11a). Without other hinge structures, only a shallow groove on the left valve posterior dorsal margin which apparently housed the right valve posterior dorsal margin.

Adductor muscle scar only seen on one left valve (Pl. 9, Fig. 7; Text-fig. 12), it is shallowly impressed and subcircular in outline, and placed at mid height and posterior to mid length. Ventrally to the adductor scar there is a set of five crescentically arranged muscle scars which, according to their position and morphology, can belong to the gill suspensors.



Text-fig. 12. Shell morphology of *Asoella asapha* (Leanza). Reconstruction based on many specimens. a – left valve external view; b – right valve external view; c – left valve internal view showing muscle scars; c – anterior view.

Measurements: Of best preserved specimens, in mm.

| Specimen MLP | Material | L (mm) | H (mm) | W (mm) | Lh (mm) |
|---|---|---|---|---|---|
| 24982 | RV EM | 5.8 | 5.2 | - | 3.5 |
| 24983-b | RV EM | 12.4 | 11.8 | 1.3 | 6.9 |
| 24984-a | RV S | 12.7 | 11.9 | 1.2 | 7.0 |
| 24985-a | RV EM | 11.6 | 10.8 | 1.7 | 7.1 |

Remarks: Left valves of this species were described by Leanza (1942) as a new species, which he referred to *Cardium*, interpreting it as an equivalve shell, but no cardiidae hinge characters are present. The fact that this species is commonly associated with a small species of cardiidae delayed the recognition of its true affinities. On the other hand, right valves were described as *Asoella*? sp. by Damborenea (1991). All these are now re-interpreted as belonging to the same inequivalve species, which is here referred to *Asoella*. Right and left valves are often found together in the same beds and have the same geographical and stratigraphical range (see Damborenea 1996). Furthermore, a few specimens in which the actual relation between both valves can be seen have also been found (see Pl. 9, Fig. 6).

Affinities: The type species of *Asoella*, *A. confertoradiata* (Tokuyama), from the upper Triassic of Japan, has a comparable shape and size, but the left valves are ornamented by more conspicuous radial ribs; right valves are flat instead of concave and also bear radial ribs (Tokuyama 1959, text-fig. 1, pl. 1, figs. 1–6, 12; Hayami 1975, pl. 2, figs. 8–9). *Asoella laevigata* (Tokuyama 1959, pl. 1, figs. 7–10, text-fig. 2) from the same beds, is also comparable to the Argentinian species, but the right valve is flat or slightly convex and has a large and conspicuos anterior auricle. *Asoella nakatsukensis* (Tokuyama 1959, pl. 1, figs. 11, 13, 14) is a poorly known species without radial ornament.

*Asoella ? illyrica* (Bittner 1902, pl. 7, figs. 13, 14), from the Late Triassic of the Alps, has a larger shell which is higher than long, with both valves ornamented by radial riblets and deep byssal notch. *Asoella convexa* (Mansuy), from the middle Triassic of Laos has similar radial threads on the left valve but lacks the regular comarginal ornament (Mansuy 1912, pl. 9, figs. 5a-c), whilst *Asoella*? *laosensis* (Mansuy 1912, pl. 9, figs. 8a-d) has a very long posterior dorsal line.

*Asoella spitzbergensis* (Böhm) is only known by left valves from Carnian beds of Bear Island and probably Japan (Böhm 1903a, pl. 2, figs. 10–13), which have more pointed auricles.

*Etalia johnstoni* Begg & Campbell (1985, figs. 2–4), from the Middle Triassic of New Zealand, has less convex left valve and an almost flat right valve, with a very deep byssal notch and a more prosocline shell.

Hudson (1983) refers to *Asoella* sp. material from the Ururoan of the North Island of New Zealand and states that some specimens referred to *Meleagrinella* in the past could belong to this genus, such as Speden's (1971) record of *Meleagrinella* cf. *echinata* (Smith) from below *Pseudaucella* in the South Island. Material from the Awakino area in the North Island seen at the University of Auckland (AU 9467-9468) could belong to this genus, and is comparable to the Argentinian material.

From species of *Meleagrinella* this taxon differs by having a relatively large right anterior auricle which lies on the same place as the commissure and a short, not pointed, posterior auricle. The ornament is also different.

Material from the Sinemurian of Chile described as *Leptochondria* sp. (Escobar 1980, pl. 3, figs. 7–8) can also be compared with *Asoella asapha*. The Chilean specimens are all right valves which have a deeper byssal notch than the Argentinian ones but with a similar regular comarginal ornament. "*Monotis* sp." in Quenstedt (1856, pl. 10, fig. 16), from the Sinemurian of Germany, is likewise very similar to the Chilean material.

The right valve of "*Pecten*" *tingensis* Tilmann (1917, pl. 24, fig. 6), from the Hettangian-Sinemurian of Perú, has a similar shape but is larger and the auricles seem to be better separated from the disc than in *Asoella asapha*. "*Pecten*" *tingensis* is a very poorly known species which was doubtfully referred to *Camptonectes subulatus* (Münster) by Johnson (1984) and to *Leptochondria* by Prinz (1985, p. 183, pl. 1, fig. 3), who figured a large radially ribbed left (?) valve.

Autecology: This small monotoidean lived almost certainly byssally attached during at least the young stage, and may have been free, resting on its convex left valve, when fully grown. It occurs in dark mudstones and shales only and appears concentrated at certain levels. The accompanying fauna is usually of low diversity and small size: the byssally attached *Otapiria neuquensis* Damb. and *Parainoceramus apollo* (Leanza), but mainly the shallow burrowers *Palaeoneilo patagonidica* (Leanza), other nuculanoideans, cardiidae and *Grammatodon costulatus* (Leanza). Plant débris is a common feature at these levels, suggesting that drift wood may have been one of the suitable substrates for *Asoella asapha*.

## Superfamily Pectinoidea Wilkes 1810

## Family Propeamussiidae Abbott 1954

The family Propeamussiidae forms a well-characterized group of pectinoideans represented in Recent seas by several genera. Most species live at depths greater than 150 m and are either byssate or free living (Waller 1971, 1972b, 1984, Schein 1988, 1989, Dijkstra 1991, 1995).

The family Propeamussiidae was not recognized by Hertlein (in Cox et al. 1969) but was re-validated by Waller (1971, 1972b, 1978, 1984, 1993) and Carter (1990a), who proved the consistency of the group and characterized it on anatomical and microstructural features.

During the Early Jurassic this family seems to have been not restricted to deep-water fine grained deposits. According to the latest review (Johnson 1984) by that time this family was only represented by the genus *Propeamussium* de Gregorio in Europe, but Jurassic species should be referred to *Parvamussium* instead (see discussion here under this genus and in Damborenea 1995, 1997b). This cosmopolitan genus is also present in the Lower Jurassic deposits of South America, but the occurrence here of the genus *Kolymonectes* Milova & Polubotko, which is also referred to the Propeamussiidae (Damborenea 1995, 1997b), shows that the family diversity in Mesozoic times may have been greater than previously thought. The family included genera with as well as without internal ribs (*Parvamussium* and *Kolymonectes* respectively). These two stocks are recognizable since Triassic times and the latter provides links with the Palaeozoic stem group, represented by *Pernopecten* Winchell (Waller 1984, Damborenea, 1997b).

The environmental range of propeamussiid genera apparently shifted from sublittoral in Mesozoic times to bathyal-abyssal during the Cainozoic (Damborenea 1995, 1997a, 1997b).

### Genus *Kolymonectes* MILOVA & POLUBOTKO 1976

Type species: *Aequipecten* (?) *anjuensis* MILOVA (1969, p. 182–185, pl. 1, figs. 1–9), from the Lowest Jurassic of eastern Siberia, by original designation.

MILOVA & POLUBOTKO introduced the new name *Kolymonectes* in a couple of almost simultaneous papers (in BYCHKOV et al. 1976, p. 66–67 and in MILOVA 1976, p. 67–68). Their diagnosis is freely translated as follows: "Shell thin, small- to medium-sized, nearly circular shells with weakly convex valves. Surface of left valve always covered with radial plicae of a few orders of magnitude, surface of right valve smooth, with growth lines or faintly visible traces of radial ornament, especially along the shell margin. Auricles subequal, the anterior slightly larger than the posterior. Byssal notch absent or only scarcely insinuated under the anterior auricle of the right valve. Both valves have internal lateral swellings, the posterior lateral swelling always a little wider and longer than the anterior."

*Kolymonectes* is here referred to the Propeamussiidae on account of the absence of ctenolium and the inferred presence of an extensive outer prismatic calcitic layer on the right valve (DAMBORENEA 1995, 1997a, 1997b). These are the two main diagnostic skeletal features discussed by WALLER (1971, 1972b, 1978, 1984; see also CARTER 1990a and DIJKSTRA 1991, 1995) of species of this family.

Although no proper study of the shell microstructure of *Kolymonectes* could be performed so far, the presence of an outer calcitic prismatic layer over most of the right valve disc (ectostracum) is strongly suggested by the different ornament on both valves and by the observation of some peculiarities of preservation in the abundant material of *Kolymonectes weaveri* DAMBORENEA.

Shells with an outer prismatic layer are generally smooth or faintly ornamented (WALLER 1972b, SCHEIN 1989) and the combination of a smooth right valve and a radially or concentrically ornamented left valve is widespread within the Propeamussiidae.

As happens with species of *Parvamussium* (see HÖLDER 1978) the layers of the shell are differently preserved in *Kolymonectes weaveri* and careful examination is needed to interpret the observed differences in ornament and even shape. Concerning right valves, two main types of "outline" can be recognized (DAMBORENEA 1997b):

a) Valves with distinct angles at the postero-ventral and antero-ventral corners of the disc and consistently longer than high. If matched with left valves with the same hinge-length, these valves appear to be smaller than the left ones along the ventral margin (Text-fig. 13a). They show faint radial lines on the outer surface (e.g. Pl. 2, Figs. 4, 6, 15).

b) Valves with an outline quite similar to the corresponding left valves, slightly higher than long and without angular corners on the disc. These valves may have an up-turned margin. They are externally smooth or show very faint traces of radial lines (e.g. Pl. 2, Figs. 8, 14, 19).

Right valves of group a seem to have lost their outer shell layer due to taphonomic processes and the observed "outline" shows the outermost extension of the inner shell layer(s) preserved. Right valves of group b show the actual outline of the shell. Some specimens found with both valves articulated (Pl. 2, Fig. 4) or only slightly displaced (Pl. 2, Figs. 1, 2, 6, 8) confirm the presence of apparently discordant valves. These facts are in accordance with the distribution of shell layers in Propeamussiidae (WALLER 1972b, CARTER 1990a), where a thin prismatic calcitic layer externally covers the fibrous calcitic layer over most of the right valve disc, extending beyond it towards the distal regions of the valve. This distal apron of prismatic layer is flexible but not strong, fracturing easily (WALLER 1972b, NEWELL & BOYD 1985a). No comparable differences in shell outline have been observed among left valves, thus rendering the possibility of a taxonomic distinction unlikely. Samples and localities with right valves of the a type coincide with those in which *Oxytoma inequivalvis* (SOW.) exhibits apparently discordant valves (DAMBORENEA 1987b), thus confirming that this could be the result of a taphonomic process. Similar differences in shell outline had previously been interpreted as discordant valves (NEWELL & MERCHANT 1939) but later proved to be due to the loss of the fragile marginal band (NEWELL & BOYD 1985a) and called paradiscordant valves (NEWELL & BOYD 1995). Right valves of the preservation type a (Text-fig. 13a) can be compared in outline with right valves of Recent Propeamussiidae in which the flexible prismatic apron has broken away from the margin (see TEBBLE 1966, fig. 26; NEWELL & BOYD 1985a, fig. 1; DIJKSTRA 1991, figs. 1–4; 1995, figs. 4, 7–14, 29–30, 45–46).

According to the emended diagnosis of *Cyclopecten* VERRILL provided by MOORE (1984), SCHEIN (1989) and DIJKSTRA (1995), this is the most closely related genus to *Kolymonectes*. Features in common include valves with different ornamentation, right valve with byssal notch, and lack of internal ribs (VERRILL 1897, pl. 16, pl. 19), but *Kolymonectes* has the posterior auricle separated from the disc by a deeper suture, its byssal notch is shallower and shell size is greater. Nevertheless, this resemblance is so great that they may even belong to the same genus-group.

*Similipecten* WINCKWORTH also lacks internal ribs and ctenolium, but both valves are externally smooth and the byssal notch is deeper (see SCHEIN 1989 for emended diagnosis).

Comparison of the generic characters with those of *Aequipecten* FISCHER, *Entolium* MEEK, *Ochotochlamys* MILOVA & POLUBOTKO and *Propeamussium* DE GREGORIO has already been done by MILOVA & POLUBOTKO (in BYCHKOV et al. 1976 and in MILOVA 1976). Some comments about *Parvamussium* may be added here. The main difference with this genus is the absence of internal ribs in *Kolymonectes*, though some living species referred to *Parvamussium* have only rudimental internal lirae, such as *P. araneum* DIJKSTRA (1991, figs. 3–4) or *P. vesiculatum* DIJKSTRA (1995, figs. 59–62). The external ornament pattern of *Kolymonectes*, on the other hand, is almost identical to the sculpture of some *Parvamussium* species (see for instance MACNEIL 1967, pl. 5; HÖLDER 1978, pl. 1, figs. 1-2; MOORE 1984, pl. 2, figs. 3, 5, 7; JOHNSON 1984, pl. 1, figs. 4–6; DIJKSTRA 1990, pl. 1, figs. 5–8; 1991, figs. 11-21, 53–61; 1995, figs. 55–58). In Argentina, *Kolymonectes* is never found together with *Parvamussium* and their local time ranges do not overlap.

The shell of *Kolymonectes*, including the distal extension of the prismatic layer on the right valve, is similar to the late Palaeozoic genus *Pernopecten* WINCHELL, a probable precursor of the Propeamussiidae according to WALLER (1984). However, this has externally smooth shells and dorsally projecting left auricles (see NEWELL & MERCHANT 1939, NEWELL & BOYD 1985a, 1995).

Some species from the Triassic of the alpine region and western USA have a very similar morphology. ALLASINAZ (1972) grouped them under the generic name *Entolioides*, which is characterized by subequivalve shells with subequal auricles, byssal notch absent or just insinuated and different ornament on both valves, with a smooth right valve and a radially costate left valve. Despite their superficial resemblance with species of *Kolymonectes*, the alpine species have a thick shell with strong auricular crura. *Entoliodes utahensis* (MEEK), from lower Triassic beds of western USA, recently illustrated by NEWELL & BOYD (1995, fig. 54) is even closer to *Kolymonectes* species. It is believed that there is a close phylogenetic relationship between *Entolioides* and *Kolymonectes*. This is also indicated by the same combination of shell microstructure of the outer shell layer of left and right valves (NEWELL & BOYD 1995, table 1), which again relates them to the Propeamussiidae.

The species "*Pecten*" *carlottensis* WHITEAVES (1884, pl. 33, fig. 7), from the Maude Formation (Pliensbachian, see MCLEARN 1949) of western Canada was included in *Kolymonectes* according to the morphology of the left valves as originally described (ABERHAN 1998).

"*Pecten*" *amaltheus* OPPEL in STOLICZKA (1861, pl. 6, fig. 7), from the early Jurassic of the Alps, was doubtfully referred to *Propeamussium pumilum* (LAM.) or to *Chlamys textoria* by JOHNSON (1984) but, as inner characters are unknown, it is also possible that it belongs to *Entolioides* or even to *Kolymonectes*. This cannot be explored further now, but it may be interesting from the palaeobiogeographical point of view.

*Pecten newberryi* WHITFIELD, from the (Middle ?) Jurassic of South Dakota (WHITFIELD 1880, p. 350, pl. 4, figs. 12–15; Text-fig. 16 here) has a very similar shape and ornament to those species assigned to *Kolymonectes* and could probably belong to this or to a closely related genus, if so extending its range into younger levels within the Jurassic.

Up to now, this genus was believed to be a typical element of boreal faunas, restricted to the Late Triassic to Early Jurassic of northeastern Russia and northern Siberia and was thought to control the outline of the Arctic Subprovince of the Boreal Province. The genus *Kolymonectes* has recently been recognized from Sinemurian and Hettangian (?) beds of northern Yukon, Canada (POULTON 1991, pl. 6, figs. 21–28; ABERHAN 1998, pl. 10, fig. 19, pl. 11, figs. 2, 4, 6, 9–11, 15). The species formerly known as *Pecten coloradoensis* WEAVER (1931) [non NEWBERRY 1861] described from western Argentina can be assigned to this genus without doubts and thus its geographical range is extended to the southeastern Pacific, at least during the Pliensbachian (Text-figs. 6–7). This is then another pectinoidean genus with a seemingly bipolar distribution during early Jurassic times, together with *Palmoxytoma*, *Ochotochlamys*, *Otapiria*, *Agerchlamys* and *Radulonectites* (DAMBORENEA 1993a, 1996).

The latitudinal range of *Kolymonectes* in the Andes spans from 35° to 43°, and the abundance of the local species increases to the south. It is unknown further north in Argentina and Chile, although the right facies are present there (ABERHAN 1993b, DAMBORENEA 1996, 1997b).

### *Kolymonectes weaveri* Damborenea 1997

(Pl. 2, Figs. 1–15; Text-figs. 8h-i, 13, 45b)

? p. 1931 *Oxytoma inaequivalve* – Weaver, p. 213–214, pl. 19, fig. 87.
v * 1931 *Pecten* (*Variamussium*) *personatus coloradoensis* – Weaver, p. 274–275, pl. 28, fig. 164 [non *Pecten* (*Monotis*?) *coloradoensis* Newberry 1861]
v 1942 *Pecten* (*Variamussium*) *coloradoensis* – Leanza, p. 176–178, lam. 7, figs. 3, 5; lam. 10, fig. 3.
1953 *Pecten* (*Variamussium*) *coloradoensis* – Groeber et al., p. 156.
1955 *Pecten* (*Variamussium*) *coloradoensis* – Ugarte, p. 149.
v 1975 *Propeamussium* ? – Damborenea et al., cuadro 1, 19.
?? 1983 *Propreamussium* [sic] *(P.) coloradoensis* – Nullo, p. 41.
v 1992 *Kolymonectes coloradoensis* – Damborenea, pl. 115, figs. 11–12.
v 1992 *Kolymonectes coloradoensis* – Damborenea & Manceñido, pl. 1, fig. 8a.
v 1993a *Kolymonectes coloradoensis* – Damborenea, fig. 3.f.
* v 1997b *Kolymonectes weaveri* Damborenea, pl. 1, figs. 1–16; figs. 1(A-B), figs. 2(A-C).

Material: Holotype – A complete specimen with valves slightly displaced, preserved as internal and external moulds, from between Cerro Roth and Cerro Del Vasco, Piedra Pintada region, southern Neuquén (D.14): MLP 23686, figured on Pl. 2, Fig. 1 a-d.

Paratypes – about seven hundred specimens, most of them preserved as external or internal moulds of isolated valves. A few specimens have fragments of shell material and about a dozen have both valves preserved, though not usually articulated.

The species appears always in fine-grained, generally light-coloured sediments from southern Mendoza to Chubut, at the following localities, from north to south: Puesto Araya, rio Atuel, Mendoza (B.1): MLP 23790 and 26560 (M 365, 1928); Portezuelo Ancho region (B.4): MLP 27925 (Lanés'collection); Cerro La Brea, rio Atuel, Mendoza (B.2): MLP 6667, 6675 and 6686; Arroyo Serrucho, Mendoza (B.8): MLP 19675, 23795 to 23801 (M 1330, 1334 to 1336, 1338, 1340, 1342, 1343); Cerro Puchenque, Mendoza (B.9): MLP 23786 to 23789 (M324, 325, 327, 331); Estación Rajapalo, Cordillera del Viento, Neuquén (C.1): MLP 23802, 27549 to 27551 (M 1223, 1856', 1867, 1869); Arroyo Lista Blanca, Cordillera del Viento, Neuquén (C.2): MLP 23811 to 23814 (Clavijo's collection); Ayo. Chacay Melehue, Neuquén (C.3): MLP 23785, 23803 to 23810, 27552 to 27555 (M 245, 1873, 1874 and Clavijo's collection); Espinazo del Zorro, Neuquén (C.10): MLP 23794 (M 1074a); South of Estancia Santa Isabel, Neuquén (D.1): MLP 23793 (M 1053); NW of Puesto Manqueú, Neuquén (D.6): MLP 6000, 6011, 6031, 23791, 23792 (M 1046); Subida a Sañicó, Neuquén (D.7): MLP 6001, 6002, 6004, 6007, 6010, 6012, 14407, 14415, 16194, 23744 to 23783 (M 136, 137, 139, 140); SW of School 27, Piedra Pintada, Neuquén (D.9): MLP 6003, 16425, 23732 to 23743 (M 133); Cerro Mesa, Piedra Pintada, Neuquén (D.11): MLP 6006, 6102, 6209; Cerro Del Vasco, Piedra Pintada, Neuquén (D.12): MLP 6009, 6017, 23719 to 23731 (M 119); Cañadón La Pintada, Neuquén (D.13): MLP 5809, 6005, 23712 to 23718 (M 118); Between Cerro Roth and Del Vasco, Neuquén (D.14): MLP 23687 to 23711 (M 112, 113, 117); Cerro Roth, Piedra Pintada, Neuquén (D.16): MLP 16189, 23685 (M 107); Cañadón de Los Chilenos, Neuquén (D. 17): MLP 6008; Loma de Plate, Chubut: MLP 18203 (Piatnitzky's collection).

Other material: Holotype of *Pecten coloradoensis* Weaver: external mould of a left valve, almost complete but damaged during preparation, from Weaver's locality 1029, immediately to the north of Catan Lil, Neuquen, figured by Weaver (1931, pl. 28, fig. 164) and here on Pl. 2, Fig. 11: BMW SA 155/1029 (= cast MLP 22355). Weaver erroneously mentioned that the specimen was found in Mendoza (1931, p. 275).

This species ranges in age from upper Early Pliensbachian to latest Pliensbachian, i.e. mostly coinciding with the *Fanninoceras* Ammonite Zone in the sense of Riccardi (1984) and has been found both in the *Otapiria neuquensis* and *Radulonectites sosneadoensis* Assemblage Zones.

Remarks: This species is the most abundant pectinoidean in Pliensbachian deposits of Argentina. It includes the specimen described by Weaver (1931) as *Pecten* (*Variamussium*) *personatus* var. *coloradoensis*. The name *Pecten* (*Monotis*?) *coloradoensis* had been given to a Permian species from North America by Newberry (1861), later merely listed under *Aviculopecten* by Girty (1903, p. 48) and then transferred to *Acanthopecten* by Newell (1938; see also Newell & Boyd 1995). Newberry's and Weaver's species-group names are thus primary homonyms and, furthermore, Weaver's type specimen is not adequately preserved (cf. Pl. 2, Fig. 11) and there are serious uncertainties about its accurate geographical and stratigraphical provenance. Therefore, a new species was erected in order to correctly characterize this important taxon, with Weaver's name falling into subjective rather than objective synonymy of this taxon (Damborenea 1997b). This is supported by a suitable holotype, from an accessible type locality and well-defined type horizon, where the species is known to be frequent.

Despite its great abundance, this species was very poorly known. Furthermore, both Weaver (1931) and Leanza (1942) assumed that the radial external ornament present on the left valve corresponded to internal ribs instead. As a consequence, they referred this species to *Variamussium* and their descriptions were not only incomplete but misleading. Weaver (1931) apparently only had a very poorly preserved left valve yet he stated that the shell was inequivalve. Leanza had more than a hundred specimens but failed to notice that the ornament was different on both valves and simply declared that the exterior of the shell was smooth and the interior ribbed.

He even figured (1942, pl. 10, fig. 3) a composite mould of a left valve as an "inner surface of right valve". Though realizing that the costae were external, JOHNSON (1984, p. 28) doubtfully referred the material figured by LEANZA (1942) to *Propeamussium (P.) laeviradiatum* (WAAGEN). The Argentinian species could indeed be compared with some coarsely ornamented *Propeamussium* on external appearance alone, as seen below.

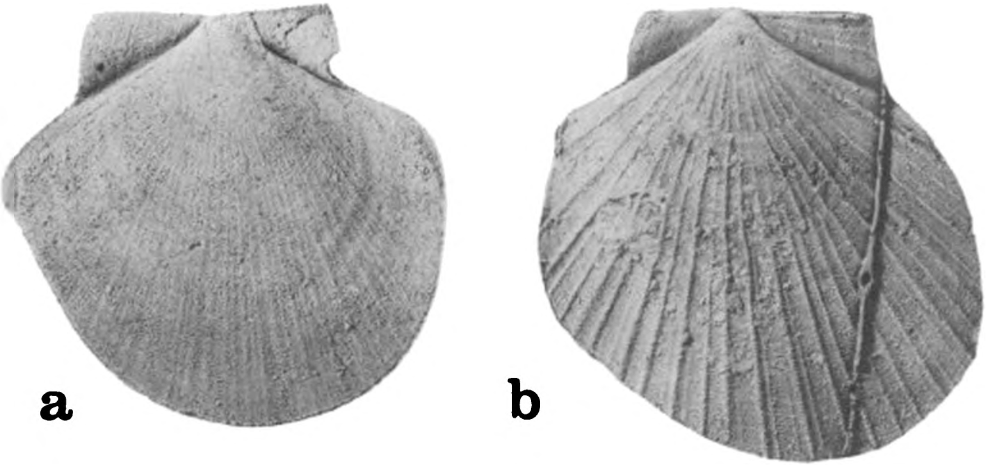
At least part of the material described by WEAVER (1931) as *Oxytoma inaequivalve* (SOW.) from Piedra Pintada may also belong here. His description and especially his figure (pl. 19, fig. 87) agree quite well with left valves of *K. weaveri*. This species is also very common at the locality mentioned by WEAVER (= D.7 here).

It is surprising that this species (or comparable material) has never been figured or reported from Chile, where, judging from its abundance and ubiquity in Argentina, its presence could be expected. Perhaps, right valves could have been mistaken with *Entolium* spp. and left valves with *Chlamys* or other pectinids.

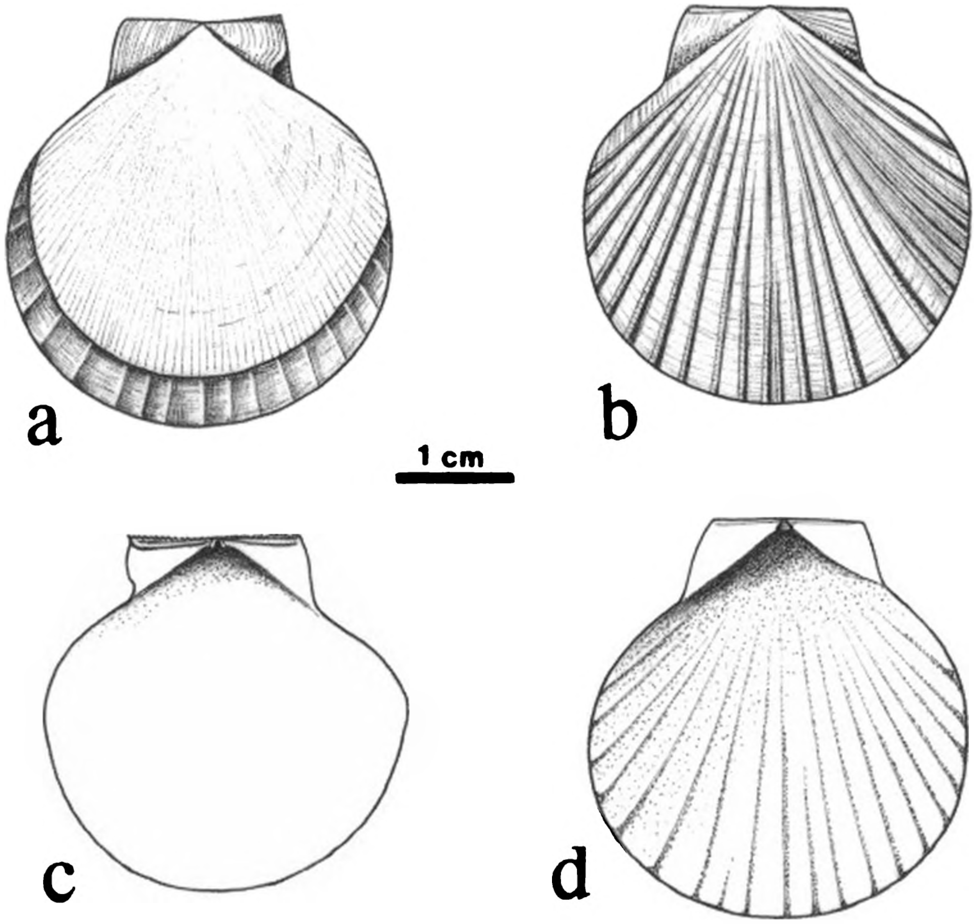
Description: Medium-sized orbicular shells, inequivalve and slightly inequilateral. Shell convexity low and nearly equal on both valves. Young shells higher than long, difference in these measures diminishes with size, some large valves are longer than high. Young shell orthocline, turning to somewhat prosocline with growth, with the posterior portion larger than the anterior (Pl. 2, Fig. 6). Anterior and posterior auricles subequally long, right auricles externally convex and left auricles concave. Right auricles neatly separated from disc by a deep suture, left valve sutures less deep though still clear. Right anterior auricle bears a very shallow byssal notch without ctenolium (Pl. 2, Figs. 4, 6, 8, 14). Left anterior auricle may show traces of a byssal sinus (Text-figs. 13, 14).

Umbonal angle always wider than 100°, tending to increase with size. Umbones low and inconspicuous. Dorsal margin a bit less than half the total shell length. Anterior auricles with dorsal margin on crest of a low fold that increases its amplitude distally, with short projecting spines. Angle of dorsal margins of right valve around 170°. Anterior and posterior auricle margins meet dorsal line at an obtuse angle, posterior ones less obtuse. Anterior and posterior margins of disc straight but evenly merging into the rounded ventral margin. On some right valves there is sometimes a angulation where the posterior and ventral margins of the disc meet (Pl. 2, Figs. 1b, 6, 15). This is due to the disappearance of the outermost shell layer on these particular shells (see discussion above).

Anterior and posterior regions of the disc flatter than the central portion, especially on the posterior region of the left valve, which has a distinct and abrupt change in shell convexity. Ornament pattern differs on both valves (Text-figs. 13, 14): right valves are sub-externally covered by very faint closely set radial lines (Pl. 2, Figs. 3, 4, 6, 15) and are internally smooth except sometimes for a narrow marginal band (Pl. 2, Fig. 14). Left valves are ornamented by up to 40 (mean 29) narrow radial plicae separated by very wide intervals (Pl. 2, Figs. 5, 6, 7) and very delicate and closely set comarginal growth-lines (Pl. 2, Fig. 13). The radial plicae increase in number by intercalation in a somewhat irregular pattern. The primary plicae are clearly seen on internal moulds (Pl. 2, Figs.



Text-fig. 13. *Kolymonectes weaveri* DAMBORENEA, both valves of same specimen showing differences in shell size and ornament pattern, MLP 23807, latex cast, X 2 (same specimen figured on Pl. 2, Fig. 6), a – external view of right valve, ventral "apron" missing; b – external view of left valve, portions of ventral margin incomplete.



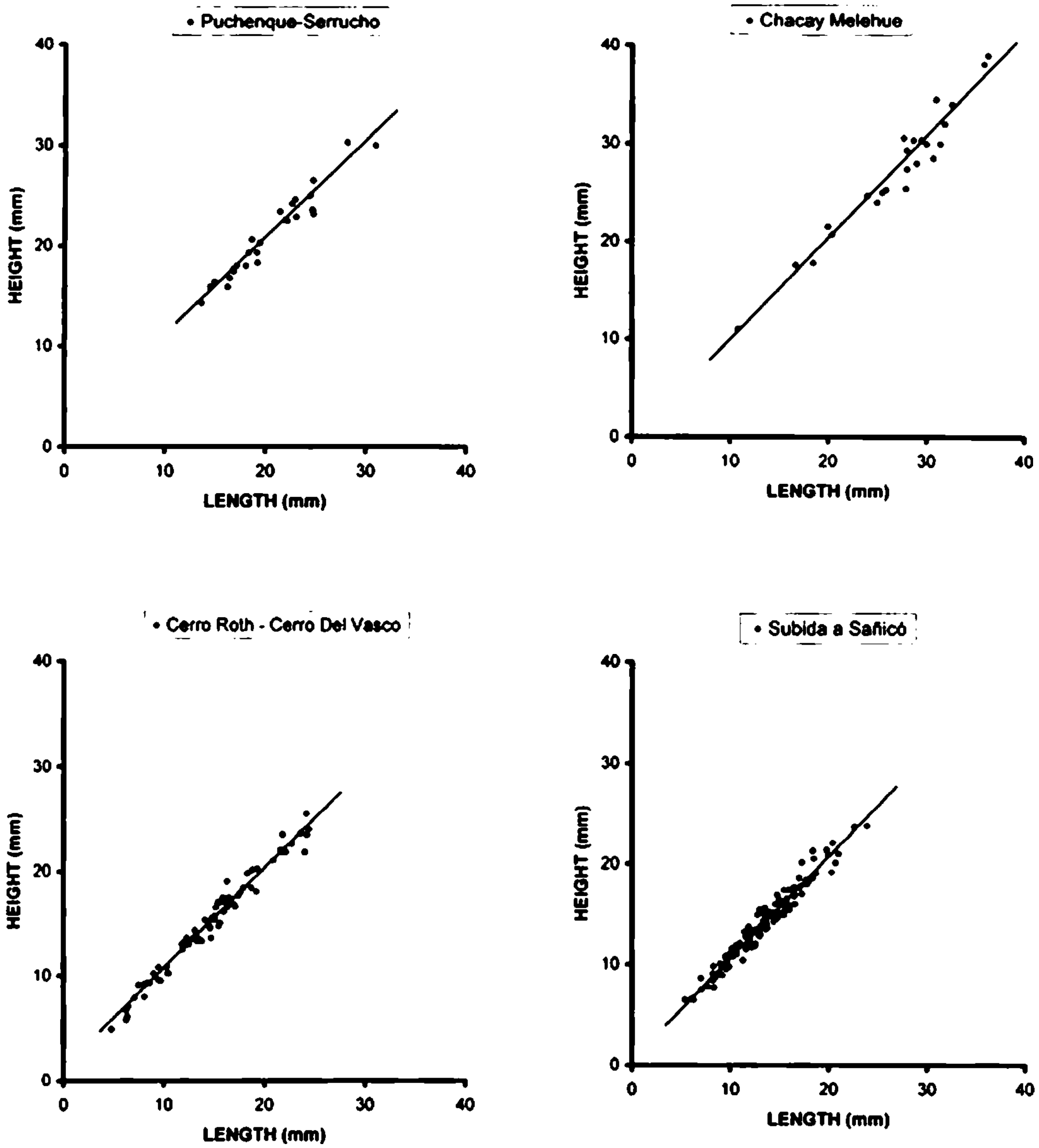
Text-fig. 14. Shell morphology of *Kolymonectes weaveri* DAMBORENEA. Reconstruction based on many specimens. a – right valve external view of specimen with both valves; b – left valve external view; c – right valve internal view; d – left valve internal view.

1, 2). The growth-lines are stronger on the tops of the plicae. The radial plicae are straight on the anterior half of the left valve but tend to curve backwards on the posterior region of the disc. Left posterior auricle bears a few faint radial lines (Pl. 2, Figs. 6, 7), other auricles are smooth with regular growth-lines only.

One long cardinal crus extends to each side of the sub-triangular and centrally placed resilifer (Pl. 2, Fig. 1 c). In the right valve the resilifer is laterally limited by one short ridge on each side. Right valve sutures are internally thickened but without forming true auricular crura. Other internal characters unknown. Shell very thin.

Measurements: Average measurements vary according to localities and a synthesis is offered below. Right and left valves have been treated separately. [1] Mean number of plicae. See also diagrams on Text-fig. 15.

| LOCALITY | Valve | n | L (mm) | H (mm) | [1] |
|---|---|---|---|---|---|
| Subida a Sañicó | left | 70 | 14.48 | 15.38 | 27.37 |
| Subida a Sañicó | right | 64 | 12.20 | 12.50 | - |
| Cerro Roth-Vasco | left | 41 | 15.83 | 16.49 | 27.05 |
| Cerro Roth-Vasco | right | 35 | 13.30 | 13.46 | - |
| Puchenque-Serrucho | left | 11 | 22.35 | 22.93 | 29.73 |
| Puchenque-Serrucho | right | 15 | 19.12 | 19.66 | - |
| Atuel-Pzo. Ancho | left | 3 | 20.70 | 21.98 | 29.66 |
| Atuel-Pzo. Ancho | right | 2 | 17.70 | 18.10 | - |
| Chacay Melehue | left | 15 | 28.77 | 29.55 | 30.21 |
| Chacay Melehue | right | 9 | 23.75 | 23.55 | - |



Text-fig. 15. Scatter diagram and regression line showing length/height (L/H) ratios for different associations of *Kolymonectes weaveri* Damborenea. a – Puchenque – Serrucho region (B.8, B.9), n = 26; b – Chacay Melehue region (C.1, C.2, C.3), n = 24; c – Cerro Roth – Cerro Del Vasco region (D.14), n = 76; and d – Subida a Sañicó region (D.7), n = 134.

Affinities: *Kolymonectes anjuensis* (Milova), from the Sinemurian of northern Russia (Milova 1969, pl. 1, figs. 1–9; 1976, pl. 11, figs. 1–9) is very similar to *K. weaveri* in outline and ornament, but the type species of *Kolymonectes* has much smaller shells and a relatively larger number of radial plicae. From all boreal species, the most similar to the Argentinian species is *K. staeschei* (Polubotko) from upper Sinemurian–lower Pliensbachian beds of Russia (Polubotko 1968b, pl. 7, figs. 1–9; Polubotko & Milova 1986, pl. 15, figs. 9–13; Milova 1988, pl. 5, figs. 9–27; Damborenea 1993a, text-fig. 3e) and Canada (Poulton 1991, pl. 6, figs. 21–28; Aberhan 1998, pl. 10, fig. 19). Right valves of this species show a marginal band of radial plicae which could be a reflection of the inner margin of left valves through the thin and flexible marginal apron of the prismatic shell layer. Radial plicae on left valves are more numerous and irregular than in *K. weaveri* and have beaded tops.

Very similar to *K. staeschei* is *Kolymonectes carlottensis* (Whiteaves 1884, pl. 33, fig. 7; Aberhan 1998, pl. 11, figs. 2, 4, 6, 9-11, 15) from the Pliensbachian of western Canada.

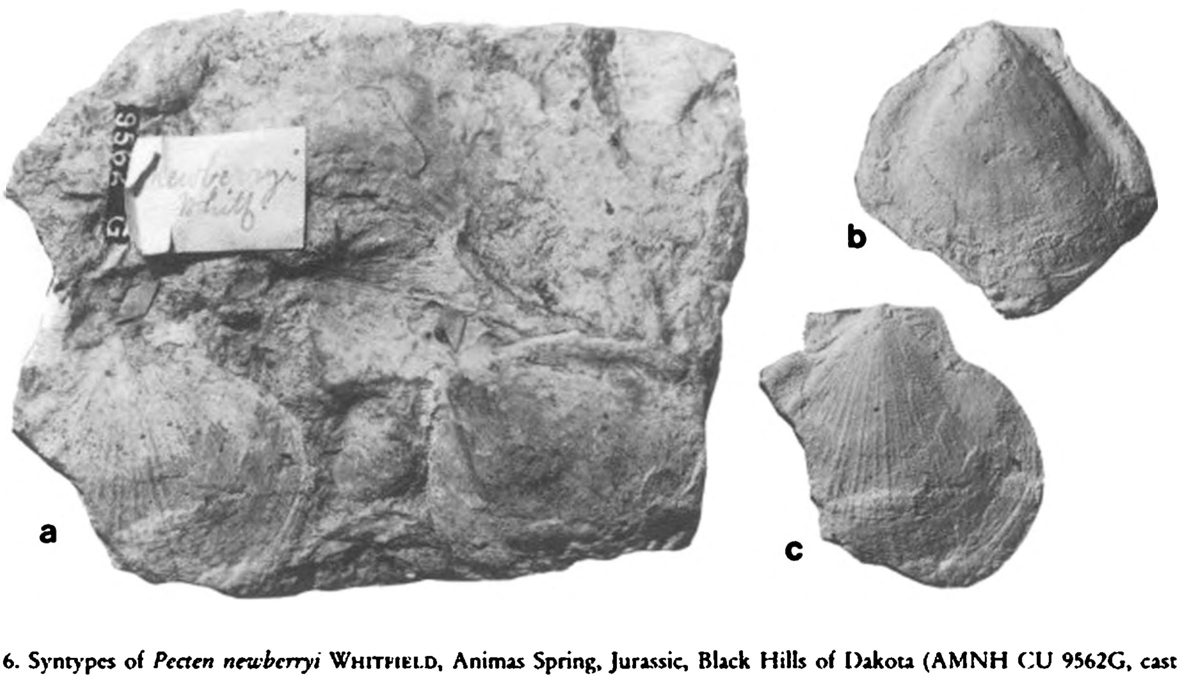
*Kolymonectes kedonensis* Polubotko (in Polubotko & Milova 1986, pl. 15, figs. 1–8), from the Hettangian (?) – Sinemurian of northeastern Russia, has fewer radial ribs with strongly beaded tops. The Pliensbachian species from the same region *K. mongkensis* Polubotko (in Polubotko & Milova 1986, pl. 15, figs. 14–19) has a similar radial ornament but this is superimposed by concentric irregular folds which are absent in the Argentine material.

*Kolymonectes terekhovi* (Polubotko 1968b, pl. 26, figs. 2–3; Milova 1988, pl. 6, figs. 13–15) from the Pliensbachian of the Alazei Plateau, has strong internal ribs limiting the disc flanks of the right valves, which are lacking in *K. weaveri*.

From the species referred to *Ochotochlamys* Milova & Polubotko, *K. weaveri* differs mainly in having a very shallow byssal notch without ctenolium.

The left valves figured by Tilmann (1917, pl. 24, figs. 4–5) as *Pecten peruanus*, from the Sinemurian of Peru, could in fact belong to a species of *Kolymonectes* on account of their peculiar ornament, wide umbonal angle, subequal auricles and flattened disc flanks. They are indeed very similar to large left valves of *K. weaveri* but differ from them by more numerous radial plicae, a narrower umbonal angle and the presence of radial ornament on both auricles. Though he did not figure any right valve, Tilmann mentioned the presence of a deep byssal notch. If those right valves belong to the same species, this cannot be referred to *Kolymonectes*, but could be a representative of *Ochotochlamys* instead. Tilmann's species was referred to *Chlamys* by Johnson (1984). The specimens figured by Willard (1966) as *Pecten peruanus* belong in fact to *Oxytoma* and not to Tilmann's species. On the other hand Prinz (1985, p. 183, pl. 1, fig. 4) assigned Tilmann's species to *Antiquilima* without further comments and figured an incomplete specimen from the Sinemurian of Utcubamba (Perú). Evidently, this Peruvian species in badly in need of revision.

"*Pecten*" *newberryi* Whitfield (1880, pl. 4, figs. 12–15), from the Jurassic beds of the Black Hills of Dakota, is comparable to *K. weaveri* in shape and ornament pattern, but radial ornament on the left valve is made up of more numerous fine costae which are hardly reflected on the inner surface of the shell. The right valve figured by Whitfield is not kept with the other syntypes (AMNH CU 9562 G). A photograph of the slab containing the left valves drawn in Whitfield (1880, pl. 4, figs. 12–13) is here provided in Text-fig. 16 for comparison. Unfortunately, no accurate data regarding the age of this interesting species could be found so far and more material is needed to ascertain its relationships with species of *Kolymonectes*.



Text-fig. 16. Syntypes of *Pecten newberryi* Whitfield, Animas Spring, Jurassic, Black Hills of Dakota (AMNH CU 9562G, cast MLP 23816), X 1. a – whole slab; b – right (?) valve; c – left (?) valve.

The Triassic species referred by Allasinaz (1972) to his new genus *Entolioides* have a smooth right valve and a radially costate left valve. The shell is thicker and has more regular and numerous radial costae on the left valve than *K. weaveri*. Of all species referred to *Entolioides*, *K. weaveri* is most similar to *E. utahensis* (Meek; see Newell & Boyd 1995, fig. 54), though this species has a smooth right valve and fewer left valve costae.

Some coarsely ribbed specimens of Jurassic to Tertiary *Parvamussium* species show a remarkable resemblance to *K. weaveri* in external appearance, such as the left valves figured by Hölder (1978, pl. 1, figs. 1–2) as *Parvamussium pumilus atlasense* Hölder; Polubotko (1968b, pl. 66, figs. 1a-1b) as *Variamussium* sp.; Moore (1984, pl. 2, figs. 3, 5, 7) as *Parvamussium alaskaensis* (Dall); Johnson (1984, pl. 1, figs. 5–6) as *Propeamussium laeviradiatum* Waagen and here (Text-fig. 19) as *Parvamussium pumilum andium* (Tornquist).

Autecology: Already discussed by Damborenea (1997b), only a summary will be given here.

*Kolymonectes weaveri* only occurs in very fine-grained, mostly light-coloured sediments, forming shell pavements and are rare in black shales. Both left and right valves appear in almost equal proportions and always disarticulated but commonly as complete external or internal moulds, except for the usual lack of the outer prismatic layer on right valves already mentioned.

Young individuals were probably byssally attached but the byssal notch became obsolete in adults and was then probably not functional. Adults are supposed to have lived resting on the substrate and have been very good swimmers, as suggested by the thin, compressed and equally convex shells, with very wide umbonal angle and small subequal auricles. Only one left valve shows traces of a repaired injury near the antero-ventral shell margin (Pl. 2, Fig. 12), and another is encrusted by *Harpax rapa* (Pl. 2, Fig. 10; Text-fig. 45b), but this is thought to be a post-mortem epibiont.

Populations from different localities differ greatly in mean shell size and this is thought to be related to depth and/or oxygen availability rather than temperature or other latitude related factor in view of the geographical distribution of these gradients (Damborenea 1997b, fig. 3). Larger sizes are attained at greater depth and/or less water turbulence, the only accompanying fauna being ammonites. The largest specimens occur in the Cordillera del Viento area of northern Neuquén and in Chubut in very fine grained greenish brown pyroclastic sediments. Within the Piedra Pintada area in southern Neuquén, differences in mean size are clearly related to the type of sediment, the smallest specimens are found in dark grey shales with almost no other fossil invertebrates. Those from light-coloured sediments are consistently larger and are commonly associated with a benthonic bivalve fauna of nuculanoideans, arcoideans, inoceramids, monotids and also ammonoids. A similar relationship was observed for species of *Parvamussium* from several European localities (Johnson 1984), those from the "Posidonienschiefer" being the smallest.

They may occasionally be mixed with other benthonic invertebrates in tempestitic (e.g. at Cerro Puchenque or Arroyo Serrucho) or turbiditic (e.g. at Espinazo del Zorro) sequences.

Living Propeamussiidae are rare at depths shallower than 60 m and most species live deeper than 150 m up to 4000 m on fine sediment and avoid areas of high turbulence (Waller 1972b, 1984, Schein 1988, 1989, Dijkstra 1991, 1995). The depth range was severely restricted or shifted from neritic during the Jurassic to bathyal-abyssal during the Cainozoic (Damborenea 1995, 1997a, 1997b) but other environmental requirements seem to have remained unchanged. Species of the closely related genus *Cyclopecten* live mostly in deep water (Verrill 1897, Dijkstra 1991, 1995). All these deep water living species have smaller shells than *K. weaveri*.

### *Kolymonectes* sp.

(Pl. 2, Figs. 16–19)

* v 1997b *Kolymonectes* sp., Damborenea, pl. 1, figs. 17–20.

Material: Two left, two right valves and several fragmentary valves from Sinemurian beds (*Agassiceras* and *Miltoceras* Ammonite Zones) at Arroyo Malo, Mendoza (B.14): MLP 25002 to 25005 (M 1428 and 1474).

Description: Inequivalve medium-sized orbicular shells, moderately inflated. Length and height almost equal. Anterior auricle longer than posterior one, right valve auricles externally convex and left auricles concave. All auricles separated from disc by a deep suture. Byssal notch and byssal sinus shallow. Umbones low and centrally placed, umbonal angle about 110°. Anterior and posterior margins of disc straight, ventral margin evenly rounded. Disc flanks flattened, especially in left valves.

Inner and outer surface of right valve smooth, sub-internally faint radial lines are present (Pl. 2, Fig. 16). Marginal band of right valve upturned and internally slightly crenulated (Pl. 2, Fig. 19). Left valves ornamented by more than 40 narrow radial plicae separated by wider intervals (Pl. 2, Fig. 18). The plicae increase in number by intercalation and are irregularly spaced. Surface of all auricles smooth.

Resilifer triangular and centrally placed, in the right valve laterally limited by one short tooth-like ridge on each side. Other internal characters unknown.

Measurements: In mm of best preserved specimens. [1] = total number of radial plicae.

| Specimen MLP | Material | L (mm) | H (mm) | W (mm) | [1] | ε (°) |
|---|---|---|---|---|---|---|
| 25002 | IM LV | 18.6 | 18.2 | 1.4 | – | 106 |
| 25003 | IM RV | 22.1 | 22.8 | 2.0 | – | 109 |
| 25004 | IM RV | 17.2 | 17.8 | 1.3 | – | 109 |
| 25005 | EM LV | 17.8 | 18.4 | 2.2 | 42 | 111 |

Affinities: This material is very similar to *Kolymonectes weaveri* n. sp. from the Andes (see Pl. 2, Figs. 1–15) but is treated separately here because of the following morphological differences: at equal size *K.* sp. has more radial ribs (about double), anterior and posterior auricles are unequal in *K.* sp. and all of them have a smooth outer surface. This material is also older than *K. weaveri* and may be regarded either as a mere morphological variant within a long ranging taxon or as a different species. Unfortunately, only a few specimens are available and a more detailed comparison must wait until more material from Sinemurian beds is obtained.

*Kolymonectes* sp. is also closely related to *K. staeschei* (Polubotko) from Sinemurian-Pliensbachian beds of northern Russia, but radial plicae have beaded tops in this Boreal species (Polubotko 1968b, pl. 7, figs. 1–9; see also Damborenea 1993a, text-fig. 3a).

### Genus *Parvamussium* Sacco 1897

Type species: *Pecten duodecimlamellatum* Bronn 1831, from the Upper Miocene of Italy, original designation.

Synonymy: – *Variamussium* Sacco 1897 (type species *Pecten cancellatum* Smith)
– *Ctenamusium* Iredale 1929 (type species *Amussium thetidis* Hedley)
– *Glyptamussium* Iredale 1939 (type species *Amussium torresi* Smith)
– *Squamamussium* Oyama 1944 (type species *Amussium squamigerum* Smith)
– *Polynemamussium* Habe 1951 (type species *Pecten intuscostatus* Yokoyama)
– *Amussiopsis* Andrejeva 1966 (type species *Pecten paradoxus* Münster)
– ? *Varientolium* Andrejeva 1966 (type species *V. horridum* Andrejeva)

For more details see Dijkstra (1995, p. 25).

Remarks: Internally ribbed propeamussiids are known from Early Jurassic to Recent times. After the erection of *Propeamussium* by de Gregorio, the first systematization of this group was proposed by Sacco (1897), who recognized three taxa: *Propeamussium*, *Parvamussium* Sacco and *Variamussium* Sacco, all of them included as subgenera within *Amusium* Röding. It is now known that *Amusium* and propeamussiids belong to different pectinoidean groups (Waller 1971, 1972b, 1984, Yonge 1981, Carter 1990a) on account of different shell structure, lack of true ctenolium in the latter and other anatomical features. But the status of *Variamussium*, *Parvamussuim* and *Propeamussium* and their mutual relationships have not been adequately established. Early Jurassic species in particular have been successively referred to each of these three generic names. Damborenea (1997b) discussed this matter and concluded that most Triassic and Jurassic species of internally ribbed propeamussiids should be referred to *Parvamussium* rather than to *Propeamussium*.

A summary of characters of the two subgenera recognized is provided below, in agreement with the criteria summarized by Dijkstra (1995, table 1).

*Propeamussium* s.s. includes large flat and rather inequilateral shells with very small subequal auricles and only a very small or non-existent byssal notch. Shells have anterior and posterior lateral gapes. The dorsal length is between 1/4 and 1/3 of the total shell length. Internal ribs start early in ontogeny and do not extend near the shell margin and their length is a very variable character in different species. This genus is known at least since the Cretaceous and has several living species.

*Parvamussium* includes small to medium-sized rounded equilateral shells, without lateral gapes and with a well-developed byssal notch (see Sundberg 1989). Waller (1984) described the presence of a fasciolar pseudoctenolium in the species *P. sayanum* (Dall). The auricles are unequal and relatively larger than in *Propeamussium* s.s. (as already pointed out by Nakazawa 1961, Tamura 1973 and Hölder 1978), the dorsal length is about half the total shell length. Internal ribs extend almost to the margin and in living species they start late in ontogeny. Different ornament on both valves is common. The oldest known species of this group seems to be "*Propeamussium* (*Variamussium*) n. sp. indet." described by Nakazawa (1961, p. 256, pl. 12, figs. 8-9) from Anisian beds in Japan, whilst "*Pecten* (*Variamussium*) *margariticostatus*" Diener (1908, p. 97, pl. 18, figs. 1–3) is probably an *Indopecten* Douglas.

Using these criteria, the Early Jurassic species *P. pumilum* (Lamarck) belongs to *Parvamussium* and as such is regarded by most recent authors (Hayami 1972, 1975, Skwarko 1974, Hölder 1978). Hayami (1961) stated that *Variamussium* seems ancestral to Cretaceous and younger *Propeamussium* and that *Variamussium* is more closely related to *Parvamussium* than to *Propeamussium* (Hayami 1972). In fact, Early Jurassic species are included in *Propeamussium* only when this is regarded in a broad sense or when just one group is recognized, except by Nitzopoulus (1974), Johnson (1984) and Aberhan (1994) who explicitly include them in *Propeamussium* s.s. without further comments.

### *Parvamussium pumilum* (Lamarck 1819)

(Pl. 1, Fig. 12–20; Text-fig. 18b)

1891 *Pecten* (*Amusium*) *paradoxus* – Behrendsen, p. 393.
1894 *Amusium paradoxum* – Möricke, p. 38.
1899 *Pecten pleuronectoides* – R. Philippi, p. 37.
vp 1899 *Pecten paradoxus* ? – R. Philippi, p. 37, lám. 20, fig. 10 (right only).
1900a *Amusium personatum* – Burckhardt, p. 32, lám. 21, fig. 1.
1903 *Pecten* (*Amusium*) *personatus* – Burckhardt, p. 22–23, Taf. 2, Fig. 7.
1917 *Pecten* (*Amusium*) *paradoxus* – Tilmann, p. 681.
1922 *Pecten* (*Amusium*) *paradoxus* – Behrendsen, p. 176.
1926a *Pecten* (*Variamussium*) *personatus* = *pumilus* – Jaworski, p. 165–166.
? 1931 *Amusium* sp. – Weaver, p. 286.
v 1978a *Propeamussium* sp. – Volkheimer et al., cuadro 2.
1981 *Propeamussium* sp. – Hillebrandt & Schmidt-Effing, p. 10, 22, 23, 24.
v 1992 *Propeamussium* (*Variamussium*) *pumilum* – Damborenea. pl. 117, figs. 13–15.
1994 *Propeamussium* (*Propeamussium*) *pumilum* – Aberhan, p. 36–37, pl. 17, figs. 9–14.

Note: Only South American references are included. For further synonymy see Staesche (1926) and Hölder (1978).

Material: About a hundred isolated complete valves, many of them preserved as internal or external moulds and a few with shell preserved, from Toarcian beds from Arroyo La Laguna, San Juan (A.2); Rio Salado (B.6), Arroyo Serrucho (B.8), Cerro Puchenque (B.9), Cerro Tricolor (B.11), Mendoza; and Southern Cordillera del Viento (C.1) and Arroyo Ñiraico (C.4), Neuquen: MLP 15448, 15539, 15545, 17130, 17159, 17179, 17477, 23817 to 23862, 27573 to 27575 (M 331, 332, 334, 437, 438, 448, 807, 808, 1315, 1346 to 1349, 1351 to 1353, 1995, 1996 and G 222, 302, 904, 918 and 1031). This species has never been reported south of northern Neuquén.

In Argentina this species ranges from early Toarcian (*Dactylioceras hoelderi* Ammonite Zone) to early Bajocian (*Emileia giebeli* Ammonite Zone) in age. Its greatest abundance corresponds to the *D. hoelderi* Zone (early Toarcian), only a couple of specimens were found in the *Collina chilensis* Zone at Arroyo La Laguna and again just a few specimens with *Phymatoceras* faunule at Cerro Tricolor. The species is then very rare in the uppermost Toarcian and Aalenian levels but becomes again relatively common in lower Bajocian beds (*P. singularis* – *E. giebeli* Ammonite Zones). These oscillations may be due to the development of the proper facies in the Cuyan Basin, but this cannot be properly evaluated at the moment. Part of the Bajocian material is here regarded as a different subspecies (see Text-fig. 19).

This species is also present in equivalent levels at several localities in Chile (Möricke 1894, R. Philippi 1899, Hillebrandt & Schmidt-Effing 1981). Philippi's illustration of *P. paradoxus* ? (1899, pl. 20, fig. 10) includes two different specimens: fig. 10 left (SGO-PI 3142, Text-fig. 18a here) is in fact a well preserved *Posidonotis cancellata* (Leanza), while fig. 10 right (SGO-PI 894, Text-fig. 18b here) belongs to the species here described. This last specimen was also mentioned in Philippi's text as *Pecten pleuronectoides* Phil.

Description: Small to medium-sized pectiniform equivalve and equilateral shells. Dorsal length a bit less than half total shell length.

Disc suborbicular, with a wide (around 115°) umbonal angle. Auricles small, well-demarcated from disc by deep sutures. Anterior auricles larger than posterior (Pl. 1, Fig. 19). Right anterior auricle with a shallow byssal notch without ctenolium (Pl. 1, Fig. 19). Left valve anterior auricle with shallow byssal sinus (Pl. 1, Fig. 18). The anterior margin of anterior auricles meets dorsal margin at a straight angle, the posterior margin of posterior auricles meets dorsal margin at an obtuse angle. Anterior and posterior margins of disc straight, ventral margin evenly rounded. Disc evenly convex with rather flatter flanks.

The exterior of left valves is ornamented by very fine radial riblets which extend over the whole disc but are weaker on the flanks (Pl. 1, Figs. 16, 18, 20). Exterior of right valves smooth with comarginal growth-lines only (Pl. 1, Figs. 12, 13).

Subinternal radial costae on both valves extend to 8/9 of total shell height, being stronger and wider near the margin (Pl. 1, Figs. 15, 17, 19). Most Argentinian specimens have 10 radial costae. Only one specimen shows an intercalated internal costa (Pl. 1, Fig. 14).

Auricular crura well developed as one rod-like knob parallel to suture on each auricle (Pl. 1, Figs. 15, 17, 19). There is also one long cardinal crus parallel to the hinge-line on each auricle (Pl. 1, Fig. 14). Resilifer triangular and centrally placed, bounded by one tooth-like crus to each side (Pl. 1, Fig. 19).

Measurements: Of figured specimens, in mm. [1] Height of central inner costa. [2] Number of internal costae. See also scatter diagram in Text-fig. 17.

| SPECIMEN MLP | Material | L (mm) | H (mm) | Lh (mm) | [1] (mm) | ε (°) | [2] |
|---|---|---|---|---|---|---|---|
| 15448 | RV? IM | 26.1 | 27.4 | 12.0 | 24.3 | 117 | 11 |
| 15539-a | LV? SP | 20.0 | 19.6 | 12.0 | - | 109 | 10 |
| 17477-a | RV SP | 25.0 | 24.2 | – | – | 115 | – |
| 17477-c | RV SP | 15.2 | 16.5 | 6.3 | – | 102 | 10 |
| 23818-a | LV SP | 29.7 | 30.2 | 14.1 | 26.7 | 113 | 9 |
| 23818-b | LV EM | 23.3 | 22.1 | 10.2 | – | 120 | – |
| 23839 | RV IM | 24.6 | 25.1 | 12.0 | 23.1 | 118 | 10 |
| 23848-a | LV? IM | 17.0 | 19.4 | 8.0 | 18.2 | 119 | 10 |
| 23848-b | LV? IM | 16.5 | 18.4 | 7.0 | 17.1 | 119 | 10 |

Remarks: This is a widely distributed species. To the map in JOHNSON (1984, text-fig. 12) records in Siberia (POLUBOTKO 1968b), the Himalayas (WEN et al. 1976, WEN 1982) and northern Iran (FANTINI-SESTINI 1966) must be added.

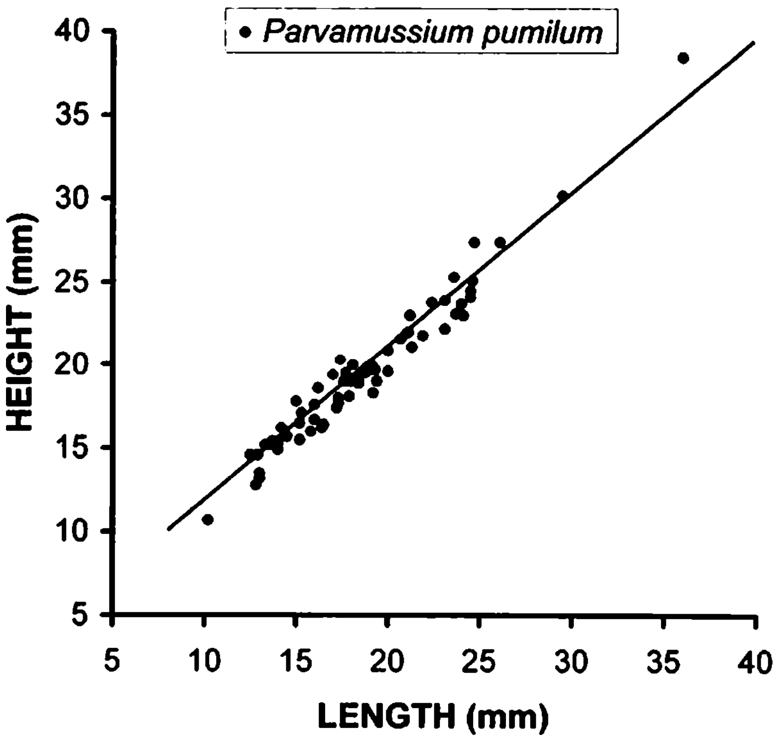
The Argentinian specimens show similarities to the following illustrated material: the syntypes (see HÖLDER 1978, fig. 2); the syntypes of *P. paradoxus* MÜNSTER (GOLDFUSS 1835, p. 77, pl. 99, figs. 4a-f; HÖLDER 1978, fig. 1 at the top); specimens from the Toarcian of Provence figured by LANQUINE (1929, pl. 5, fig. 7) and of Siberia figured by POLUBOTKO (1968b, pl. 41, figs. 1–2); material from the Swabian Toarcian (HÖLDER 1978, fig. 3, pl. 5, fig. 6); specimens from the Bajocian of southern Russia (ROMANOV 1985, pl. 7, figs. 6-10) and the Middle Jurassic of the Jura region (SCHMIDTILL 1926, pl. 2, figs. 1, 9, 12).

The specimens here described are very similar in shape, size and other morphological characteristics, to *P. duodecimlamellatum* (BRONN), type species of *Parvamussium*, from the Italian Tertiary. This species, though, has concentric ornament on both valves (SACCO 1897, pl. 14, figs. 2–6). On the other hand specimens referred to species of *Variamussium* by SACCO (1897) are comparable in all details of shell morphology, including ornament.

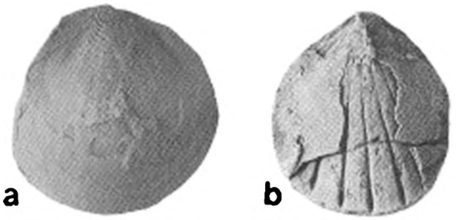
*Propeamussium donaiense* (MANSUY), from the lower Jurassic of Saigon, is similar in shape and size but consistently has fewer (7 or 8) internal ribs and lacks a byssal notch (MANSUY 1914, pl. 4, fig. 3; SAURIN 1935, pl. 12, figs. 8–9; HAYAMI 1972, pl. 34, figs. 11–12; pl. 38, figs. 6-7).

R. PHILIPPI (1899, p. 37) mentions that the Chilean specimen he described as *P. paradoxus* has only 7 internal ribs. Nevertheless, examination of the incomplete specimen (SGO-PI 894, see Text-fig. 18b here) shows that there are at least 9 internal ribs.

The material from lower Bajocian beds at Paso del Espinacito, San Juan, described by GOTTSCHE (1878, p. 20, pl. 5, fig. 4; 1925, p. 252–252, pl. 5, fig. 4) as *Pecten pumilus* was later named *Pecten andium* by TORNQUIST



Text-fig. 17. Scatter diagram and regression line showing length/height (L/H) ratios in *Parvamussium pumilum* (Lamarck), n = 64.



Text-fig. 18. The two specimens illustrated as *Pecten paradoxus* ? by R. Philippi (1899, lám. 20, fig. 10), X 1. a- SGO-PI 3142, *Posidonotis cancellata* (Leanza); b- SGO-PI 894, *Parvamussium pumilum* (Lamarck).

Text-fig. 19. *Propeamussium pumilum andium* (Tornquist) from Bajocian beds in Argentina. Left valves, X 2. a – MLP 24323; b – MLP 24885; c – MLP 24886. a and b from Paso del Carro Quebrado, Neuquén, c from Paso del Espinacito, San Juan.

(1898, p. 163). Examination of Gottsche's figures and material personally collected from the same locality and age (Damborenea & Manceñido 1992, pl. 3, fig. 2a; Text-fig. 19 here) shows that the Bajocian specimens are much smaller than the Toarcian ones and show a stronger radial ornament on the left valve. These morphological differences could perhaps merit a distinction at a subspecific level, pending a thorough treatment of Middle Jurassic material. Burckhardt (1903) examined Gottsche's originals and referred them to *P. personatus* Zieten.

Autecology: Recent species of *Propeamussium* and *Parvamussium* live at depths greater than 150 m and are probably byssate during young stages (Waller 1972b, 1984, Dijkstra 1995, table 2). Highest diversity in New Caledonia is found between 600–800 m deep (Dijkstra 1995). Very little is known about the biology of living forms, but at least some deep-water species prey on copepods and even show a high sex selectivity for male preys (Hicks & Marshall 1985), suggesting good mobility abilities.

On the other hand, during the Jurassic *Parvamussium* had a neritic distribution, which later shifted (or was severely restricted) to bathyal-abyssal, probably as a result of the "Mesozoic marine revolution" (Damborenea 1997a, 1997b).

JOHNSON's (1984, p. 26) proposition that *Otapiria* may have competitively restricted the development of this species in circum-Pacific regions must be regarded as doubtful since *Otapiria* is everywhere very rare in beds younger than early Pliensbachian, whilst *P. pumilum* became widespread only by late Pliensbachian-early Toarcian times.

## Family Entoliidae v. TEPPNER 1922

This family of pectinoideans is represented worldwide since Carboniferous times. Some authors regard this as an extinct family, but the inclusion in it of species of *Pectinella* VERRILL extends its range to the present times (see for instance DIJKSTRA 1991, 1995). Several species of *Entolium* are known in the Jurassic deposits of the Andes, of which only the Early Jurassic material will be described here. In addition, the species *Posidonotis cancellata* (LEANZA) has also been referred to this family (DAMBORENEA 1987b; 1989).

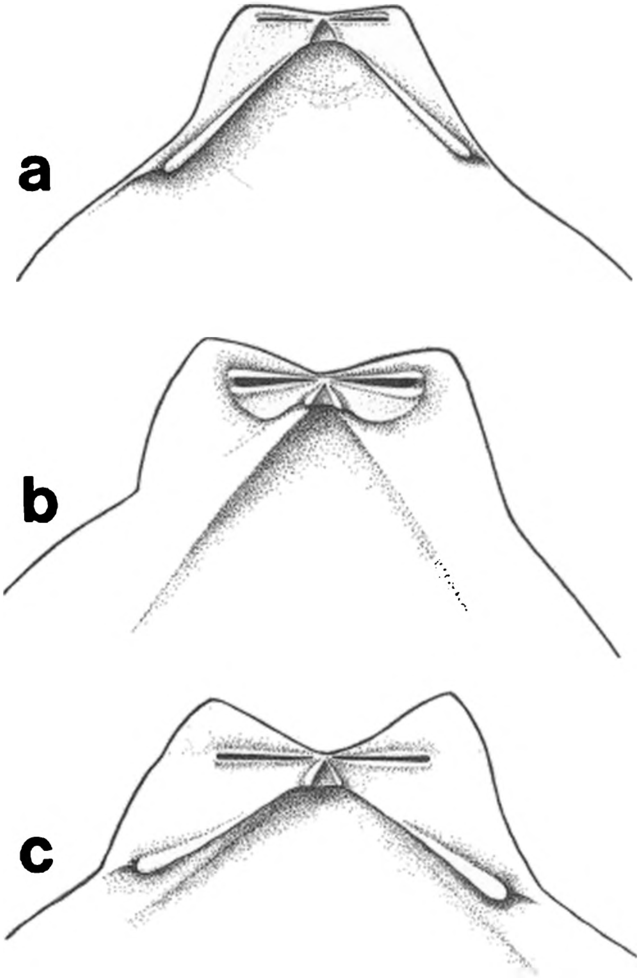
The systematic arrangement of species within this cosmopolitan family has always proved to be difficult due to the few available characters and the fact that many features are substantially affected by the kind of preservation of the material. This is further complicated by the very large number of specific names available and the poor knowledge of most of the taxa. Besides, authors working in different regions or stratigraphical levels have often done so in mutual ignorance of each other.

No attempt to unravel the supraspecific taxonomy of this group will be made here. The following discussion on potentially useful characters is only intended to contribute to a comprehensive discussion of this problem.

The presence or absence of lateral internal ridges was regarded as an important feature by STAESCHE (1926) to characterize his group of *Entolium cingulatum* GOLDFUSS, which was later separated as a subgenus *Costentolium* by FRENEIX (1980) or as a genus *Cingentolium* by YAMANI (1983) and *Neoentolium* by ROMANOV (1985). These last three objective synonyms differ though in the scope their original authors gave them. FRENEIX (1980) had a wide concept, including all forms with any sort of internal ridges, whereas YAMANI (1983) and ROMANOV (1985) only included shells with sharp and well-defined ridges. ALLASINAZ (1972) used this character at a generic level. JOHNSON (1984), on the other hand, after discussing this feature at length, dismissed its relevance for the distinction of different taxa. He did not use it even at the species level, arguing that it "is a result of diagenetic processes", except perhaps in certain specimens with sharp internal ridges, preferring "to reserve judgement on the status of these specimens" (JOHNSON 1984, p. 36). This character is also present in the genus *Pernopecten* WINCHELL and in other groups, such as in some species of *Kolymonectes*.

Similarly, the presence or absence of byssal notch was used as a distinctive subgeneric feature by YAMANI (1983) to erect *Cingentolium* (*Colpentolium*); whereas ROMANOV (1985) used this character at generic and subfamilial level. The absence of byssal notch was commonly included as a diagnostic feature of *Entolium* s.s. (see for instance STAESCHE 1926, COX 1952, HERTLEIN in COX et al. 1969, ROMANOV 1985) yet many authors admit specimens with a very shallow byssal notch within the genus (DECHASEAUX 1936, DHONDT 1971, ALLASINAZ 1972; DUFF 1978, KELLY 1984, JOHNSON 1984) and use this character to distinguish different species. Thus, the specimen figured as *Camptonectes* sp. B by SZENTE (1995b, pl. 6, fig. 13) can be regarded as an *Entolium*. Careful consideration to preservation is again important regarding this feature.

The dorsal projection of auricles above hinge-line was used in the orientation of the shells to distinguish left from right valves. Nevertheless, whereas some authors (such as NEWELL & HERTLEIN in COX et al. 1969, DUFF 1978) believe that only the left valve has dorsally projected auricles, others (ARKELL 1930, JOHNSON 1984) state that the margin is dorsally projected only in the right valve. This agrees with the auricle shape in living species of *Pectinella* (see DIJKSTRA 1995, figs. 71-74). COX (1952) regarded this as a feature which varies in different species and KELLY (1984) later demonstrated that, at least in some well-characterized species of *Entolium*, both valves have dorsally projected auricles, as is the case of the material described here. According to KELLY (1984) it is not possible to use the elevation of the dorsal wings in the orientation of the valves. Forms with extreme development of this character were recognized as the group of *Entolium cornutum* QU. by STAESCHE (1926) or the genus *Cornutoentolium* by ROMANOV (1985). Since most species have tooth- and socket-like structures parallel to the hinge axis, this is a weak line and thus specimens easily break along it. There is a change in the convexity of the auricles along the hinge-line (see Pl. 4, Fig. 5 here) which may also cause the valves to break along this line. Regarding the likely function of this character, JOHNSON (1984) suggested that it might help to maintain life position while reclining with the dorsal portion of the shell sunken in the sediment. On the other



Text-fig. 20. Right valve hinge region of *Entolium* species described here. a – *Entolium mapuche* n. sp.; b – *Entolium (E.)* cf. *lunare* (Römer); c – *Entolium (E.) disciforme* (Schübler).

hand, it is here postulated that the dorsal extension of the auricles could act as "stoppers" limiting the shell widest gape while swimming. Due to this change of convexity, the dorsal portion of the auricles slope away from the commissure plane. If such is the function of this structure, both valves should have it, as has indeed been observed in well-preserved material (Kelly 1984; this paper).

The detailed morphology of the hinge region was only casually mentioned but not analized by most authors. Kelly (1984) described and excellently illustrated the set of characters involved in *Entolium orbiculare* (Sow.). Despite the fact that these characters have been neglected in the past, it is thought that the presence/absence and different arrangement of these structures are useful tools in characterizing (together with other morphological features) species-group taxa, as in other pectinoidean groups. Three kinds of crura can be distinguished (see Text-fig. 20):

a) Longitudinal hinge crura, parallel and close to hinge-axis, a pair of tooth-like structures probably accompanying the lateral lamellar band ligament (Kelly 1984, text-figs. 52, 53, pl. 13, figs. 5, 8-10; Newell & Boyd 1987, fig. 8-D). These features were called either "cardinal crura" (Speden 1967, Allasinaz 1972, Duff 1978), "incised ligamental area" (Cox et al., 1969), "horizontal teeth" (Kelly 1984) or "false teeth" and "hinge crura" (Romanov 1985). They are present (though variably developed) in all species of *Entolium*. Unlike what happens in other pectinoideans, the ligament does not reach the anterior and posterior margins of the auricles but is much shorter than the hinge-line.

b) Radiating hinge crura on either side of resilifer: although thought by some authors to be absent in *Entolium* (Speden 1967), they may be present in some species (Kelly 1984, text-figs. 52, 53, pl. 13, figs. 5, 8–10). These structures were called "false teeth" (Allasinaz 1972), "hinge crura" (Sobetski & Maslennikova 1982) or "chevron-shaped teeth" (Kelly 1984).

c) Auricular crura at the ventral base of each auricle (Kelly 1984, text-figs. 52, 53; Newell & Boyd 1987, fig. 8-D). These may be very strong, only weak ridges, or be altogether absent in different species. Arkell (1930) included the presence of strong auricular crura among the diagnostic features of *Entolium*, but most authors admit a wide range of variability regarding this character. This feature has been also used to assist in the orientation of the valves, since in species with strong auricular crura, the anterior crus of the right valve is longer than the base of the corresponding auricle, whilst all other crura do not extend beyond the base of the auricle (Dhondt 1971, Kelly 1984; this paper).

Regarding details of shell surficial and sub-surficial structures, such as comarginal, divaricate or antimarginal and radial lines, it is now generally agreed that most of them are highly influenced, modified and even appear as a consequence of diagenetic processes, although they were used in the past to separate species or even to characterize different genera (Allasinaz 1972) or higher taxa (Romanov 1985). Only relatively strong and regular comarginal grooves, generally limited to only one valve, are regarded to have taxonomic value at the species level within *Entolium* (see Johnson 1984), though some authors think that this character may even vary within one species (Kelly 1984). Strong radial and comarginal plicae distinguish the genus *Posidonotis* Losacco (1942) and radial ribs the genus *Ctenioplеurium* Feldtmann.

Staesche (1926) recognized four groups within *Entolium* s.l.: 1) *Entolium hehlii* d'Orbigny, 2) *E. cingulatum* Goldfuss, 3) *E. cornutum* Quenstedt and 4) *E. demissum* Phillips. The last group corresponds to *Entolium* s.s. inasmuch as *Protamusium* Verrill 1897 is included as subjective synonym. The names *Costentolium* Freneix 1980, *Cingentolium* Yamani 1983 and *Neoentolium* Romanov 1985 have been proposed for the second group; *Cornutoentolium* Romanov 1985 for the third (also *Entolium* sensu Verrill 1897, p. 62) and the first was included in *Calvaentolium* Romanov 1985. Further genus group names erected within this family are *Scythentolium* Allasinaz 1972 (type species *Pecten tirolicus* Wittenburg) and *Palaeoentolium* Romanov 1985 with *Pleuronectites discites* Schlotheim as type, both for Triassic species.

Romanov (1985) proposed a systematic arrangement of genera into three subfamilies as follows: Protoentoliinae (= Pernopectiniinae) for *Pernopecten* Winchell and *Protoentolium* Janishevski (Carboniferous to Permian); Palaeoentoliinae including *Palaeoentolium* Romanov, *Neoentolium* Romanov (= *Costentolium* Freneix = *Cingentolium* Yamani), *Entolioides* Allasinaz and *Filopecten* Allasinaz (Triassic to Late Jurassic); and Entoliinae comprising *Entolium* Meek and *Cornutoentolium* Romanov (Jurassic to Cretaceous). Although some points are worth taking into account, this and the other systematic schemes available clearly need further research to determine their scope and evolutionary significance. Speden's (1967) assertion that "considerable work is required before the taxonomy of entoliids is clear" still holds true.

## Genus *Entolium* Meek 1865

Type species: *Entolium demissum* Meek 1865 (non Phillips 1829), figured by Quenstedt 1858, p. 353, pl.48, figs. 6, 7 as *Pecten demissus* Phillips, original designation (Meek 1865, p. 478), from the Aalenian of Germany (= *Pecten disciformis* Schübler in Zieten 1833).

Note: Most authors regard Quenstedt's material (1858, pl. 48, figs. 6, 7) as belonging to *Pecten disciformis* Schübler in Zieten 1833 and not to Phillips' species *P. demissus* (Burckhardt 1903, Hertlein in Cox et al. 1969, Duff 1978). This misidentification of the type species was discussed by Duff (1978), whose criteria are followed here. On the other hand Johnson (1984, p. 45) includes Phillips', Schübler's and Quenstedt's material together in the synonymy of *Entolium corneolum* (Young & Bird 1828). The possible identity of *E. disciforme* and *E. demissum* was already mentioned by Staesche (1926), Schmidtill (1926), Jaworski (1926a, 1926b) and Cox (1956). In any case, the synonymy between *Entolium* Meek and *Protamusium* Verrill is subjective and not objective as stated by Vokes (1967, 1980) and Cox et al. (1969).

Synomyms: *Protamusium* Verrill 1897 (type species: *Pecten demissum* Phillips 1829, original designation)
*Protamussium* Paris & Richardson 1915 (error for *Protamusium*)
*Protomusium* Stewart 1930 (error for *Protamusium*)
*Entholium* Tsankov & Bonchev 1933 (error for *Entolium*)
*Etolium* McLearn 1949 (error for *Entolium*)

Recently Johnson (1984) revised European Jurassic species of the genus and recognized only three species, based on the presence or absence of a byssal notch and the presence or absence of strong comarginal grooves on the right valve. He referred all Early Jurassic material to only one species. Nevertheless, systematic arrangement based on a few "key" features have not proven satisfactory and the taxonomy of the group is far from being adequately solved.

Early Jurassic *Entolium* from South America were previously referred to either *Pecten hehlii* D'ORBIGNY (BEHRENDSEN 1891, MÖRICKE 1894, LEANZA 1942), to *Pecten glaphyrus* PHILIPPI (R. PHILIPPI 1899, JAWORSKI 1915, 1925), to *Pecten disciformis* SCHÜBLER (MÖRICKE 1894, BURCKHARDT 1900a, 1903, JAWORSKI 1915, 1925, WAHNISH 1942, LEANZA 1942), or to *E. corneolum* (ABERHAN 1992, 1994). Some of these records were later referred by COX (1956) and PÉREZ (1982) to *Entolium demissum* (PHILLIPS).

The figured specimen of *Pecten glaphyrus* R. PHILIPPI (1899, pl. 20, fig. 1) was not found in SGO-PI collection and is probably lost. The only available specimen (syntype ?), SGO-PI 910 (part, see Text-fig. 28d) is incomplete and not identifiable at the specific level. It also lacks precise geographic and stratigraphic location data, which hinders the obtention of any topotypes. Therefore, this species is not included in the discussion that follows.

Similarly, most previous Middle Jurassic records from the Andes were referred to *P. disciformis* (MÖRICKE 1894, TORNQUIST 1898, BURCKHARDT 1903, JAWORSKI 1925, 1926a, 1926b, WEAVER 1931) or to *E. demissum* (R. PHILIPPI 1899, COX 1956). In his revision of European species, JOHNSON (1984) synonymyzed Early Jurassic South American records to *E. lunare* (ROEMER) and Middle Jurassic ones to *E. corneolum* (YOUNG & BIRD).

In fact, most of the Argentinian material described here does not differ significantly from specimens from other places of the world. About five hundred specimens were examined for this revision and at least three distinct taxa are here recognized for Early Jurassic Argentinian *Entolium*. Each of these species is characterized by a series of internal and external characters and each has a wide geographical distribution and its own (only partly overlapping) stratigraphical range. One species is regarded as new, whereas the other two can be referred to already named species. Nevertheless, having had no access to key type material from abroad, the nomenclature used here is only provisional. For the same reason, synonymy lists contain only South American references. As happens elsewhere, many shells are not identifiable at the specific level.

Early Jurassic *Entolium* species from Argentina belong to two different lineages. The *E.* cf. *lunare* – *E. disciforme* stock belongs to a well-characterized cosmopolitan group, whereas the new species seems to belong to a South Pacific lineage instead.

## *Entolium (Entolium)* cf. *lunare* (RÖMER 1839)

(Pl. 3, Figs. 1-14)

1894 *Pecten hehli* – MÖRICKE, p. 37.
p. 1900a *Pecten (Entolium) disciformis* – BURCKHARDT, p. 24, lám. 19, fig. 11 (only).
1903 *Pecten (Entolium)* aff. *disciformis* – BURCKHARDT, p. 8.
? 1915 *Pecten glaphyrus* – JAWORSKI, p. 437.
1915 *Pecten (Entolium)* aff. *disciformi* – JAWORSKI, p. 438–439.
? 1925 *Pecten glaphyrus* – JAWORSKI, p. 51.
1925 *Entolium* aff. *disciformis* – JAWORSKI, p. 55–56.
? 1925 *Entolium disciforme* – GROEBER, p. 459, 461.
? v 1942 *Pecten (Entolium)* cf. *hehlii* – LEANZA, p. 175–176, lám. 9, fig. 4.
v 1942 *Pecten (Entolium)* sp. indet. – LEANZA, p. 176, lám. 9, fig. 5.
? v 1942 *Pecten (Entolium) disciformis* – WAHNISH, p. 36–38 (non lám. 2, fig. 2).
? 1955 *Pecten (Entolium) disciformis* – UGARTE, p. 146, 149.
? 1955 *Entolium disciformis* – UGARTE, p. 148.
? 1981 *Entolium* cf. *demissum* – HILLEBRANDT & SCHMIDT-EFFING, p. 10, 16, 19, 22, 25, 27, 29.
1982 *Entolium demissum* – PÉREZ, p. 37, lám. 14, fig. 7.
p.? 1994 *Entolium (Entolium) corneolum* – ABERHAN, p. 37–38, pl. 17, figs. 15–19.

Material: About 220 specimens, most of them preserved as internal or external moulds of isolated valves. They were found at the following localities: Arroyo La Laguna, San Juan (A.2): MLP 26552 (M 451); Rio Atuel region (B.1, B.2, B.14, B.16): MLP 6670, 24907, 24909 to 24913, 24921 to 24 929, 24948 to 24950, 25040, 25042, 25054, 25062, 25065, 25069, 25070, 26536, 26539, 26544, 26560, 27556 to 27559 (M 349, 352, 361, 365, 367, 371, 928, 1259, 1263, 1265, 1267 to 1269, 1273, 1274, 1410, 1411, 1415, 1416, 1418, 1419, 1792, 1793, 1843, 1904, 1910, 1917, 1919, 1925 to 1928, 1930, 1957, 1959 and UGARTE's collection), MLP 27839, 27869, 27875, 27878, 27887, 27903, LANÉS' collection; Portezuelo Ancho region (B.4 and B.5): MLP 17244, 17246, 24930 to 24936, 24954 (M599, 1287 to 1289, 1291, 1295 to 12967, 1302; G 1000, 1005); Rio Salado superior (B.6): MLP 17141, 17142, 17150, 17156, 17469, 17486, 17493 (G 900 to 902, 905, 913 to 915); Puchenque – Serrucho region (B.8 and B.9): MLP 24894 to 24908, 24937 to 24944, 24953 (M 306, 307, 309, 311 to 313, 320, 324 to 326, 329, 330, 1318, 1320, 1322, 1323, 1328, 1333, 1335 to 1338; Cordillera del Viento region (C.1): MLP 24919, 24920 (M 1220, 1221); Espinazo del Zorro area (C.7, C.12): MLP 24914 to 24918, 24947, 24955, 24977, 24981 (M 1081, 1082, 1085, 1365, 1366, 1372); Arroyo Ñireco (C.20):

MLP 24945, 24946 (M 1362, 1363); Charahuilla area (C.15): MLP 8856 (Suero's collection); Piedra Pintada area (D.7, D.11, D.12, D.17): MLP 6022, 6025 to 6027, 24951, 24952 (M119, 140 and Frenguelli's collection).

This species ranges in age from Early Sinemurian to late Pliensbachian (*Epophioceras* to *Fanninoceras* Ammonite Zones) in Argentina. It is also known from Chile (Möricke 1894; Pérez 1982).

Remarks: This is the most common *Entolium* species in Early Jurassic deposits from the Andes. Most previous references probaly belong here, though many of them are only doubtfully placed in the synonymy list because the material is not figured.

Leanza (1942) distinguished three different taxa in the Piedra Pintada area. His material has been re-examined and his references *to E.* cf. *hehli* and *E.* sp. are here regarded as *E.* cf. *lunare.*

Description: Medium-sized to large shells, compressed and almost equivalve, orbicular in outline, equilateral. Disc height and length nearly equal at average size. Umbonal angle wider than 100° at all growth stages, reaching 120° in large shells. Dorsal margin raised above hinge axis in both valves. Auricles small and of equal size. Right valve anterior auricle may show traces of a very shallow indentation (= trace of byssal notch ?) at its base (Pl. 3, Figs. 4, 13). Margins of all other auricles meet disc margins at an obtuse angle. No distinct suture, surface of auricles merges with disc with a change in convexity.

Shell thin, external surface smooth with growth lines. Central part of disc evenly convex, triangular anterior and posterior areas almost flat. Surface of auricles slightly convex, leaving narrow anterior and posterior gapes along auricle margins. Inner surface smooth with conspicuous but not sharp radiating ridges at each side of disc.

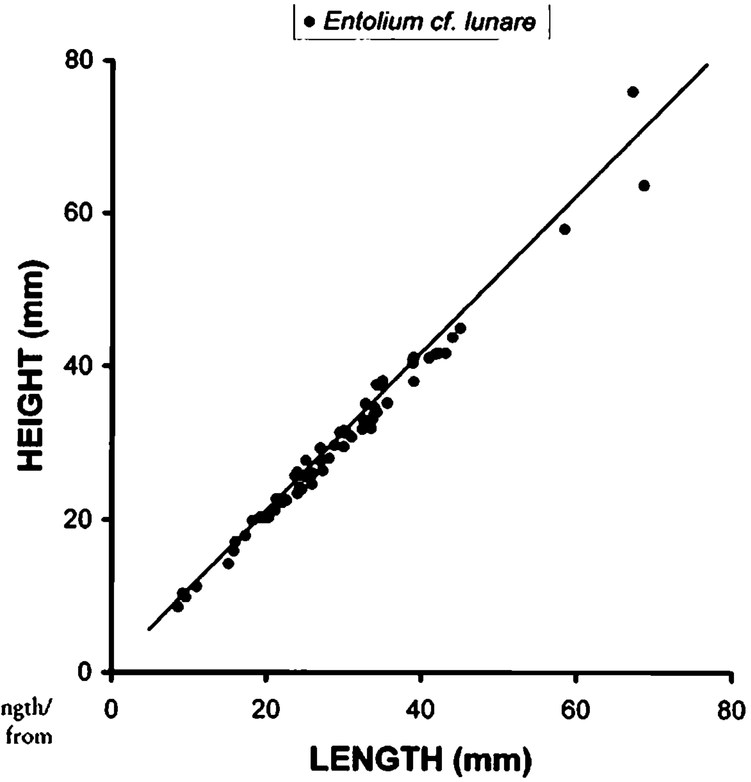
No auricular crura. Dorsal hinge crura parallel to hinge axis, strong and well-developed, one on left valve (Pl. 3, Fig. 12) and two on right valve (Pl. 3, Figs. 4, 13), acompanying lateral lamellar band of ligament. Weak radiating hinge crura on either side of resilifer also present, right valves have crura close to triangular resilifer, left valves show shallow sockets close to resilifer and crura on either side of them. Dorsal and radiating hinge crura placed on a slightly raised platform (Text-fig. 20b). Other internal characters unknown.

Measurements: Of well-preserved specimens, see diagram on Text-figs. 21, 24.

| Specimen MLP | Material | L (mm) | H (mm) | AL (mm) | I (mm) | ε (") |
|---|---|---|---|---|---|---|
| 6670 | LV IM | 38.9 | 40.9 | 8.0 | 14.0 | 121 |
| 17486-a | LV IM | 32.8 | 35.1 | 6.3 | 12.5 | 113 |
| 24901 | RV IM | 34.3 | 34.0 | 8.3 | 14.2 | 115 |
| 24902-b | LV IM | 21.3 | 22.7 | 6.0 | 11.1 | 112 |
| 24903-a | RV IM | 35.0 | 38.1 | 8.7 | 13.4 | 110 |
| 24921-a | LV? IM | 32.5 | 33.0 | 10.2 | 14.2 | 104 |
| 24944 | LV IM | 44.0 | 43.8 | 10.0 | 18.0 | 112 |
| 24950-a | RV IM | 24.0 | 26.2 | 6.2 | 9.8 | 107 |

Affinities: This species belongs to a well-defined group of *Entolium* species which flourished during the Early Jurassic of Europe and elsewhere, characterized by orbicular shape, subequal auricles and wide umbonal angle. They belong to the *E. demissum* group of Staesche (1926) or the *E. disciforme* group of Dechaseaux (1936). The Early Jurassic material has been referred to a large number of nominal specific names, which, together with the scarcity of good illustrations and the lack of direct knowledge of original material, makes the nomination of the Andean specimens difficult.

According to Staesche (1926) this group is represented in the Early Jurassic of Europe by two species: *E. lunare* (Römer) in older beds and *E. liasianum* (Nyst) in younger levels. On the other hand Johnson (1984) included almost all Early Jurassic records of *Entolium* within one species, which he calls *E. lunare.* In his sense, this species even includes forms such as *E. hehli* (d'Orbigny) which, according to most authors, belongs to a different group and can be distinguished from *E. lunare* by its narrower umbonal angle (see for instance Staesche 1926) and the unequal auricles (see Dechaseaux 1936). The Argentinian material falls well within the concept of *E. lunare* even in its strict sense, according to the few figures available (Staesche 1926, p. 96, pl. 4, figs. 1-2; Shopov 1970, pl. 1, figs. 3–4; see also Hayami 1959a, pl. 6, fig. 11; Johnson 1984, pl. 1, fig. 17) and material from the Wutach area, Germany, personally collected (MLP). The original material of this species has not been figured and thus most authors follow Staesche's figures when making identifications. The Argentinian



Text-fig. 21. Scatter diagram and regression line showing length/height (L/H) ratios in *Entolium (E.)* cf. *lunare* (RÖMER) from Argentina, n = 57.

specimens also show close similarities to material referred to *E. liasianum* (NYST), which is regarded by JOHNSON (1984) as a synonym of *E. lunare* (see figures in GOLDFUSS 1836, pl. 98, fig. 11 as *Pecten corneus*; STAESCHE 1926, pl. 6, fig. 5).

The internal features of the European material have not been adequately discussed and consequently open nomenclature is still preferred here.

*Entolium frontale* (DUMORTIER 1869, pl. 37, figs. 1–2, pl. 38, fig. 1; see also ROSENKRANTZ 1942, fig. 15; SHOPOV 1970, pl. 1, figs. 5–6) and *E. fraiponti* (ROLLIER 1915, pl. 30, fig. 7), from the Early Jurassic of Europe, could also belong to this group, though they may be distinguished from *E.* cf. *lunare* by their very large shells.

Among non-European taxa, the shape of the Andean material shows affinities with *E. semlini* CRICKMAY (1930b, p. 56, pl. 4, e) from the Bajocian of British Columbia and with *E. dongshanensis* LI & GRANT-MACKIE (1994, figs. 4.16–4.20) from China, but again no comparison of internal characters is possible.

*Entolium* cf. *lunare* can be easily distinguished from other Early Jurassic species from the Andes described here. *Entolium mapuche* n. sp. (Pl. 5, Figs. 1-8) has narrower umbonal angle, its height is greater than the length and has conspicuous auricular crura and less projected dorsal margins. *Entolium* cf. *lunare* is more similar to the Toarcian *E. disciforme* from the Andes (Pl. 4, Figs. 4-8) in shape and size, but it lacks auricular crura and has smaller auricles. Its average size is also smaller. *Entolium* cf. *lunare* and *E. disciforme* from the Andes seem to belong to the same evolutionary lineage. Intermediate forms (which here have been doubtfully referred to the latter) appear in late Pliensbachian beds of the Piedra Pintada region (Pl. 4, Figs. 1–3).

Autecology: This is the Early Jurassic species of *Entolium* more widespread in the Andean region, both in space and time. It also appears in a wider range of lithofacies than the other two species described below. Nevertheless, it is more common in fine-grained sandstones and mudstones, where it sometimes dominates the invertebrate fauna (see for instance ABERHAN 1992). Different populations show a wide range in mean size, which seems to be related to bottom conditions rather than to latitute. Shell characters indicate a reclining mode of life with capability for efficient swimming.

This species and the closely related *E. disciforme* are occasionally found forming "*Entolium*-pavements". This term has been used to name densely-packed but thin *Entolium* shell-beds with considerable lateral extension, usually made up of complete valves and even articulated shells (cf. Kidwell et al. 1986). Specimens are large for the species and of similar size, no young specimens are present. These pavements are generally monospecific, at most paucispecific, as other invertebrates, such as other pectinoideans and gastropods may occasionally occur together. Fragments of fossil wood may be also found in the same beds. Examples of this type of preservation occur at different times and in several places in the Andean region: in Sinemurian levels of Arroyo Las Chilcas (B.16) and Pliensbachian of Rio Salado (B.6) they are formed by *Entolium* cf. *lunare*, whereas in late Pliensbachian levels of Piedra Pintada (D.5 and D.15) and Toarcian of Poti Malal (B.12) they are formed by *E. disciforme.*

### *Entolium* (*Entolium*) *disciforme* (Schübler in Zieten 1833)

(Pl. 4, Figs. 4–8)

? 1878 *Pecten* sp. – Gottsche; p. 21, Taf. 5, Fig. 1.
1894 *Pecten (Entolium) disciformis* – Möricke; p. 37–38.
1898 *Pecten (Entolium) disciformis* – Tornquist; p. 163
? 1898 *Pecten (Entolium)* cf. *disciformis* – Tornquist; p. 164.
v 1899 *Pecten bisulcatus* – R. Philippi; p. 28, lám. 16, fig. 7.
1899 *Pecten demissus* – R. Philippi; p. 35 (lám. 20, fig. 3 is a copy from Goldfuss).
p 1900a *Pecten (Entolium) disciformis* – Burckhardt; p. 32, lám. 21, fig. 2 (only).
1903 *Pecten (Entolium) disciformis* – Burckhardt; p. 22.
1915 *Pecten (Entolium) disciformis* – Jaworski, p. 438.
1925 *Entolium disciformis* – Jaworski, p. 54–55.
? 1925 *Pecten* sp. – Gottsche; p. 252, lám. 5, fig. 1.
? 1926a *Pecten (Entolium) disciformis = demissus* – Jaworski; p. 164–165.
? 1926b *Pecten (Entolium) disciformis = demissus* – Jaworski; p. 393.
1931 *Pecten (Entolium) disciformis* – Weaver; p. 273–274, pl. 28, fig. 170.
? 1934 *Pecten* sp. – Feruglio; p. 56.
v 1942 *Pecten (Entolium) disciformis* – Leanza, p. 174–175, lám. 11, fig. 1.
1956 *Entolium demissum* – Cox; p. 1183.
1978 *Entolium disciformis* – Camacho & Riccardi; cuadro 2.
1998 *Entolium (Entolium) disciforme* – Damborenea & González-León, figs. 5.3–5.5.

Material: This species is common in upper Toarcian levels at Poti Malal, Mendoza (B.12), where large specimens form conspicuous shell beds. About 25 specimens have been collected there: MLP 24820 to 24825 (M 801, 803 and 804), preserved as internal or external moulds, in some cases with recrystalized shell.

Fourteen specimens from early Toarcian beds at Cerro Granito, Neuquén (C.14) are also referred to this taxon: MLP 24826 and 24827 (M 167).

Specimens intermediate in morphological characters between *E.* cf. *lunare* and *E. disciforme* occur in late Pliensbachian levels at several localities of the Piedra Pintada area (Cerro Roth, Cerro Del Vasco, North of Sañicó, Carrán Curá, Estancia Santa Isabel). They are here referred to *E. disciforme* ? (Pl. 4, Figs. 1-3): MLP 5603, 5828, 6020, 6021, 6023, 24893, 24956 to 24973 (M 94, 101, 122, 141, 145, 1037, 1050, 1051, 1052, 1055, also Fernández' and Frenguelli's collection).

*Entolium* disciforme is also known from Chile (Möricke 1894, R. Philippi 1899) and Mexico (Damborenea & González León 1998).

This species extends into Middle Jurassic deposits in the Andes and it reaches its greatest abundance in Aalenian – Bajocian beds from several localities in the Neuquén Basin (Gottsche 1878, Tornquist 1898, Burckhardt 1900a, 1903, Jaworski 1926a, 1926b, Weaver 1931; also personally collected material housed at MLP).

Remarks: The name *Entolium disciforme* was the most widely used for Jurassic material from South America, but here each previous record is critically analyzed according to the illustrations and descriptions provided and is allocated to one of the taxa here recognized.

The first figure of Argentinian material of *P. disciforme* is probably *Pecten* sp. in Gottsche (1878 pl. 5, fig. 1; 1925, pl. 5, fig. 1). Though some authors (Jaworski 1925, Weaver 1931) regarded it as a *Camptonectes*, it looks like an incomplete and somewhat distorted *E. disciforme.*

The incomplete specimen named *Pecten bisulcatus* by R. Philippi (1899, p. 28, pl. 16, fig. 7) has been examined in Santiago de Chile (SGO-PI 896) and can confidently be included in *P. disciforme.*

The shape of the auricles in Weaver's (1931, pl. 28, fig. 170) drawing of *P. disciforme* corresponds neither to his description of the material nor to the shape inferred from the growth lines on the same figure.

Description: Shell suborbicular in outline, compressed, sub-equivalve, only slightly higher than long, adult length more than 50 mm. Both valves equilateral and very thin. Umbonal angle wider than 110° in large specimens (up to 121°), may be as narrow as 100° in young specimens. Medium to large subequal auricles, with rounded dorsal corners, dorsal margin slightly projecting above hinge-line. Anterior and posterior margin of auricles oblique, meeting lateral margins of valve at a very obtuse angle. In some valves one auricle has a steeper lateral margin. Both auricles are clearly limited from the disc, one of them (anterior ?) by a narrow but deep suture, the other by only a neat line (Pl. 4, Fig. 5).

When auricles are well-preserved (see Pl. 4, Figs. 5, 8), a strong dorsal projection is evident. A clear change in shell convexity is present along the hinge-line. Portions of the auricle dorsal to this line slope dorsally away from the hinge. These dorsal parts of the auricles also seem to be structurally different, appearing to be made of external shell layer only. All these may account for the observed variation in this character, even in material from the same beds. The internal hinge characters can also be described in specimens from Argentina. Auricular crura are strong and dorsal longitudinal hinge crura are well-developed (Text-fig. 20c).

Two wide radiating internal ridges are seen on the interior of shells. These ridges are variably developed but usually not sharp (Pl. 4, Fig. 8). Other internal characters unknown.

Exterior of shell smooth, only faint comarginal growth-lines are present. Specimens from Cerro Granito show some weak but regular comarginal lines in some valves.

Measurements: Of well-preserved specimens. See also scatter diagram in Text-figs. 22, 24.

| Specimen MLP | Material | L (mm) | H (mm) | AL (mm) | I (mm) | ε (°) |
|---|---|---|---|---|---|---|
| 24820 | ?V EM | 53.7 | 56.2 | 13.6 | 20.2 | 111 |
| 24821-a | ?V IM | 76.0 | 76.0 | 18.4 | 34.3 | 118 |
| 24822-d | ?V IM | 61.4 | 62.0 | – | 24.1 | 121 |
| 24822-e | ?V IM | 19.8 | 23.0 | – | 9.2 | 100 |
| 24823-a | ?V IM | 49.5 | 52.8 | 12.8 | 18.5 | 113 |
| 24824-b | ?V IM | 57.7 | 63.4 | 18.0 | 25.6 | – |
| 24825-o | ?V IM | 39.9 | 45.3 | 12.9 | 20.8 | – |
| 24825-p | ?V IM | 51.0 | 52.3 | 12.3 | 21.6 | – |
| 24968-a | LV? EM | 41.7 | 43.3 | 8.9 | 15.0 | – |

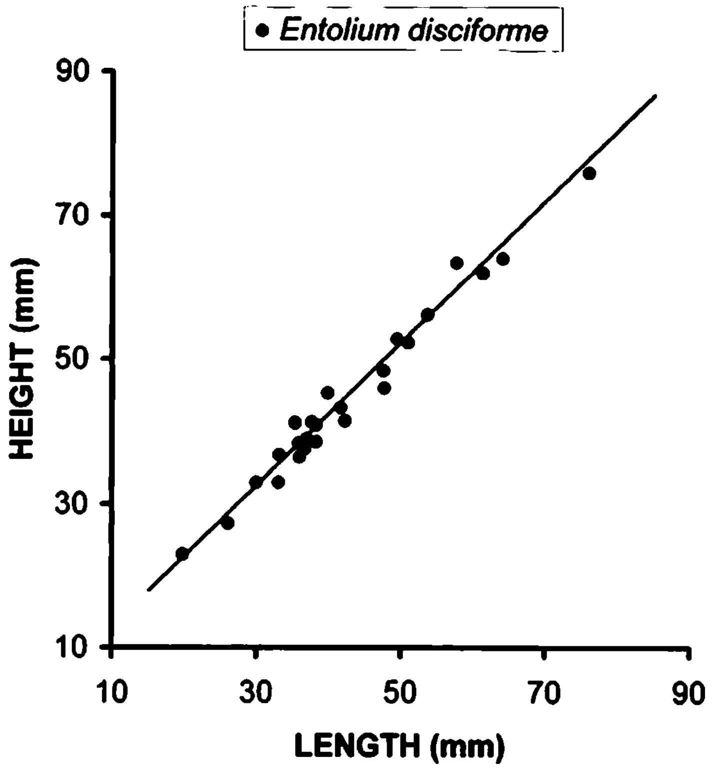
Affinities: The Argentinian material here described can be confidently referred to *Entolium disciforme* (Schübler) according to the figures by Schübler in Zieten (1833, pl. 53, fig. 2), Quenstedt (1856, pl. 48, figs. 6, 7 only), Borissjak & Ivanoff (1917, pl. 1, figs. 5, 8, 10, 15, 18), Schmidtill (1926, pl. B, figs. 5, 11), Hayami (1959b, pl. 5, fig.19), Iordan (1966, pl. 5, fig. 4), Dietl & Etzold (1977, pl. 2, fig. 4) and Nutsubidze (1966, pl. 3, fig. 1).

Some authors (Jaworski 1926a, 1926b, Vörös 1971, Johnson 1984) followed Staesche (1926, p. 99) and regard *E. disciforme* as a synonym of *E. corneolum* (Young & Bird 1828). It is impossible to decide on this point without seeing the original material. Nevertheless, on the basis of the available illustrations, the neotype of *E. corneolum* (Arkell 1930, pl. 7, fig. 4, designated by Duff 1978, p. 62) and the holotype of its synonym *E. demissum* (Phillips 1829, pl. 6, fig. 5; Arkell 1930, pl. 9, fig. 8; 1931b; Duff 1978, pl. 5, fig. 3) have a less orbicular form, larger auricles and a smaller umbonal angle than typical *E. disciforme*, as noted by Duff (1978, p. 64).

*Entolium vulcanicum* Crickmay (1930a, pl. 14, fig. 2), from the Middle Jurassic of British Columbia, may be a very closely related species but its hinge characters are unknown.

*Entolium mapuche* n. sp. from Early Jurassic beds from western Argentina has a consistently narrower umbonal angle and very low or absent lateral internal ribs, smaller auricles and never attains such a large size (see Pl. 5, Figs. 1-8 here).

*Entolium* cf. *lunare* (Roemer), from Sinemurian-Pliensbachian of Argentina (Pl. 3, Figs. 1–14), lacks auricular crura, has smaller auricles and has a suggestion of a byssal notch. Despite these differences, this species is probably related to *E. disciforme* and intermediate forms are found in late Pliensbachian deposits of Piedra Pintada (Pl. 4, Figs. 1–3). In Europe this transition, according to Johnson (1984, 1985), seems to occur slightly later, during the Toarcian.



Text-fig. 22. Scatter diagram and regression line showing length/height (L/H) ratios in *Entolium (E.) disciforme* (SCHLOTHEIM) from Lower Jurassic beds of Agentina, n = 25.

Autecology: This species is found forming conspicuous shell-beds in littoral late Pliensbachian and Toarcian deposits of the Andes (Pl. 4, Fig. 7). In these "*Entolium*-pavements" other invertebrates are extremely rare and *Entolium* specimens are usually of large and equal size. Most of them are preserved as complete shells with even both valves together occasionally, suggesting a life assemblage rather than a post-mortem association. Similar occurrence has been reported from other places, such as the Greenland Pliensbachian (ROSENKRANTZ 1942, fig. 15). Shell characters indicate a reclining mode of life with ability for efficient swimming.

### *Entolium mapuche* n. sp.

(Pl. 5, Figs. 1–8, Text-figs. 8m-n)

1891 *Pecten hehli* – BEHRENDSEN, p. 392–393.
? 1922 *Pecten hehli* – BEHRENDSEN; p. 176.

Material: About sixty specimens, most of them isolated but complete valves preserved as internal or external moulds. This species has a relatively short time-range from latest Pliensbachian (*Fanninoceras* Ammonite Zone) in southern Neuquén to early Toarcian (*Hoelderi* Ammonite Zone) in northern Neuquén and southern Mendoza.

Holotype: an almost complete internal mould of a left valve, MLP 24861, from Arroyo Serrucho, Mendoza Province (B.8), figured on Pl. 5, Figs. 2 a-b.

Paratypes: The species has also been found at the following localities: Arroyo Serrucho, Mendoza (B.8): MLP 24860 to 24870, 27575 (M 1349, 1351, 1996); Cerro Puchenque, Mendoza (B.9): MLP 24856 to 24859 (M 332 to 334). Doubtfully referred specimens: MLP 24851 to 24855 (M 310, 315, 316); South of Cordillera del Viento, Neuquén (C.1): MLP 15443 (GULISANO's collection); Arroyo Ñiraico, Neuquén (C.4): MLP 15536, 15544 (GULISANO's collection); Cerro Del Vasco, Piedra Pintada, Neuquén (D.12): MLP 24842 to 24850 (M 124). Doubtfully referred specimens: South of Cerro Roth, Neuquén (D.15): MLP 24974, 24975 (M 94).

From previously described material from Argentina, only BEHRENDSEN's (1891, 1922) record of *Pecten hehli* from the Portezuelo Ancho region, Mendoza, could doubtfully be included here.

The species was also recognized in Alexander Island, Antarctica (KELLY et al. 1993, KELLY 1995, p. 66).

Diagnosis: Very compressed equivalve shells, higher than long, small subequal auricles, disc with straight anterior and posterior margins. Umbonal angle about 100°. Auricles limited from disc by deep sutures and sharp ridges. Auricular crura straight, long and sharp, ending ventrally in s swollen knob. External surface smooth, internal surface with radial lines.

Description: Shell medium-sized, very compressed and equivalve. Valves suborbicular in outline, almost equilateral. Disc with long and straight anterior and posterior margins and evenly curved ventral margin. Consistently higher than long, adult length not exceeding 30 mm. Umbonal angle narrow for genus, about 100° in adults. Small subequal auricles which meet disc at an obtuse angle, wider for the posterior auricles. Dorsal margins only slightly projecting above hinge-line, dorsal corners of anterior auricles rounded, of posterior auricles less so. Both auricles clearly separated from disc by a deep suture bounded by low sharp ridges clearly seen on the exterior of the disc (Pl. 5, Fig. 1a). Judging from the auricle surfaces, narrow gapes along the anterior and posterior margins of auricles were present. Without byssal notch.

Shell very thin, external surface smooth, only very faint growth-lines can be seen. Subdued comarginal undulations are present on the umbonal region of some specimens.

Inner surface smooth, most well-preserved specimens show traces of very weak radial lines (Pl. 5, Figs. 2, 6). No lateral radiating ridges. Narrow ventral band flatter than remaining portion of disc (Pl. 5, Fig. 6). Auricular crura long and sharp, well developed in all auricles (Pl. 5, Figs. 1, 2, 3, 6, 7). They are straight, form between them an angle of less than 90° and end ventrally in an swollen knob (Pl. 5, Figs. 1-c, 3-a). Ventrally, posterior crura reach just to the base of the auricles, anterior crura extend beyond the base of the auricles (Text-fig. 20a). Longitudinal hinge crura parallel to hinge axis weakly developed, one to each side of resilifer in left valves, two on right valves. Sub-triangular resilifer centrally placed (Text-fig. 20a). Other internal characters unknown.

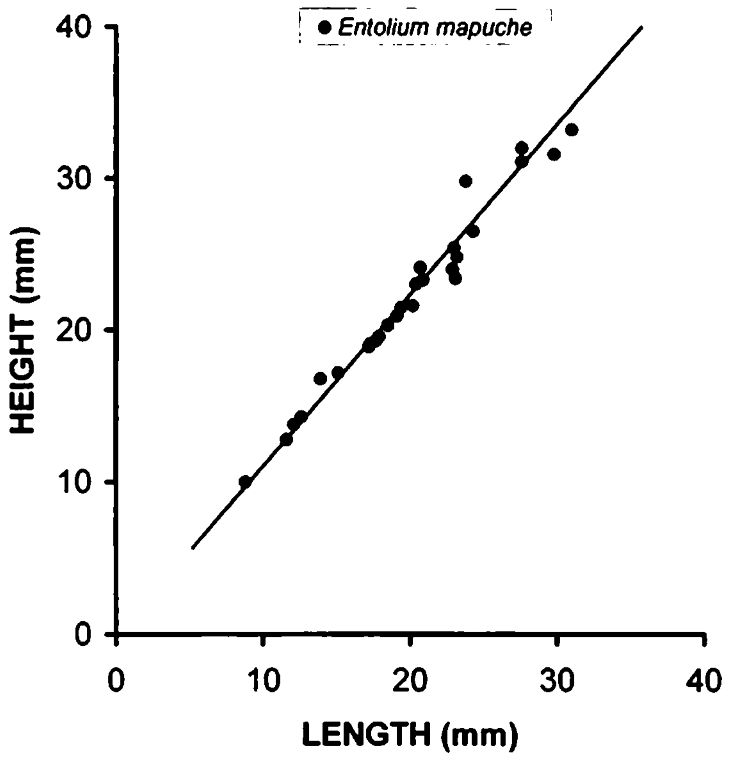
Measurements: Of well-preserved specimens. See also scatter diagram on Text-figs. 23, 24.

| Specimen MLP | Material | L (mm) | H (mm) | AL (mm) | I (mm) | ε (°) |
|---|---|---|---|---|---|---|
| 15536-a | RV IM | 31.0 | 33.2 | 9.1 | 13.9 | 108 |
| 15544-a | RV IM | 23.8 | 29.8 | 4.7 | 9.8 | 100 |
| 24842-a | RV? EM | 23.1 | 23.4 | 5.6 | 11.1 | 104 |
| 24843-b | RV? IM | 18.5 | 20.3 | 5.3 | 11.7 | - |
| 24845-e | LV EM | 20.9 | 23.3 | 6.1 | 9.6 | - |
| 24845-g | ?V IM | 15.1 | 17.2 | 4.5 | 7.4 | - |
| 24848-l | LV IM | 17.3 | 19.1 | 5.0 | 9.2 | - |
| 24848-m | ?V IM | 11.6 | 12.8 | 3.1 | 6.2 | - |
| 24849-n | ?V IM | 13.9 | 16.8 | 3.5 | 6.6 | - |
| 24857-a | ?V EM | 27.6 | 32.0 | 9.7 | 14.6 | - |
| 24858-c | RV IM | 24.3 | 26.5 | 6.9 | 11.9 | - |
| 24860-a | ?V IM | 29.8 | 31.6 | 6.6 | 14.0 | - |
| 24861-d | LV? IM | 23.0 | 25.4 | 5.8 | 12.0 | 104 |
| 24862-e | RV? IM | 22.9 | 24.0 | 5.3 | 10.3 | - |
| 24863-g | ?V IM | 17.9 | 19.6 | 5.0 | 8.5 | - |
| 24864-i | ?V IM | 17.7 | 19.3 | 4.7 | 9.3 | - |
| 24869-a | BV IM | 27.6 | 31.1 | 6.2 | 12.6 | 104 |
| 24870-b | ?V IM | 19.4 | 21.5 | 5.0 | 9.6 | - |
| 24870-c | ?V IM | 20.4 | 23.0 | 4.4 | 8.3 | - |
| 24870-d | ?V IM | 19.1 | 20.9 | 5.5 | 9.2 | - |

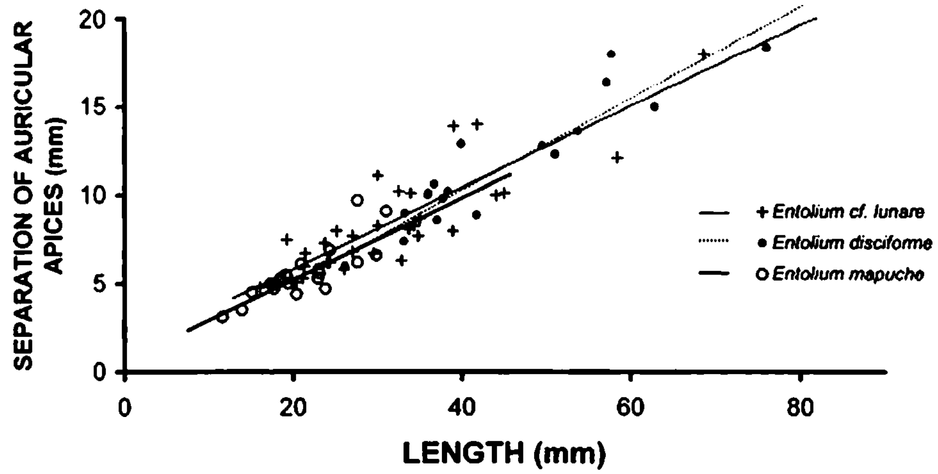
Affinities: This well-characterized material differs from most Early Jurassic *Entolium* species by the presence of conspicuous auricular crura and narrower umbonal angle.

*Entolium kedonensis* Milova (1988, p. 74, pl. 5, figs. 1-7), from Toarcian beds of northeast Russia, is the most similar species in shape and size. It also has strong straight auricular crura. Although details of its hinge region are not known, this species clearly belongs to the same group as *E. mapuche* n. sp.

The similarities of the Argentinian material with the species *Entolium fossatum* Marwick (1953a, pl. 13, figs. 1-4; see also Text-fig. 25 here) are great, although the New Zealand type material is older (late Aratauran, i.e. Sinemurian-early Pliensbachian). Nevertheless, according to Marwick's description auricle shape and size are unequal. The extant type specimens (NZGS TM 2402 and TM 2403) are somewhat distorted internal moulds but



Text-fig. 23. Scatter diagram and regression line showing length/height (L/H) ratios in *Entolium mapuche* n. sp., n = 27.

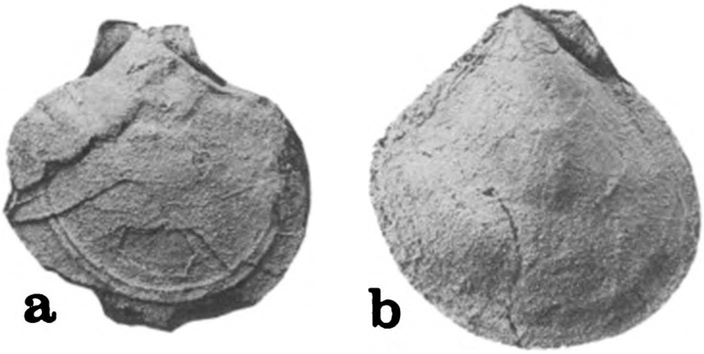


Text-fig. 24. Scatter diagrams and regression lines showing length/separation of auricular apices (L/AL) in *Entolium* species described here.

clearly show the internal characters, which are very similar to those of the species here described. The Argentinian material belongs to a new though closely related species.

Ururoan *Entolium* from New Zealand mentioned by MARWICK (1953a, p. 99) seem to be very akin to *E. mapuche* according to his short description. Also *Entolium lackeyi* QUILTY (1978, figs. 50–52), from the Middle and Late Jurassic of Antarctica, belongs to this group, but differs from *E. mapuche* in being longer than high and having unequal auricles.

According to JOHNSON (1984, p. 43) most records of European Toarcian *Entolium* are "equivocal" since it is difficult to refer them to one of the species recognized by him. Although this is also the situation in the Andes for



Text-fig. 25. *Entolium fossatum* Marwick from Otapiri Creek, Hokonui Hills, New Zealand, X 2, a – MLP 24891, b – MLP 24890.

the lineage *E. lunare – E. disciforme*, *E. mapuche* is quite distinct and easily differentiated from other species of the same region.

The shape and size of shell and auricles are very similar to those of *E. equabile* Hyatt in Crickmay (1933a, p. 904, pl. 24, figs. 4-6), from the Middle Jurassic of California, but the internal characters of this species are unknown.

Lack of lateral internal ridges, hinge characters and umbonal angle are reminiscent of those in *Entolium corneolum* (Young & Bird) from Middle-Upper Jurassic beds (see figures in Speden 1967, pl. 3, fig. 3; Duff 1978, pl. 4, figs. 25, 29, 30, pl. 5, figs. 3–5, Text-fig. 20; Johnson 1984, pl. 1, figs. 24–26; Fürsich & Werner 1989b, pl. 8, figs. 3–4), but auricle shape and size are different.

*Entolium nieniexionglaense* Wen (in Wen et al. 1976, p. 93, pl. 22, figs. 1–11; Cui & Liu 1987, pl. 2, figs. 22–23) from the Early Jurassic of Tibet, has similar shape and umbonal angle, but it has unequal auricles and is smaller.

This species can be distinguished from other Early Jurassic *Entolium*, such as *E. lunare* (Römer) from Europe (see Staesche 1926, pl. 4, figs. 1–2; Johnson 1984, pl. 1, figs. 17–18) and *E.* cf. *lunare* from Argentina (Pl. 3, Figs. 1–14) by the narrower umbonal angle and strong auricular crura.

*Entolium (E.) disciforme* from the late Toarcian to middle Jurassic of Argentina (Pl. 4, Figs. 4–8) has a consistently wider umbonal angle than *E. mapuche* and has well-defined lateral internal ribs. *Entolium mapuche* also has smaller auricles and never attains such a large size as the Argentinian specimens of *E. disciforme*.

Autecology: This nektobenthonic species is almost exclusively restricted to very fine-grained sediments, either light or dark mudstones. It is never associated to a diverse littoral bivalve fauna but to a characteristic low-diversity fauna dominated by pectinoideans (*Propeamussium*, *Chlamys*) instead. *Entolium mapuche* appears mostly as scattered, isolated or articulated valves and does not form shell-beds or pavements as other *Entolium* species do.

### Family Pectinidae Wilkes 1810 (emend. Waller 1978)

The ctenolium on the ventral edge of the byssal notch of the right valve is the single apomorphy of this family (Waller 1984, 1993).

Waller (1993) discussed a subfamily arrangement of Cenozoic Pectinidae. No attempt has been made here of trying to extrapolate such a scheme to the Early Jurassic faunas.

This family is represented in Argentina by some cosmopolitan genera, such as *Eopecten*, *Camptonectes*, *Praechlamys* and "*Chlamys*" as well as by three genera with bipolar distribution, i.e. *Radulonectites*, *Ochotochlamys* and *Agerchlamys*. One notable difference from the European early Jurassic is that *Pseudopecten* is only represented by few specimens (see discussion under *Pseudopecten*).

### Genus *Eopecten* Douvillé 1897

Type species: *Hinnites tuberculatus* Goldfuss 1835 (error pro *Spondylus tuberculosus* Goldfuss 1835), from the Middle Jurassic of Germany, original designation.

See comments on the type species, diagnosis and systematic affinities of this cosmopolitan genus in Johnson (1984, p. 149–150) and Damborenea (1987b, p. 198–199). Harper & Palmer (1993) discussed the life-habits of different species of *Eopecten*, some of which lived cemented to hard substrates.

## *Eopecten* cf. *velatus* (Goldfuss 1833)

(Pl. 6, Figs. 1–3)

cf. 1833 *Pecten velatus* – Goldfuss, p. 45, Taf. 90, Fig. 2.  
cf. 1984 *Eopecten velatus* – Johnson, p. 150–155, pl. 5, figs. 4, 5, 7, 8; text-figs. 137–141. (see this paper for a complete up-dated synonymy list)  
? 1985 *Antiquilima peruana* – Prinz, p. 183, Taf. 1, Fig. 4.  
v 1988 *Eopecten* cf. *velatus* – Riccardi et al., p. C368, lám. 2, fig. 5.  
v 1991 *Eopecten* cf. *velatus* – Riccardi et al., p. 166, fig. 4.15.  
v 1992 *Eopecten* cf. *velatus* – Damborenea, pl. 115, fig. 2.  
1994 *Eopecten velatus* – Aberhan, p. 41, pl. 21, figs. 2, 6–7.

Material: Three left valves and one specimen with both valves together, from late Hettangian (*Badouxia canadensis* Ammonite Zone) to early Sinemurian (*Agassiceras* Ammonite Zone) levels of the Arroyo Malo area, Mendoza (B.14): MLP 22256, 22381 to 22383, 27546, 27547 (M 1715, 1718, 1731, 1784).

Remarks: The specimen from the early Sinemurian of Perú figured by Prinz (1985, pl. 1, fig. 4) as *Antiquilima peruana* (Tilmann) seems to be a slightly distorted left valve of the species here described rather than an *Antiquilima* and is probably also misidentified at the specific level. The generic status of *Pecten peruanus* Tilmann (1917, p. 673, pl. 24, figs. 4–5) has never been critically discussed, but recently Johnson (1984, p. 165, 173) placed it in the synonymy of *Chlamys textoria* (Schlotheim). In any case, Tilmann's original specimens cannot belong to a limid since he described a deep byssal notch on the right valve. Certainly the ornament pattern, as originally described and figured, could also belong to many pectinoidean genera, including *Eopecten* as acknowledged by Tilmann (1917, p. 673). The well-delimited auricles of the left valves as seen on the original figures (Tilmann 1917) preclude reference to *Eopecten*, but no definite opinion can be given without seeing Tilmann's material.

Description: Shell medium to large, slightly inequilateral and prosocline and very inequivalve. Right valve flat, left valve convex. Auricles small, not clearly separated from the disc (incomplete in the analyzed material). Umbones low and not prominent. Byssal notch large and wide.

The left valve is ornamented by about 10 main sinuous radial plicae of equal strength, which extend from the beak to the margin of the shell and irregular radial striae on the intervals (Pl. 6, Fig. 2). The left anterior auricle is covered by densily packed radial striae. There are also irregular comarginal folds. The right valve bears only fine radial striae of equal strength over the whole surface and comarginal folds.

Internal characters unknown.

Measurements: [1] Number of primary radial plicae.

| Specimen MLP | Material | | L (mm) | H (mm) | W (mm) | [1] |
|---|---|---|---|---|---|---|
| 22256 | LV | CM | 55.4 | 63.7 | 9.0 | 10 |
| 22381 | BV | CM | 46.8 | 49.0 | 15.4 | - |
| 22382 | LV | S | 47.9 | 55.5 | 17.0 | 9 |
| 2383 | LV | IM | 39.3 | 44.6 | 16.5 | 8 |

Affinities: The material here described shows close affinities with the European *Eopecten velatus* (Goldf.) and open nomenclature was used only because a few specimens were available. In fact, the Argentinian material is clearly referable to Goldfuss' species if Johnson's (1984, p. 149) diagnostic criteria are adopted. They are very similar in shape and ornament pattern to the neotype (Johnson 1984, pl. 5, fig. 7) from the Lower Pliensbachian of southern Germany and also to other illustrated specimens of this species (Goldfuss 1833, pl. 90, fig. 2; Quenstedt 1856, pl. 18, fig. 26; pl. 23, fig. 3; Dumortier 1869, pl. 21, figs. 9–10 as *H. davaei*; 1874, pl. 62, figs. 3–4; Cox 1935, pl. 1, figs. 2–3; Dechaseaux 1936, pl. 8, fig. 14 as *V. bonjouri*; pl. 9, fig. 1 as *V.*

*hettangiensis*; NUTSUBIDZE 1966, tabl. 3, fig. 11; FÜRSICH & WERNER 1989b, pl. 13, figs. 1–3; JAITLY et al. 1995, pl. 19, figs. 5, 9–11, pl. 20, fig. 1; SZENTE 1995a, pl. 2, fig. 3).

The Pliensbachian and Toarcian specimens described as *Eopecten hartzi* (ROS.) ? (DAMBORENEA 1987b, p. 199, pl. 6, figs. 16–19, textfig. 31) are smaller and more orthocline than the material now described and they also have a few plicae which are stronger than the rest. According to JOHNSON's (1984) criteria, ROSENKRANTZ' species should belong to the group of *Eopecten abjectus* (PHILLIPS).

*Eopecten* sp., described below, has a different kind of ornament with more equally strong plicae.

Autecology: Several aspects related to the ecology of *Eopecten* species were discussed by COX (1942, p. 120), JOHNSON (1984, p. 154, 158, 160), DAMBORENEA (1987b, p. 201) and HARPER & PALMER (1993). The species *E. velatus* is regarded by these last authors as byssally attached thoughout ontogeny.

### *Eopecten* sp.

(Pl. 6, Figs. 4–6)

? 1926a *Velopecten tuberculosus* – JAWORSKI, p. 167–168.
? 1926b *Velopecten tuberculosus* – JAWORSKI, p. 377.
? 1981 *Eopecten* cf. *tuberculosus* – HILLEBRANDT & SCHMIDT-EFFING, p. 20, 25, 27, 29.

Material: One right valve and two left valves preserved as internal moulds with some shell, from lower Toarcian beds (*D. hoelderi* Ammonite Zone) at Arroyo Serrucho, Mendoza Province (B.8): MLP 19687 (M 1348). This species may range into lower Middle Jurassic deposits of the Andes if material from Aalenian beds in Argentina (JAWORSKI 1926a; 1926b) and Chile (HILLEBRANDT & SCHMIDT-EFFING 1981) is conspecific.

Description: Medium-sized, very inequivalve sub-orbicular shells. Right valve flat, left valve inflated. Shell very thin. Length and height equal. Umbones narrow and prominent in left valve, placed at about mid-length. Dorsal margin long and straight. Right anterior ear separated from disc by a very deep byssal notch. Left anterior ear merges into disc. No distinct posterior ears.

Left valve disc ornamented by about 20 primary radial plicae between which other ribs of second and third order are intercalated. Plicae and ribs are narrow with smooth tops. Anterior auricle ornamented by numerous radial ribs of equal strength, not so prominent as disc primary plicae. Right valve disc ornamented by more than 50 narrow radial plicae of equal strength which increase in number by intercalation. Right anterior auricle bears few radial ribs and prominent comarginal lines. Both valves have irregular comarginal folds.

Primary and secondary plicae are seen on internal moulds. Ventral margin scalloped. Other internal characters unknown.

Measurements: [1] number of primary radial plicae.

| Specimen MLP | Material | L (mm) | H (mm) | W (mm) | [1] |
|---|---|---|---|---|---|
| 19687-a | LV IM | 33.2 | 35.6 | 5.3 | 22 |
| 19687-b | LV IM | 31.4 | 31.8 | 8.6 | 20 |
| 19687-c | RV IM | (29.0) | 31.9 | 0.0 | 57 |

Affinities: Taking into account the scarcity of material and the great variability within species of *Eopecten* a definite specific determination is not possible. According to the criteria summarized by JOHNSON (1984) this species is intermediate between the European stocks *Eopecten velatus* (GOLDFUSS) and *E. spondyloides* (ROEMER). The number of primary plicae is similar to those in *E. velatus* (GOLDFUSS 1833, pl. 90, fig. 2; QUENSTEDT 1858, pl. 18, fig. 26; pl. 23, fig. 3; DUMORTIER 1874, pl. 62, figs. 3–4; STAESCHE 1926, pl. 6, fig. 11; DECHASEAUX 1936, pl. 8, fig. 14; pl. 9, fig. 1; COX 1952, pl. 3, figs. 8–10; 1965, pl. 6, figs. 7–8; JOHNSON 1984), but between them secondary plicae which increase in size and a third order of radial ribs can be distinguished. Nevertheless, these secondary plicae never attain a size equal to the primary ones, as happens in *E. spondyloides*, but the material here described is very close to some of the figures of ROEMER's species (MORRIS & LYCETT 1853, pl. 2, figs. 2, 3; DUMORTIER 1874, pl. 43, fig. 6; COSSMANN 1906, pl. 1, fig. 3–5; STAESCHE 1926, pl. 6, figs. 10, 12;

ARKELL 1931a, pl. 9, figs. 1-3; COX 1952, pl. 3, figs. 5-7; KASUM-ZADE & ROMANOV 1986, pl. 2, figs. 5–7; SZENTE 1995a, pl. 2, fig. 3).

*Eopecten* sp. differs from *Eopecten* cf. *velatus* from Hettangian-Sinemurian beds in the Andes (Pl. 6, Figs. 1-3) by the greater number of primary plicae which are regularly arranged.

In shell shape and size this species is similar to *Eopecten hartzi* (ROS.) ? described by DAMBORENEA (1987b, pl. 6, figs. 16-19; text-fig. 31), but the latter has a few ribs significantly stronger than the others. This feature also distinguishes the species here described from the group of *Eopecten abjectus* (PHILLIPS) from the Toarcian-Middle Jurassic of Europe (see JOHNSON 1984 for references and figures).

### Genus *Camptonectes* AGASSIZ in MEEK 1864

Type species: *Pecten lens* J. SOWERBY 1818, Upper Jurassic, England (= *Chamites auritus* SCHLOTHEIM 1813), subsequent designation by STOLICZKA 1871, p. 425 (see also MEEK 1864, p. 39).

The type species of this genus is now very well-known, having been recently revised by several authors (SPEDEN 1967, DUFF 1978, JOHNSON 1984).

This genus, traditionally restricted to Mesozoic species, has modern morphological analogues in genera such as *Eburneopecten* CONRAD and *Delectopecten* STEWART, some of which were regarded by HABE (1977) as belonging to a same subfamily Camptonectinae (see also WALLER & MARINCOVICH 1992, WALLER 1993). KALISHEVICH et al. (1981) and MOORE (1984) described fossil species of *Delectopecten* which show the typical ornament of *Camptonectes*. Some Tertiary and recent species were referred to *Camptonectes* by some authors (see for instance DAVIS 1913; ABBOT & DANCE 1982, p. 311).

Even restricting *Camptonectes* to Mesozoic species, the variability admitted within this genus is great and several subgenera have been proposed, mainly based on the pattern of external ornament, as follows:

*Mclearnia* CRICKMAY (1930a, p. 45): similar to *Camptonectes* s.s. but of larger size and with ctenolium obsolete in adults. *Boreionectes* ZAKHAROV (1965, p. 72) is now regarded as a junior synonym (see DHONDT 1972, KELLY 1984, KELLY et al. 1984, 1986). This taxon is not restricted to boreal regions as would seem scanning through the previous literature (see DHONDT 1972) but it is also represented in New Zealand at the Heterian (see MARWICK 1953a, p. 100, pl. 14, figs. 6–7) by *C. grandis* (HECTOR).

*Annulinectes* ALLASINAZ (1972, p. 316) has concentric laminae and weak radial costae and initially included only Triassic species.

*Indonectes* KANJILAL (1979): originally proposed to accommodate species ornamented with equidistant erect concentric laminae which divide the divaricating striae into several comarginal bands and radial costae restricted to the umbonal region. Whereas KELLY (1984, p. 67) considered this to be a synonym of *Camptonectes* s.s., JOHNSON (1984, p. 134) placed its type species, *C. obscurus* (J. SOW.) within *C.* (*Camptochlamys*), without discussing KANJILAL's paper.

*Costicamptonectes* FÜRSICH (1982, p. 50): with a few radial costae restricted to the anterior region of disc.

*Camptonectes* s.s. is thus restricted to externally smooth shells, which only bear antimarginal punctate grooves.

*Camptochlamys* ARKELL (1930, p. 102), originally proposed as a subgenus of *Chlamys*, is considered by most authors (COX 1952, KELLY 1984, JOHNSON 1984) as a subgenus of *Camptonectes* on account of the presence of antimarginal striae. This taxon is here regarded as having generic status.

The term "antimarginal" ornament, introduced by WALLER (1986), is here used to refer to the pattern known as "divaricate" ornament or "*Camptonectes*" microsculpture by different authors. The origin and significance of this surface sculpture was examined by HAYAMI & OKAMOTO (1987), who showed that it is characterized by an antimarginal relation to growth increments. It is not restricted to *Camptonectes*, on the contrary, it is widespread among several bivalve families (DALL 1898, E. PHILIPPI 1900, WALLER 1972a, 1986, HAYAMI & OKAMOTO 1987). It is variably developed within the above mentioned subgenera of *Camptonectes*: over most of the shell surface, even on the posterior auricles of *Camptonectes* s.s., *Indonectes* and *Costicamptonectes* and absent or restricted to localized areas of the shell on *Mclearnia* (see KELLY 1984, pl. 11, fig. 11; pl. 12, fig. 1) and on the related genera *Radulonectites* (Pl. 6, Fig. 12–20 here), *Chlamys* (WALLER 1972a), *Camptochlamys* and *Agerchlamys* (Pl. 7, Figs. 1–10 here).

*Camptonectes* is known in Europe from the Hettangian (Johnson 1984) and probably the Rhaetian of Burma (Healey 1908). It has been identified with certainty in lower Toarcian deposits of the Andes, nevertheless, there are some doubtfull specimens in older beds which, as seen below, could also belong to this genus.

## Subgenus *C. (Camptonectes)*

Synonyms: *Campstonectes* v. Teppner 1922 (error pro *Camptonectes*)
*Campitonectes* Salisbury 1939 (error pro *Camptonectes*)
*Camponectes* Vyalov & Korobkov 1939 (error pro *Camptonectes*)

### *Camptonectes (Camptonectes) auritus* (Schlotheim 1813)

(Pl. 6, Figs. 9–10; Text-fig. 26)

1813 *Chamites auritus* Schlotheim, p. 103.
1878 *Pecten laminatus* – Gottsche, p. 21, Taf. 5, Fig.5.
1878 *Pecten* sp. – Gottsche, p. 40, Taf. 5, Fig. 16.
? 1878 *Pecten* (?) sp. – Gottsche, p. 21, Taf. 5, Fig. 3.
1925 *Pecten laminatus* – Gottsche, p. 252, Taf. 5, Fig. 5.
1925 *Pecten* sp. – Gottsche, p. 273, Taf. 5, Fig. 16.
? 1925 *Pecten* (?) sp. – Gottsche, p. 252, Taf. 5, Fig. 3.
? 1926a *Pecten (Camptonectes) lens* – Jaworski, p. 166–167.
? 1926b *Camptonectes lens* – Jaworski, p. 377.
? 1931 *Pecten (Camptonectes) lens* – Weaver, p. 275–276.
non 1942 *Pecten (Camptonectes) lens* – Leanza, p. 173–174, lám. 10, figs. 1–2.
1994 *Camptonectes (Camptonectes) auritus* – Aberhan, p. 39, pl. 18, figs. 7–9.

Note: Only South American references have been included in the synonymy list. For a detailed synonymy see Johnson (1984, p. 113–115).

Material: This species already appears in early Toarcian (*hoelderi* Ammonite Zone) sediments of Mendoza Province, at Rio Salado superior (B.6) Arroyo Serrucho (B.8) and Arroyo Poti Malal (B.12), though it is more abundant in Middle Jurassic deposits of the Andes. The Toarcian material consists of one specimen with both valves, three external and four internal moulds of right valves, two internal moulds of left valves and fragments (MLP 17484, 22346 to 22350, 23847, 27572; M 802, 1348, 1349, 1995 and G 918).

Five poorly preserved valves from late Pliensbachian beds of Puesto Araya (B.1), Mendoza (MLP 23645 to 23647, 25059, 25067; M 1913, 1920) are referred to the genus and might belong to this species (see Pl. 6, Fig. 11).

In Chile the species also appears in Toarcian deposits (Aberhan 1994).

Remarks: The material described by Jaworski (1926a, p. 166–167, 1926b, p. 377) and Weaver (1931, p. 275276) as "*Pecten (Camptonectes) lens* Sow.", from the late early Jurassic at Cañada Colorada, Mendoza, belongs to *Camptonectes* and is doubtfully referred to this species. On the other hand the material similarly referred by Leanza (1942, p. 173–174), from the Pliensbachian of Piedra Pintada, is not a *Camptonectes* and is here included in *Radulonectites sosneadoensis* (Weaver) (see below).

Description: Medium-sized shell with sub-ovate disc and height slightly greater than length. Inequilateral, anterior auricle larger than posterior. Slightly inequivalve, left valve more convex than right. Umbonal angle between 97° and 107°, greater on larger specimens. Umbones small, orthogirate.

Right valve auricles well demarcated from disc, the anterior one meeting both the hinge line and the disc at about 90° and having a wide byssal fasciole. Right posterior auricle meeting hinge line at an obtuse angle (about 110°). Deep byssal notch in right valve, which also bears a strong ctenolium. Both left valve auricles meet the hinge line at an obtuse angle and with sutures not so deep as on the right valve.

Dorsal margin straight, anterior margin concave and ventral margin evenly convex. Posterior margin convex to straight.

Exterior of disc and posterior auricles ornamented with densely-packed, fine, antimarginal striae, which increase in number by intercalation and which appear punctate in the intersection with growth-lines (Pl. 6, Figs. 9, 10). The striae are stronger towards the margins of the shell. The auricles also have fine comarginal striae, which are less strong on the byssal fasciole of the right anterior auricle. The right anterior auricle also bears a few very faint radial costae (Pl. 6, Fig. 10).

Shell inner surface smooth, with faint radial striae. Other internal characters not seen on the Argentine material.

Measurements: Of best preserved specimens.

| SPECIMEN MLP | Material | L (mm) | H (mm) | W (mm) | Lha (mm) | Lhp (mm) | Haa (mm) | N (mm) | ε (°) |
|---|---|---|---|---|---|---|---|---|---|
| 17484 | LV IM | 22.2 | 24.0 | 3.0 | 7.9 | 5.6 | 4.7 | - | 107 |
| 22349 | RV EM | 18.3 | 21.5 | 1.8 | 6.3 | 4.1 | 4.0 | 3.8 | 97 |
| 22350 | RV EM | (30.0) | (32.0) | 2.0 | 11.0 | 5.9 | 6.5 | 5.0 | 102 |
| 22347 | RV IM | (22.0) | 25.1 | 1.5 | 8.7 | 4.9 | 5.8 | 4.9 | - |

Affinities: Although there are only a few specimens, the material is complete and well-preserved and allows a detailed description and thus a confident reference to the type-species of *Camptonectes*, which was recently revised by Duff (1978, p. 66–68, pl. 5, figs. 22, 25, text-fig. 22), who also designated the neotype, see also Johnson (1984, p. 113–124, pl. 3, figs. 25–40, text-figs. 98–107), Szente (1995b, pl. 6, fig. 12), Sha & Grant-Mackie (1996, fig. 6c) and Aberhan (1998, p. 109, pl. 12, fig. 8).

The Argentine specimens fall well within the admitted range of variability of the well-known species *C. auritus*, the only minor difference observed with the European material is the presence of traces of radial ornament on the right anterior auricle. This is regarded as just an example of phenotypic variation, especially taking into account that some specimens referred by Johnson (1984) to this species do show this character (see for instance Sharpe 1850, pl. 24, fig. 3 as *Pecten lusitanicus*; Skwarko 1974, pl. 26, fig. 17 as *Camptonectes greenoughi*; Jaitly et al. 1995, pl. 19, fig. 1). This feature is more conspicuous in Bajocian material from Argentina (see Text-fig. 26) and is also present in a middle Jurassic species from the United States, *C. stygius* White (see Imlay 1964, p. 25, pl. 2, figs. 1–10), which could be regarded as a synonym of *C. auritus*.

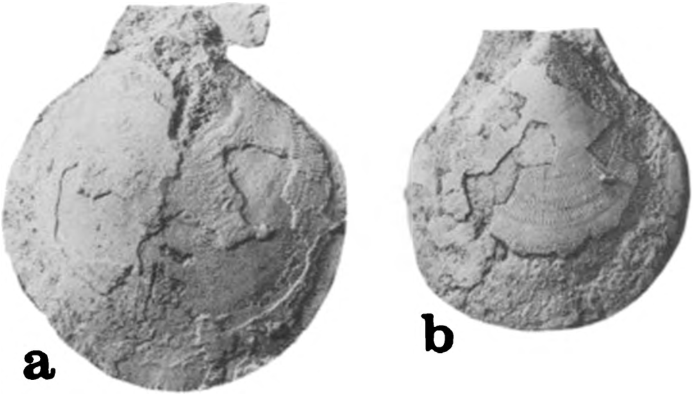
*Camptonectes (C.) fromageti* Hayami (1972, pl. 34, figs. 5–8), from the Toarcian of Vietnam, is also very close to the Argentinian material, but apparently lacks radial striae on the right anterior auricle. *Camptonectes inexpectatus* Hayami (1959c, pl. 7, figs. 4–5), from the Japanese lower Jurassic, is similar in shape but has stronger comarginal lamellae.

On the other hand, *C. bellistriatus* (Meek), from the Oxfordian of North America, is larger and lacks radial costae on the auricles (Meek & Hayden 1865, text-fig. A–D, p. 77; Stanton 1899, pl. 72, fig. 12; McLearn 1924, pl. 5, figs. 4–5).

*Camptonectes (C.) rubusta* Quilty (1983, p. 403, figs. 15–16), from the Bajocian at Ellsworth Land, Antarctica, has a stronger antimarginal ornament and taking into account that a deformed external mould of a left valve was described by Quilty as a right valve, it is allied to, if not conspecific with, *C. laminatus* (J. Sow.). The Middle Jurassic North American species *C. platessiformis* White (1880, pl. 37, fig. 5; Imlay 1964, pl. 2, figs. 11–14) is also related to *C. laminatus*.

In Europe *Camptonectes auritus* ranges from the Hettangian to the Bathonian and the Tithonian according to Johnson (1984, 1985). In Argentina this is a rare species in early Jurassic deposits, known with certainty only from Toarcian and probably late Pliensbachian deposits of southern Mendoza. This is a "remarkably eurytopic species" (Johnson 1984, p. 123) and taking into account that older deposits of the Andes have been thoroughly sampled, the apparent absence or scarcity of *C. auritus* from rocks older than late Pliensbachian in this part of the world cannot be attributed to either lack of appropriate facies or poor knowledge of the faunas concerned. Furthermore, this species becomes more abundant in Aalenian and Bajocian deposits in Argentina (see Text-fig. 26). It is thus probable that *C. auritus* reached South America from the western Tethys sometime during the late Pliensbachian – early Toarcian, probably through the now called "Hispanic corridor", a migration route which seems to have been used by many benthonic invertebrates (Damborenea & Manceñido 1979, 1988, Hillebrandt 1981, Hallam 1983, Westermann & Riccardi 1985). Apart from the regions mentioned by Johnson (1984), material referable to *C. auritus* was also figured from China (Wen et al. 1976, Zhang et al. 1979, Wen 1982, Yin & Fürsich 1991) and northeastern Russia (Sey & Kalacheva 1980).

Autecology: Already discussed at length by Johnson (1984, p. 123–124).



Text-fig. 26. *Camptonectes (C.) auritus* (Schlotheim) from the Middle Jurassic of Argentina. a - MLP 24887, X 2, Paso del Carro Quebrado, Neuquén, Bajocian; b - MLP 25013, Charahuilla, Neuquén, Bajocian, X 1.

### *Camptonectes* ? cf. *subulatus* (Münster in Goldfuss 1835)

(Pl. 6, Figs. 7–8)

cf. 1835 *Pecten subulatus* Münster in Goldfuss, p. 73, pl. 98, figs. 12a-c.
? 1915 *Pecten strionatis* – Jaworski, p. 417–418.
? 1925 *Pecten strionatis* – Jaworski, p. 50.
Note: see further synonymy in Johnson (1984, p. 107–108).

Material: Five right and three left valves, preserved as internal moulds, from late Hettangian to early Pliensbachian beds (*Waehneroceras-Schlotheimia* Ammonite Zone to *Miltoceras* Amm. Z.) in the Atuel river region (B.14, B.16): MLP 24987 to 24995 (M 1393, 1419, 1424, 1464, 1474, 1710).

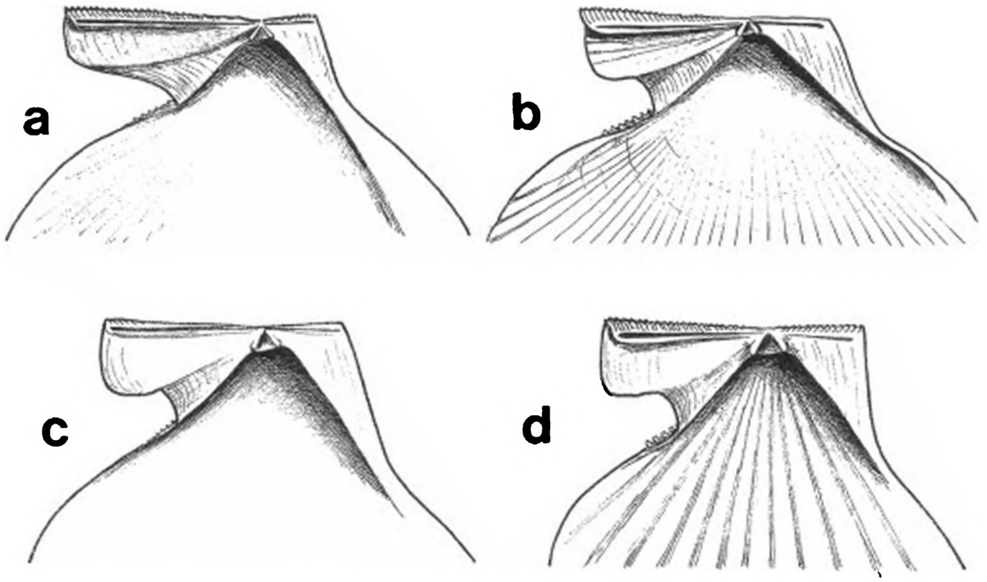
Remarks: Jaworski's (1915, 1925) reference of one specimen from Chacay Melehue to Quenstedt's species *P. strionatis*, now regarded as a synonym of *C. ? subulatus* (see Johnson 1984), may belong here. Jaworski mentioned fine radial striae and very unequal auricles in his short description.

Description: Large shell with sub-orbicular disc. Height only slightly greater than length. Inequivalve, left valve more convex than right. Dorsal margin long, anterior auricle three times longer than posterior. Right valve with deep byssal notch bearing a strong ctenolium. Right anterior auricle meets dorsal line at about 90° and disc at an acute angle. Right posterior auricle meets hinge-line at an obtuse angle. Right valve auricles clearly separated from disc, left valve auricles less so.

Inner surface of the shell smooth, only very faint radial lines can be seen on one right valve (Pl. 6, Fig. 7). Inner surface of auricles smooth, without auricular crura. Right anterior auricle with a clear ridge running from the beak to the antero-ventral extremity of the auricle. Resilifer triangular, centrally placed and somewhat prosocline in the right valve. The right valve bears two weak tooth-like processes to each side of the resilifer and two long cardinal crura extending parallel to the hinge-line. The right valve has a dorsally projected band which is nearly vertically striated (Text-fig. 27a). External characters unknown.

Measurements:

| SPECIMEN MLP | Material | L (mm) | H (mm) | W (mm) | Lha (mm) | N (mm) |
|---|---|---|---|---|---|---|
| 24987 | RV IM | (72.0) | (74.0) | (10.0) | - | - |
| 24988 | RV IM | 47.8 | 50.4 | 4.3 | 18.2 | 10.2 |
| 24989 | LV IM | 23.8 | 24.2 | 2.4 | - | - |
| 24990 | LV IM | (21.0) | 23.1 | 1.5 | - | - |
| 24991 | LV IM | 20.6 | 21.8 | 2.5 | - | - |
| 24992 | RV EM | 14.7 | 16.0 | 1.5 | - | - |
| 24993 | RV IM | 18.7 | 17.8 | 1.6 | - | - |



Text-fig. 27. Comparison of right valve hinge-region in *Camptonectes*, *Agerchlamys*, *Radulonectites* and "*Chlamys*". a – *Camptonectes* ? cf. *subulatus* (Münster), based on specimen MLP 24988; b – *Agerchlamys wunschae* (Marwick), based on specimen MLP 23655; c – *Radulonectites sosneadoensis* (Weaver), based on specimens MLP 22339 and MLP 22327; d – "*Chlamys*" *textoria* (Schlotheim), based on specimens MLP 23611 and MLP 23630.

Affinities: The most similar species seems to be *Camptonectes ? subulatus* (Münster), from the Early Jurassic of northern Europe, Canada and Greenland (Goldfuss 1835, pl. 98, figs. 12a-c; pl. 99, figs. 1a-c as *Pecten calvus*; Quenstedt 1858, pl. 18, fig. 21; pl. 23, fig. 2 as *Pecten strionatis*; Ernst 1923, pl. 1, fig. 9 as *Pecten sublaevigatus*; pl. 1, figs. 10–11 as *Pecten dehmensis*; Staesche 1926, pl. 2, figs. 9–10; pl. 5, fig. 6; Trümpy 1949, fig. 18; Troedsson 1951, pl. 20, fig. 17; pl. 23, figs. 5–6; Johnson 1984, pl. 4, figs. 3–9; Aberhan 1998, pl. 12, figs. 10–12). Shell and auricle shapes are identical. The presence of fine radial striae also relates this material to *C. ? subulatus*. The species *Pleuronectites freneixi* Calzada (1981, pl. 1, figs. 1 a-c) has a similar shape but its state of preservation does not reveal any ornament. "*Chlamys*" *tullbergi* (Lundgren) in Troedsson (1951, pl. 23, figs. 5–6), from the Hettangian of Sweden, belongs to this group, but it has a smooth right valve and radially striated left valve. *Pecten etheridgii* Tawney (1866, pl. 3, fig. 4) from the British lowest Jurassic has a comparable shape but radial ribs are more evident and fewer in number.

The difficulties to recognize the generic and specific affinities of these weakly ornamented pectinids were pointed out by many authors (Staesche 1926, Johnson 1984, Romanov 1985). Such specimens have many shell features of *Camptonectes* s.s., such as shape, size, type of auricles, ctenoliate byssal notch and internal hinge-structures. Nevertheless, antimarginal ornament is absent in many of them or restricted to the anterior and posterior portions of the shell. Taking into account the presence of weak radial lines, some of these forms could likewise be referable to *Radulonectites*, as done for instance by Polubotko & Milova (1986, pl. 16, figs. 6–7). In a different approach, Romanov (1985) erected the new genus *Subulatachlamys* with *Pecten subulatus* Münster as type and which comprise several species ranging in age from early to middle Jurassic.

*Pecten tingensis* Tilmann (1917, pl. 24, fig. 6), from the Hettangian and Sinemurian of Perú, was referred to this group of species by Staesche (1926) and Johnson (1984). This Peruvian species as figured by Tilmann differs from the material here described by the subequal auricles and much smaller size. Prinz (1985, pl. 1, fig. 3) referred this species to *Leptochondria*.

The specimens here described also agree in general shape with *Camptonectes* cf. *auritus* (Schlotheim) (Pl. 6, Figs. 9–10), but they have much larger size with more unequal auricles and none of them shows the typical antimarginal ornament.

### Genus *Radulonectites* HAYAMI 1957

Type species: *Radulonectites japonicus* HAYAMI 1957a, from the Pliensbachian (or thereabouts) of Japan, by original designation.
Synonym: ? *Hunanonectes* FANG 1978 (type species *Camptonectes (Hunanonectes) sanduensis* FANG 1978, from the Lower Jurassic of China.

HAYAMI (1957a) described *Radulonectites* as a new genus of Pectinidae similar to *Pleuronectites* and *Camptonectes*, characterized by slightly inequivalve shell with deep byssal notch (seemingly without ctenolium) and external surface with numerous wavy radial grooves. Besides the type species, he originally included in his new genus the specimens referred by LEANZA (1942) to *Camptonectes lens* Sow. and *Pecten (Pleuronectites) laterestriatus* E. PHILIPPI (1899b). The same author (HAYAMI 1961, p. 320) stated that *Pecten sosneadoensis* WEAVER (1931) is morphologically similar to the type species. His opinion is fully confirmed here, as shown below.

Since the original description of the genus, *Radulonectites* species were described from East Siberia and East China (POLUBOTKO 1968b, CHEN 1982a, POLUBOTKO & MILOVA 1986) and Canada (ABERHAN 1998) also from Pliensbachian sediments. HAYAMI (1985, p. 44, 48) considered that *R. japonicus* is probably Late Pliensbachian in age, although it is not accompanied by index fossils in Japan. This genus has thus become a typical element of early Jurassic circum – Pacific faunas (see Text-figs. 6–7). HAYAMI (1957a) doubtfully included within the genus *Chlamys kakanuia* MARWICK (1956, text-fig. 1), from the late Triassic of New Zealand. This species is only known by a badly preserved left valve which does not allow a definite opinion about its affinities with this or related genera. The same happens with doubtfully referred material from the Triassic of Europe (ALLASINAZ 1962, pl. 27, figs. 3–4).

Nevertheless, its affinities have not been established yet, mainly due to inadequate knowledge of morphological details, such as the hinge characters. The Argentinian material is fairly well-preserved and a complete and detailed description can be given. The new evidence now points to a close relation to *Camptonectes* AGASSIZ, as suggested by WALLER & MARINCOVICH (1992), who doubtfully included *Radulonectites* within the Camptonectinae. Its resemblance to *Pleuronectites* SCHLOTHEIM may be just superficial. As was already said (DAMBORENEA 1987b, p. 199; NEWELL & BOYD 1995, p. 71) *Pleuronectites* seems to be closely allied to *Eopecten* DOUVILLÉ and *Hemipecten* ADAMS & REEVE and certainly not to the Streblocondrinae as was placed in Cox et al. (1969). This relation is based not only on shell outline and habit but mainly on the pectinoidean-type hinge (TAMURA 1973) and ligament system (WALLER 1984, p. 219), a feature which was already pointed out by SALOMON (1900, 1902) but overlooked by later workers.

Among Tertiary and Recent pectinoideans, *Delectopecten* STEWART is a morphological analogue, with a similar shape and identical ornament pattern (see illustrations in MOORE 1984, pl. 2). Relationships between *Radulonectites* and *Delectopecten* are still to be discussed.

The hinge characters (see Pl. 6, Figs. 12, 17 and Text-figs. 27c) are in fact almost identical to those of *Camptonectes auritus* (SCHLOTHEIM), the type species of the genus (cf. for instance SPEDEN 1967, pl. 4, figs. 1, 3; DUFF 1978, text-fig. 22, pl. 5, fig. 22b) and C. ? cf. *subulatus* (MÜNSTER) (Text-fig. 27a). The presence of a weak ctenolium (Text-fig. 27c) makes it necessary to emend HAYAMI's diagnosis and further provides more evidence on its relation to *Camptonectes*. Some of the Argentinian specimens show also traces of the antimarginal ornament which is a typical feature of *Camptonectes* s.s., but restricted only to the disc flanks.

For these reasons *Radulonectites* is here regarded as a genus allied to *Camptonectes*, characterized by the external surface covered by numerous wavy radial grooves and the antimarginal ornament absent or restricted to the disc flanks.

In 1978 FANG described the new subgenus *Camptonectes* (*Hunanonectes*) from the Early Jurassic of Guangdong and Hunan, China, for shell ornamented by a combination of antimarginal striae, radial riblets and comarginal striae. This taxon will probably prove to be a synonym of *Radulonectites*, with which FANG (1978) failed to compare his material. The three species described by FANG have small faintly ornamented shells but are otherwise similar in general shape and other morphological aspects to both North and South Pacific species of *Radulonectites*.

The middle Triassic material from Italy referred by ALLASINAZ (1972, p. 331–332, pl. 44, fig. 3) to this genus, is almost certainly not a *Radulonectites*, but an *Eopecten* instead.

### *Radulonectites sosneadoensis* (Weaver 1931)

(Pl. 6, Figs. 12–20; Text-figs. 8o-p)

? v 1899 *Pecten humilis* – R. Philippi, p. 28, lám. 16, fig. 5
? v 1899 *Pecten tinguiriricanus* – R. Philippi, p. 36, lám. 20, fig. 8.
!*v 1931 *Pecten sosneadoensis* – Weaver, p. 272–273, pl. 28, fig. 169.
v 1942 *Pecten (Camptonectes) lens* – Leanza, p. 173–174, lám. 10, figs. 1–2.
1953 *Pecten (Camptonectes) lens* – Groeber et al., p. 156.
v 1975 *Camptonectes* – Damborenea in Damborenea et al., cuadro I, 20.
v 1978 *Camptonectes lens* – Camacho & Riccardi, cuadro I.
1978 *Pecten sosneadoensis* – Volkheimer, p. 25.
?? 1983 *Camptoc chlamys* sp. – Nullo, p. 41.
v ! 1992 *Radulonectites sosneadoensis* – Damborenea, pl. 116, figs. 6–7.
v 1993a *Radulonectites sosneadoensis* – Damborenea, fig. 3j.
1994 *Radulonectites sosneadoensis* – Aberhan, p. 41–42, pl. 20, figs. 5–6.
1998 *Radulonectites sosneadoensis* – Aberhan, p. 118, pl. 14, figs. 14–15; pl. 15, figs 1, 4.

Material: Holotype: BMW 153/SA1136 (cast = MLP 22353), a left valve from the Rio Atuel area, Mendoza, Weaver's collection (re-illustrated here on Pl. 6, Fig. 13).

The examined material, preserved mainly as moulds, consists of two specimens with both valves, 14 left and 17 right isolated valves and several fragments. Most of it was collected by the author and colleagues at various localities of Mendoza Province: Las Chilcas (B.16), Puesto Araya (B.1), Arroyo Serrucho (B.8) and Cerro Puchenque (B.9): MLP 19040, 19667, 22329 to 22332, 22336 to 22342, 24937, 25041, 25068, 25558, 27825, 27854 (M 320, 324, 1321, 1322, 1324, 1326, 1329 to 1332, 1919, 1931, 1932) and Neuquén Province: South of Estancia Santa Isabel (D.1), Salitral Grande (D.3), Cerro Corona (D.10), Cerro Del Vasco (D.12), South of Cerro Roth (D.15) and Cerro Roth (D.16): MLP 16338, 16377, 22321 to 22328, 22333 to 22335, 22351, 22352 (M 94, 97, 99, 100, 104, 124, 129, 142, 144, 145, 1051, 1053 and 1055).

The material described by Leanza (1942, p. 173–174) as "*Pecten (Camptonectes) lens* Sow." was collected by J. Frenguelli and A. Leanza at Cerro Corona (D.10) and Cañadón de Los Chilenos (D.17): MLP 6032 to 6034, 6215, 6250). Unfortunately one of the specimens figured by A. Leanza (1942, pl. 10, fig. 1) could not be re-located in the collections at the MLP.

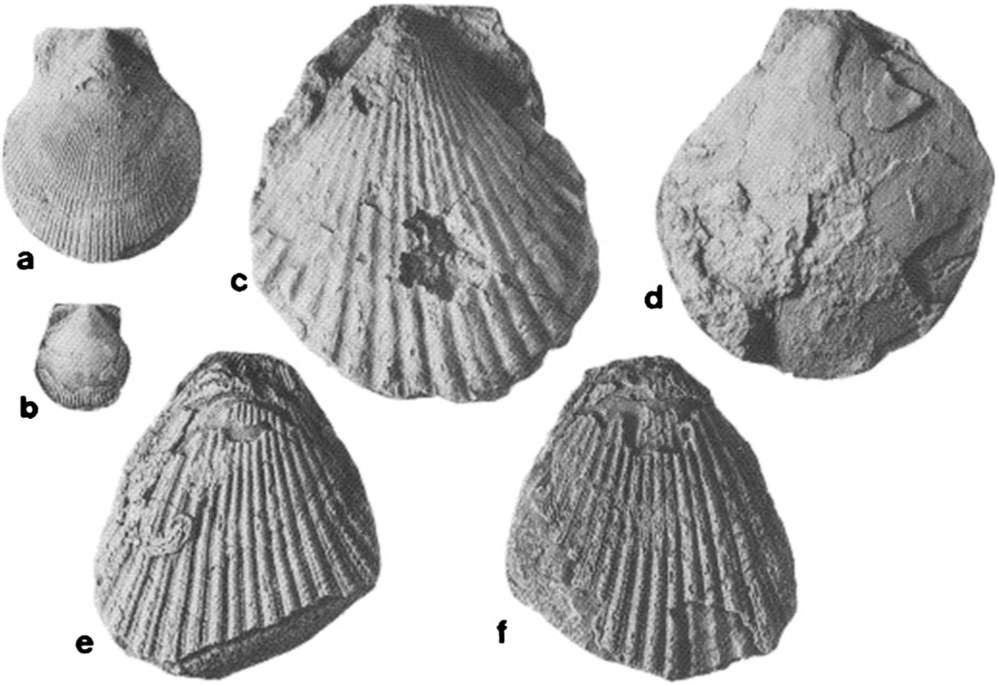
This species is restricted to the upper Pliensbachian (upper part of *Fanninoceras* Ammonite Zone) in all the above mentioned localities.

Remarks: In his paper on the Secondary Fossils from Chile, R. Philippi (1899) described a couple of new pectinid species which are similar to the taxon here considered. *Pecten tinguiriricanus* R. Philippi (1899, p. 36, pl. 20, fig. 8; see also Text-fig. 28a here), an almost complete left valve (SGOPI 907), is very similar in size and shape and its ornament pattern is also comparable, though appears more regular than in the material here described. Although R. Philippi (1899) indicated that his specimen was collected by C. Stolp in 1890 in Cretaceous sediments from the Tinguiririca valley, an old manuscript label kept with the specimen states the locality as "Sasneado" and the collector as "F. Albert, 1891". In the same paper (R. Philippi, 1899, p. 20), Sasneado is said to be on the eastern slope of the San Fernando Cordillera, i.e. the headwaters of the Atuel river. Thus, it is more than probable that Sasneado corresponds to Sosneado in Argentina, which is the type locality of *Pecten sosneadoensis* Weaver. *Pecten tinguiriricanus* was only doubtfully included in the synonymy list due to the slight differences in ornament just mentioned and the uncertainty about its provenance, but should it be proved to belong to this taxon, it is the first available name for it.

*Pecten humilis* R. Philippi (1899, p. 28, pl. 16, fig. 5; see also Text-fig. 28b here) is a small but almost complete left valve which in places bears a radial ornament comparable to that of *P. tinguiriricanus*. The only specimen (SGO–PI 903) is not complete enough as to refer it with certainty to any pectinid species, but can be a young *P. tinguiriricanus*. These two Chilean species were never mentioned again in the literature.

The material described by Jaworski (1915, 1925) as *Pecten strionatis* Quenst., from the Early Jurassic beds at Chacay Melehue, could also belong here if the radial lines described by this author correspond to the radial grooves typical of this species. Nevertheless, these radial lines may also represent the faint inner radial striae in *Camptonectes? subulatus* (Münster) and thus Jaworski's entry is here included with doubts in the synonymy of this later species (see above).

Johnson's (1984, p. 121) statement that the specimen figured by A. Leanza (1942, pl. 10, fig. 1) has an abnormally high height/umbonal angle relation is untrue, as he measured one of the illustrated specimens but failed to realize that it was reproduced with a magnification of 2.5 X. In fact the H/ε relation of *Radulonectites sosneadoensis* is well within the range of variation of the suborbicular species of *Camptonectes*.



Text-fig. 28. Some pectinoideans of dubious validity described by R. Philippi 1899, X 1. a – *Pecten tinguiriricanus* R. Philippi, SGO PI 907, holotype, almost complete left valve (Philippi, lám. 20, fig. 8), see discussion under *Radulonectites sosneadoensis* (Weaver).; b – *Pecten humilis* R. Philippi, SGO PI 903, holotype, almost complete left valve of a young specimen, probably conspecific with fig. a (Philippi, lám. 16, fig. 5), see discussion under *Radulonectites sosneadoensis*; c – *Pecten martinezi* R. Philippi, SGO PI 910, holotype, incomplete internal mould (Philippi, lám. 20, fig. 9), see discussion under "*Chlamys*" *textoria* (Schl.); d – *Pecten glaphyrus* R. Philippi, SGO PI 910, only available syntype (not figured by Philippi); e, f – *Lima exasperata* R. Philippi, SGO PI 941, holotype, almost complete shell without auricles (Philippi, lám. 10, fig. 3), see discussion under "*Chlamys*" *textoria* (Schl.).

It is interesting to note that since the original description, *P. sosneadoensis* was only reported once again from the Andean region. This is probably due to the poor illustration provided by Weaver (1931), which made this species almost unrecognizable. The material from the Chilean Pliensbachian listed by Hillebrandt & Schmidt-Effing (1981, p. 12, 19) as *Camptonectes* sp., may in fact belong to this species. This may also be the case of the reference to "*Camptoc chlamys*" sp. from Chubut by Nullo (1983).

Description: Shell of medium size, inequivalve, left valve moderately inflated, more than the right, which may even be almost flat. Inequilateral, slightly opistocline, with unequal auricles. Anterior auricle almost twice as long as the posterior. Disc sub-orbicular to sub-ovate, height always greater than length. Umbonal angle between 90° to 106°, greater on larger specimens. Beaks not projecting above the hinge line.

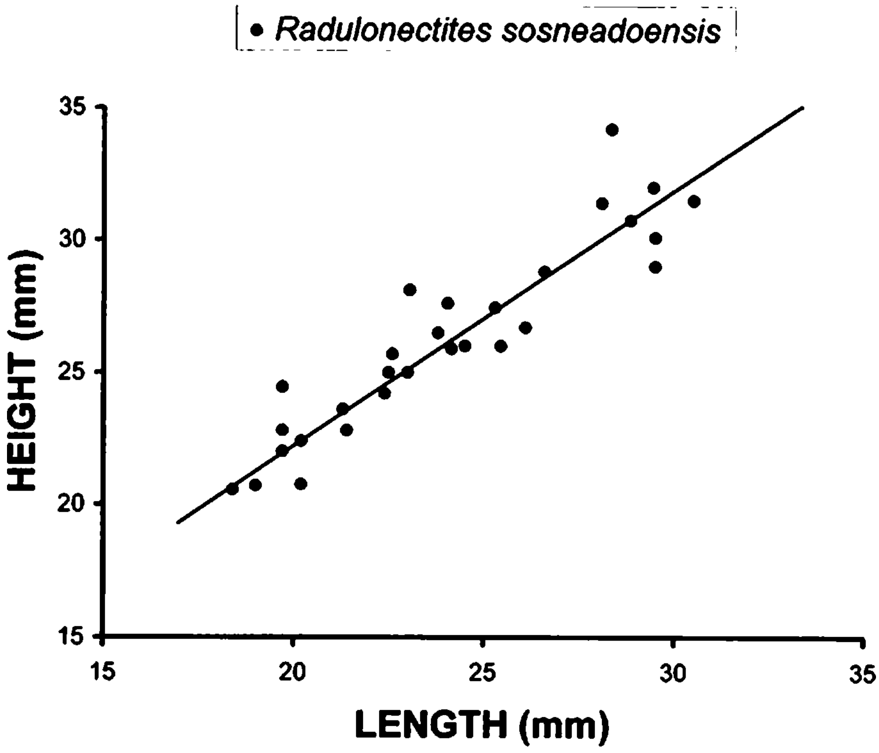
Dorsal margin straight. Anterior margin of right anterior auricle truncated, with a wide byssal fasciole and concave byssal notch, meeting anterior margin of disc at about a right angle (Pl. 6, Figs. 12, 16). Posterior auricle of right and left valves with obliquely truncated posterior margin, meeting dorsal margin at about 110°. Anterior margin of left anterior auricle sinuous and with narrow byssal sinus (Pl. 6, Figs 13–15, 20). Anterior margin of disc slightly concave, ventral and posterior margins evenly convex. All auricles clearly separated from disc, though sutures are not deep.

Disc and auricles ornamented by numerous wavy radial grooves formed by rows of pits, which are stronger near the shell margins, the central part of the disc being almost smooth. In portions of the shell where the comarginal growth lines are more conspicuous, such as near the ventral margin, the shell surface may appear reticulate. The radial grooves, which increase in number by intercalation, are more closely packed towards the disc flanks. The radial ornament is equal on both valves. The external surfaces of the auricles also bear growth lines which become lamellose on the byssal fasciole. On the best preserved left valves traces of antimarginal ornament can be seen on the anterior disc flanks, near the suture (see Pl. 6, Fig. 20).

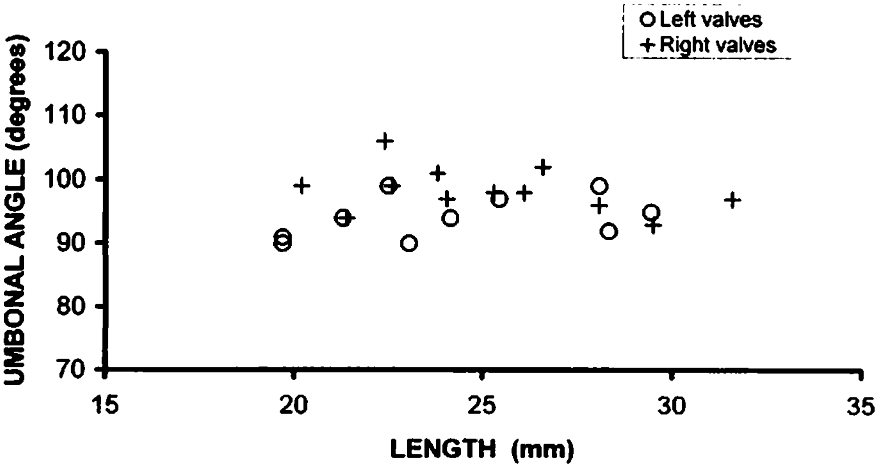
The inner surface of the shell is smooth or bears very faint radial grooves. The inner surface of the auricles is also smooth, without auricular crura. On the right anterior auricle there is a ridge running from the beak to the antero-ventral extremity of the auricle, dorsally limiting the byssal fasciole. The resilifer is triangular, centrally placed on the left valve but somewhat anteriorly placed on the right valve. There are two weak tooth-like processes on the right valve, one on each side of the resilifer and two cardinal crura extending almost through all the hinge length (see Text-fig. 27c). Some of the available right valves show traces of a weak ctenolium, but this feature is not preserved on all specimens.

Measurements: of best preserved specimens. See also diagrams on Text-figs. 29 and 30.

| SPECIMEN MLP | Material | L (mm) | H (mm) | W (mm) | Lha (mm) | Lhp (mm) | Haa (mm) | N (mm) | ε (°) |
|---|---|---|---|---|---|---|---|---|---|
| 6032 | LV SI | 19.7 | 24.4 | 3.2 | 7.1 | 4.0 | 6.2 | - | 91 |
| 6033 | LV EM | 23.0 | 28.1 | 4.7 | 8.5 | 5.1 | 6.4 | - | 90 |
| 16377 | LV IM | 25.4 | 26.0 | 3.8 | 9.0 | - | 6.5 | - | 97 |
| 22327 | RV SI | 21.4 | 22.8 | 2.5 | 8.9 | 4.0 | 5.0 | 4.0 | 94 |
| 22331-c | RV IM | 20.2 | 20.7 | 1.7 | 7.3 | 4.0 | 3.8 | 4.4 | 99 |
| 22333 | LV EM | 22.5 | (25.0) | 3.6 | 8.8 | 5.0 | 4.8 | - | 99 |
| 22334 | LV EM | 19.7 | 22.0 | 3.1 | (8.7) | - | 6.3 | - | 90 |
| 22339 | RV IM | 22.4 | 24.2 | 1.2 | 7.8 | 3.4 | 4.0 | 4.1 | 106 |
| 22353 | LV SE | 24.5 | 26.0 | 3.1 | 7.8 | 4.7 | 5.4 | - | 106 |



Text-fig. 29. Scatter diagram and regression line showing length/height (L/H) ratios in *Radulonectites sosneadoensis* (Weaver), n = 30.



Text-fig. 30. Scatter diagram showing the length/umbonal angle (L/ ) relation in *Radulonectites sosneadoensis* (Weaver).

Affinities: The material from the Upper Sinemurian or Pliensbachian of northern Yukon described by Poulton (1991, pl. 11, figs. 17–22) as *Camptonectes* (*Camptochlamys*) sp. belongs to *Radulonectites* and is very similar to the Andean species described below (Aberhan 1998).

The type species of *Radulonectites*, *R. japonicus* Hayami (1957a, p. 90, pl. 16, figs. 1–7; 1975, p. 80, pl. 3, figs. 9–10 and Cox et al. 1969, figs. C74,3a-b) from the late Pliensbachian (?) of Japan (see Hayami 1985, p. 44, 48; in Sato & Westermann 1991), is very close to *R. sosneadoensis*, but has fewer and more conspicuous radial grooves, less distinct sutures, lacks radial ornament on anterior auricles and attains a larger size. *Radulonectites hayamii* Polubotko (1968b, p. 82–83, pl. 24, figs. 1–5; Milova 1988, pl. 12, figs. 7–9; pl. 13, figs. 1-6; see also Damborenea 1993a, text-fig. 3i), from the Late Pliensbachian of east Siberia, is probably a synonym of the type species (see Hayami 1975, p. 162) and both *R. hayamii* and *R. japonicus* appear together in eastern Russia (Polubotko & Repin 1988).

*Radulonectites antiquus* Milova (1988, pl. 10, figs. 1–6), from the Pliensbachian beds of the Viliga river region, has a smoother shell with very faint riblets.

*Radulonectites mongkensis* Milova (1985, pl. 12, figs. 1–9; Polubotko & Milova 1986, pl. 16, figs. 3–5; Milova 1988, pl. 10, fig. 9; pl. 11, figs. 1–11; pl. 12, figs. 1–6), from the Pliensbachian of eastern Russia, has wider umbonal angle and larger auricles than *R. sosneadoensis*. *Radulonectites ? exsertus* Chen (1982a, p. 411, pl. 2, figs. 19–22), from the early Pliensbachian of Guangdong, east China, has a more regular radial ornament which is not wavy as in the Japanese and Argentinian species.

*Radulonectites sosneadoensis* differs from *R.? laterestriatus* (E. Philippi 1899b, text-fig. 3.6), from the Triassic of Germany, by a less deep byssal notch and less opisthocline right valve.

*Camptonectes* (*Camptonectes ?*) *sublens* Milova (1976, p. 66–67, pl. 10, figs. 6–9) from the Norian of Siberia, also has radial striae superimposed on fine antimarginal ornament and may be related to *Radulonectites*.

Three species from the earliest Jurassic of east China that have been referred to the subgenus *Camptonectes* (*Hunanonectes*) are also comparable to the Argentinian material. They are *C. (H.) sanduensis* Fang (1978, p. 462, pl. 1, figs. 7–13; Chen 1982a, p. 411, pl. 2, figs. 1–4), *C. (H.) parachlamys* Fang (1978, p. 463, pl. 1, figs. 1–6, 14) and *C. (H.) yizhangensis* Fang (1978, p. 464, pl. 1, figs. 15–20; Chen 1982a, p. 411, pl. 2, figs. 5–8). All have a very small size and their distinctive characters are not well known. Although the ornament pattern is only poorly known, from the available evidence *Hunanonectes* Fang 1978 is here considered as a probable junior synonym of *Radulonectites* Hayami 1957. Specimens figured by Fang (1978, pl. 1, fig. 10b) and Chen (1982a, pl. 2, fig. 3) show the superposition of radial and antimarginal ornament on the disc flanks, a feature also seen on some Argentinian specimens of *R. sosneadoensis*.

*Radulonectites sosneadoensis* (Weaver) can be compared to "*Pecten*" *peruanus* Tilmann (1917, p. 673–674, pl. 24, figs. 4–5), from the Sinemurian of central and northern Perú, on account of a similar outline, but the radial ribs of the Peruvian material are fewer and less wavy and seem to be equally strong over all the shell surface.

Johnson (1984, p. 111) has stated that "most of the 16 syntypes of *'Pecten' tingensis* are unlike Tilmann's figure in that they display radial and, in some cases, comarginal ornament". On this account part of the syntypes of *P. tingensis* may be referable to *Radulonectites*, but the evidence is not enough, since they could also belong to *Camptonectes ? subulatus* (Münster) or other species.

Calzada (1981) described an early Jurassic species from Camarasa, northern Spain, which he referred to *Pleuronectites*, thus extending the stratigraphical range of this genus. The species *P. freneixi* Calzada (1981, p. 214, pl. 1, figs. 1 a-c) is very similar in shape and size to *Radulonectites* species, but all known specimens have a smooth outer surface, which distinguishes them from adult *Radulonectites*. Nevertheless, the Spanish material is scarce and could be abraded, making the outer ornament pattern, which might be *Radulonectites*-like or *Camptonectes*-like, unknown. The same happens with *Pecten (Pleuronectites) sublaevigatus* Ernst (1923, pl. 1, fig. 9) from the late Toarcian of north-west Germany, now regarded as a synonym of *Camptonectes? subulatus* (see Johnson 1984). In fact, these forms appear intermediate between *Camptonectes* and *Radulonectites* and may indicate a relationships between the two stocks. Similarly smooth specimens from the Pliensbachian of eastern Russia were doubtfully referred to *Radulonectites* (see Polubotko & Milova 1986, pl. 16, figs. 6–7).

Autecology: The shell shape, relative convexity of valves and presence of a deep byssal notch point to an epibyssate mode of life for this species. Further evidence is provided by epizoic organisms, which encrust nearly all left valves (see Pl. 6, Figs. 15, 20) but none of the available right valves.

This species is never an abundant one, but nevertheless it is geographically widespread from Mendoza to southern Neuquén, always subordinated to other taxa. Though it apparently has a wide range of associated lithologies from medium sandstones to finely grained calcareous mudstones, it is more common in the last mentioned type. An equivalent bottom-type range has been reported for the morphologically similar living species *Delectopecten vancouverensis* (Whiteaves) (Moore 1984, p. 17).

### Genus *Agerchlamys* Damborenea 1993

This genus was first described in an appendix of a palaeogeographical paper (Damborenea 1993a) and therefore a more complete description will be included here.

Type species: *Chlamys (Camptochlamys) wunschae* Marwick 1953a, from the Early Jurassic (Aratauran) of New Zealand and Pliensbachian of the Andes (type specimen figured in Marwick 1953a, pl. 10, figs. 23–24; Speden & Keyes 1981, pl. 13, figs. 2, 7; Damborenea & Manceñido 1992, pl. 1, fig. 6b; Damborenea 1993a, fig. 4a; Text-fig. 32a here).

Diagnosis: Medium to large-sized pectinids, with sub-equivalve and sub-equilateral thin, discoidal, compressed shells. Umbonal angle wider than 90°. Anterior auricle at least twice as long as the posterior. Right anterior auricle with deep ctenoliate byssal notch. Fine cancellate ornament comprises very numerous narrow, nearly straight radial costae, dense continuous comarginal lamellae and fine antimarginal striae over the whole shell surface. Disc and auricles equally ornamented. Inner shell surface almost smooth. Central triangular resilifer, one cardinal crus parallel to the hinge axis and one tooth-like crus to each side of resilifer. No auricular crura.

Included species:
- *Chlamys (Camptochlamys) inspecta* Kiparisova 1966 (in Kiparisova et al. 1966, p. 124–126, pl. 17, figs. 7–10; pl. 18, figs. 1–2) from the Carnian – Norian of Siberia.
- *Chlamys (Camptochlamys) wunschae* Marwick 1953a (p. 98–99, pl. 10, figs. 23–24; Text-fig. 32 here) from the Pliensbachian of New Zealand, Argentina and Canada (herein).
- *Chlamys (Camptochlamys) proprius* Milova 1976 (p. 60–61, pl. 7, figs. 10–11) from the Pliensbachian of Siberia.

To the above-mentioned species, perhaps the following material could be added:
- *Pecten verticillus* Stoliczka 1861 (p. 197, pl. 6, figs. 3–4) and *Pecten subreticulatus* Stoliczka 1861 (p. 196, pl. 6, figs. 1–2), from the Hierlatz Schichten of the Austrian Alps, and *Pecten laosensis* Mansuy (1912, pl. 7, fig. 3) from the Early Jurassic of Laos. Antimarginal ornament was not reported in these species.
- *Chlamys* ex. gr. *textoria* (Schlot.) in Polubotko 1968b (p. 78–79, pl. 23, figs. 5–6) from the Pliensbachian of Siberia.
- *Agerchlamys* sp. A, Aberhan (1998, p. 108, pl. 12, figs. 6, 7, 9) from the Pliensbachian to Toarcian of western Canada.

Also some Middle Jurassic material from Tethyan regions may also be related to this taxon (see discussion below), but a full analysis must await until more information about them becomes available.

Distribution: *Agerchlamys* ranges in age from the Late Triassic to the Toarcian of the Boreal and Austral Pacific regions (Text-fig. 6-7) and perhaps extends to the Callovian of Tethyan regions.

Discussion: Species of this taxon have been referred either to *Chlamys* or to *Camptochlamys* in the past and it has been regarded as a distinct group (DAMBORENEA & MANCEÑIDO 1992)

According to the general shell-shape, hinge details, presence of antimarginal ornament and type of ornament pattern *Agerchlamys* has affinities to *Camptochlamys*. *Agerchlamys* has, nevertheless, a more delicate and wavy nature of the concentric lamellae that, together with the higher density of both radial and comarginal elements of the ornament, gives the shell a finer appearance if compared with the type species of *Camptochlamys*. The numerous, regularly spaced, fine comarginal lamellae, are normally stronger and convex outwards on the interspaces than on the costae in *Agerchlamys*. The shell is also thinner in the group of species under consideration.

*Agerchlamys* could also be compared to some finely ornamented pectinids referred to *Chlamys* by most authors, but in this case, the wide umbonal angle, the presence of costae instead of plicae and of continuous comarginal lamellae and the *Camptonectes*-like shape of the shell are the characters which prevent assignment to this genus and point to allocation within Camptonectinae in the sense of WALLER (1993) instead. Relations with a Boreal stock of finely ribbed pectinids, which flourished from Late Triassic to mid Jurassic times, is still unclear. These are usually referred to *Chlamys*. The most conspicuous member of this group is *C. mojsisovicsi* KOBAYASHI & ICHIKAWA (1949; see also HAYAMI 1975) from the Late Triassic of Japan, Siberia and western North America. Though the ornament pattern is comparable, species of this group seem to lack antimarginal ornament. The same differences can be observed with *"Pecten" subreticulatus* STOLICZKA (1861, pl. 6, figs. 1–2), from the Hierlatz Schichten (Alps), which was also referred to *Chlamys* by JOHNSON (1984).

ARKELL (1930, p. 102–103; see also ARKELL 1931b) originally erected *Camptochlamys* as a subgenus of *Chlamys* RÖDING, but stressed its affinities with *Camptonectes* AGASSIZ. Besides the type (*Pecten intertextus* ROEMER), he included within this taxon the following nominal species: *C. retiferus* (MORRIS & LYCETT), *C. obscurus* (SOWERBY) and *C. lamellosus* (SOWERBY). ARKELL proposed that this group of species may have derived from ribbed *Chlamys* independently from *Camptonectes* and mentioned *P. rosimon* D'ORBIGNY, from the Middle Jurassic, as a transitional form. This species was later included in *Camptonectes* (*Camptochlamys*) by COX & ARKELL (1948).

DECHASEAUX (1936) considered *Camptochlamys* to have the same rank as *Chlamys* and *Camptonectes*, both of them regarded as subgenera of *Pecten*. She also stated that the range of this taxon extends from the Triassic to the Hauterivian but acknowledged it was unknown in the Lias. A finely ornamented species, *P. mantonensis* ETALLON, was included by DECHASEAUX (1936) in *Camptochlamys*. BARBULESCU (1961) also treated *Camptochlamys* as a separate genus.

On the other hand COX & ARKELL (1948, p. 13) regarded *Camptochlamys* as a subgenus of *Camptonectes* and COX (1952, p. 22) argued at length to uphold this idea. Most later authors (for instance FISCHER 1969, ALLASINAZ 1972, FÜRSICH 1982, JOHNSON 1984, KELLY 1984) followed this view without further comments and considered *Camptochlamys* to range from the Aalenian to the Tithonian and perhaps to the early Cretaceous. The presence of *Camptochlamys*, even considered in the strictest sense, well within the early Cretaceous, is documented, for instance, by *Pecten coquandiana* D'ORBIGNY (1843–1847, pl. 432, figs. 1–3) from France and Valanginian specimens from Argentina housed in MLP. WALLER & MARINCOVICH (1992) and MARINCOVICH (1993) even referred to this genus a Danian species from Alaska, regarded as a *"Lazarus"* species.

*Costicamptonectes* FÜRSICH (1982, p. 50) may be regarded as an intermediate form between *Camptonectes* and *Chlamys*.

It is interesting to note, though, that these authors based their opinion mostly upon the evidence from Middle and Late Jurassic European forms and did not include in and sometimes specifically excluded from *Camptochlamys* the group of finely ornamented species from the circum-Pacific late Triassic – early Jurassic here separated as *Agerchlamys*.

Significantly, those authors who included within *Camptochlamys* these finely cancellated species, regarded this as a subgenus of *Chlamys* (MARWICK 1953a, KIPARISOVA et al. 1966, MILOVA 1976), somehow suggesting the probable independent origin of *Camptonectes* and *Camptochlamys* and the close affinities of the latter with *Chlamys*, in view of the early appearance of the species of the *A. wunschae* group.

To the above-mentioned species, perhaps the following could be added to *Agerchlamys* if more information about them becomes available:

- *Camptochlamys rosimon* (d'Orbigny) in Fischer 1969 (pl. 9, fig. 21) and other papers, from the Middle Jurassic of Europe.
- *Camptochlamys mantochensis* (Etallon) in Dechaseaux 1936 (p. 40, pl. 5, figs. 12–13) from the Middle Jurassic of France.
- *Camptochlamys intertextus* (Roemer) in Romanov (1985, pl. 16, figs. 1–2) from the Bathonian of southern Russia and in Kanjilal 1979 (figs. 8a-b), from the Callovian of western India.
- *Camptochlamys kutchensis* (Kanjilal 1979, figs. 9a-b), from the Callovian of western India.
- *Camptonectes* (*Camptochlamys*) sp. in Quilty 1978, fig. 54, from the Late Jurassic of Antarctica.

### *Agerchlamys wunschae* (Marwick 1953)

(Pl. 7, Figs. 1–10; Text-figs. 8l, 8q, 32, 45c)

? 1891 *Pecten* sp. – Behrendsen, p. 389.
? 1922 *Pecten* sp. – Behrendsen, p. 174.
v 1942 *Pecten (Chlamys) textorius torulosa* – Leanza, p. 173; lám. 7, fig. 4.
! * 1953a *Chlamys (Camptochlamys) wunschae* – Marwick, p. 98–99; pl. 10, figs. 23–24.
v 1980 *Chlamys textoria torulosa* – Lizuain, p. 178.
v 1981 *Chlamys textoria torulosa* – Haller et al., p. 226.
* v 1981 *Chlamys (Camptochlamys) wunschae* – Speden & Keyes, pl. 13, figs. 2, 7.
v 1981 *Pecten (Chlamys) textorius torulosa* – Cuerda et al., p. 9.
v 1982 *Pecten (Chlamys) textorius torulosa* – Cuerda et al., p. 331.
?? 1983 *Camptoc chlamys* sp. – Nullo, p. 41.
v 1984 *Chlamys textoria* – Manceñido & Damborenea, p. 424; lám. 1, figs. 15–17.
v 1992 *Camptochlamys wunschae* – Damborenea, pl. 116, figs. 9–10.
! v 1992 "*Camptochlamys*" *wunschae* – Damborenea & Manceñido, pl. 1, fig. 6a-6b.
v 1992 *Camptonectes (Camptochlamys) wunschae* – MacFarlan, p. vi, fig.
! v 1993a *Agerchlamys wunschae* – Damborenea, figs. 4(a-j).
?? 1994 *Agerchlamys wunschae* - Aberhan, p. 38, pl. 18, figs. 1–6.
1998 *Agerchlamys wunschae* - Aberhan, p. 108, pl. 12, figs. 1–5.

Material: Sixteen left valves, sixteen right valves and about 20 fragmentary specimens, all of them preserved as external or internal moulds, were collected from the following localities (from North to South): Arroyo del Portezuelo Ancho, Mendoza (B.5): MLP 23657, 27923 (M 1307 and Lanés' collection); South of Cordillera del Viento, Neuquén (C.1): MLP 23656, 26559 (M 1224, 1740); Arroyo Lista Blanca, Neuquén (C.2): MLP 23665 (Clavijo collection); Vuta Picún Leufú, Neuquén (C.7): MLP 23649, 23650 (M 1083, 1085); Arroyo Lonqueo, Neuquén (C.9): MLP 23651-23655 (M 1187-1189); RahueAluminé, Neuquén (C.13): MLP 15324 (Cuerda et al. collection); Arroyo Lapa, Neuquén (C.15): MLP 23648 (M 191); Arroyo Ñireco, Neuquén (C.20): MLP 23658 to 23664, 24996 and 24997 (M 1362, 1363); Subida a Sañicó, Neuquén (D.7): MLP 6028 to 6030 (Frenguelli and A. Leanza collection); Cerro Piltriquitrón, Rio Negro: MLP 17841 to 17843 (Lizuain collection).

Material doubtfully referred to this species was found in Cañadón Cerro Negro region (E.1), Chubut Province: MLP 27597 to 27600 (M 1236).

This species ranges in age from middle to late Pliensbachian in Argentina (*Fanninoceras* Ammonite Zone). In New Zealand *Agerchlamys wunschae* is known only from the lower Ururoan (cf. Grant-Mackie 1959), i.e. Pliensbachian according to Stevens & Speden (1978), and in Canada it ranges from early Hettangian to late Sinemurian (Aberhan 1998).

Remarks: The description provided by Behrendsen (1891, p. 389; 1922, p. 174) of *Pecten* sp. from Portezuelo Ancho, Mendoza, seems to refer to a *Chlamys* species. This reference is here doubtfully included in the synonymy list of this species on account of material from the same locality and of the high (110°) umbonal angle reported by Behrendsen.

The specimens referred to *Chlamys textoria torulosa* by Leanza (1942), Lizuain (1980), Haller et al. (1981), Cuerda et al. (1981, 1982) and Manceñido & Damborenea (1984) also belong here.

Nullo (1983) listed "*Camptoc chlamys*" sp. from Chubut. This mention could either belong here or refer to *Radulonectites sosneadoensis* (Weaver).

Description: Medium to large-sized shells, sub-equivalve and sub-equilateral. Both valves are almost equally gently inflated and thin-shelled. The anterior auricles are at least twice as long as the posterior, all of them are clearly delimited from the disc by deep sutures. The right anterior auricle bears a deep byssal notch with a strong ctenolium and its anterior end meets the dorsal margin at an almost straight angle. Its dorsal margin projects above the hinge-line (Pl. 7, Figs. 2a, 9a-b). The left anterior auricle is equally long but its dorsal margin is not projected and its anterior margin meets the disc at an acute angle (Pl. 7, Fig. 7). The posterior margins of the posterior auricles meet the hinge-line at an obtuse angle and the disc at an acute angle.

Disc sub-orbicular, height and length almost equal, umbonal angle variable between 100° and 115°. Posterior margin of disc straight, anterior slightly concave.

Both valves are externally covered by numerous very fine, straight to gently wavy in some specimens, rounded radial costae, separated by slightly wider interspaces. This radial ornament is crossed by more numerous, fine, comarginal lamellae, stronger on the interspaces than on the costae. The lamellae are slightly convex towards the ventral margin on the interspaces. These two types of ornament give the shell outer surface a very fine cancellate appearance (Pl. 7, Figs. 1, 3, 6, 9, Text-fig. 45c). New riblets are intercalated in the interspaces at irregular intervals, increasing the number of radial costae as the shell grows. The number of radial costae varies between 45 and 53 at a length of 20 mm and between 63 and 65 at a 40 mm length. Large specimens have around 70 riblets on each valve. This ornament also appears on the four auricles, though there the comarginal lamellae are stronger and the radials weaker. On the left anterior auricle every alternate comarginal lamella forms a scale-like projection against the suture (Pl. 7, Fig. 7). The whole surface is also covered by very fine antimarginal striae, which are more evident near the posterior and anterior margins of the disc and on the posterior auricles, where they are oblique to the costae. In the central part of the disc, where the antimarginal striae are parallel to the radials, there are between 3 and 4 striae on each interspace between costae.

The inner surface of the shell is almost smooth, the radial costae reflect only very slightly internally (Pl. 7, Fig. 2, 10). The margin is gently scalloped. The resilifer is triangular and centrally placed and there is one cardinal crus on each auricle, long and parallel to the hingeline and one tooth-like crus to each side of the resilifer in the right valve (Text-fig. 27b). No auricular crura are present. There is a conspicuous inner ridge on the right anterior auricle, from the beak to the antero-ventral extremity of the auricle, dorsally limiting the wide byssal fasciole. The dorsally projected portion of the right anterior auricle is vertically striated.

Measurements: Of best preserved specimens, [1] = number of radial riblets at a 20 mm length; [2] = total number of radial riblets. See also diagram on Text-fig. 31 and distribution of radial riblets on Text-fig. 33.

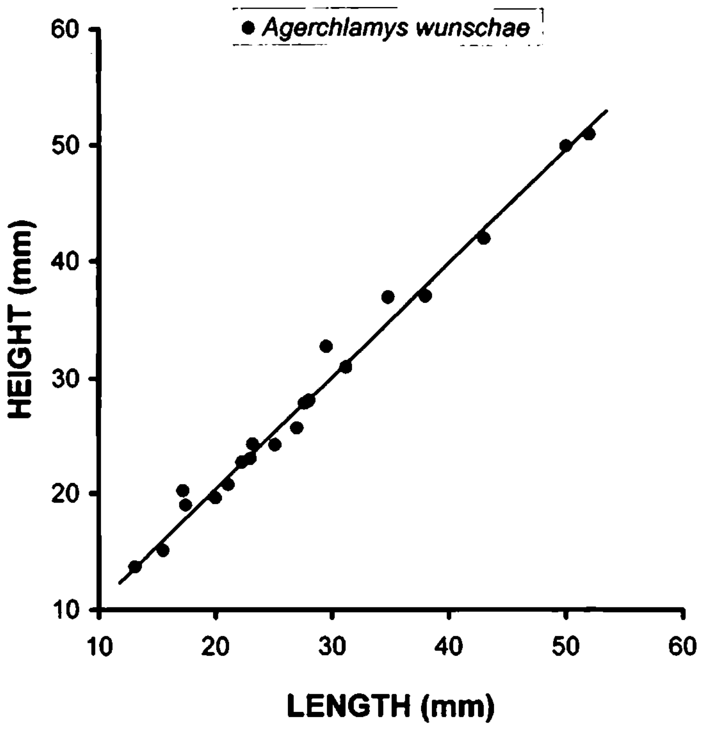
| Specimen MLP | Material | L (mm) | H (mm) | W (mm) | Lha (mm) | Lhp (mm) | Haa (mm) | N (mm) | ε (°) | Radials | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | [1] | [2] |
| 6029 | EM LV | 17.2 | 20.9 | 1.5 | 5.6 | – | 4.3 | – | – | 53 | 53 |
| 23653a | IM RV | 38.0 | 37.1 | 2.0 | 11.9 | 7.0 | 6.6 | 2.9 | – | – | – |
| 23653 | IM RV | 29.5 | 32.8 | 2.0 | 9.7 | 4.4 | 6.4 | 2.7 | – | – | – |
| 23656 | EM LV | 31.2 | 31.0 | 2.3 | 11.5 | – | 6.0 | – | 104 | 52 | 66 |
| 23658 | EM RV | 52.0 | 51.0 | 5.0 | 17.8 | 8.5 | 11.0 | 4.8 | 104 | 53 | 71 |
| 23659 | IM RV | 43.0 | 42.0 | 4.4 | 15.0 | 8.3 | 9.3 | – | 102 | – | – |
| 23660 | EM LV | 22.3 | 22.7 | 2.6 | 8.0 | 4.1 | 5.0 | – | 101 | 52 | 54 |
| 23664v | EM LV | 27.6 | 27.8 | 3.0 | 10.2 | 4.9 | 6.1 | – | – | 50 | 62 |
| 23664w | EM LV | 50.0 | 50.0 | 4.5 | 15.1 | 8.0 | 8.6 | – | – | – | – |

Affinities: The Argentinian specimens are confidently referable to Marwick's species *Agerchlamys wunschae* since they are similar in every detail to the New Zealand specimens (Marwick 1953a, pl. 10, figs. 23-24; Speden & Keyes 1981, pl. 13, figs. 2, 7; Damborenea & Manceñido 1992, fig. 6b; Damborenea 1993a, fig. 4a; Text-fig. 32 here). Observed differences concern, for instance, number of radial costae on the auricles, which is variable even within the Argentinian specimens.

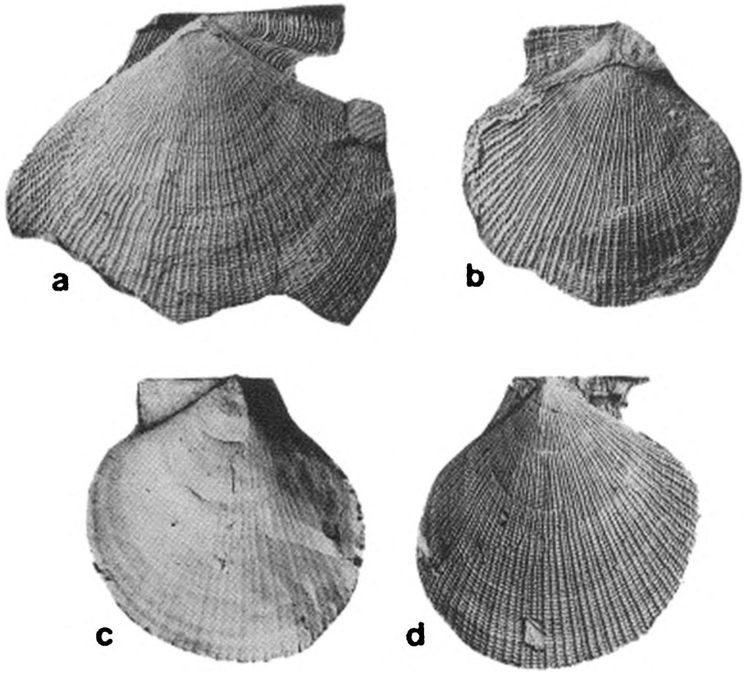
The most closely related species seems to be *A. inspecta* (Kiparisova) from the Late Triassic of eastern Siberia (Kiparisova in Kiparisova et al. 1966, pl. 17, figs. 7, 10; pl. 18, figs. 1–2; Bychkov et al. 1976, pl. 10, figs. 3–5) which has, nevertheless, much smaller shells, on some of which the cancellate ornament is restricted to the interspaces.

Both "*Pecten*" *subreticulatus* Stoliczka (1861, pl. 6, figs. 1-2) and "*P.*" *verticillus* Stoliczka (1861, pl. 6, figs. 3–4), from the Hierlatz Schichten of the Austrian Alps, have a similar shell shape and ornament pattern but are smaller and their right posterior auricle has a concave posterior margin.

Finely cancellated *Camptochlamys* from the middle Jurassic of Europe are known as *C. rosimon* (d'Orb.) (Morris & Lycett 1853, pl. 1, fig. 19 as *P. clathratus*; Fischer 1969, pl. 9, fig. 21; Radulovic & Mitrovic-



Text-fig. 31. Scatter diagram and regression line showing length/height (L/H) ratios in *Agerchlamys wunschae* (MARWICK) from Argentina, n = 22.



Text-fig. 32. New Zealand specimens of *Agerchlamys wunschae* (MARWICK), X 1. a – Holotype, NZGS TM 2406 (= MLP 24572), right valve, rubber mould; b – paratype, NZGS TM 2407 (= MLP 24573), left valve, rubber mould; c, d – Internal and external mould of a left valve, OU 14940.

Petrovic 1984, pl. 2, fig. 6) or treated as variants within *C. clathratus* (Roemer) (in Johnson 1984, pl. 5, figs. 1–2; Fürsich & Werner 1989b, pl. 15, figs. 6–7). These have a similarly ornamented disc, especially in the young portion of the shell, though the concentric lamellae seem to be more continuous and sometimes restricted to the umbonal region if compared to *Agerchlamys wunschae*.

Kanjilal (1979) figured a couple of specimens from the Callovian of western India as *Camptonectes (Camptochlamys) intertextus* (Roemer) (fig. 8) and *Camptonectes (Camptochlamys) kutchensis* Kanjilal (fig. 9). These are comparable to *A. wunschae* but the first has stronger comarginal lamellae and the second is much smaller.

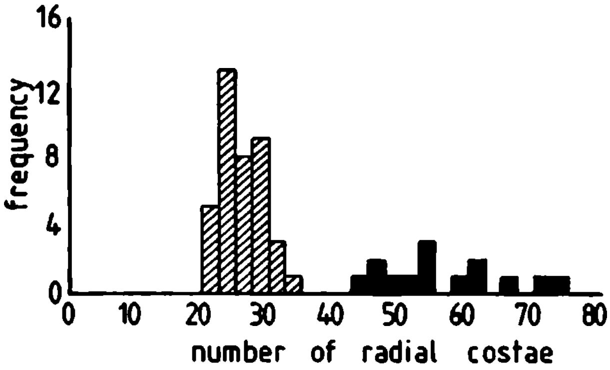
The internal and composite moulds of the Argentinian material are very similar to the specimens from the Pliensbachian of Japan described by Hayami (1957b, p. 122–123, pl. 20, figs. 7–10) as "*Camptonectes*" *oishii* Kobayashi & Hayami. If this relation could be proved, then the group of *Agerchlamys wunschae* may be also present in Japan, but unfortunately all the Japanese material described so far is preserved as sub-internal moulds.

"*Chlamys*" *mojsisovicsi* Kobayashi & Ichikawa, from the late Triassic of Japan, China, eastern Siberia and Oregon (Kobayashi & Ichikawa 1949, pl. 5, figs. 1–5; Hayami 1975, pl. 3, fig. 8; Bychkov et al. 1976, pl. 70, figs. 1–2; Chen 1982b, pl. 6, fig. 15; Newton et al. 1987, figs. 41.8–41.11) has a cancellate ornament but the radial costae are fewer and differentiated into several orders, the umbonal angle seems to be smaller and nobody has reported antimarginal striae on this shell.

The general shape of the shell, the ornament density and pattern are similar to those of *Chlamys transdanubialis* (Bittner) in Allasinaz (1972, pl. 47, fig. 10), but this species seems to lack the antimarginal striae.

*Agerchlamys wunschae* differs from some finely plicated species of *Chlamys*, for instance *C. bedfordensis* Duff (1978, pl. 5, figs. 14–16, 18, 21) from the middle Jurassic of Great Britain, the specimens referred to *Chlamys textoria* by Hayami (1959a, p. 52–55, pl. 5, figs. 23–26), from the Sinemurian of Japan; those referred to *Chlamys torulosa* (Qu.) by Sey (1984, tabl. 16, figs. 1517), from the Pliensbachian of eastern Russia; and *C. rollei* (Stoliczka) (Moore 1867, pl. 17, fig. 25; Dumortier 1869, pl. 22, fig. 1; Cox 1928, pl. 18, fig. 7) from the early Jurassic of Europe, by the more orbicular shape of the disc, the wider umbonal angle and raised comarginal lamellae. Johnson (1984) regarded these as variants of *C. textoria* (Schloth.). Specimens from several British localities housed at the Sedgwick Museum show that although the number of costae es similar to that in *Agerchlamys wunschae*, the costae are *Chlamys*-like, i.e., with beaded tops, quite different from *Agerchlamys* ornamentation. Johnson also (1984, p. 166) considered *Agerchlamys wunschae* as a possible junior synonym of *C. textoria* but stated (p. 173) that the antimarginal striae may serve to distinguish it. Although never reported for fossil species of *Chlamys*, antimarginal ornament is present in Recent species of this genus (Waller 1972a, text-fig. 11), in most cases limited to the umbonal region of the shell.

Autecology: In South America this species is found only in very finely-grained sediments, from marls to tuffaceous siltstones, but never in laminated dark mudstones. There is only one specimen known from a tuffaceous sandstone. *Agerchlamys wunschae* is locally abundant in certain beds rather than widespread and seems to have been a stenotopic species limited to very low-energy but well-oxygenated environments. It is generally associated to a variety of limid species and commonly occurs with sponge spicules (Pl. 7, Fig. 6). It is never associated to corals or thick-shelled epifaunal bivalves.



Text-fig. 33. Histogram showing the distribution of the number of plicae in "*Chlamys*" *textoria* (ruled) and *Agerchlamys wunschae* (black) from the Argentinian Early Jurassic.

*Agerchlamys wunschae* was a byssally attached pectinid, as shown by the deep byssal notch and strong ctenolium. Sponges could have been one of the suitable substrates for this species. The valves often bear epizoic organisms on its external surface, such as plicatuloideans (Pl. 7, Figs. 1, 6; Text-fig. 45c), small oysters and serpulids (Pl. 7, Fig. 7). *Placunopsis* cf. *striatula* (Oppel) and serpulids are also found as epizoic on inner surfaces of left valves, and MacFarlan (1992) figured a right valve of this species from New Zealand with the brachiopod *Herangirhynchia herangiensis* MacFarlan attached to its inner surface.

### Genus *Ochotochlamys* Milova & Polubotko 1976

Type species: *Chlamys (Ochotochlamys) gizhigensis* Polubotko 1976 (in Milova 1976), from Norian beds of Gizhiga river basin, northeast Russia, original designation.

Remarks: Milova & Polubotko introduced the name *Ochotochlamys* as a subgenus of *Chlamys* in two almost simultaneous papers: in Bychkov et al. (26/7/1976, p. 69) and in Milova (23/8/1976, p. 61). The first paper precedes the latter by a few days, and it also offers a more complete diagnosis. This is freely translated as follows:

"Shell of almost circular outline with valves moderately and equally convex. Left valve with delicate to fairly thick radial ornament, but right valves smooth or with very faint radial lines. *Chlamys*-like auricles but less different in size than in that genus, sometimes almost subequal; below the anterior right valve auricle there is a shallow byssal notch, sometimes scarcely visible. Left valve with lateral depressions and swellings, of which the posterior one is better developed, the anterior one being weak or even imperceptible" (Bychkov et al. 1976, p 70).

This genus was thought to be endemic to the Upper Jurassic-Lower Jurassic of northeast Asia (Sey & Kalacheva 1988, p. 41) but since then it was found in Canada (Aberhan 1998) and southern Argentina (Damborenea 1997a, species described herein) (Text-figs. 6–7). It is absent from peri-equatorial regions, for instance, it has not been found in southern Russia (Romanov 1985) or Europe.

As stated by Damborenea (1997b) the relationships of *Ochotochlamys* were poorly known and it was thought it could even belong to the Propeamussiidae, but the presence of a ctenolium indicates its inclusion within the Pectinidae s.s. Furthermore, it is probably related to the *Hyalopecten* Verrill group (Damborenea 1997a), as shown by a direct comparison of the diagnosis of both genera (see above and in Schein 1989, p. 77–78; Dijkstra 1995, p. 47). Waller & Marinkovich (1992) stressed that *Hyalopecten* lacks antimarginal microsculpture and stated that it is closely related to *Praechlamys*.

### *Ochotochlamys* sp.

(Pl. 9, Figs. 16–20, Text-figs. 8j-k)

Material: Four right, four left valves and several fragments preserved as internal or external moulds, from late Pliensbachian (*Fanninoceras* Zone) in Cañadón Cerro Negro (E.1), Chubut: MLP 27590 to 27596 (M 1236).

Description: Medium-sized sub-equivalve and sub-equilateral shells (up to 36 mm long), of subcircular outline, with rather large auricles. Both valves equally convex but convexity very low. Dorsal margin straight, anterior auricles longer than posterior ones. Anterior margin of anterior auricles meets the dorsal margin at an acute angle, posterior margin of posterior auricle meets dorsal margin at an obtuse angle. Rather deep byssal notch with ctenolium made up of very small equally spaced denticles. Anterior auricles with two or three radial ribs, right posterior auricles with very faint radial line. Disc flat, umbo placed at about mid-length. Anterior and posterior margins of disc straight, posterior margin merging with posterior margin of posterior auricle without interruption, ventral margin evenly convex. Anterior sutures well-defined, posterior sutures inconspicuous. Umbonal angle wider than 100°.

Left valve ornamented by narrow and wavy radial lines of different orders separated by wide interspaces and which intersect narrow, numerous and equally spaced comarginal lines (Pl. 9, Fig. 20). Right valve ornamented by regular comarginal lamellae and only very faint radial costae which do not interrupt the comarginal elements (Pl. 9, Figs. 18, 19).

Triangular small resilifer and narrow dorsal ligamental grooves. The inner surface seems to be smooth and the hinge region is quite simple without cardinal or auricular crura or denticles.

Measurements: Of well-preserved specimens.

| Specimen MLP | Material | L (mm) | H (mm) | Lh (mm) | Lha (mm) | ε (°) |
|---|---|---|---|---|---|---|
| 27590 | EM RV | 36.3 | 35.4 | 18.4 | 13.1 | 115 |
| 27591 | IM RV | 12.2 | - | 8.8 | 5.4 | 104 |
| 27592 | EM RV | 18.4 | 18.2 | 9.5 | 6.3 | 105 |
| 27593 | IM ?V | 16.3 | 16.0 | - | - | - |

Affinities: This species is characterized by its regular comarginal ornamentation on both valves and unequal auricles. Nevertheless, due to the scarcity of material no new name is erected and open nomenclature is used. The specimens are, though, sufficiently well-preserved to establish detailed comparisons.

Of the known species of *Ochotochlamys*, the most similar to the material here described is *O. kiparisovae* (Milova 1983, pl. 1, figs. 1–9; 1988, pl. 15, figs. 17–20, pl. 16, figs. 1–9), from Hettangian beds in eastern Russia, with equivalent size and shape, though the comarginal ornamentation is more regular in the Argentine material.

All Pliensbachian species from northeastern Russia differ significantly from O. sp. Thus, *Ochotochlamys grandis* (Polubotko) (in Polubotko & Milova 1986, pl. 16, figs. 8–10; Milova 1988, pl. 16, figs. 10–13, pl. 17, figs. 1–3) is much larger and has stronger radial costae and less conspicuous comarginal ornament. *Ochotochlamys bureiensis* (Sey) (1984, pl. 17, figs. 1–3; Sey & Polubotko 1992, pl. 121, fig. 8) has subequal auricles.

From the type species, *O. gizhigensis* (Polubotko) (in Milova 1976, pl. 8, figs. 8–12; in Bychkov et al. 1976, pl. 50, figs. 6–10; Okuneva 1989, pl. 1, figs. 16–17) the material here described can be distinguished by its unequal auricles and deeper byssal notch. Among the late Triassic species from the northern hemisphere, O. sp. can be compared to *O. vodopadnyensis* (Milova 1976, pl. 8, fig.13, pl. 9, figs. 1–6), which has a similar shell shape and size, but denser radial ornament and less regular comarginal lines.

This species differs from *Agerchlamys wunschae* (Marwick), with which it is associated, by its different ornament on both valves, less regular radial ribs (of several orders) and the lack of antimarginal microsculpture.

Among living pectinids the *Hyalopecten* group includes deep-water species which are comparable to O. sp. in shape and ornament pattern, though they are much smaller, such as *H. mireilleae* Dijkstra (1995, figs. 79–82), but *Hyalopecten* species have narrower umbonal angle and lack posterior sutures.

Autoecology: The material here described was found in fine-grained light coloured mudstones with other pectinids, nuculids and brachiopods as the only accompanying fauna. They correspond to relatively deep (or restricted) littoral environments. *Ochotochlamys* was a byssate pectinid.

As already stated, *Ochotochlamys* is morphologically similar to the pectinid genus *Hyalopecten*, which contains small thin-shelled species nowadays restricted to deep-sea habitats (Schein 1989, Dikjstra 1991, 1995). If this is so, the environmental range of this group of pectinids shifted from littoral during the late Triassic-Early Jurassic to bathyal-abyssal in Caenozoic times (Damborenea 1997a).

### Genus *Praechlamys* Allasinaz 1972

Type species: *Pecten (Chlamys) inaequialternans* Parona 1889, Carnian, Alps, by original designation (Allasinaz 1972, p. 340).

In his revision of Triassic pectinids, Allasinaz (1972) described *Praechlamys* as a subgenus of *Chlamys*. A translation of his diagnosis (p. 340) is as follows:

"Medium-sized to large shells, equilateral, equivalve or with right valve slightly flatter than left valve. Auricles well defined and proportionated, byssal sinus present, generally deep. Ornament similar on both valves, made up of radial costae and lines of different orders, regularly distributed and without nodes or scales; interspaces of variable width; concentric lines generally present, sometimes in relief. Internal characters unknown."

This diagnosis is not very practical since it includes many general features that are shared by several taxa. Throughout his paper Allasinaz (1972) paid special attention to ornament patterns for his supraspecific arrangement. From an analysis of the type species and others which he included in this taxon, it is concluded that

*Praechlamys* shells are equilateral and have auricles of subequal size. WALLER & MARINCOVICH (1992, p. 223) add that costae increase by intercalation on both valves, shells lack prominent antimarginal microstructure even on its disc flanks and usually have a peculiar radial depression on the posterior part of the left disc. MONARI (1994) listed several early Jurassic species with this last-mentioned character, which was not mentioned in the original diagnosis.

The material here described can be readily accomodated within *Praechlamys* even in its strict sense (group of *P. inaequialternans* sensu ALLASINAZ 1972, p. 235, 341). This is also the case of other Early Jurassic species from elsewhere (see WALLER & MARINCOVICH 1992, MONARI 1994 and discussion below). This re-opens the question of the true relationships of Mesozoic taxa previously referred to *Chlamys* s.l., which are badly in need of revision. *Praechlamys* may be a useful taxon to accomodate some of them, but its diagnosis and included species should be reviewed.

### *Praechlamys* cf. *valoniensis* (DEFRANCE 1825)

(Pl. 8, Figs. 9–15)

cf. 1984 *Chlamys* (*Chlamys*) *valoniensis* – JOHNSON, p. 179–185, pl. 9, figs. 1–6. (see synonymy list in this paper).
1994 *Chlamys* (*Chlamys*) *valoniensis* – ABERHAN, p. 40, pl. 19, figs. 7–9.
1998 *Chlamys* (*Chlamys*) *valoniensis* – ABERHAN, p. 112, pl. 12, figs. 14, 17, 19, 22.

Material: Fifteen specimens, most of them moulds, from latest Hettangian (*Badouxia canadensis* Ammonite Zone) to late Sinemurian (*Epophioceras* Amm. Zone) in the Atuel river area, Mendoza Province (localities B.14 and B.16): MLP 25006 to 25011 (M 1415, 1419, 1468 and 1718).

Description: Medium-sized nearly equilateral inequivalve shells, with sub-ovate to sub-orbicular disc and long dorsal line. Height greater than length in young specimens, becoming equal to each oher in large shells. Right valve almost flat, left valve moderately inflated. Umbonal angle about 90°. Auricles large and clearly separated from the disc but deep sutures only present on right valve. Anterior auricles between two and three times longer than posterior ones. Right anterior auricle narrow and long, sub-rectangular in shape and with a deep ctenoliate byssal notch (Pl. 8, Figs. 11, 13). Anterior margins of anterior ears meet dorsal margin at about 90°, whereas posterior margin of posterior ears meet dorsal line at an obtuse (c. 120°) angle. Umbones low and placed at about mid-length, left one slightly protruding above hinge-line.

Disc and auricles ornamented by irregular radial plicae separated by narrow intervals. Plicae have smooth rounded tops and increase in number by intercalation to about 60 in large specimens (Pl. 8, Figs. 13, 14). Primary plicae are reflected on internal moulds. Large specimens have strong comarginal folds near ventral margin which may indicate sharp variations in growth rates at that stage (Pl. 8, Fig. 13).

Other internal characters unknown.

Measurements: Of best preserved specimens. [1] = total number of radial plicae.

| Specimen MLP | Material | L (mm) | H (mm) | W (mm) | [1] |
|---|---|---|---|---|---|
| 25006 | LV? EM | (22.0) | 24.5 | 4.2 | 43 |
| 25007 | LV? IM | 32.1 | 34.9 | 3.8 | 50 |
| 25008 | LV IM | (18.4) | 19.3 | 2.1 | 26 |
| 25009 | RV EM | 22.0 | – | 2.0 | 37 |
| 25011 | RV IM | 28.4 | 30.0 | 2.0 | c.60 |
| 25012 | LV IM | 26.5 | 31.6 | 4.2 | c.50 |

Affinities: The specimens described here clearly belong to the group of "*Chlamys valoniensis*" (DEFRANCE) as defined by STAESCHE (1926) and can be compared with the few available figures on this or closely related taxa from Rhaetian-Sinemurian beds of Europe (TERQUEM 1855, pl. 23, fig. 6 as *Pecten dispar*; QUENSTEDT 1858, pl. 1, figs. 33–34 as *Pecten cloacinus*; pl. 4, figs. 8–9 as *Pecten disparilis*; TAWNEY 1866, pl. 3, fig. 4 as *Pecten etheridgii*; pl. 3, fig. 3 as *Pecten suttonensis*; STAESCHE 1926, pl. 2, fig. 4 as *Chlamys acutaurita*; KOCHANOVA 1961, pl. 2, fig. 2; 1967, pl. 1, fig. 3; LENTINI 1974, pl. 14, figs. 8–10; pl. 15, figs. 1, 2, 4, 5 as *Chlamys dispar*; JOHNSON 1984, pl. 9, figs. 1–6), Chile (ABERHAN 1994, pl. 19, figs. 7-9) and Canada (ABERHAN 1998, pl. 12, figs. 14, 17, 19, 22). Specimens from Argentina have more unequal auricles and more radial plicae according to Johnson's description but are nevertheless very similar to some of the above mentioned figures. Open nomenclature has been preferred on account of these differences.

*Praechlamys inaequialternans* (PARONA) (ALLASINAZ 1972, pl. 46, figs. 6–8) and *P. badiotica* (BITTNER) (ALLASINAZ 1972, pl. 45, figs. 4–5), both from the Carnian of the Alps, have more radial ribs which are separated by very narrow interspaces. The ribbing patters of *P. subalternicosta* (BITTNER) (ALLASINAZ 1972, pl. 48, figs. 1–2), from the Hungarian Carnian, is coarser and the auricles of this Triassic species are more equal to each other than in the Argentinian material.

WALLER & MARINCOVICH (1992) referred to *Praechlamys* the species *Pecten palosus* and *Pecten subreticulata* STOLICZKA (1861), from the Hierlatz Schichten of the Austrian Alps, but these shells have a cancellate ornament more akin to that of *Agerchlamys* and thus differ from *P.* cf. *valoniensis*.

Some imperfectly preserved specimens from the earliest Jurassic of the Andes have intermediate characters between *Camptonectes ? subulatus* (MÜNSTER) and *Praechlamys* cf. *valoniensis* (DEFRANCE) and are difficult to refer to either of these two species. These "pairs" include, for instance, *Pecten cloacinus* and *Pecten disparilis* in QUENSTEDT (1858) or *Pecten suttonensis* and *Pecten etheridgii* in TAWNEY (1866). This problem has been discussed by JOHNSON (1984) and his criteria are basically followed here to refer intermediate specimens from Argentina.

The material here described can be distinguished from "*Chlamys*" *textoria* (SCHLOTHEIM) by its more inequivalve shell with a left valve more inflated, the shape and ornament of the auricles, the greater number of radial plicae and the smooth or only faintly irregular tops of radial plicae (see below).

### Genus "*Chlamys*" RÖDING 1798

Type species: *Pecten islandicus* MÜLLER 1776, recent, circumboreal, subsequent designation by HERRMANNSEN 1847, p. 231.
Synonyms: see DUFF (1978, p. 68) and JOHNSON (1984, p. 161).

The genus *Chlamys* was regarded as one of the main stocks within the Pectinidae, known with almost no change since Triassic times (COX 1952). It was used in a very broad sense by most authors and a great number of species, both living and extinct, have been referred to it.

Concerning Mesozoic species of *Chlamys*-like form, there have been many attempts, most of them unsuccessful, to recognize different groups within the genus (see extensive discussion in ALLASINAZ 1972).

WALLER (1993) analyzed the phylogenetic relationships of Cenozoic Chlamydinae and recognized four extant tribes. Shell microstructure and type, order of appearance and distribution of the different kinds of ornament on early growth stages are key characters at the generic level. Unfortunately, there is no comparable knowledge on these useful characters for the Mesozoic species and it is unlikely that a sufficient amount of data on these features could ever be achieved to provide a comparably sound basis for their classification. It is evident that other characters should be used.

WALLER & MARINCOVICH (1992) and MARINCOVICH (1993) regard *Chlamys* as a mainly Cainozoic genus. WALLER (1993) characterizes the tribe Chlamydini by the presence of shagreen microsculpture at least on some growth stages and by having hinge plate and auricles composed of foliated calcite. This leaves out the vast number of Mesozoic species.

ALLASINAZ (1972) revised Triassic species and recognized three taxa of subgeneric rank: *Chlamys* s.s., *C. (Praechlamys)* and *C. (Granulochlamys)*. These are distinguished, in their original sense, mainly by ornament patterns. Though these taxa were not generaly adopted by subsequent authors (except by MONARI 1994), they could accomodate some Jurassic species if properly revised to take into account other shell characters and allow for variability.

Concerning the material here described, it can be easily referred to the ubiquitous species "*Chlamys*" *textoria* (SCHLOTHEIM). Its generic affinities, though, are much more difficult to establish and this question is, unfortunately, beyond the possibilities of this research, since it involves revision of European key material.

Although ALLASINAZ (1972) mentioned that *Praechlamys* could even include Mesozoic species of the *textoria* group, his original diagnosis states that shell is equilateral with proportionated auricles and that radial costae lack scales or nodes. Moreover, the type species and others originally included in *Praechlamys* differ from the group of "*Chlamys*" *textoria* in many shell and ornament features. Jurassic shells referred to "*Chlamys*" *textoria* (see Johnson 1984) are slightly but always inequilateral, with very unequal auricles and scaly ribs and thus cannot be referred to *Praechlamys* without a revision of its diagnosis. It seems that a new generic name is needed to include these species, but a new taxon cannot be erected without a proper revision of its key species and thus open nomenclature is preferred here.

### "*Chlamys*" *textoria* (Schlotheim 1820)
(Pl. 8, Figs. 1–8)

1891 *Pecten textorius* – Behrendsen, p. 389.
1894 *Pecten textorius* – Möricke, p. 37.
? v 1899 *Lima exasperata* – R. Philippi, p. 19, lám. 10, fig. 3.
? 1899 *Pecten andinus* – R. Philippi, p. 28, lám. 16, fig. 4.
v p 1899 *Pecten heterodines* – R. Philippi, p. 29, lám. 16, fig. 8 right (only).
? v 1899 *Pecten martinezi* – R. Philippi, p. 36–37, lám. 20, fig. 9.
?vp 1899 *Pecten abnormis* – R. Philippi, p. 37–38, lám. 20, fig. 12a (only) (non Hupé).
1900a *Pecten textorius* – Burckhardt, p. 24, lám. 19, fig. 10.
1900a *Pecten* cf. *textorius* – Burckhardt, p. 37.
1903 *Pecten textorius* – Burckhardt, p. 7–8.
1915 *Pecten textorius* – Jaworski, p. 436–437.
1915 *Pecten textorius torulosa* – Jaworski, p. 437.
1922 *Pecten textorius* – Behrendsen, p. 173.
1925 *Pecten textorius* – Jaworski, p. 48–49.
1925 *Pecten textorius torulosa* – Jaworski, p. 49–50.
1926a *Pecten* (*Chlamys*) *textorius* – Jaworski, p. 167.
1931 *Pecten textorius torulosa* – Weaver, p. 271, pl. 28, figs. 165–166.
? 1934 *Pecten* sp. – Feruglio, p. 38.
v p 1942 *Pecten* (*Entolium*) *disciformis* – Wahnish, lám. 2, fig. 2 (only, not the description).
v 1942 *Pecten textorius* – Wahnish, p. 38–39 (+lám. 2, fig. 2, see above).
v 1942 *Pecten* sp. – Wahnish, p. 40.
v 1942 *Pecten* (*Chlamys*) *textorius* – Leanza, p. 172, lám. 7, fig. 2.
1955 *Pecten* (*Chlamys*) *textorius* – Ugarte, p.149.
v 1975 *Chlamys* – Damborenea et al., cuadro I, 21.
1981 *Chlamys* cf. *textoria* – Hillebrandt & Schmidt-Effing, p. 12, 19, 21, 25.
v 1992 *Chlamys textoria* – Damborenea, pl. 117, fig. 4.
1992 *Camptonectes* (*Camptochlamys*) sp. – Thomson & Smith, pl. 2, fig. 1.
1994 *Chlamys* (*Chlamys*) *textoria* – Aberhan, p. 39–40, pl. 18, fig. 10; pl. 19, figs. 1–6; text-fig. 18.
1998 *Chlamys* (*Chlamys*) *textoria* – Aberhan, p.111, pl. 12, figs. 15, 16, 20, 21, 23.

Note: Only post 1984 and main South American references have been included. For a complete synonymy list see Johnson (1984, p. 163–167), who also designated and figured the lectotype of the species.

Material: About a hundred almost complete specimens were available, most of them isolated valves preserved as external or internal moulds, plus many fragmentary valves. This species has a very wide geographical distribution in Argentina from San Juan to Chubut Provinces. It has been found at the following localities, listed from North to South: Arroyo La Laguna (A.2): MLP 23605, 23606 (M 447); Puesto Araya (B.1): MLP 25055, 25069 (M 1925, 1926); Arroyo Las Chilcas (B.16): MLP 23643 (M 1269); Portezuelo Ancho (B.4): MLP 17248; Arroyo del Portezuelo Ancho (B.5): MLP 23607, 23619 to 23629, 27946 (M 599, 1291 to 1293, 1298, 1299, 1301, 1302, 1306, 1307 and Lanés' collection); Arroyo Serrucho (B.8): MLP 22340, 23630 to 23637 (M 1316, 1328 to 1331, 1333, 1341, 1342); Cerro Puchenque (B.9): MLP 22330, 23593 to 23604 (M 320 to 327, 331, 335); Mina Tránsito (B.17): MLP 10417; Cordillera del Viento (C.1): MLP 15422, 15428, 15444, 15483, 23644 (M 1221 and Clavijo's collection); Vuta Picún Leufú (C.7): MLP 23614, 23642 (M 1081, 1085); Arroyo Lonqueo (C.9): MLP 23615 to 23617 (M 1193, 1196); Cerro Granito (C.14): MLP 2389, 4859; Charahuilla (C.16): MLP 8807, 8846; Arroyo Ñireco (C.20): MLP 23638 (M 1362); South of Estancia Santa Isabel (D.1): MLP 23609 to 23613 (M 1055); Salitral Grande (D.3): MLP 16267, 23608 (M 145, 1042); Eastern slope of Cerro Corona (D.10): MLP 6013 to 6016, 6018, 6019, 6213, 6218, 6247, 6250, 6256, 6263, 23589 to 23591 (M 129); Cerro Del Vasco (D.12): MLP 23588 (M 121); South of Cerro Roth (D.15): MLP 23584 to 23587 (M 98, 99, 101); Cerro Roth (D.16): MLP 6062, 23639 (M 1383); Nueva Lubecka, Chubut: DNGM 8843, 8858, 8859.

This species ranges in age through most of the Early Jurassic in Argentina, at least from Sinemurian times up to Toarcian. It is also present, though far less common, in Middle Jurassic Argentinian deposits, where it attains a larger size.

Remarks: Johnson (1984, p. 173) stated that "the figures of '*P. peruanus*' Tilmann ... depict imperfectly preserved specimens in which neither the number of plicae nor the metric proportions could be accurately measured" and included them in the synonymy of "*Chlamys*" *textoria*. Nevertheless this cannot be done with certainty without examining the actual specimens, as the umbonal angle of TILMANN's specimens (1917, pl. 24, figs. 45) seems to be higher than in "*C.*" *textoria* and the sutures are not so deep. Furthermore, the pattern of ornamentation shows some differences, such as the lack of imbricate lamellae on top of the plicae and the wavy appearance of the plicae-tops. Thus this record cannot be regarded, as stated by JOHNSON (1984, p. 173) as the earliest occurrence of this species in South America (see further discussion under *Kolymonectes weaveri* DAMBORENEA).

The material described by WAHNISH (1942) as *Pecten textorius* (DNGM 8843, 8859) and the specimen erroneously figured by her as *Entolium disciformis* (DNGM 8858) are all regarded here as "*C.*" *textoria*. The specimens from Chubut are not well preserved and thus the details of the ornamentation cannot be observed. Some of the specimens seem to have smooth-topped plicae.

The specimens referred by LEANZA (1942) and by some later authors (LIZUAIN 1980, HALLER et al. 1981, CUERDA et al. 1981, 1982, MANCEÑIDO & DAMBORENEA 1984) to *Chlamys textoria torulosa*, are here regarded as belonging to *Agerchlamys wunschae* (MARWICK), but those equally referred to by JAWORSKI (1915, 1925) and WEAVER (1931) do belong here.

The specimen described by R. PHILIPPI (1899, p. 36–37) as "*Pecten Martinezi*" was regarded by GROEBER et al. (1953, p. 240) as "a young form of the group of *Vola alata* v. BUCH" but the material (SGOPI 910) clearly shows an internal mould of a *Chlamys* species (Text-fig. 28c) which is very similar to those of the species here described. Likewise, R. PHILIPPI's material of both *Pecten abnormis* HUPÉ (SGOPI 888) and *Lima exasperata* PHIL. (SGOPI 941, Text-fig. 28e, f) correspond to incomplete specimens of a "*Chlamys*" of the textoria group.

Description: Middle-sized, slightly inequilateral and inequivalve, weakly inflated shell. Left valve more convex than right valve, which is almost flat. Valves sub-equilateral, disc shape sub-ovate in adults, more suborbicular in young specimens, but always higher than long. Umbonal angle about 90°, variable between 85° and 97°, increasing with ontogeny.

Hinge-line long, about two-thirds of total length. Dorsal margin of right valve concave, straight in left valve. Auricles clearly demarcated from disc by a deep suture. Anterior auricle larger than posterior. Posterior auricles subequal. Margins of posterior auricles meet dorsal line at an obtuse angle and disc at an acute angle (Pl. 8, Figs. 1–2). Margins of anterior auricles meet hinge-line at slightly less than 90° and disc at approximately 90°. Right anterior auricle with deep byssal notch with strong ctenolium and wide byssal fasciole (Pl. 8, Figs. 1–2). The dorsal margin of the anterior right auricle projects above the hinge-line. External surface of right valve auricles flat, of left valve auricles slightly convex. Auricular gapes probably present.

Disc ornamented with a variable number (see Text-fig. 33) of radial plicae, which increase in number by splitting (or branching) and sometimes also by intercalation on left valves. Regularly spaced comarginal lamellae are also present on the interspaces and every third one of these is higher on the tops of the plicae and become scales, whilst the others are limited to the bottom of the interspaces (Pl. 8, Fig. 8). The lamellae are generally stronger on left than on right valves. Comarginal strong lamellae cover all the auricles. The posterior auricles also bear about seven radial costae and the left anterior auricle about four radial costae. The density of radial plicae and the distribution of the scales is very variable.

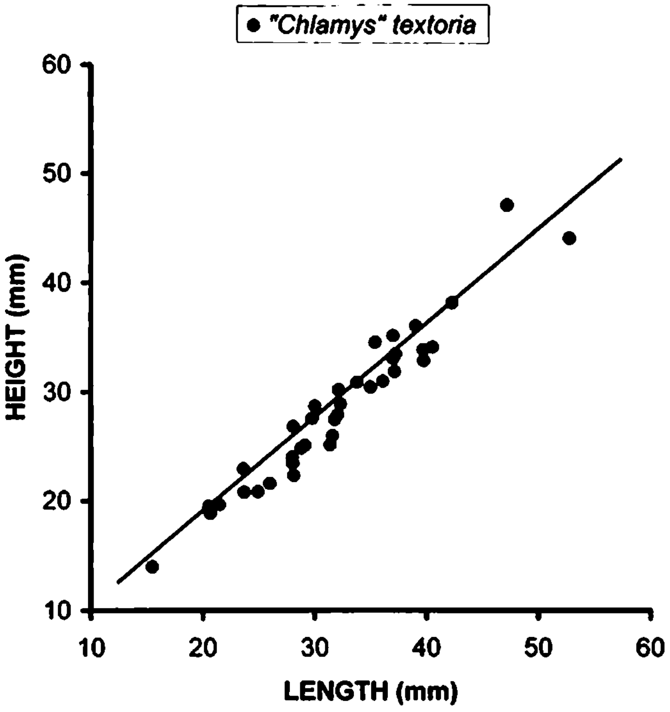
The main plicae are also seen on the inner surface of the valves (Pl. 8, Figs. 2, 7). The inner margin of both valves is scalloped. The inner surface of the auricles is smooth, without auricular crura. The right anterior auricle bears an inner ridge running from the beak to the antero-ventral extremity of the auricle, dorsally limiting the byssal fasciole. The resilifer is triangular in shape. It is central in the left valve but slightly anterior to the beak in the right valve. Each auricle bears a long cardinal crus which extends for most of the auricle length, parallel to the hinge-line (Text-figs. 27d). The dorsal projection of the right valve auricles is vertically striated.

Measurements: Of best preserved specimens; see also scatter diagrams on Text-fig. 34 and 35 and distribution of radial plicae on Text-fig. 33. [1] = number of plicae at a length of 20 mm; [2] = total number of plicae.

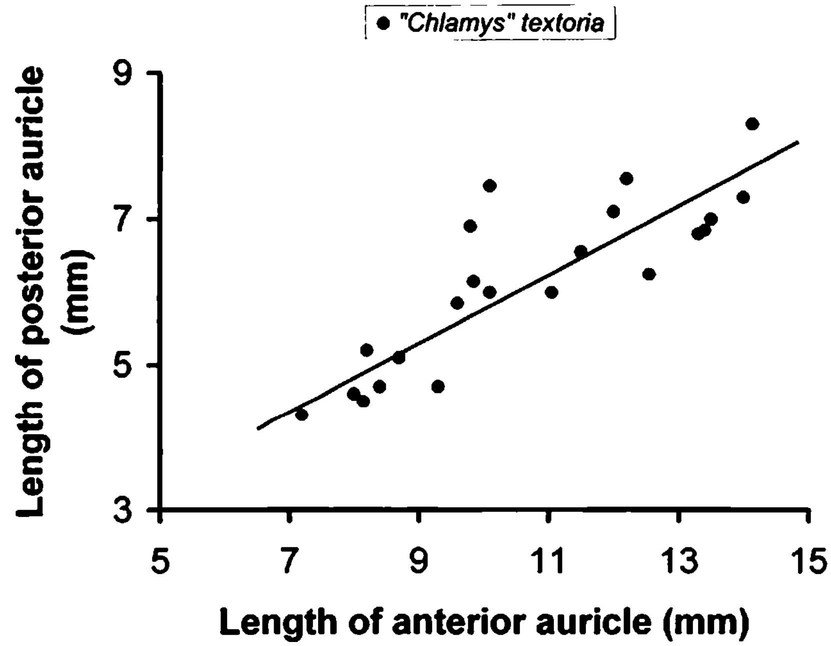
| Specimen MLP | Material | | L (mm) | H (mm) | W (mm) | Lha (mm) | Lhp (mm) | Haa (mm) | N (mm) | ε (°) | [1] | [2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22330 | RV | EM | 31.9 | 37.1 | 2.0 | 12.2 | 7.5 | 7.9 | 5.0 | 93 | 27 | 29 |
| 23593 | RV | EM | 28.9 | 32.3 | 2.5 | 12.5 | 6.2 | 7.1 | 6.0 | 91 | 30 | 32 |
| 23602 | LV | IM | 27.5 | 31.8 | 3.4 | 10.1 | 7.4 | 8.8 | – | – | 23 | 26 |
| 23607 | RV | EM | 36.1 | 39.0 | 1.7 | 14.1 | 8.3 | 8.0 | 7.1 | 92 | 25 | 29 |
| 23609 | RV | EM | 33.5 | 37.2 | 2.3 | 13.4 | 6.8 | 10.0 | 7.0 | 88 | 29 | 35 |
| 23611 | RV | IM | 34.1 | 40.1 | – | 13.5 | 7.0 | 8.6 | 6.2 | 86 | 19 | 24 |
| 23630 | RV | IM | 28.7 | 30.0 | 2.2 | 9.8 | 6.1 | 5.9 | 4.6 | 97 | 22 | 25 |
| 23633 | RV | IM | 30.9 | 33.8 | 1.0 | 12.0 | 7.1 | 7.0 | 4.0 | 94 | 23 | 24 |

Affinities: This is a cosmopolitan species with a very wide distribution along all the Jurassic sea-ways (Johnson 1984). The Argentinian specimens fall well within the accepted range of morphological variability of this species, even if considered in a restricted sense (see illustrations in Goldfuss 1833, pl. 89, figs. 9a-d; Quenstedt 1858, pl. 9, fig. 12, pl. 18, fig. 17, pl. 42, fig. 10, pl. 67, fig. 5, pl. 98, fig. 3; Dumortier 1869, pl. 22, fig. 2, pl. 39, figs. 1–2; 1874, pl. 44, fig. 12; Parona 1890, pl. 1, figs. 11–12; Staesche 1926, pl. 1, figs. 8, 9; Dechaseaux 1936, pl. 1, figs. 1–4; Petrova 1947, pl. 17, fig. 7; Johnson 1984, pl. 6, figs. 10–12, pl. 7, figs. 1–21, pl. 8, figs. 1–3, 5–20; Romanov 1985, pl. 8, fig. 9; Jaitly et al. 1995, pl. 20, figs. 3–7; see Johnson 1984 for more references). Johnson (1984) recognized three morphotypes according to the ornamentation pattern, called "coarse", "intermediate" and "fine" phenotypes. Following his criteria, the material here described belongs mostly to the first morphotype, though there are some specimens of the second and third. The variability in ornament patterns is great, as is the case of most pectinoideans which are adequately known by abundant material (see for instance Newell & Boyd 1985b). The specimens figured by Thomson & Smith (1992, pl. 2, fig. 1) as *Camptonectes* (*Camptochlamys*) sp. from the Pliensbachian of western Canada seem to belong here.

This species differs from *Agerchlamys wunschae* (Marwick) from the Pliensbachian of New Zealand and Argentina (Marwick 1953a, p. 98–99, pl. 10, figs. 23–24; Speden & Keyes 1981, pl. 13, figs. 2, 7 and Pl. 7,



Text-fig. 34. Scatter diagram and regression line showing length/height (L/H) ratios in "*Chlamys*" *textoria* (Schlotheim), n = 39.



Text-fig. 35. Scatter diagram and regression line showing the length of anterior auricle/length of posterior auricle (Lha/Lhp) relation in "*Chlamys*" *textoria* (SCHLOTHEIM), n = 23.

Figs. 1–10 here) and from "*Chlamys*" *bedfordensis* DUFF (1978, p. 69–70, pl. 5, figs. 14–16, 18, 21, text-fig. 23) from the Callovian of Great Britain, by having a smaller umbonal angle, less orbicular shape and by the kind of ornamentation. While "*C.*" *textoria* has relatively few radial plicae, the other two species have densely packed radial costae, which do not appear on the inner surface of the valves. *Agerchlamys wunschae* also has antimarginal ornamentation.

Autecology: Already discussed at length by JOHNSON (1984).

### Family uncertain

### Genus *Pseudopecten* BAYLE 1878

Type species: *Pecten equivalvis* J. SOWERBY 1816, Early Jurassic of Europe, by monotypy.

Species of *Pseudopecten* are conspicuous elements of Early Jurassic faunas in Europe, where specimens may attain a very large size (more than 15 cm). This genus is comparatively rarer in the Americas. This fact was already noticed by E. PHILIPPI (1900) who suggested that the group of *P. equivalvis* was replaced in South America by its vicariant species *Weyla alata* (v. BUCH). Lately HALLAM (1977a, p. 64; 1977b, p. 26; 1983, p. 187) reworded this idea proposing ecological competition between *Pseudopecten* and *Weyla* as the cause of their mutual exclusion in those areas. JOHNSON (1984) pointed out that both *Weyla* and *Pseudopecten* are absent from Asia, Australia and Antarctica. Nevertheless, small specimens from the lower Jurassic of Japan (those described as "*Aequipecten*" *toyorensis* by HAYAMI 1959a, p. 55–57, pl. 6, figs. 1–5) and eastern Siberia (*Aequipecten priscus borealis* MILOVA 1976, p. 66, pl. 10, figs. 3–5) may be referable to *Pseudopecten*. *Pseudopecten* only displays a great abundance and diversity in Europe and northern Africa, being uncommon elsewhere. Nevertheless, it is present, and attains locally large size, in the central Andes of Argentina and Chile, as discussed below, and has recently been recognized in the Australian continental slope (GRANT-MACKIE 1994).

Curiously enough, the generic name *Pseudopecten* was almost exclusively used by French authors for a long time (DOUVILLÉ 1897, DUBAR 1925, 1931, LANQUINE 1929, DECHASEAUX 1936, CHARLES 1948 and TROEDSSON 1951), most of whom also recognized its biostratigraphical value. This name was only adopted in a generalized way very recently (SHOPOV 1966, 1970, HERTLEIN in COX et al. 1969), its species having been traditionally referred to *Aequipecten* FISCHER and also to *Pecten* MÜLLER or even to *Chlamys* RÖDING.

Furthermore, the systematic relations of this genus have never been discussed, not even superficially and important morphological aspects are totally unknown. This subject is outside the scope of the present work but a few pertinent observations will be outlined here. It is interesting to note that *Pseudopecten* shells, though certainly byssate at least during early ontogenetic stages, apparently lacked a ctenolium, an important difference from its homoeomorph *Aequipecten*. In Waller's (1984) view pectinoideans without ctenolium must be excluded from the Pectinidae and thus a large number of Mesozoic genera need a reassessment of their systematic relationships. In this particular case this is not yet possible since despite the large number of available and/or figured European specimens, the hinge and other internal characters are almost unknown.

The feature referred to by Johnson (1984) as "vertically striated disc flanks" is probably homologous to the so-called "chomata tracks" present in *Weyla* as described by Damborenea (1987b). As in *Weyla*, these lines are not limited to the disc flanks but are also present on the auricles, especially on the posterior ones. Johnson (1984) stated that the absence of this character is diagnostic for *P. equivalvis* (Sow.) but this view is here challenged. Johnson himself included in the synonymy of *P. equivalvis* Dumortier's (1869, pl. 21, fig. 8) illustration of a specimen with clearly striated disc flanks [admittedly, he also included this same specimen in the synonymy of *P. dentatus* (Sow.)]. When analizing samples with large number of specimens (such as personally collected material from northern Spain, or collections at the Sedgwick Museum) it is evident that striated flanks are preserved on only some of the specimens. It is concluded that all species of *Pseudopecten* may present this character which is then probably a diagnostic feature of higher rank.

### *Pseudopecten* aff. *equivalvis* (J. Sowerby 1816)

(Pl. 7, Figs. 11–17)

1915 *Pecten priscus* – Jaworski, p. 418.
1925 *Pecten priscus* – Jaworski, p. 51–52.
v ? 1931 *Pecten* sp. – Weaver, p. 272, pl. 28, fig. 167.
v 1942 *Pecten priscus* – Wahnish, p. 39–40.
v 1978a *Chlamys* aff. *prisca* – Volkheimer et al., p. 215, cuadro 2.
? 1982 *Chlamys* cf. *textoria* – Pérez d'A., lám. 16, fig. 5.

Note: Only South American references have been included in this list. For a synonymy of European *P. equivalvis* see Johnson (1984, p. 61–62), who also designated and re-illustrated the lectotype of the species. Johnson also included in his synonymy *P. bodenbenderi* Behrendsen, based on specimens he saw at the Universität Museum Göttingen, which included "apparently a type". Behrendsen's (1891) description and illustration undoubtedly refer to a *Weyla* species (see Damborenea 1987b, p. 178–184), though it is possible that specimens of *Pseudopecten* were included under the same name in old collections as they are difficult to distinguish from young *Weyla*. The mention by Johnson (1984, p. 66) of great convexity and small umbonal angle in these specimens may even indicate that they are young *Weyla* (*Lywea*) *unca* (Phil.) instead of young *W. bodenbenderi* or *Pseudopecten* sp.

Material: Thirty five isolated valves, most of them preserved as external moulds and a few internal moulds. Though scarce, this species is widely distributed geographically in Argentina, from Arroyo La Laguna (A.2) in San Juan Province and Puesto Araya (B.1), Arroyo del Portezuelo Ancho (B.5) and Cerro Puchenque (B.9), Mendoza Province, to South of Cordillera del Viento (C.1) and South of Estancia Santa Isabel, Neuquén Province: MLP 23667 to 23684, 25043, 25045, 25047, 27576 (M 320, 356, 370, 428, 1051 to 1053, 1296, 1299, 1303, 1756, 1757, 1794, 1871, 1919, 1921). The material described by Wahnish (1942) extends the geographical range to the Nueva Lubecka area, western Chubut Province. Jaworski's (1915, 1925) specimens were found at the Atuel River area (B.1), Mendoza Province.

The Argentinian specimens range in age from Pliensbachian to earliest Toarcian.

Remarks: When compared to the European forms, most South American specimens of *Pseudopecten* are usually small and thus they were traditionally referred to *P. priscus* (Schl.), which is now regarded by some authors as a synonym of *P. equivalvis* (see discussion below). A few unusually large specimens (up to 15 cm long) are known from Pliensbachian beds in Cordillera del Viento, Neuquén. These specimens are not included in this description because their relationships with the other material are not completely clear yet. Their general morphology is very similar to large European *P. equivalvis*, with about 18 strong simple radial costae and biconvex shells. They can thus be distinguished from coeval species of *Weyla* of similar size.

Although it was not seen, the material referred to *P. priscus* by Jaworski (1915, 1925) is here included in this species on account of his brief description and also own material from nearby areas. The specimen from the same region described by Weaver (1931, p. 272, pl. 28, fig. 167) may belong here or be an eroded valve of a *Chlamys* species. Wahnish's material described as *P. priscus* (DNGM 8852) also belongs here, despite Leanza's (1942, p. 200) reference of it to *C. textoria*.

Description: Shell of medium to small size, equilateral and almost equivalve. Both valves moderately inflated. Dorsal margin straight, anterior auricles only slightly larger then posterior ones. Shell height equal to length. Umbonal angle near or just over 100°. Disc sub-orbicular, with evenly rounded ventral margin. All auricles triangular in shape and clearly limited from the disc by a neat suture. The right anterior auricle bears a very shallow byssal notch without ctenolium. Both auricles meet the dorsal margin at about 90°.

Exterior shell surface covered by 17 to 21 (mode 18) simple radial plicae, which are commonly narrower than the intervals between them. Top of the plicae narrow, acute or rounded, sides always steep. The bottoms of the intervals between plicae are flat. The two or three anterior and posteriormost plicae are less strong than the central. On some specimens, faint radial costae are seen on the whole surface of the shell, but especially on the plicae tops. All the shell surface is also covered by regularly and closely spaced comarginal striae, which on some specimens (Pl. 7, Fig. 17) show a tendency to become ventrally convex on the intervals, but never reaching the degree of curvature called by JOHNSON (1984) "down-sulcal tongueing of the comarginal striae". The largest specimen also shows the crowding of the comarginal striae near the ventral margin indicative of the adult stage.

All auricles are covered by regular comarginal striae and the right anterior auricle also bears two or three radial costae. The anterior and posterior disc flanks and part of the auricles also bear sinuous parallel ridges oblique to the growth-lines, similar to the "chomata tracks" described by DAMBORENEA (1987b) in *Weyla* species.

Shell margin scalloped, evenly rounded to somewhat wavy in some specimens.

Internal moulds show the radial plicae on the whole surface, though they are less strong near the umbones and on the anterior and posterior areas of the disc. The inner surface of the auricles is smooth, with no auricular crura or ridges. One cardinal crus parallel to the hinge-line can be seen near the dorsal margin of each auricle. Other internal characters unknown.

Measurements: Of best preserved specimens. See also diagram on Text-fig. 36.

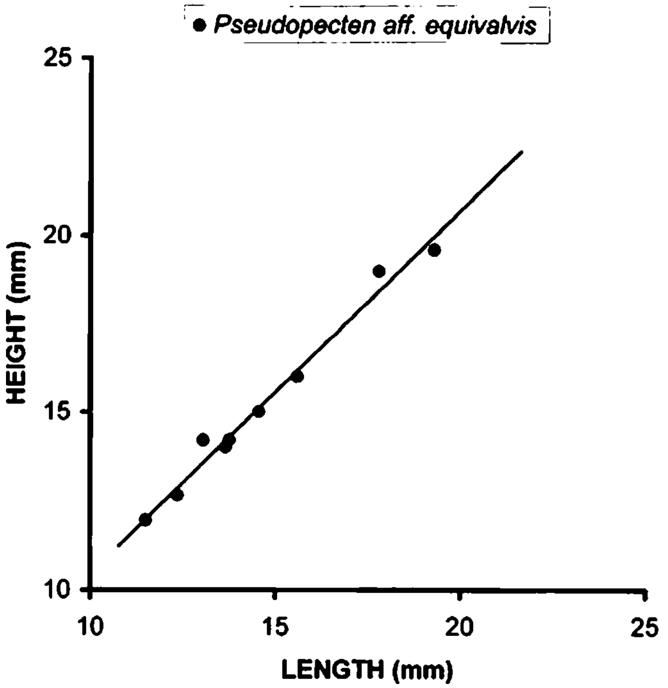
| Specimen MLP | Material | L (mm) | H (mm) | W (mm) | Lha (mm) | Lhp (mm) | Haa (mm) | ε (°) | Number of plicae |
|---|---|---|---|---|---|---|---|---|---|
| 23667 | EM LV | 19.30 | 19.60 | 1.85 | 5.57 | 4.65 | 4.20 | 98 | 18 |
| 23668 | IM LV | 12.35 | 12.65 | 2.10 | - | - | - | - | 19 |
| 23671 | EM LV | 13.05 | 14.20 | 1.45 | - | - | - | - | 18 |
| 23674-e | EM LV | 13.75 | 14.20 | 2.00 | 3.90 | 3.00 | 2.55 | - | 19 |
| 23675-h | EM RV | 13.65 | 14.00 | 2.00 | 3.50 | 2.40 | 2.50 | 100 | 20 |
| 23677 | EM RV | - | 15.40 | 2.10 | 3.60 | 2.40 | 2.70 | 104 | 21 |
| 23678-a | IEM ? | 23.00 | - | 2.30 | - | - | - | - | 17 |

Affinities: JOHNSON (1984) recognized three species within *Pseudopecten*. Previous authors had distinguished between the type species, *P. equivalvis* (SOW.) and *P. acuticosta* (LAMARCK) according to the presence of rounded or acute plicae-tops respectively, but large collections, such as those from Great Britain housed at the Sedgwick Museum, do show a wide range of variability in this character, and in fact JOHNSON (1984) synonymized both names. He also regarded *P. priscus* (SCHLOTHEIM) as a junior synonym of *P. equivalvis* although most previous authors considered this as a different species (DUMORTIER 1869, E. PHILIPPI 1900, TRAUTH 1909, COSSMANN 1916, DUBAR 1925, LANQUINE 1929, VÖRÖS 1971, CALZADA 1983, RADULOVIC 1982) and even as not belonging to the same species-group (DECHASEAUX 1936, HAYAMI 1959a).

The material described here differs from *P. equivalvis* (SOW.) in the sense of JOHNSON (1984), from the Hettangian to Toarcian of Europe, by the fewer modal number of plicae, though this is still well within the accepted range for *P. equivalvis* and by the smaller size (GOLDFUSS 1833, pl. 89, fig. 4; QUENSTEDT 1858, pl. 23, fig. 1; TERQUEM & PIETTE 1865, pl. 12, figs. 15–19; DUMORTIER 1869, pl. 21, figs. 7–8, pl. 39, fig. 3, pl. 42, figs. 16–17; LEYMERIE 1878, pl. D, fig. 1; JEKELIUS 1915, fig. 2; KUHN 1936, pl. 10, fig. 19, pl. 13, fig. 24; NUTSUBIDZE 1966, pl. 3, fig. 56; SIRNA 1966, fig. 4; SHOPOV 1970, pl. 2, figs. 5–6; RADULOVIC 1982, pl. 1, fig. 8; JANKICEVIC et al. 1983, fig. 3; JOHNSON 1984, pl. 2, figs. 1, 2, 4–10; ROMANOV 1985, pl. 29, figs. 10, 11; SZENTE & VÖRÖS 1992, pl. 2, fig. 4).

The next closest species is *P. dugong* GRANT-MACKIE (1994, fig. 1d-1l), from the Early (?) Jurassic of the Australian continental slope, which has more radial plicae, larger shells and unequal auricles.

The smaller number of radial plicae and the presence of "chomata tracks" on the disc flanks are two of the



Text-fig. 36. Scatter diagram and regression line showing length/height (L/H) ratios in *Pseudopecten* aff. *equivalvis* (Sow.) from Argentina, n = 9.

features used by JOHNSON to characterize *P. dentatus* (J. DE C. SOWERBY), from the Hettangian to Bajocian of Europe (GOLDFUSS 1833, pl. 89, fig. 5; JOHNSON 1984, pl. 2, figs. 11–14), with which the material here described can also be compared. The Argentinian material differs from the European specimens in their low disc flanks and by the absence of the down-sulcal tongueing of the comarginal striae and corresponding toothed shell margin. Some of the specimens show faint radial striae on top of the plicae, a character mentioned for *P. equivalvis* but not for *P. dentatus*.

Until more material becomes available, all Argentinian specimens are referred to one species and their affinities to *P. equivalvis* are stressed using open nomenclature.

Argentinian specimens differ from *P. priscus*, if this is regarded as a separate species, only by their wider umbonal angle and shallower byssal notch (see illustrations in DUMORTIER 1869, pl. 22, fig. 3; E. PHILIPPI 1900, fig. 14; COSSMANN 1916, pl. 33, fig. 16; DUBAR 1925, pl. 5, figs. 1–6; LANQUINE 1929, pl. 3, fig. 2; KUHN 1936, pl. 9, fig. 6; VÖRÖS 1971, pl. 2, fig. 6; CALZADA 1983, figs. 3/2–3; RADULOVIC 1982, pl. 2, fig. 4; ROMANOV 1985, pl. 29, figs. 1–6). *Pseudopecten julianus* (DUMORTIER 1869, pl. 40, fig. 1) from the Lower Jurassic of France, is also small but has fewer (around 12) radial plicae. The species "*Aequipecten*" *toyorensis* HAYAMI (1959a, pl. 6, figs. 1–5) from the Sinemurian of Japan, is almost certainly a *Pseudopecten*, but it is smaller and has fewer radial plicae than the Argentinian specimens.

*Pseudopecten* aff. *equivalvis* can be distinguished from young *Weyla* spp., by the larger number of radial plicae, the absence of auricular crura and vertically striated lamellae and the equal convexity of both valves.

Autecology: Most authors agree that *Pseudopecten* species were byssally attached early in ontogeny, becoming free recliners in adult life, and that they could actively swim (SHOPOV 1966, JOHNSON 1984). Shell characters are shared by living species of *Aequipecten*, such as *A. opercularis* (LINNÉ) (see TEBBLE 1966) and *A. irradians* (LAMARCK) (see STANLEY 1970), both of which are recliners with the ability to swim though in a rather clumsy way.

In Argentina *P.* aff. *equivalvis* appears in normal littoral environments with a varied benthonic invertebrate fauna, which in most samples contains *Weyla* spp. Ecological competition between *Pseudopecten* and *Weyla* has been invoked (E. PHILIPPI 1900, HALLAM 1977a, 1977b, 1983) to explain the apparent mutual exclusion of these two pectinoideans. Their life habits were, nevertheless, not the same and have never been compared in detail. While *Weyla* is a semi-infaunal recliner (DAMBORENEA 1987b. DAMBORENEA & MANCEÑIDO 1979, 1988), *Pseudopecten* was an epifaunal recliner with a swimming ability, which *Weyla* lacked altogether.

## Family Terquemiidae Cox 1964

The genus *Terquemia* and its allies form a group of bivalves which has been found in Permian to Upper Jurassic rocks, but which is, nevertheless, poorly known due to the scarcity and often bad preservation of the specimens. The first significant attempt to understand properly these bivalves was done by E. PHILIPPI (1899a), followed by WAAGEN (1907). COX (1964, p. 48) included this family within the Pectinoidea and suggested that it may form a link between the Pseudomonotidae and the Ostreoidea. On describing exceptionally well-preserved material from the Permian of Texas, NEWELL & BOYD (1970) discussed this problem at length, speculating about the possible relationships of the Terquemiidae with both the Ostreina and other pectinoideans, such as Spondylidae and Plicatulidae. CARTER (1990a, p. 251) tentatively placed this family within the Monotoidea and included in it only *Terquemia*, *Paleowaagia* and *Newaagia*.

No representative of this family was known from South American Jurassic deposits. The Argentinian material described below does not show the hinge characters and is thus only doubtfully referred to the genus *Terquemia*. Alternatively, it may belong to *Plicatula*, though no teeth are preserved either, as the internal shell layer has probably not been preserved on any specimen.

### Genus *Terquemia* TATE 1876

Type species: *Carpenteria pectiniformis* EUDES-DESLONGCHAMPS 1860, from the early Jurassic of France, subsequent designation by STOLICZKA 1871, p. 443.
Synonym: *Carpenteria* EUDES-DESLONGCHAMPS 1860 (non GRAY 1858, Protozoa).

### *Terquemia? andina* n. sp.

(Pl. 11, Figs. 1–8)

Material: Holotype – A complete shell from upper Rio Salado region (B.6) collected by MANCEÑIDO and others in lower Toarcian deposits: MLP 17132-ab, figured on Pl. 11, Figs. 1a-d.

Paratypes – The rest of the examined material consists of about 110 isolated valves, two specimens with both valves and several fragments. Some of the material was found by the author and colleagues and by GULISANO in early Toarcian deposits of Mendoza Province, at Cerro Tricolor (B.11), upper Rio Salado (B.6) and Arroyo Serrucho (B.8): MLP 16504 to 16506, 17132-c-d, 17175, 17476, 17483, 17484, 17496, 19685 and 27571 (M 807, 1347, 1995, G 904, 918). Most of the specimens were collected in equivalent beds of southern Cordillera del Viento (C.1), Neuquén: MLP 15450, 22290 to 22310, 27569, 27570 (M 1756, 1757, 1871, 1974). Up to now, this species was not found in younger or older beds.

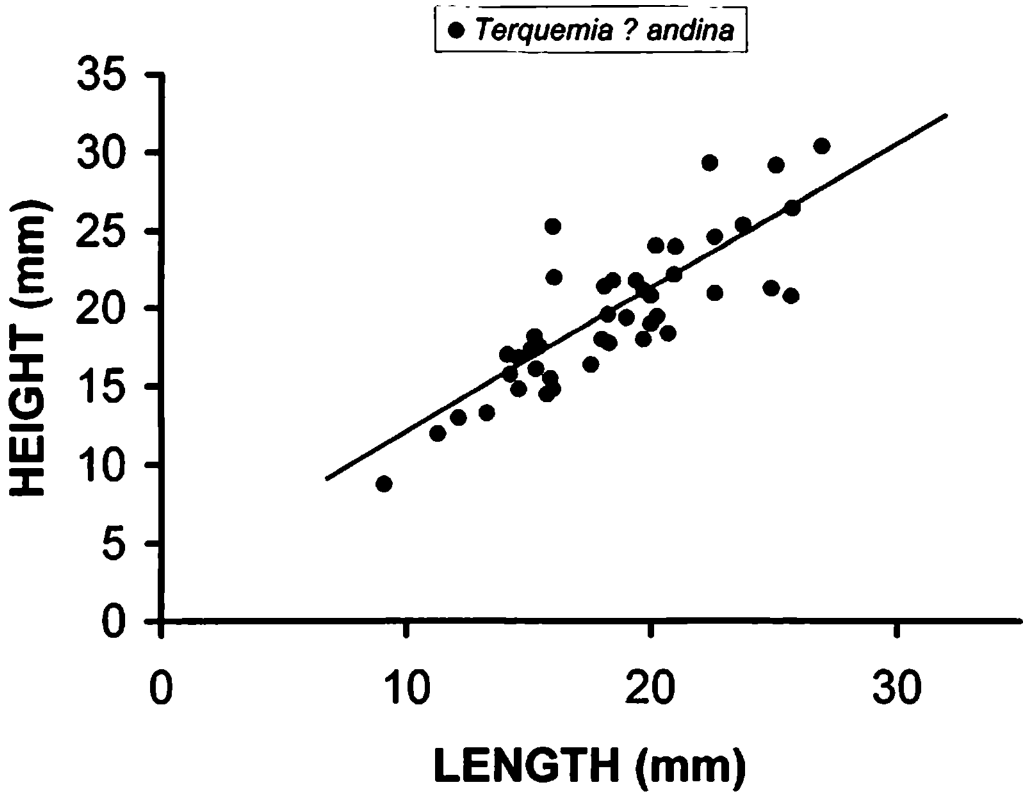
Diagnosis: Irregular inequivalve shell, without distinct auricles, right valve more convex than left. Attachment scar of variable size, left valve with xenomorphic area, rest of shell ornamented by 8 to 15 radial costae which extend into spines at the shell margin. Adductor muscle scar subcircular in shape and centrally placed.

Description: Shell of medium size, inequivalve. Right (attached) valve more convex than the left one, convexity being nevertheless a very variable character. Shell of irregular outline, almost subcircular, subequilateral valves, without distinct auricles. The umbones do not protrude above the dorsal margin and are subcentrally placed.

The attachment scar, always near the umbonal region on the more convex right valve, is of variable shape and size, most commonly a concave subcircular area few milimeters long (Pl. 11, Figs. 1a, 4, 6), but occasionally involving almost all the shell length in medium-sized specimens. The left valve bears a matching area of xenomorphic sculpture near the umbonal region (Pl. 11, Figs. 1b, 3, 5a, 7, 8).

The remaining surface of the valves is covered by 8 to 15 coarse irregular radial costae that may increase in number by intercalation. The top of these costae is normally irregular, sometimes nodose. The shell surface has also a lamellose appearance due to the irregular strength of the growth lines. The costae prolong into spines beyond the shell margin (Pl. 11, Fig. 2). These marginal spines are radially arranged and in the dorsal region of the shell are not related to the costae. The spinose area of the valves seems to be confined to the marginal region of the shell and appears more developed on the left than on the right valve (see Text-fig. 38a).

The adductor muscle scar is of subcircular shape and is placed at mid-height of the valves, nearer the posterior margin (Pl. 11, Fig. 1b). Hinge characters unknown.



Text-fig. 37. Scatter diagram and regression line showing the length/height (L/H) ratios of *Terquemia ? andina* n. sp., n = 44.

Measurements: Figured specimens. See also scatter-diagram on Text-fig. 37. [1] = number of costae; [2] = height of attachment area (or xenomorphic sculpture, between square brackets); * = measured with both valves together.

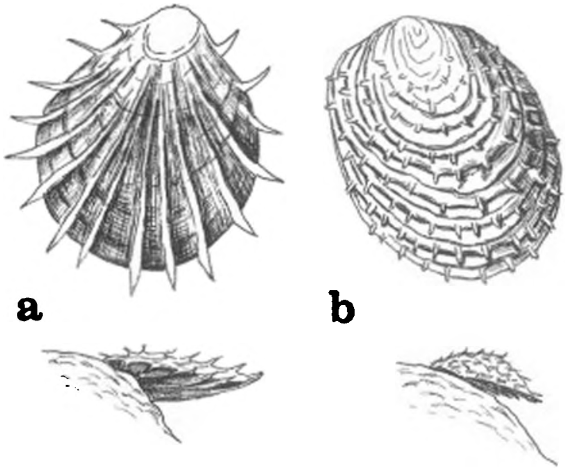
| SPECIMEN MLP | Material | L (mm) | H (mm) | W (mm) | L/H | [1] | [2] (mm) |
|---|---|---|---|---|---|---|---|
| 16504 | BV S | 14.1 | 17.0 | 4.6* | 0.83 | - | 15.5 |
| 16506 | LV? S | 13.3 | (13.3) | 1.1 | (1.00) | 11 | - |
| 17132-ab | BV S | 25.7 | 26.5 | 6.7* | 0.97 | 3 | 7.7 |
| 17132-c | RV IM | 22.6 | (21.0) | (9.0) | (1.08) | 12 | 9.8 |
| 17132-d | LV IM | 26.6 | 24.6 | 2.3 | 1.08 | 13 | 12.2 |

Affinities: The species of this genus are normally represented by few individuals, which exhibit a wide range of variability in shape and ornament, thus preventing detailed comparison.

*Terquemia? andina* n. sp. has its greatest affinities in shape, size and number of costae with *T. arietis* (Quenstedt), from the early Jurassic of Europe (see Quenstedt 1856, pl. 10, fig. 10; Schäfle 1929, pl. 6, figs. 11–12; Troedsson 1951, Kochanova 1967; also material from Great Britian housed at the Sedgwick Museum).

The type species, *Terquemia pectiniformis* (Eudes-Deslongchamps 1860, pl. 19, figs. 2–9), from the early Jurassic of Calvados, France, is larger and has more costae on both valves. *Terquemia* sp. nov. ? in Dubar (1948, pl. 29, figs. 11ad), from the Domerian of the Middle Atlas, Morocco, has flatter valves and due to the large attachment area of the only figured specimen, it is difficult to compare the costae pattern, which is confined to a very narrow marginal strip.

*Terquemia multicostata* (Münster) from the late Triassic – Hettangian of Europe (see Münster in Goldfuss 1833, pl. 72, fig. 2; pl. 72, fig. 3 as *Ostrea complicata*; Terquem 1855, pl. 25, fig. 1; Terquem & Piette 1865, pl. 13, figs. 1–3; Atanasiu & Raileanu 1958, pl. 2, fig. 15; both as *Carpenteria heberti*; Joly 1907, 1936;



Text-fig. 38. Reconstruction of a – *Terquemia? andina* n. sp. and b – *Harpax rapa* (Bayle & Coquand) in life position.

Dechaseaux 1936) is also comparable species, though it has more radial costae than the Argentinian species. The affinities are closer with the material described by Lentini (1974, pl. 16, fig. 9) as *T.* aff *multicostata* (Münster), from the early Jurassic of Sicily.

Quite different from *Terquemia? andina* n. sp. is *T. ostreiformis* (d'Orbigny) from the late Oxfordian of France (see Peron 1907, pl. 8, fig. 4; pl. 11, fig. 7), which has very large and thick shells.

The Argentinian material has also some superficial resemblance to some species referred to *Plicatula*, such as *P. peregrina* d'Orb. from the middle Jurassic of India (Cox 1952, pl. 4, figs. 26) and *P. tegulata* (Münster) from the Middle Jurassic of Germany (Goldfuss 1835, pl. 107, fig. 4; Kuhn 1938, pl. 4, fig. 10). *Harpax rapa* (Bayle & Coquand), described below, has a quite different type of ornament, with scaly spines not arranged in costae.

Autecology: The specimens of *Terquemia? andina* n. sp. clearly lived cemented to hard substrates, at least during the early stages of growth (Text-fig. 38a). The xenomorphic sculpture, when present, reveals that the nature of the substrate was most commonly other molluscs' shells or pebbles. One left valve shows xenomorphism due to substrate bioimmuration by the right valve on an organism characterized by a pennate ribbing pattern consisting of two series of transverse ribs oblique to a main rachis, possibly a pennatuloidean (Pl. 11, Fig. 5a).

This species was found at only few localities, but at least in two instances it is the dominant species of thin conspicuous beds in which they are very abundant, though mostly represented by disarticulated valves.

## Order Ostreoida Férussac 1822

### Superfamily Plicatuloidea Watson 1930

Yonge (1975) proposed the separation of the Plicatuloidea from the Pectinoidea on the grounds of several anatomical characters. He included within this superfamily the families Plicatulidae and Dimyidae and regarded that these have close resemblance with the Spondylidae. Some years later Freneix et al. (1985) added their new family Placunopsidae to the Plicatuloidea.

### Family Plicatulidae Watson 1930

This family includes monomyarian species that live with their right valve cemented to the substratum. They differ from other pectinoideans by a set of characters adequately summarized by Watson (1930) and Yonge (1973, 1975). Among these, the lack (or extreme reduction) of the foot in adults has led some authors to speculate about the possible relationships between Plicatulidae and Ostreidae (Newell & Boyd 1970, p. 229). On the other hand Yonge (1973, p. 188) stressed that *Plicatula* and the ostreids have important differences both in hinge and ligament characters. Yonge (1975) discussed the relationships of this group with the Spondylidae, Pectinidae and Propeamussidae and concluded that the peculiar characteristics of the ligament in both Plicatulidae and Dimyidae allow the separation of them in a superfamily, the Plicatuloidea, thus restricting the Pectinoidea to the other groups. WALLER (1978, p. 352) later raised the rank of the Dimyidae to superfamily and included both the Plicatuloidea and Dimyoidea within the Ostreina.

## Genus *Harpax* PARKINSON 1811

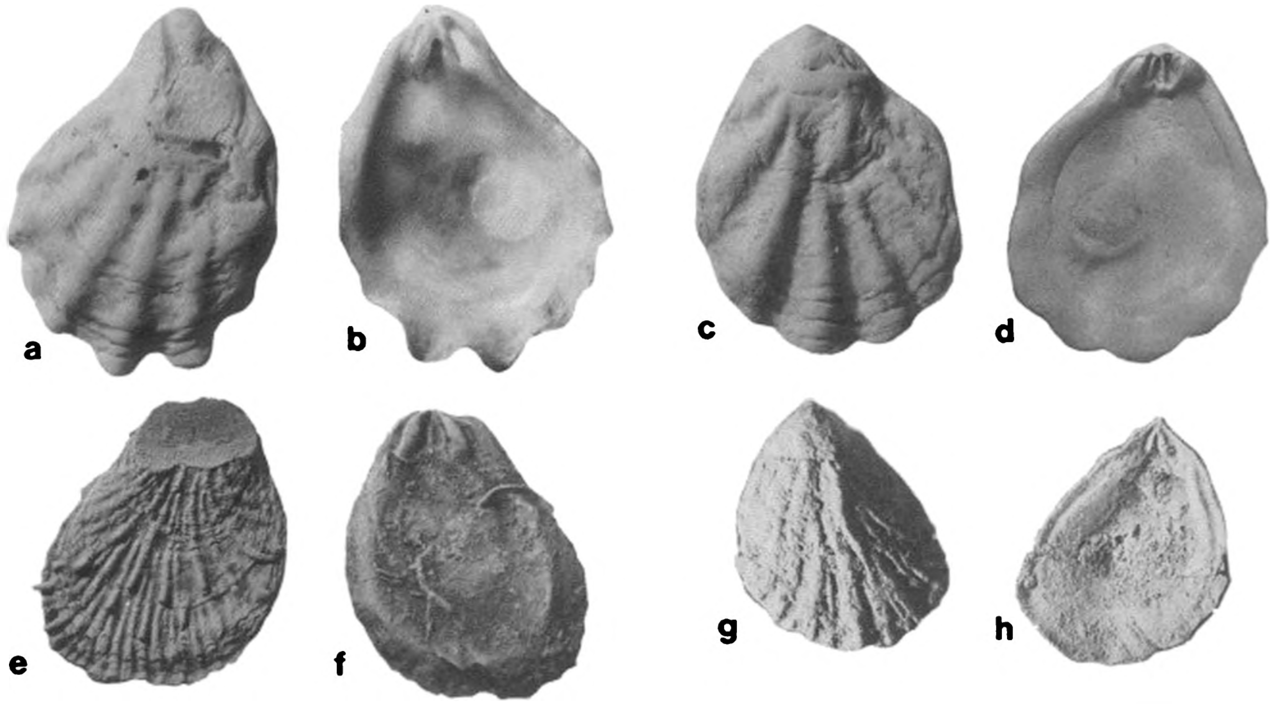
Type species: *Harpax parkinsoni* BRONN 1824, from the early lower Jurassic of Great Britain, by monotypy (= *Plicatula spinosa* J. SOWERBY 1819, see COX 1935, p. 6).

In 1811 PARKINSON included in his catalogue several figures of early Jurassic British specimens named simply as *Harpax*. Some years later BRONN (1824, fide COX 1935) called those same specimens *Harpax parkinsoni* BRONN, which then became the type species of the genus *Harpax*. COX (1935, p. 6) argued that the species *Plicatula spinosa* SOWERBY 1819 and *Harpax parkinsoni* BRONN 1824 should be regarded as subjective synonyms. Several authors had previously included all the material in one species, though some, notably EUDES-DESLONGCHAMPS (1860), had treated them separately (see also DUMORTIER 1869 and TRAUTH 1909).

EUDES-DESLONGCHAMPS (1860) argued at length about the differences between *Harpax* and *Plicatula*, recognizing among them the inverse relation of convexity of the valves (p. 6) and the differences in ornament pattern (p. 25–26, 60). Although he recognized the different hinge details that will be discussed below, he did not give these characters much importance in the distinction of the two taxa, but he assigned exceptional prominence to minor differences in shell structure instead. Perhaps for this reason his detailed analysis was dismissed by many later authors, who traditionally considered *Harpax* as junior synonym of *Plicatula*, without providing a clear discussion of this point (see for instance STOLICZKA 1871, LAMY 1939, COX et al. 1969, DUFF 1978, etc.). On the other hand some authors followed EUDES-DESLONGCHAMPS and maintained *Plicatula* and *Harpax* as separate taxa (such as DUMORTIER 1864, 1869, WHIDBORNE 1883, BÖHM 1901, 1903b, ROLLIER 1917, PETROVA 1947, DUBAR 1948; HAYAMI 1961, KOSHELKINA 1962, POLUBOTKO 1968a, 1968b, POULTON 1991), at least at subgeneric level. POULTON (1991) stressed the importance of the hinge characters and regarded *Harpax* as a separate taxon, as it will be treated here.

*Plicatula spinosa* SOW. is a relatively abundant species and its hinge was exceptionally well illustrated by GOLDFUSS (1835, pl. 107, figs. 1d, g, i, k) and others (such as EUDES-DESLONGCHAMPS 1860, pl. 9, figs. 9, 14, 20; pl. 10, figs. 4, 6, 10, 21, 23, 28, 30, 34, 36, 37; DUMORTIER 1869, pl. 40, fig. 12; KUHN 1935, pl. 18, fig. 1; TROEDSSON 1951, pl. 21, figs. 2a, 3a, 5, 6, 8; KOSHELKINA 1962, pl. 4, fig. 3 and POULTON 1991, pl. 7, figs. 5–7, 27, 28). These figures, plus specimens from Britian seen at the Sedgwick Museum, material from Germany housed at the MLP (MLP 5799 and 9471) and material referable to this species personally collected in Spain (Text-figs. 39e-h) show that the arrangement of teeth and sockets is inverse to the pattern present in the type species of *Plicatula* and other well-known species of this genus (such as *P. marginata* SAY, see COX et al. 1969, figs. C981a-e; *P. gibbosa* LAMARCK, see YONGE 1973; Text-figs. 39a-d here; *P. (Darteplicatula) polymorpha* BELLARDI, see COX et al. 1969, figs. C982a-b; *P. daharensis* var. *berberica* DUBAR 1948, fig. 52, pl. 30, figs. 1b-c; etc.). Furthermore, the shell microstructure of the left valve of *P. spinosa* was regarded by CARTER (1990b, p. 350) as unusual for a *Plicatula* because it has a relatively thick calcitic outer shell layer, a middle complex crossed lamellar (instead of crossed lamellar) aragonitic shell layer and this is underlain near the beak by an innermost layer of calcitic foliated structure.

While in *Plicatula* (see emended diagnosis in CARTER 1990a, p. 221) the right valve shows teeth immediately adjacent to the ligamental pit, in the group of *P. spinosa* this pattern is present in the left valve (see Text-fig. 39). This cannot be regarded as an example of transposed hinge, because it is consistently present in several Mesozoic species, among them *P. rapa*, the species here described. It was observed also in the following species (besides those already mentioned by EUDES-DESLONGCHAMPS 1860): *P. kolymica* POLUBOTKO (figured by POLUBOTKO 1968a and BYCHKOV et al. 1976), *P.* sp. II TROEDSSON (1951), *P. orbiculoides* (ROEMER)? in TROEDSSON (1951), *H. terquemi* DESL. in KOSHELKINA 1962, pl. 5, fig. 1; *P. laevigata* D'ORBIGNY (figured in THEVENIN 1908 and POLUBOTKO 1968b), *H. simplex* MILOVA (1976), *P. bekiensis* NAKAZAWA (in NEWTON et al. 1987) and perhaps also in *P. praenipponica* HAYAMI (1959a), *P. papillata* DUBAR 1948, *Harpax* cf. *spinosa* (SOW.) in POULTON (1991) and *Plicatula* sp. from the Ururoan of New Zealand (see Text-fig. 44).



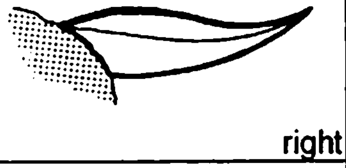
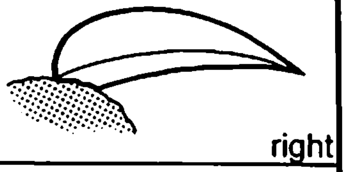
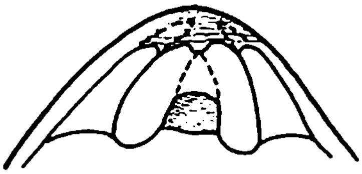
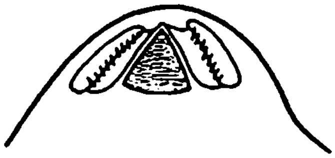
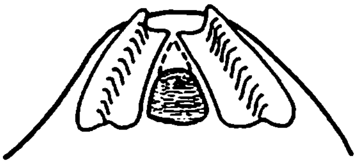
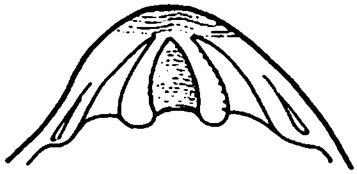
Text-fig. 39. Comparison of hinge region of *Plicatula* and *Harpax*, X 2. a-d – *Plicatula gibbosa* Lamarck, Recent, Claromecó beach, Buenos Aires Province, Argentina: a-b – MLP 16658-a, right valve, c-d – MLP 16658-b, left valve; e-h – *Harpax spinosa* Sowerby, early Toarcian, Lérida, Spain, e-f – MLP 16657, right valve, g-h – MLP 22311, left valve.

This particular kind of hinge appears together with other characters that distinguish this group of species from those of *Plicatula* and which have been summarized in Text-fig. 40. The most obvious difference is the relative convexity of the valves, already noticed by Eudes-Deslongchamps (1860) and Rollier (1917): whilst in *Plicatula* the right valve is more convex than the left one, in *Harpax* the inverse relation is present. In both of them the attached valve is the right one.

Another fundamental difference concerns the ligamental pit, which is almost marginal and not dorsally covered by shell in *Harpax*, whilst in *Plicatula* s.s. the "inner" ligament is dorsally enclosed in a cavity and therefore it is not in contact with the "outer" ligament (Yonge 1975). In this respect *Harpax* has a ligament similar to that of *P. (Eoplicatula)* (see Carter 1990a), and it likewise represents an intermediate step in the evolution of the peculiar ligament structure observed in *P. (Plicatula)*. It is interesting to note that Yonge (1975, p. 548) regarded this as an "all-important" character in the classification of this group of bivalves.

Therefore, the distinction of these two groups of species seems to be both phylogenetically meaningful and stratigraphically useful and thus the name *Harpax* is used for the group of *P. spinosa*. An emended diagnosis of this taxon, in the sense used in the present paper, is given below:

*Harpax:* Inequivalve shell, right (attached) valve less convex than the left (free) one, dorsal margins of both valves approximately coincident. Left valve with shallow subumbonal cavity and hinge made up of a pair of strong rod-like teeth, one on either side of the ligamental pit. Next to each tooth, there is a deep socket limited towards the margin of the shell by a low ridge or lateral crus. Right valve without subumbonal cavity. Right hinge with a pair of low crura adjacent to the ligamental pit, followed by deep sockets and strong teeth near the margin of the shell. The lateral surfaces of the teeth are all crenulated and the teeth themselves do not project dorsally as they do in species of *Plicatula*. Internal ligamental pit triangular and shallow, similar on both valves, subcentrally placed and without dorsal shell cover. Monomyarian, muscle scar variably shaped and mid-posteriorly placed. External surface smooth, squamose or with radial costae, with or without spines. Commissure straight or feebly wavy. Internal margin and surface smooth.

| TAXON | ***Plicatula*** | ***Harpax*** |
|---|---|---|
| Attached valve |  |  |
| Relative convexity | right valve more convex | left valve more convex |
| Subumbonal cavity | RV: present<br>LV: absent | RV: absent<br>LV: present |
| Right valve hinge |  |  |
| Left valve hinge |  |  |
| Teeth | Laterally crenulated, projected dorsally  | Laterally crenulated, not projected dorsally  |
| Dorsal enclosement of ligament | YES<br>by dorsal extension of hinge platform | NO<br>triangular depression on both valves |
| Adult commissure | Straight or folded | Straight |
| Dorsal margin | Right umbo higher than left | Left umbo higher than right (or equal) |
| Ornament | Variable<br>Common: folds | Costae, squamose or spinose<br>Never: folds |

Text-fig. 40. Comparative chart of morphological characters of *Plicatula* and *Harpax*.

There is probably a functional correlation between the position of the teeth and the relative convexity of the valves, as suggested by the fact that the outermost teeth are always present on the flatter valve, irrespective of which is the attached valve.

It is also interesting to note that both taxa (*Plicatula* and *Harpax*) coexisted during the early history of the group, but whilst *Harpax*, known from the Triassic and early Jurassic, seems to have disappeared shortly afterwards, *Plicatula* persisted to the present. The time range of each group is difficult to be accurately established now because the hinge characters of many species have not been adequately described or illustrated.

Species of the *Harpax rapa* group are conspicuous elements of Boreal and Austral Early Jurassic (mainly Pliensbachian) bivalve faunas (see Text-figs. 6–7).

### *Harpax rapa* (Bayle & Coquand 1851)

(Pl. 2, Fig. 10; Pl. 7, Fig. 1; Pl. 10, Figs. 1–17; Text-figs. 45a-c)

1851 *Plicatula rapa* – Bayle & Coquand, p. 16, pl. 5, figs. 8–10.
1854 *Plicatula rapa* – Hupé, p. 293–294.
1867 *Plicatula rapa* – Rémond de Corbineau, p. 127.
1894 *Plicatula rapa* – Möricke, p. 35.
? 1924 *Plicatula* – Groeber, p. 89.
p v 1981 Pelecypoda indet. – Cuerda et al., p. 9.
p v 1982 Pelecypoda indet. – Cuerda et al., p. 331.
v 1992 *Plicatula rapa* – Damborenea, pl. 116, figs. 13–14.
1992 *Plicatula (Harpax) rapa* – Damborenea & Manceñido, pl. 1, fig. 7a.
v 1993a *Plicatula (Harpax) rapa* – Damborenea, fig. 3h.
1994 *Plicatula (Harpax) rapa* – Aberhan, p. 29, pl. 11, figs. 15–18.
1998 *Plicatula (Harpax) rapa* – Aberhan, p. 91, pl. 8, figs. 13–14.

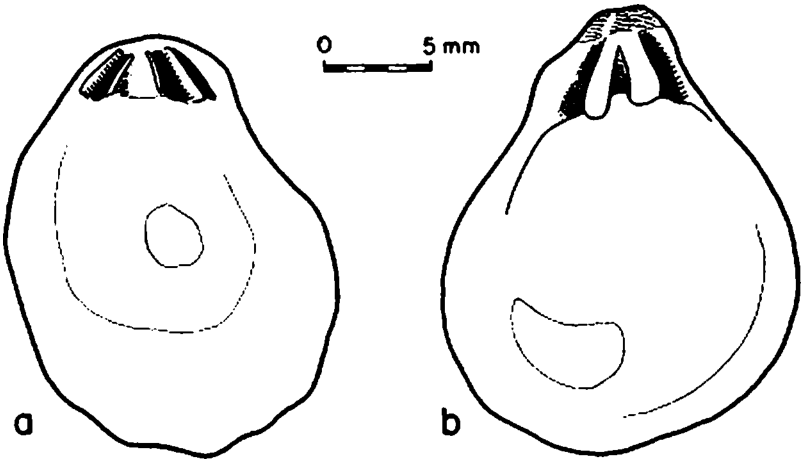
Material: All the available material is preserved as internal or external moulds of mostly isolated valves. There are 33 left and 16 right valves and several fragments, collected by the author and colleagues at the following localities: in Mendoza Province: Rio Atuel near Puesto Araya (B.1), Arroyo del Portezuelo Ancho (B.5), Arroyo Santa Elena (B.7), Arroyo Serrucho (B.8), Cerro Puchenque (B.9): MLP 15271, 16507 to 16509, 16515, 19065, 19070, 19073, 19643, 19648, 19654, 19665, 19667, 19670, 19673, 22319, 22320, 26560, 26561 (M 320, 322, 331, 350, 352, 369, 1301, 1304, 1307, 1316, 1318, 1319, 1321, 1329 to 1338, 1343, 1903, 1928 and G 874); in Neuquén Province: South of Cordillera del Viento (C.1), Arroyo Lonqueo (C.9), Arroyo LlaoLlao (C.11), Arroyo Ñireco (C.20), South of Estancia Santa Isabel (D.1), Salitral Grande (D.3) and North of Sañicó: MLP 16510 to 16514, 16516 to 16518, 16656, 19074, 20687, 20688 and 22312 to 22318, 23658, 24996, 24997, 27567, 27568 (M 1037, 1048, 1053, 1055, 1083, 1085, 1188, 1191 to 1193, 1196, 1221, 1362, 1363, 1742', 1866). A few specimens were collected by Cuerda and others at 13.5 km south of Aluminé, Neuquén (MLP 15326) and by Fernández on the way to Media Luna, Charahuilla, Neuquén (MLP 8807).

In Argentina this species ranges through most of the Pliensbachian and may reach the earliest Toarcian.

Remarks: This species was originally described by Bayle & Coquand (1851, p. 16) with material from the early Jurassic at Manflas, Chile and was later mentioned from other Chilean localities, such as Sierra de La Ternera, Atacama (Rémond de Corbineau 1867, p. 127) and Sierra de la Destiladera (Möricke 1894, p. 35). The identity of the material listed by Hillebrandt & Schmidt-Effing (1981, p. 18) as *Plicatula* sp., from the Sinemurian of Quebrada Larga, Chile, is unknown, but it could belong here. On the other hand *Plicatula* sp. described by Hayami et al. (1977, pl. 28, fig. 4) from the Late Triassic of the Domeyko range in Chile is probably a different species.

Being a fairly common species, it is somewhat surprising that it has never been mentioned from Argentina before, probably because it was not recognized as such. Almost certainly Groeber's (1924, p. 89) mention of a *Plicatula* for the upper Catan Lil river region in early Jurassic sediments (that he had erroneously assigned to the Triassic) refers in fact to *H. rapa*, as this is an abundant species in nearby localities. Part of the material recorded by Cuerda et al. (1981, 1982) as Pelecypoda indet., belongs to *H. rapa*.

Description: Thick shell of medium size, of irregularly sub-elliptical outline, inequivalve, generally higher than long and slightly elongated postero-ventrally. The posterior margin is straight to slightly concave, all other margins are irregularly convex. The shell lacks auricles, but some specimens have a long and almost straight dorsal margin (Pl. 10, Figs. 6, 7; Text-fig. 45). The umbo is low and sub-centrally placed. Although shell convexity is a very variable character, the left valve is always more globose than the right one, which is even concave in some specimens. The latter lacks a subumbonal cavity.



Text-fig. 41. Inner views of *Harpax rapa* (Bayle & Coquand), camera lucida drawings, a – right valve, MLP 16507; b – left valve, MLP 16656.

The inner ligamental pit is triangular and centrally placed in both valves. The left valve has, to each side of the ligamental pit, a strong, subrectangular tooth with a crenulated outer surface. Both teeth meet dorsally at a variable angle between 30 to 60°. To each side there is a deep crenulated socket, subtriangular in shape and then a low ridge or accessory crus almost meeting the lateral margin of the shell Text-fig. 41b).

In the right valve the central ligamental pit is located between two low ridges or crura that meet dorsally. To each side of them there is a deep subrectangular socket and a strong subtriangular tooth with crenulated surfaces (Text-fig. 41a).

The teeth do not meet each other dorsally and they form an angle of about 70–90°. The angle between teeth is very variable on both valves and it does not seem to be correlated with size (see Text-fig. 43).

On both valves the anterior teeth are slightly stronger than the posterior ones. Faint lines parallel to the hinge margin appear dorsal to the teeth and sockets. One of these lines probably housed the secondary (or "external") ligament, being the others related to successive growth stages of this feature.

The adductor muscle scar is faint. It is sub-central and only slightly shifted towards the posterior margin in the right valve, whereas in the left valve it is posteriorly placed. The pallial line is continuous and nearer the ventral margin in the left valve than in the right, it completely surrounds the adductor muscle scar, without touching it (Pl. 10, Fig. 6). The inner margin of the shell is smooth.

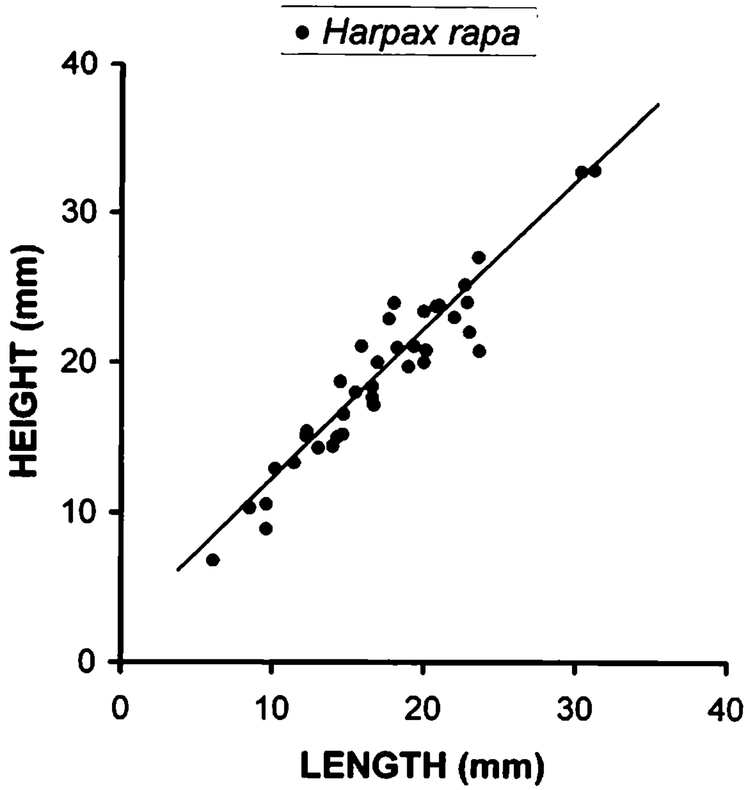
The external ornament is equal on both valves. It consists of comarginal high lamellae, irregularly arranged, that are distally prolonged into numerous long, thin, hollow scaly spines (hyote spines), that are alternatively, though somewhat irregularly, distributed over the whole shell surface, giving the appearance of a file surface, to which the name *rapa* so aptly refers (Pl. 10, Figs. 1, 2, 5, 8, 9, 16, 17). The attachment scar is small on most available right valves, though occasionally it may be as large as the whole shell (Text-fig. 45). Some specimens show xenomorphic sculpture on the left valves, reproducing the ornament pattern of the shell to which they are attached to (see Text-fig. 45). The shell lacks radial costae or plicae and only in two very large specimens there is a slight undulation of the shell surface near the ventral margin (Pl. 10, Fig. 14).

Measurements: Best preserved specimens. See also scatter- diagrams on Text-figs. 42 and 43. [1] Angle between teeth. *: measured on latex casts.

| SPECIMEN MLP | Material | | L (mm) | H (mm) | W (mm) | L/H | [1] (°) |
|---|---|---|---|---|---|---|---|
| 16508 | RV | IM | 16.6 | 17.6 | 1.0 | 0.94 | 88 |
| 16511 * | LV | EM | 14.0 | 14.4 | 2.0 | 0.97 | - |
| 16512 | LV | IM | 30.3 | 32.8 | 5.0 | 0.92 | 42 |
| 16514 * | RV | EM | 12.2 | 15.7 | 2.7 | 0.78 | - |
| 16656 * | LV | IM | 16.9 | 20.0 | - | 0.85 | 29 |
| 19643 | LV | IM | 16.6 | 18.4 | 2.9 | 0.90 | 55 |
| 19654 | RV | IM | 20.8 | 23.7 | 0.1 | 0.87 | 73 |

Measurements: (continued).

| SPECIMEN MLP | Material | L (mm) | H (mm) | W (mm) | L/H | [1] (°) |
|---|---|---|---|---|---|---|
| 20687-a | LV? EM | 31.2 | 32.9 | 3.5 | 0.95 | – |
| 20687-b | LV IM | 23.6 | 20.7 | 5.7 | 1.14 | 45 |
| 26560 * | BV EM | 9.4 | 12.8 | 1.5 | 0.73 | - |
| 26561-a * | BV EM | 18.7 | 18.2 | 4.2 | 1.03 | - |
| 26561-b * | RV IM | 15.8 | 14.7 | - | 1.07 | - |
| 26561-c * | LV EM | 15.5 | 16.0 | 3.3 | 0.97 | - |



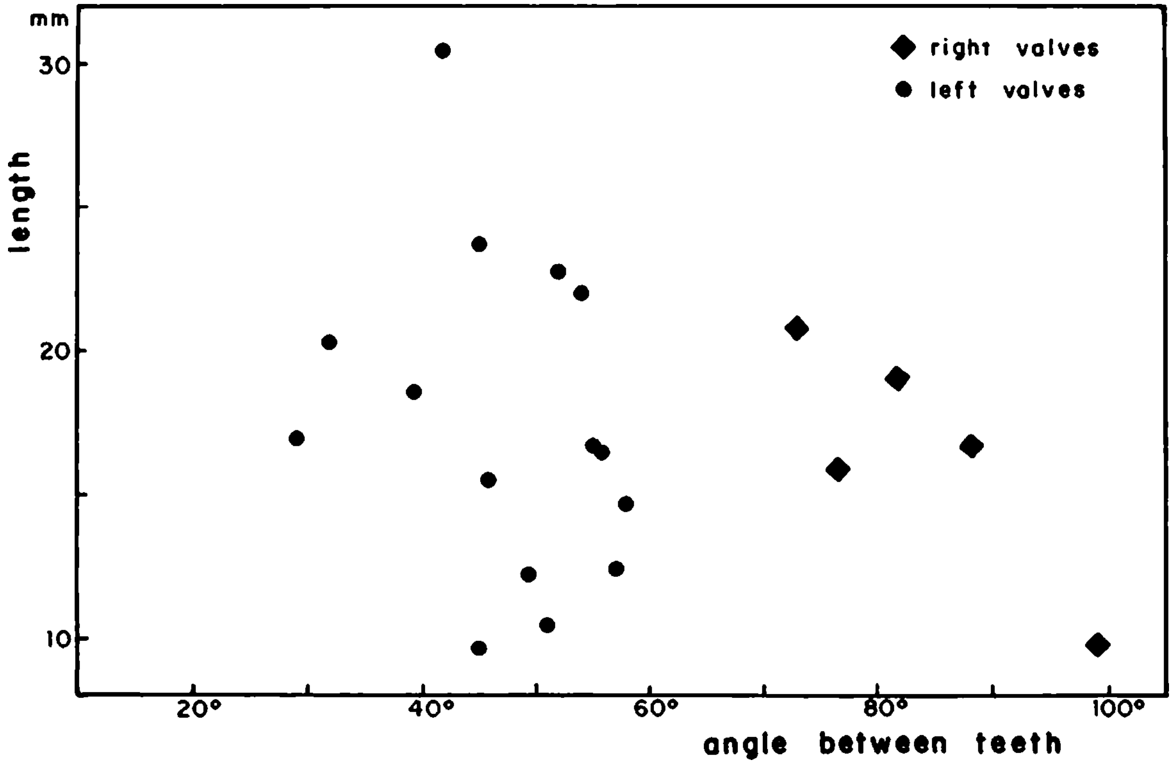
Text-fig. 42. Scatter diagram and regression line showing length/height (L/H) ratios in *Harpax rapa* (BAYLE & COQUAND), n = 38.

Affinities: *Harpax rapa* shows its greatest affinities with *H. kolymica* POLUBOTKO (in KIPARISOVA et al. 1966, pl. 27, figs. 1–6; POLUBOTKO 1968a, pl. 53, figs. 6–8; BYCHKOV et al. 1976, pl. 72, figs. 1–3), from the late Triassic (Norian – Rhaetian) of Siberia, both in internal and external characters. The only significant difference is the absence of lateral crura in the left valve, as mentioned by POLUBOTKO (op. cit.) for her species.

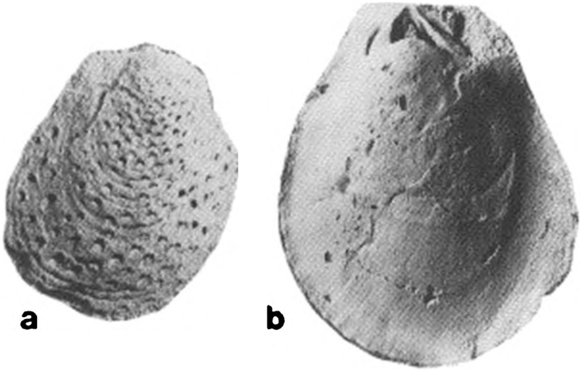
Specimens from the Ururoan of Heale Ridge, Hokonui, New Zealand, seen at Otago University (OU 14395, 14437, 14942, 14944, 14947, 14950) also belong to the group of *H. rapa* (see DAMBORENEA & MANCEÑIDO 1992, pl. 1, fig. 7b; Text-fig. 44 here). The internal moulds show no significant difference with the Argentinian specimens and they also have the same ornament type. Although scales seem to be fewer in New Zealand specimens, this is a variable character in the Andean material. In both regions they are associated to *Camptochlamys wunschae* (MARWICK).

The specimens from northeast Siberian Pliensbachian deposits, described by POLUBOTKO (1968b, p. 87–88, pl. 28, figs. 4–5) and SEY (1984, pl. 17, figs. 8–11) and from the Sinemurian-Pliensbachian of northern Yukon described by POULTON (1991, pl. 7, figs. 2–7, 27, 28, pl. 9, figs. 7, 12) referred to *Harpax spinosus* (SOW.) lack radial costae and their ornament is very similar to that of *H. rapa* and *H. kolymica* instead (see DAMBORENEA 1993a, text-fig. 3g).

A left valve figured by EUDES-DESLONGCHAMPS (1860, pl. 9, figs. 23–24) as *H. parkinsoni* ? var. *recuperata* ?, from the Pliensbachian of France, shows striking similarities both in shape and ornament pattern to *H. rapa*.



Text-fig. 43. Scatter diagram showing the relation between length of shell (L) and angle between teeth in right and left valves of *Harpax rapa* (Bayle & Coquand).

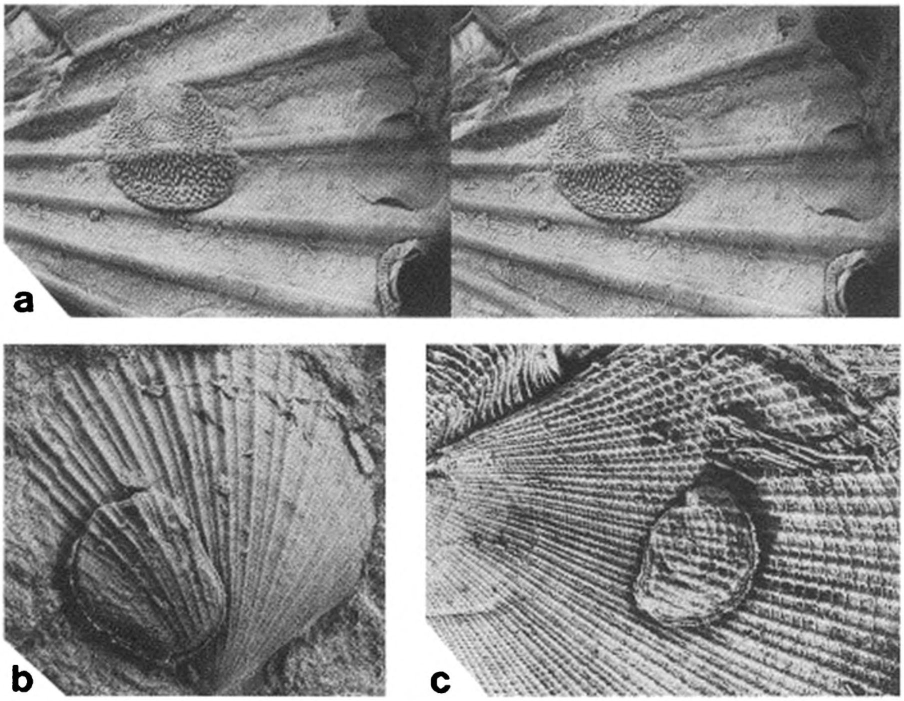


Text-fig. 44. *Harpax* cf. *rapa* (Bayle & Coquand) from New Zealand, X 2. a – OU 14947, external mould, left (?) valve; b – OU 14943, internal mould, left valve.

Eudes-Deslongchamps compared that specimen to *P. ventricosa* Münster (in Goldfuss 1835, pl. 107, fig. 3), which, although having the same kind of ornament as *P. rapa* on its left valve, has a smooth right valve. The small specimens figured by Eudes-Deslongchamps (1860, pl. 11, figs. 1–5) as *H. asperrimus* E.–D. (later renamed *P. spinosissima* by Rollier 1917, p. 513), from the early Jurassic of France, are probably young stages of this same taxon. A small specimen from the lower Lias of Worcestershire and referred to *P. asperrima* Desl. housed at the Sedgwick Museum (J 40297-313) is also similar but has a smooth right valve.

The ornament of *H. rapa* also allows comparison with *H. papillata* Dubar (1948, pl. 28, figs. 21a-c), from the Domerian of Morocco, but in this species the superficial tubercles may not be the bases of spines. If a right valve as stated by Dubar, his illustrated specimen differs from *H. rapa* by its hinge characters and shell convexity.

The well-known and abundant early Jurassic European species *H. spinosa* J. Sowerby (1819, pl. 245, figs. 1–4; Kuhn 1935, pl. 18, fig. 1) has a very similar hinge, but the ornament, although very variable in this species, is



Text-fig. 45. *Harpax rapa* (Bayle & Coquand) as an epizoan on other shells showing xenomorphic sculpture. a – On left valve of *Weyla alata* (von Buch), MLP 26561, X 1, stereographic pair, same specimen on Pl. 10, Fig. 16; b – On left valve of *Kolymonectes weaveri* Damborenea, MLP 26560, X 2, same specimen on Pl. 2, Fig. 10; c – On right valve of *Agerchlamys wunschae* (Marwick), MLP 23658, X 2, same on Pl. 7, Fig. 1.

characterized by irregular radial costae which may bear spines of different length and density (see illustrations in Goldfuss 1835, pl. 107, figs. 1a-k; de Verneuil & Collomb 1853, pl. 3, fig. 5; Quenstedt 1856, pl. 18, figs. 27–28, pl. 23, figs. 5–6; Eudes-Deslongchamps 1860, pl. 9, figs. 1–22, 25–46, pl. 10, figs. 1–23 as *H. parkinsoni*, pl. 10, figs. 24–37; Quenstedt 1867, pl. 52, figs. 20–25; Dumortier 1869, pl. 40, figs. 3–5, 12 as *H. parkinsoni*; Whidborne 1883, pl. 15, fig. 20; Jekelius 1915, pl. 7, figs. 15–16; Cohen 1931, pl. 1, fig. 18; Cox 1935, pl. 1, figs. 4–5; Bonchev & Tsankov 1935, pl. 4, figs. 2–3; Troedsson 1951, pl. 21, figs. 1–8; Behmel & Geyer 1966, pl. 5, fig. 5; Schweizer 1969, fig. 3; Jankicevic et al. 1983, pl. 1, figs. 2–3; see also Text-figs. 43e-h here)

The hinge characters and the internal moulds of left valves of *H. rapa* are similar to those of *P. laevigata* d'Orbigny (Thevenin 1908, pl. 12, figs. 29–30; Polubotko 1968b, pl. 20, figs. 1–4), from the early Jurassic of Europe and eastern Russia and *H. simplex* Milova (1976, pl. 15, figs. 7–8), from the Sinemurian of eastern Russia, but these species lack spines and only bear concentric lamellae or subdued tubercles.

Autecology: The living species *Plicatula gibbosa* Lam. lives in the intertidal zone cemented to hard (though not necessarily large) objects (Yonge 1973). Although fossil specimens are ocasionally found encrusting hard substrates, such as other shells (see Text-fig. 45), the majority of specimens are normally found loose in the sediments (see for instance Hallam 1971), which is also the case for the Argentinian species. The ratio between left (free) and right (attached) valves found is about 3 : 1 for the material here described, i. e. equivalent to the same ratio obtained for loose valves of *Plicatula* collected from a Recent drift-line. Schweizer (1969) statistically analyzed the early Jurassic species *H. spinosus* Sow. and concluded that its mode of life changed during ontogeny, being attached to other objects only when young and then living free on the sediment. The same has been postulated by Carter (1972, p. 337) for *P. inflata* J. de C. Sowerby from the British Cretaceous chalk.

This conclusion can be probably applied to most plicatulid species, especially those with a small attachment area, such as *H. rapa* (Text-fig. 38b). Young specimens of *H. rapa* have been observed cemented to the outer surface of *Camptochlamys wunschae* (Marwick), a very thin-shelled pectinid. Some left valves of *H. rapa* even show xenomorphic sculpture reproducing the substrate shell ornament, superimposed to its typical scaly spines

(Pl. 7, Fig. 1b; Text-fig. 45c). In fact these two species are commonly associated and this pectinid shell was probably one of the main substrates for juvenile *H. rapa*, although subsequently the pectinid shell almost certainly disintegrated easily leaving *H. rapa* free. Specimens of *H. rapa* were also found attached to the outer shell surface of *Kolymonectes weaveri* DAMBORENEA (MLP 26560; Pl. 2, Fig. 10; Text-fig. 45b) and left valves of *Weyla bodenbenderi* (BEHRENDSEN), a coarsely ribbed pectinid (MLP 26561; Pl. 10, Fig. 16; Text-fig. 45a), in these cases cemented by the whole right valve and with extensive and very detailed xenomorphic sculpture on their left valves. According to the orientation of *H. rapa* on the substrate shells, it is thought that these were dead shells at the time of fixation.

## Family Placunopsidae FRENEIX et al. 1985

The affinities of the genus *Placunopsis* are not yet completely understood. Specimens of this genus were commonly referred to *Anomia*, in part due to poor preservation and frequent erosion of the tip of the umbo. FÜRSICH & PALMER (1982) stated that most Jurassic references to *Anomia* should be placed in *Placunopsis* instead.

*Placunopsis* was doubtfully referred to the Terquemiidae by COX (in COX et al. 1969; see also MARINCOVICH 1993 and ABERHAN 1998). Recently FRENEIX et al. (1985) described in detail one of the species of this genus and proposed the new family name Placunopsidae, which, according to inferred ligamental characters, they placed in the Plicatuloidea. This arrangement is followed here. Nevertheless, the relations of this genus to the Anomioidea cannot be completely dismissed and a thorough study of shell morphology is still needed to elucidate the relative importance of the conflicting evidence described below. CARTER (1990a) excluded *Placunopsis* from the Terquemiidae stating that details of its shell microstructure are not known in sufficient detail and referred this genus to the Terquemiidae? (CARTER 1990c).

### Genus *Placunopsis* MORRIS & LYCETT 1853

Type species: *Placunopsis fibrosa* LAUBE 1867 [= *Placunopsis jurensis* ROEM. in MORRIS & LYCETT 1853, p. 6 (non ROEMER 1836)], Bathonian of Great Britain.

Synonyms: *Placunopis* MEEK 1873
?*Holocraspedum* CRAGIN 1893 (type species *Ostrea anomiaeformis* ROEMER 1852)

MORRIS & LYCETT (1853) did not designate a type species and included four nominal species in their new genus. STOLICZKA (1871, p. 474) mentioned *P. jurensis* ROEMER as the type, but, as COX (1952, p. 45) discussed, MORRIS & LYCETT's specimens were misidentified and should be referred as *P. fibrosa* LAUBE 1867. On the other hand FÜRSICH (1982) included MORRIS & LYCETT's material in his synonymy of *P. radiata* (PHILLIPS 1829), but at the same time mentioned the type species of the genus as *P. fibrosa*. *Placuna jurensis* ROEMER (1836) is regarded by some authors as a junior synonym of *Placunopsis radiata* (PHILLIPS) (see ARKELL 1937, FRENEIX et al. 1985), whilst others (FÜRSICH 1982) consider it as a different species. These controversies only stress the lack of a proper revision of the species of this group.

COX (in COX et al. 1969) stated in his diagnosis of this genus that crura are "typically absent". Nevertheless, some internal anterior ridges which could be interpreted as crura have been illustrated by SEILACHER (1954) in the attached valves of a Triassic species. A similar structure was described by FRENEIX et al. (1985) in free valves of *P. radiata*. One of the Argentinian specimens here described, clearly referable to this genus, shows a pair of radiating crura in the free valve (Pl. 11, Fig. 12; Text-fig. 46). This, together with the dorsal fusion line, is clearly reminiscent of the left valve interior of the living species *Pododesmus cepio* (GRAY) as described by YONGE (1977, fig. 2), regarded as the most primitive living genus of the Anomiidae.

It is important to note that the inner shell morphology is unknown in most species of *Placunopsis* and thus the presence or absence of internal crura may vary in different species, instead of being generically diagnostic. The genus *Juranomia* (FÜRSICH & WERNER 1989a) shows some similarities in the hinge region of the left valve with material traditionally referred to *Placunopsis*, but it is placed in the Anomiidae on the basis of some very well preserved right valves with remains of a calcified byssus.

## *Placunopsis* cf. *striatula* (Oppel 1856)

(Pl. 11, Figs. 9–12; Text-fig. 46)

cf. 1856 *Anomia striatula* Oppel, p. 227.
cf. 1865 *Anomia striatula* – Terquem & Piette, p. 113, pl. 14, fig. 5.
? 1878 *Placunopsis* sp. indet. – Gottsche, p. 19.
? 1891 *Anomia* sp. nova – Behrendsen, p. 394.
1894 *Anomia striatula* – Möricke, p. 34.
1915 *Anomia striatula* – Jaworski, p. 440.
1922 *Anomia* sp. nueva – Behrendsen, p. 177.
? 1925 *Placunopsis* sp. ind. – Gottsche, p. 250.
1925 *Anomia striatula* – Jaworski, p. 56–57.
1926a *Anomia striatula* – Jaworski, p. 168–169.
cf. 1990 *Placunopsis striatula* – Hölder, p. 20, fig. 4d.
1994 *Placunopsis radiata* – Aberhan, p. 36, pl. 17, figs. 6–8.

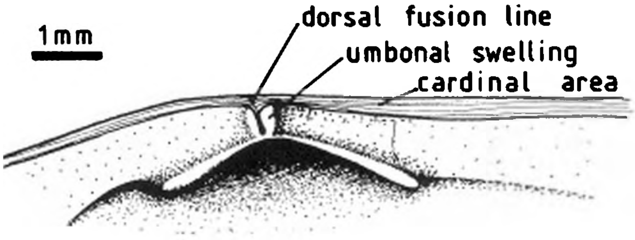
Material: Seven internal (or composite) and one external moulds of single valves, believed to be free (left) valves, from Pliensbachian beds in Mendoza and Neuquén Provinces, at Puesto Araya, rio Atuel (B.1), Southern Cordillera del Viento (C.1), Arroyo Serrucho (B.8), Arroyo Ñireco (C.20), Estancia Santa Isabel (D.1) and Cerro Roth, Piedra Pintada (D.15): MLP 24309 to 24314, 24996, 25060 and 27543 (M 99, 371, 1051, 1317, 1362, 1920 2043).

Apart from these localities, Early Jurassic material most probably belonging to this species was reported from Upper Rio Salado (Behrendsen 1891, 1922) and Cañada Colorada (Jaworski 1926a) in Argentina and Las Amolanas, Chile (Möricke 1894). This species was also found in Aalenian and Bajocian deposits in west-central Argentina (own material and probably in Gottsche 1878, 1925), thus its stratigraphical range extends well into the Middle Jurassic.

Remarks: As happened elsewhere, South American material of *Placunopsis* was referred mostly to *Anomia* in the past. Conversely, some South American Jurassic specimens referred to *Placunopsis* have very doubtful affinities. *Placunopsis cordobaensis* Tornquist (1898, pl. 8, fig. 8) from the Callovian of San Juan, lacks radial ornament and has a peculiar shape not typical for the genus, but no definite opinion about its affinities can be offered without seeing the type material. This is also the case of *Anomia ? koeneni* Behrendsen (1891, 1922, Sokolov 1946) from the latest Jurassic of western Argentina, which has a very prominent umbo and perhaps should be excluded from this group as well. *Anomia antiqua* R. Philippi 1899 non McCoy 1844 (= *Anomia chilensis* Cossmann 1901) is a name based on a single specimen of unknown geographic and stratigraphic provenance, which was examined in Santiago de Chile (SGO-PI 919). The specimen is an incomplete internal mould, probably of an ostreid and certainly does not belong to *Placunopsis.*

Description: Shell of medium size for genus, of very irregular outline though generally sub-orbicular. Length and height roughly equal in medium-sized specimens, becoming longer than high in larger ones. Dorsal margin long and straight, other margins evenly convex. Umbo sub-central, not prominent and placed a short distance from the dorsal margin (Pl. 11, fig. 9). Free valves feebly and variably convex. The greatest inflation of the shell in centrally placed. Shell very thin.

The margin of the shell is very irregular and sometimes slightly wavy. One valve shows a sharp marginal sinus on the dorsal region, of subtriangular shape (Pl. 11, Fig. 10).



Text-fig. 46. Hinge characters of *Placunopsis* cf. *striatula* (Oppel), based on MLP 24311.

Shell ornamented with numerous closely-set antimarginal riblets which are stronger towards the margins (Pl. 11, Fig. 9, 11). Strong irregular comarginal folds are also present.

A long but very narrow longitudinally striated cardinal area can be interpreted, following Freneix et al. (1985) as an external ligamental area. This cardinal area shows an umbonal indentation (described as dorsal fusion line by Freneix et al. 1985), below which a transverse swelling with a central furrow can be seen on the interior of left (?) valves (Pl. 11, Fig. 12b; Text-fig. 46). Two weak crura radiate from this umbonal swelling limiting a flat narrow dorsal area. Following Yonge (1977) the crura can be interpreted as part of the internal ligamental structures, i.e. the ridges supporting the right valve crurum. Other internal characters unknown.

Measurements:

| SPECIMEN MLP | Material | L (mm) | H (mm) | W (mm) |
|---|---|---|---|---|
| 24310 | EM LV? | 42.8 | 41.2 | 3.0 |
| 24309 | IM LV? | 31.3 | 31.0 | 2.0 |
| 24311 | IM LV? | 26.0 | 23.9 | 1.6 |
| 24312 | IM LV? | 33.0 | 29.0 | 2.8 |
| 24313 | IM LV? | 38.5 | 32.8 | 3.0 |
| 24314 | IM LV? | 31.3 | 25.0 | 2.1 |
| 24991 | IM LV? | 20.2 | 16.3 | 1.6 |

Affinities: In most species only the external characters are known and of these, mostly those of the left (free) valve, thus making a detailed comparison very difficult.

The Argentinian specimens are very similar in all external details to *Placunopsis striatula* (Oppel 1856 [non Zittel 1864, p. 33]), from lower Jurassic beds of Europe (see illustrations in Terquem & Piette 1865, pl. 14, fig. 5; Hölder 1990, text-fig. 4d) and are probably conspecific. The internal morphology of European specimens is, nevertheless, unknown and thus open nomenclature was preferred. They are also close to *P. gingensis* (Qu.) from the Middle Jurassic of Europe (Hölder 1990, text-fig. 6a, 7a, pl. 2, figs. 2, 4).

Also similar in shape and ornament are *P. radiata* (Phillips) and *P. distracta* (Eichwald) from the middle and upper Jurassic of Europe and Arctic regions (Phillips 1829, pl. 4, fig. 12; Arkell 1929, pl. 3, figs. 4–5; Fürsich 1982, figs. 24k, m; Kelly 1984, pl. 9, figs. 9–13; Freneix et al. 1985, pl. 1, pl. 2; Hölder 1990, text-fig. 9a-d, 9i, 9k, 11; Aberhan 1998, pl. 10, fig. 3), but these species lack internal radiating crura and have smaller size. "*Anomia*" *albertensis* McLearn (1924, pl. 7, figs. 6–7), from the Fernie Formation of western Canada, is comparable in shape, size and ornament, but its hinge characters are unknown.

*Placunopsis fibrosa* Laube, from the Middle Jurassic of Europe, Canada and India (see Morris & Lycett 1853, pl. 1, figs. 8, 8a, b; Cox 1952, pl. 4, figs. 14a, b; Cox in Cox et al. 1969, figs. C100, 4a-c; Hölder 1990, text-fig. 4e-f, 6b-c, pl. 2, fig. 1, pl. 3, figs. 1–3; Jaitly et al. 1995, pl. 18, fig. 1; Aberhan 1998, pl. 10, figs. 15-16; also material from Dorset housed at the Sedgwick Museum) has stronger and fewer antimarginal riblets, but is otherwise of similar shape and size. It also shows the central internal swelling in the left valve but lacks crura.

*Placunopsis parallela* Quilty, from the Bajocian of Ellsworth Land, Antarctica, has subparallel anterior and posterior margins, has an anterior umbo and is significantly higher than long (Quilty 1983, figs. 20–22).

Though not figured, the material described by Jaworski (1922, p. 112) from the Triassic of Perú as *Placunopsis* cf. *napengensis* Healy has an anteriorly placed umbo. *Placunopsis* (?) *cordobaensis* Tornquist (1898, pl. 8. fig. 8), from the Callovian of San Juan, Argentina, has a much more elongated shell, with the umbo placed near the anterior end and apparently lacks radial ornament.

Autecology: Species of *Placunopsis* lived tightly fixed to hard substrates by one valve, generally believed to be the right one, with the direction of growth declined about 65° from the vertical (Arkell 1929, Meischner 1968, Seilacher 1954, Kelly 1984). Hölder (1990) reports that they can even live free on the sediment.

In the material here described, most valves were found loose, but a few were preserved in life position. The largest specimen was attached to the inner side of the body chamber of a large ammonite, other to the inner side of a left valve of *Agerchlamys wunschae*, whereas one of the Bajocian specimens was attached to the inner surface of a *Neocrassina* which had both valves slightly displaced. This may indicate that these bivalves were negative phototropic, as are modern Dimyidae (Moore 1970). On the other hand *Placunopsis* has been found on the outer surface of other molluscs and brachiopods (SEILACHER 1954, KELLY 1984, HÖLDER 1990) and even on ammonites supposed to be alive (E. PHILIPPI 1899a, MEISCHNER 1968). Some specimens also show xenomorphic sculpture (MLP 24991; see also SEILACHER 1954; FÜRSICH 1982, fig. 24-k; KELLY 1984, pl. 9, fig. 12).

### Superfamily Dimyoidea P. FISCHER 1886

### Family Dimyidae P. FISCHER 1886

YONGE (1975) considered that this family could be included in the Plicatuloidea, whereas WALLER (1978), VOKES (1979) and CARTER (1990b) recognized it as different at the superfamily level. A detailed discussion of the relationships of the Dimyidae was other bivalve families was provided by HODGES (1991).

### Genus *Atreta* ETALLON 1862

Type species: *Ostrea blandina* D'ORBIGNY 1850, Upper Jurassic (Oxfordian) of the French Jura, subsequent designation by COX 1964, p. 45 (syntypes figured in COTTREAU 1928, pl. 48, figs. 12–13).

Synonyms: *Diploschiza* CONRAD 1866 (type species *D. cretoidea* CONRAD)
*Cyclostreon* EICHWALD 1868 (type species *Ostrea plicatuloides* LEYMERIE)
*Dimyodon* MUNIER-CHALMAS in FISCHER 1886 (type species *D. schlumbergeri* MUNIER-CHALMAS)
*Dimyodus* WÖHRMANN 1894 (for *Dimyodon* MUNIER-CHALMAS)
*Dimyopsis* BITTNER 1895 (type species *Ostrea intusstriata* EMMRICH)

COX (1964) discussed about the identity of species referred to this genus and designated a valid type species. He also considered the family relations of this genus and doubtfully referred it to the Plicatulidae, since he could not find material showing the hinge and muscle characters as described by ETALLON (1862). On the other hand, COX (1964) included *Diploschiza* CONRAD as a junior synonym and the type species of this genus clearly shows crural ridges (STEPHENSON 1934, 1935).

Recently FÜRSICH & WERNER (1989b) described material from the Jurassic of Portugal which confirms ETALLON's original description. These Portuguese specimens of *Atreta unguis* (LORIOL) show crural ridges and faint anisomyarian muscle scars. FÜRSICH & WERNER (1989b) and JAITLY et al. (1995) argued that the differences between *Atreta* and *Dimyodon* are merely due to the particular kind of preservation and regarded both genera as synonyms. They also placed *Atreta* in the family Dimyidae on account of the presence of two muscle scars. HODGES (1991) proved the presence of dimyarian musculature in *Atreta intusstriata* (EMMRICH).

*Atreta* is known by a few species which lived from late Triassic to late Cretaceous times in the Tethyan (s.l.) region, usually associated to reef facies. This genus forms part of the rich epizoan communities developed mainly on anthozoan corals since the late Triassic, which include special groups of bryozoans, brachiopods, foraminifers and serpulids. The genus time range probably extended into the Paleogene in Europe (VOKES 1979) and the probably related *Dimya* and *Dimyella* are known from Tertiary to Recent times (MOORE 1970, VOKES 1979).

Many Early Jurassic collections of corals from the Andes have well-preserved *Atreta* cf. *intusstriata* as epizoans. Nevertheless, the presence of this genus in the Andean regions was only very recently reported (MANCEÑIDO & DAMBORENEA 1991). Although no new information about the morphology of the group can be added, this material is interesting from palaeobiogeographical and palaeoecological points of view.

### *Atreta* cf. *intusstriata* (EMMRICH 1853)

(Pl. 11, Figs. 13–15)

v 1991 *Atreta* sp. – MANCEÑIDO & DAMBORENEA, p. 93.

Material: About two hundred specimens, most of them imperfectly preserved attached valves, though a few specimens also have the free valve. All the material was found at the coral bearing beds of Piedra Pintada region, Neuquén Province (D.15 and D.16) of late Pliensbachian age (*Fanninoceras* Ammonite Zone): MLP 12194, 12197, 12198, 12204, 12205, 18242, 18265, 18292, 18293, 18294, 20666, 20667, 27563 to 27566, 27577 (M 103, 105, 1382, 1383). Its restriction to this age may be either due to the lack of apropriate substrates or to imperfect sampling.

Description: Small to medium-sized irregularly orbicular shells, inequivalve, inequilateral, usually higher than long. Dorsal margin short, other margins very irregular adapting to the substrate surface and neighbouring epizoans. Right valve attached by most of its surface, with a narrow elevated rim. Left valve almost flat, slightly concave or convex according to the substrate surface.

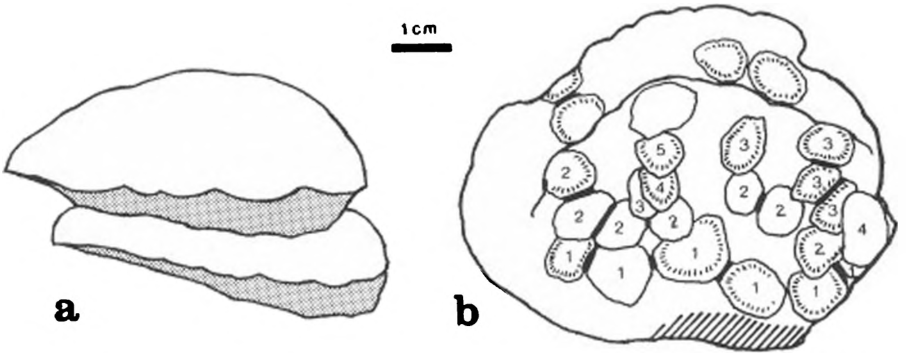
External surface of uncemented part of right valve lamellose and with numerous radial costae. External surface of left valve concentrically lamellose, sometimes showing xenomorphic sculpture. Internal surface of right valve with sinuous anastomosing radial riblets which end as transverse crenulations of the inner margin of the rim, marginal band convex and smooth. Other internal characters unknown.

Affinities: The material here described is very close to the Rhaetian-Early Jurassic species *Atreta intusstriata* (Emmrich) from Europe and Indo-Pacific regions (see lectotype designation in Hodges 1991), especially with higher than long specimens (Stoppani 1860-1865, pl. 15, figs. 9–16; Capellini 1866, pl. 6, fig. 12; Krumbeck 1913, text-fig. 3; Allasinaz 1962, pl. 27, figs. 8–9; Kochanova 1967, pl. 4, figs. 10, 12; Hodges 1991, pl. 1, figs. 1–10). In shape and size it is similar to *Terquemia* (?) sp. in Toula 1910 (pl. 12, fig. 2) from the Alpine Triassic. *Atreta alternans* (Eudes-Deslongchamps 1860, pl. 18, figs. 11-20) from the Toarcian of France, differs from *Atreta* cf. *intusstriata* by its long straight dorsal line and different pattern of internal riblets. *Atreta* cf. *intusstriata* can be distinguished from other Jurassic species on account of its smooth left valve exterior and short dorsal line.

Autecology: *Atreta* cf. *intusstriata* forms part of a varied epizoic fauna of the near-shore sublittoral coral bearing facies at Cerro Roth, Piedra Pintada region (locality D.15-D.16). This fauna includes the thecideoidean *Anchorellina ageri* Manceñido & Damborenea (1991) and also ostreids such as *Lopha* sp., bereniceiform bryozoans, serpulid tubes, *Andenipora* sp. and a variety of etchings and borings.

The commonest substrates for *Atreta* cf. *intusstriata* are the non-calyciferous surfaces of fungiform to massive thamnasterioid and meandroid coral colonies assigned to *Thamnasteria* sp. and *Collignonastraea* ? sp. (cf. Damborenea et al. 1975). Less frequently, they encrust solitary turbinate to subcylindrical *Montlivaltia* sp. and the posterior end of a variety of epifaunal or semi-infaunal bivalve shells such as *Lopha longistriata* (Jaworski), *Cardinia andium* (Giebel) and *Myoconcha* sp. The distribution and orientation of the *Atreta* shells on these substrates suggest that the substrates were living organisms. A few specimens show that they could also encrust dead shells, such as those on *Neocrassina* sp., *Myoconcha* sp., *Isocyprina* sp. and probably those on terebratuloid brachiopods. They very rarely fix onto other *Atreta* shells, but their ventral edge may grow over either an attached valve or a complete shell of an older *Atreta* cf. *intusstriata*. In this way, on heavily encrusted surfaces, up to five successive generations of *Atreta* cf. *intusstriata* can be recognized on a single coral underside (Text-fig. 47).

Many authors have described the preferred orientation of *Atreta* shells when fixed on sloping surfaces (for instance, Schmid 1949, Fürsich & Palmer 1979). The reported tendency to have the dorsal side pointing upslope is also seen on the specimens from Argentina (Text-fig. 47).



Text-fig. 47. Distribution of *Atreta* cf. *intusstriata* (Emmrich) on the underside of *Collignonastraea* ? sp., MLP 12205, same specimen figured on pl. 11, figs. 13 a-b. a – Lateral view, areas encrusted by *Atreta* cf. *intusstriata* stippled. b – Underside view, coral attachment area ruled; thick lines indicate lateral contact of shells from the same generation without mutual overgrowth; numbers indicate possible generation groups as shown by overgrown shells.

Mesozoic *Atreta* were abundant in near-shore sublittoral, often reefal, facies, but it also appeared in off-shore facies (HODGES 1991). Since then, the group apparently experienced an environmental restriction or shift. Recent species of Dimyidae are not common in reef communities, but, instead, they live in cryptic habitats usually near the edge of the continental shelf of tropical and subtropical regions (VOKES 1979). Records from littoral caves with subdued illumination can be as shallow as 6 m, otherwise the total depth-range known is 9 to 790 m (MOORE 1970). This author reports that they are negative phototropic and encrust a variety of substrates, including living corals. According to VOKES (1979) the scarcity of *Dimya* after the Eocene is due to its migration to deeper waters in the face of competition from more "aggressive" shallow water species.

Such conditions are strikingly parallel to what is known to have happened among thecideoidean brachiopods. As pointed out by MANCEÑIDO & DAMBORENEA (1991), the association of *Atreta* and cemented thecideoideans has been recurrent throughout Jurassic and Cretaceous times. Furthermore, extant thecideids are likewise sciaphilous, rugophilic, hardground encrusters, typically warm-water cryptic dwellers, living between 20 and 150 m deep, yet able to reach sea-level within coastal caves. Both dimyids and thecideoideans are members of ancient stocks specialized for a cementing life-style, which appeared in the late Triassic and share a patchy Cenozoic record after being strongly decimated at the close of the Maastrichtian.

## Acknowledgements

Dr. A.C. Riccardi (La Plata) introduced the author to the study of Mesozoic bivalves and ever since contributed with his knowledge and experience on Jurassic molluscs and stratigraphy. Dr. D.V. Ager (Swansea) helped in many ways supervising the thesis and also with bibliography, reference material, research facilities and friendly hospitality during the stay in Wales. Dr. M. O. Manceñido (La Plata) provided invaluable help during all stages of the research and preparation of the manuscript. They are all warmly acknowledged.

The field work was carried out together with M.O. Manceñido and A.C. Riccardi in most opportunities and thanks are also due to other colleagues who participated in some of the field trips. Material used in this monograph collected by other colleagues is indicated within the text with the collector's name. The geologists of the field comissions of the ex-national oil company (YPF) gave generous assistance during some field trips and made the visit to hardly accessible places possible.

The author is also grateful to those colleagues who kindly allowed access to specimens housed in the following institutions: National Geological Survey, Buenos Aires (Drs. R. Levy and H. Leanza), University of Buenos Aires (Drs. H. Camacho and B. Aguirre-Urreta), National Natural History Museum, Santiago (Mr. Frassinetti), Geological Survey of Chile (Drs. E. Pérez and V. Covacevich), Geology Department, University of Chile (Dra. I. Tapia), Natural History Museum, Basel (Dr. F. Wiedenmayer), British Museum, Natural History (Dr. N.J. Morris), Natural History Museum Ludwigsburg (Drs. B. Ziegler and M. Urlichs), Otago University Museum, Dunedin (Dr. J.D. Campbell), University of Auckland Museum (Dr. J. A. Grant-Mackie and J. Sutherland), New Zealand Geological Survey, Lower Hutt (Dr. G.A. Stevens), Canterbury Museum, Christchurch (Dr. M. Bradshaw), Sedgwick Museum, Cambridge (Dr. B. Rickards), the British Antarctic Survey (Dr. M.R.A. Thomson), The American Museum of Natural History (Dr. N. Newell), The Burke Museum, Washington (Dr. S. Mallory) and the Geological Survey of Canada at Calgary (Dr. T. Poulton). Specialists from many countries have maintained correspondence, provided reprints, comments and/or plastotypes which bear directly or indirectly on this revision. Among them, special thanks for their assistance are due to Drs. S. Kelly (Great Britain), G. Westermann (Canada), H. Tipper (Canada), R. Imlay (U.S.A.), and P. Hodges (Great Britain).

A three months stay in New Zealand allowed the direct comparison with Early Jurassic bivalves from the south-western Pacific. The trip to New Zealand was financed by The Royal Society of New Zealand and the La Plata Museum Foundation.

Funding for this project was provided by the Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina and partly by the Secretaría de Ciencia y Técnica, Argentina.

## References

ABBOTT, R.T. & DANCE, S.P. (1982): Compendium of Seashells. – x + 410 p., E.P. Dutton, Inc., New York.

ABERHAN, M. (1992): Palökologie und zeitliche Verbreitung benthischer Faunengemeinschaften im Unterjura von Chile. – Beringeria, 5: 1–174, Würzburg.

–,– (1993a): Faunal replacement in the Early Jurassic of northern Chile: implications for the evolution in Mesozoic benthic shelf ecosystems. – Palaeogeogr., Palaeoclimat., Palaeoecol., 103, 3–4: 155–177, Amsterdam.

–,– (1993b): Benthic macroinvertebrate associations on a carbonate-clastic ramp in segments of the Early Jurassic back-arc basin of northern Chile (26–29°). – Rev. Geol. Chile, 20, 2: 105–136, Santiago.

–,– (1994): Early Jurassic Bivalvia of northern Chile. Part I. Subclasses Palaeotaxodonta, Pteriomorphia, and Isofilibranchia. – Beringeria, 13: 1–115, Würzburg.

–,– (1998): Early Jurassic Bivalvia of western Canada. Part I. Subclasses Palaeotaxodonta, Pteriomorphia, and Isofilibranchia. – Beringeria, 21: 57–150, Würzburg.

Aberhan, M. & Pálfy, J. (1996): A low oxygen tolerant East Pacific flat clam (*Posidonotis semiplicata*) from the Lower Jurassic of the Canadian Cordillera. – Canad. Journ. Earth Scis., 33: 993–1006.

Allasinaz, A. (1962): Il Trias in Lombardia (Studi geologici e paleontologici). III. Studio paleontologico e biostratigrafico del Retico dei dintorni di Endine (Bergamo). – Riv. Ital. Paleont., 48, 3: 307–376, Tav. 24–28, Milano.

–,– (1972): Revisione dei Pettinidi triassici. – Riv. Ital. Paleont. Stratigr., 78, 2: 189–428, Tav. 24–48, Milano.

Alvarez, P. P. (1996a): Bioestratigrafía del Jurásico Inferior de la Cuenca de La Ramada, Alta Cordillera de San Juan (Argentina). – Rev. Españ. Paleont., 11, 1: 35–47, Madrid.

–,– (1996b): Los depósitos triásicos y jurásicos de la Alta Cordillera de San Juan. – In: Ramos, V. A. (Ed.): Geología de la región del Aconcagua, provincias de San Juan y Mendoza. – An. Subsecr. Miner. Nac., Direcc. Nacion. Serv. Geol., 24, 5: 59–137, Buenos Aires.

Andrejeva, T. F. (1966): Lamellibranchiaten aus jurassischen Ablagerungen des südöstlichen und des zentralen Pamir. – Trudy Uprav. Geol. sov. Tadsch. SSR, Paleont. Stratigr., 2: 1–70, 23 Taf, Moscow.

Arkell, W. J. (1929–1937): A Monograph of British Corallian Lamellibranchia. – Palaeontogr. Soc. Monogr., Part I = 81, 373: 1–72, pl. 1–4 (1929); Part II = 82, 374: 73–104, pl. 5–8 (1930); Part III = 83, 378: 105–132, pl. 9–12 (1931a) ; Part IV = 84, 383: 133–180, pl. 13–20 (1932); Part V = 85, 386: 181–228, pl. 21–28 (1933a); Part VI = 86, 389: 229–276, pl. 29–36 (1934); Part VII = 87, 393: 277–324, pl. 37–44 (1934); Part VIII = 88, 397: 325–350, pl. 45–49 (1935); Part IX = 89, 401: 351–376, pl. 50–56 (1936); Part X = 90, 405: 377–392 (1937). London.

–,– (1931b): Berichtigungen der Identität gewisser jurassischer Pecten-Arten. – Zentralbl. Mineral., Geol. Paläont. (B), 1931, 8: 430–443, Stuttgart.

–,– (1933b): The Jurassic System in Great Britain. – 681 p., 41 pl., Oxford University Press, London.

–,– (1956): The Jurassic Geology of the World. – 806 p., 46 pl., Oliver and Boyd,. London.

Atanasiu, I. & Raileanu, G. (1958): K Issledovaniyu Lejasa Gor Khehgimash. – Rev. Géol. Géogr., Acad. Roum., 2, 2: 337–352.

Ballent, S. C. (1987): Foraminíferos y ostrácodos del Jurásico inferior de Argentina. – Rev. Mus. La Plata (n.s.), Paleontología, 9, 53: 43–130, La Plata.

–,– (1990): Lower and Middle Jurassic Ostracoda from Argentina. – In: Whatley, R. & Maybury, C. (Eds.): Ostracoda and Global Events. – pp. 211–220, Chapman & Hall, London.

–,– (1992): Metacopina (Ostracoda) del Hettangiano superior en el sudoeste de la Provincia de Mendoza, Argentina. – Ameghiniana, 29, 2: 153–157, Buenos Aires.

–,– (1994): New marine microfaunas from the Triassic-Jurassic boundary in the Atuel river area (mendoza, Argentina). – Abstracts, 4th International Congress on Jurassic Stratigraphy and Geology: 55, Mendoza.

Barbulescu, A. (1961): Contributii la studiul Jurasicului din Valea Tichilestilor (R. Hirsova). – Stud. Cercet. Geol., Geofiz., Geogr., 6: 699–708, Bucuresti.

Bayle, E. (1878): Fossiles principaux des terrains. – Explication de la carte Géologique de la France, Atlas. Première Partie, 4, 158 pls., Impr. Nationale, Paris.

Bayle, E. & Coquand, H. (1851): Mémoire sur les Fossiles recueillis dans le Chili par M. Ignace Domeyko et sur les terrains auxquels ils appartiennent. – Mém. Soc. Géol. France, (2), 4, 1: 1–47, Pl. 1–8, Paris.

Begg, J. G. & Campbell, H. J. (1985): *Etalia*, a new Middle Triassic (Anisian) bivalve from New Zealand and its relationship with other pteriomorphs. – N. Zeal. Journal of Geology and Geophysics, 28(4): 725741. Wellington.

Behmel, H. & Geyer, O. F. (1966): Beiträge zur Stratigraphie und Paläontologie des Juras von Ostspanien. III. Stratigraphie und Fossilführung im Unterjura von Albarracín (Provinz Teruel). – N. Jahrb. Geol. Paläont., Abh., 124, 1: 1–52, Taf. 1–6, Stuttgart.

Behrendsen, O. (1891): Zur Geologie des Ostabhanges der argentinischen Cordillere. I Teil. – Z. Dt. Geol. Ges., Beitr.-Bd., 43: 369–420, Taf. 22–25, Berlin.

–,– (1892): Zur Geologie des Ostabhanges der argentinischen Cordillere. II. Teil. – Z. Dt. Geol. Ges., Beitr.-Bd., 44: 1–42, Taf. 1–4, Berlin.

–,– (1922): Contribución a la geología de la pendiente oriental de la Cordillera Argentina. – Actas Acad. Nac. Cienc. (Argentina), 7, 3: 161–227, Lám. 1–4, Córdoba.

Bengtson, P. (1988): Open nomenclature. – Palaeontology, 31, 1: 223–227, London.

Beurlen, K. (1944): Beiträge zur Stammesgeschichte der Muscheln. – Sitzungsber. Bayer. Akad. Wiss., 1–2: 133–145.

Bittner, A. (1895): Lamellibranchiaten der Alpinen Trias. I. Theil: Revision der Lamellibranchiaten von St. Cassian. – Abh. k.k. Geol. Reichsanst. Wien, 18, 1: 1–235, 24 pl., Wien.

–,– (1902): Lamellibranchiaten aus der Trias von Hudiklanec nächst Loitsch in Krain. – Jahrb. K.K. Geol. Reichsanst., 51, 2: 225–234, Taf. 7, Wien.

Bodylevskii, V. I., Glazunova, A. E., Polubotko, I. V., Repman, E. A. & Frolenkova, A.Y. (1968): Novye Mezozoiskie pektenidy nekotorykh raionov SSSR. – In: Markovskii, V. P. (Ed.): Novye vidy drevnikh rastenii i bespozvonochnykh SSSR. – Vypusk II. Chast I. – VSEGEI, Izdvo 'Nedra', pp. 215–224, Tabl. 51–54, Moskva.

Böhm, J. (1901): Über die Fauna der Pereiros-Schichten. – Z. Dt. Geol. Ges., 53, 2: 211–252, Taf. 8–10, Berlin.

–,– (1903a): Über die obertriadische Fauna der Bäreninsel. – Kungl. Svenska Veten. Akad. Hand., 37, 3: 1–76, Taf. 1–7, Stockholm.

–,– (1903b): Description de la faune des couches de Pereiros. – Comm. Com. Serviços Geolog. Portugal, 5, 1: 1–48, Pl. 1–3, Lisboa.

Bonchev, E. & Tsankov, V. (1935): Yurska fauna oty okolnostite na s. Zimevitsa. [= Eine Jurafauna von dem Umgebung des Dorfes Zimevica (W. Bulgarien).]. – Spisanie na Bulgarskogo Geologichesko Druzhestvo [= Zeitschrift, Bulgarische Geologisches Gesellschaft], 7, 1: 15–23. Tabl. 4, Sofia. [Bulg. with German abstr.]

Borissjak, A. (1909): Pelecypoda Yurskikhshch Otlozheni Evropeiskoi Rossi. Vyp. IV. Aviculidae. [Die Pelecypoden der Jura-Ablagerungen im Europaeischen Russland. IV. Aviculidae.]. – Mémoires, Com. Géologique de St.-Pétersbourg, (N.S.) 44: 1–26, Tab. 1–2, St. Petersbourg. [Russian and German]

Borissjak, A. & Ivanoff, E. (1917): Pelecypoda Yurskikhskck Otlozheni Evropeiskoi Rossi. Vyp. V. Pectinidae. [= Les pélécypodes des couches Jurassiques de la Russie d'Europe. V. Pectinidae]. – Mémoires, Com. Géologique de St.-Pétersbourg, (N.S.) 143: 1–58, Tab. 1–4, St. Petersbourg. [Russ.]

Broglio Loriga, C. & Neri, C. (1976): Aspetti paleobiologici e paleogeografici della facies a "*Lithiotis*" (Giuresi inf.). – Riv. Ital. Paleont. Stratigr., 82, 4: 651–705, Milano.

Burckhardt, C. (1900a): Profils géologiques transversaux de la Cordillère Argentino–Chilienne. Stratigraphie et tectonique. – An. Mus. La Plata, Secc. Geol. Miner., 2: 1–136, Pl. 1–32, La Plata.

–,– (1900b): Coupe géologique de la Cordillere entre Las Lajas et Curacautin. – An. Mus. La Plata, Secc. Geol. Miner., 3: 1–100, Pl. 1–26, La Plata.

–,– (1902): Le Lias de la Piedra Pintada (Neuquén). III. Sur les fossiles marines du Lias de la Piedra Pintada, avec quelques considérations sur l'age et l'importance du gisement. – Rev. Mus. La Plata, 10: 243–249. Pl. 4, La Plata.

–,– (1903): Beiträge zur Kenntnis der Jura- und Kreideformation der Cordillere. – Palaeontographica, 50, 1–3: 1–144, Taf. 1–16, Stuttgart.

Butler, B.S. et al. (1920): The ore deposits of Utah. – U.S. Geol. Surv., Prof. Pap., 111: 1–672, pl. 1–57.

Bychkov, Yu.M., Dagis, A.S., Efimova, A.F. & Polubotko, I.V. (1976): Atlas triasovoï fauny i flory Severo–Vostoka SSSR. – 267 p., Izd-vo. 'Nedra', Moskva. [Russ.]

Calzada, S. (1981): Sobre tres lamelibranquios del Lías de Camarasa (Lérida). (*Pleuronectites freneixi* n. sp., *Pleuromya rotundata* y *Pleuromya marini*). – Cuad. Geol., Univ. Granada, 10: 213–218, Granada.

–,– (1983): Algunos lamelibranquios liásicos de Alfara (Tarragona). – Acta Geol. Hispan., 17, 1-2: 121–127.

Camacho, H.H. & Riccardi, A.C. (1978): Invertebrados. Megafauna. – In: Geología y Recursos Naturales del Neuquén. – Relatorio, 7° Congr. Geol. Argentino, pp. 137–146, cuadros 1–4, Buenos Aires.

Capellini, G. (1866): Fossili infraliassici dei dintorni del Golfo della Spezia. – Atti Accad. Sci. Inst. Bologna, 5: 1–101, pl. 1–10, Bologna.

Carter, J.G. (1990a): Evolutionary significance of shell microstructure in the Palaeotaxodonta, Pteriomorphia and Isofilibranchia (Bivalvia: Mollusca). – In: Carter, J.G. (Ed.): Skeletal Biomineralization: Patterns, Processes and Evolutionary Trends. Vol. 1. – pp. 135–296, Van Nostrand Reinhold, New York.

–,– (1990b): Shell microstructural data for the Bivalvia. Part IV. Order Ostreoidea. – In: Carter, J.G. (Ed.): Skeletal Biomineralization: Patterns, Processes and Evolutionary Trends. Vol. 1. – pp. 347–362, Van Nostrand Reinhold, New York.

–,– (1990c): Shell microstructural data for the Bivalvia. Part V. Order Pectinoida. – In: Carter, J.G. (Ed.): Skeletal Biomineralization: Patterns, Processes and Evolutionary Trends. Vol. 1. – pp. 363–389, Van Nostrand Reinhold, New York.

Castell, C.P. & Cox, L.R. (1975): British Mesozoic Fossils. – British Museum (Natural History) 703, 207 p., London.

Charles, R.P. (1948): Le Lias de la Basse Provence Occidentale. Etude paléontologique et paléobiologique. – Thèse Doct. Université d'Aix-Marseille, 206 p., 10 pl., Marseille.

Chen Jin-hua (1982a) Liassic bivalve fossils from Mt. Jinji of Guangdong. – Acta Paleont. Sinica, 21, 4: 404–416, Pl. 1–3. [Chinese, with English abstr.]

–,– (1982b): A study on the bivalve fauna of the upper Triassic in Guangdong, Hunan and Jiangxi Provinces, South China. – Bull., Nanjing Institute of Geology and Paleontology, Acad. Sinica, 6, 4: 279–306, Pl. 1–8. [Chinese, with Engl. abstr.]

Cohen, E.R. (1931): Geologiya na Predbalkana v" Tetevensko zaedno s" faunata na sredniya lias". [= Geologie des Vorbalkan von Tetewen in Bulgarien nebst die Fauna des mittleren Lias.]. – Spisanie na Bulgarskogo Geologichesko Druzhestvo [= Zeitschrift, Bulgarische Geologisches Gesellschaft], 3, 1: 15–96. Tab. 1–5, Sofia. [Bulg., German abstr.]

Cossmann, M. (1901): Los fósiles secundarios de Chile, por le Dr. R.A. Philippi. – Rev. Crit. Paléozoolog., 5, 1: 21–23, Paris.

–,– (1906): Description de quelques pélécypodes jurassiques de France. Première article. – C. R. Congr. Assoc. Franç. Avancem. Scis., 1905: 284–297. Pl. 1–2, Paris.

–,– (1908): Description de quelques pélécypodes jurassiques recueillis en France (3° article). – C. R. Assoc. Franç. Avancem. Scis. (36° sess., Reims, 1907): 292–305. Pl. 3–3, Paris.

–,– (1915): Description de quelques pélécypodes jurassiques recueillis en France (6° article). – C. R. Assoc. Franç. Avancem. Scis. (Mém. hors volume).

–,– (1916) Etude complémentaire sur le Charmouthien de la Vendée. – Bull. Soc. Géol. Normandie, 33: 113–159, pl. 3–8, Caen.

Cottreau, J. (1925–1932) Types du Prodrome de Paléontologie stratigraphique universelle d'Alcide d'Orbigny. 2, Callovien – Portlandien. – Ann. Paléont., 14-91: 1–162, pl. 1–65, Paris.

Covacevich, V. & Escobar, T.F. (1979) La presencia del género *Otapiria* Marwick, 1935 (Mollusca: Bivalvia) en Chile y su distribución en el ámbito circumpacífico. – Segundo Congreso Geológico Chileno: H165–H187, Lám. 1, Arica.

Covacevich, V., Perez, E. & Escobar, F. (1991) Presencia del género *Kalentera* Marwick, 1953 (Mollusca: Bivalvia) en el Sinemuriano al Sur de Taltal, Chile. – Sexto Congreso Geológico Chileno, Actas 1, Resúmenes ampliados: 68–71, Santiago.

Cox, L.R. (1928) The gastropod and lamellibranch molluscs. – In: Lang et al.: The Belemnite Marls of Charmouth, a series in the Lias of the Dorset Coast. – Quart. Journ. Geol. Soc. London, 84, 2: 233–245, Pl. 18, London.

–,– (1935): The Triassic, Jurassic and Cretaceous Gastropoda and Lamellibranchia of the Attock District. – Mem. Geol. Surv. India, Paleontologia Indica, (N.S.) 20, 5: 1–27, Pl. 1–2, Calcutta.

–,– (1936): Fossil Mollusca from Southern Persia (Iran) and Bahrein Island. – Mem. Geol. Surv. India, Paleontologia Indica, (N.S.) 22, 2: 1–69, Pl. 1–8, Calcutta.

–,– (1940): The Jurassic Lamellibranch Fauna of Kuchh (Cutch). – Mem. Geol. Surv. India, Paleontologia Indica, (9), 3, 3: 1–157, pl. 1–10, Calcutta.

–,– (1941): Notes on Jurassic Lamellibranchia VII. On the identity of *Echinotis* Marwick with *Meleagrinella* Whitfield. – Proc. Malacol. Soc. London, 24: 133–135, London.

Cox, L.R. (1942): Notes on Jurassic Lamellibranchia VIII. On the genus *Velata* Quenstedt. - Proc. Malacol. Soc. London, 25, 3: 119-124, Pl. 4, London.

-,- (1952): The Jurassic lamellibranch fauna of Cutch (Kachh), No. 3, Families Pectinidae, Amusiidae, Plicatulidae, Limidae, Ostreidae and Trigonidae (Supplement). - Mem. Geol. Surv. India, Paleontologia Indica, 9, 3, 4: 1-128, Pl. 1-12, Calcutta.

-,- (1956): Jurassic Mollusca from Peru. - Journ. Paleont., 30, 5: 1179-1186, pl. 127-128, Tulsa, Okl.

-,- (1961): New genera and subgenera of Mesozoic Bivalvia. - Palaeontology, 4, 4: 592-598. London.

-,- (1964): Notes concerning the taxonomy and nomenclature of fossil Bivalvia (mainly Mesozoic). - Proc. Malacol. Soc. London, 36, 1: 39-48, Pl. 1, London.

-,- (1965): Jurassic Bivalvia and Gastropoda from Tanganyika and Kenya. - Bull. British Mus. (Natural History), Geology Suppl., 1: 1-213, Pl. 1-30. London.

Cox, L. R. & Arkell, W. (1948): A survey of the Mollusca of the Great Oolite Series, primarily a nomenclatorial revision of the Monographs by Morris & Lycett (1851), Lycett (1863) & Blake (1905-1907). Part I. - Palaeontogr. Soc. Monogr., 102, 444: 1-48, Revised explanation of Plates, Morris & Lycett (Bivalves), 1-15, London.

Cox, L.R., Newell, N.D., Boyd, D.W., Branson, C.C., Casey, R., Chavan, A., Coogan, A.H., Dechaseaux, C., Fleming, C.A., Haas, F., Hertlein, L.G., Fauffnab, E.G., Keen, A.M., Larocque, A., McAlester, A.L., Moore, R.C., Nuttall, C.P., Perkins, B.F., Puri, H.S., Smith, L.A., Soot-Ryen, T., Stenzel, H.B., Trueman, E.R., Turner, R.D. & Weir, J. (1969): Mollusca 6. Bivalvia. - In: Moore, R.C. (Ed.): Treatise on Invertebrate Paleontology. Part N. I: 1-489, II: 490-952. - University of Kansas Press and Geological Society of America, Kansas.

Crame, J. A. (1985): New Late Jurassic oxytomid bivalves from the Antarctic Peninsula region. - Bull. Brit. Antarct. Surv., 69: 35-55, Cambridge.

-,- (1986): Late Mesozoic bipolar bivalve faunas. - Geol. Mag., 123, 6: 611-618, Cambridge.

-,- (1996): A new oxytomid bivalve from the Upper Jurassic-Lower Cretaceous of Antarctica. - Palaeontology, 39, 3: 615-628, London.

Crickmay, C.H. (1928): The Stratigraphy of Parson Bay, British Columbia. - Univ. Calif. Publ., Bull. Dept. Geol. Scis., 18, 2: 51-70, pl. 1-4, 1 map, Berkeley.

-,- (1930a): Fossils from Harrison Lake area, British Columbia. - Bull. National Mus. Canada, 63: 33-66.

-,- (1930b): The Jurassic Rocks of Ashcroft, British Columbia. - Univ. Calif. Publ., Bull. Dept. Geol. Scis., 19, 2: 23-74, pl. 2-7, Berkeley.

-,- (1933a): Mount Jura Investigation. - Bull. Geol. Soc. America, 44, 5: 895-926, pl. 23-24, Washington.

-,- (1933b): Some of Alpheus Hyatt's unfigured types from the Jurassic of California. - U.S. Geol. Surv., Prof. Pap., 175-B: 51-64, pl. 14-18, Washington.

Cuerda, A.J., Schauer, O.C. & Sunesen, A.A. (1981): Formación Aluminé. Asociación vulcanítico-sedimentaria de edad liásica en la Provincia de Neuquén. - Resúmenes de la 1ra. Reunión de Comunicaciones Científicas, Centro de Investigaciones Geológicas, pp. 9-10, La Plata.

-,- (1982): Afloramientos fosilíferos de la Formación Aluminé, en el sector de Rahue, Provincia del Neuquén. - Rev. Asoc. Geol. Argent., 36, 4: 329-332, Buenos Aires.

Cui Xinsheng & Liu Benpei (1987): Late Triassic-early Jurassic bivalve fauna from Zanda County in Southwest Xizang (Tibet), China. - Geoscience, 1, 2: 196-206. Pl. 1-2. [Chin., with Engl. abstr.]

Dall, W.H. (1898): Contributions to the Tertiary fauna of Florida. Part 4. - Transactions., Wagner Free Institute of Sciences of Philadelphia, 3: 571- 974, Philadelphia.

Damborenea, S. E. (1987a): Early Jurassic Bivalvia of Argentina. Part 1: Stratigraphical Introduction and Superfamilies Nuculanacea, Arcacea, Mytilacea and Pinnacea. - Palaeontographica (A), 199, 1-3: 23-111, Pl. 1-4, Stuttgart.

-,- (1987b): Early Jurassic Bivalvia of Argentina. Part 2: Superfamilies Pteriacea, Buchiacea and part of Pectinacea. - Palaeontographica (A), 199, 4-6: 113-216, Pl. 1-14, Stuttgart.

-,- (1989): El género *Posidonotis* Losacco (Bivalvia, Jurásico inferior): su distribución estratigráfica y paleogeográfica. - Actas, 4° Congr. Argent. Paleont. Bioestratigr. (1986), 4: 45-51, Mendoza.

-,- (1990): Middle Jurassic inoceramids from Argentina. - Journ. Paleont., 64, 5: 736-759.

-,- (1991): Early Jurassic Bivalvia of Argentina: Superfamilies Monotacea, Pectinacea and Plicatulacea. - 221 p., Ph. D. Thesis, University College of Swansea, University of Wales, (unpubl.).

-,- (1992): South American Jurassic bivalves. - In: Westermann, G.E.G. (Ed.): The Jurassic of the Circum-Pacific, Atlas. - pp. 610-619, Cambridge University Press.

-,- (1993a): Early Jurassic South American pectinaceans and circum-Pacific palaeobiogeography. - Palaeogeogr., Palaeoclimat., Palaeoecol., 100, 1-2: 109-123, Amsterdam.

-,- (1993b): Bivalvos de utilidad bioestratigráfica y su uso en el Jurásico de América del Sur. - IGCP 322 Correlation of Jurassic Events in South America, Bol. 1: 11-13, La Plata.

-,- (1994): Circum-Pacific correlation of Argentine Early and Middle Jurassic Bivalve zones. - Géobios, Mém. Spéc. 17 (3ème Symp. Internation. Stratigr. Jurassique, 1991), 1: 141-147, Villeurbanne.

-,- (1995): The bipolar bivalve *Kolymonectes* and the diversity of Propeamussiidae in Mesozoic times. - The Fifth Canadian Paleontology Conference and International Symposium on the Paleobiology and Evolution of the Bivalvia, Joint Meeting, Program and Abstracts: 7-8, Drumheller.

-,- (1996): Palaeobiogeography of Early Jurassic bivalves along the southeastern Pacific margin. - Actas 13° Congreso Geológico Argentino y 3° Congreso de Exploración de Hidrocarburos, 5: 151-167, Buenos Aires.

-,- (1997a): High latitude Early Jurassic pectinaceans: clues to the origin of living deep-sea scallops? - Ameghiniana, 34, 1: 118, Buenos Aires.

Damborenea, S.E. (1997b): The bipolar bivalve *Kolymonectes* and the diversity of Propeamussiidae in Mesozoic times. – In: Johnston, P. A. & Haggart, J. W. (Eds.): Bivalves: An Eon of Evolution. – Paleobiological Studies Honoring Norman D. Newell, 14 p., University of Calgary Press, Calgary.

Damborenea, S.E. & González-León, C. (1998): Late Triassic and Early Jurassic bivalves from Sonora, Mexico. – Rev. Mexican. Cienc. Geol., 14,2: 178–201, Mexico.

Damborenea, S.E. & Manceñido, M.O. (1979): On the palaeogeographical distribution of the pectinid genus *Weyla* (Bivalvia, Lower Jurassic). – Palaeogeogr., Palaeoclimat., Palaeoecol., 27, 1/2: 85–102, Amsterdam.

–,– (1988): *Weyla*: semblanza de un bivalvo Jurásico andino. – Actas 5° Congreso Geológico Chileno, 2: C13–C25, Santiago de Chile.

–,– (1992): A comparison of Jurassic benthonic faunas from South America and New Zealand. – Journ. Roy. Soc. N. Zeal., 22, 2: 131–152, Wellington.

Damborenea, S. E., Manceñido, M. O. & Riccardi, A. C. (1975): Biofacies y estratigrafía del Liásico de Piedra Pintada, Neuquén, Argentina. – Actas 1° Congreso Argentino de Paleontología y Bioestratigrafía, 2: 173–228, Tucumán.

Damborenea, S.E., Polubotko, I.V., Sey, I.I. & Paraketsov, K.V. (1992): Bivalve zones and assemblages of the circum-Pacific region. – In: Westermann, G.E.G. (Ed.): The Jurassic of the Circum-Pacific. – pp. 300-307, Cambridge University Press.

Dareste de la Chavanne, J. (1930): Monographie paléontologique de faunes liasiques et jurassiques du Maroc Nord-oriental (Brachiopodes, Echinodermes, Lamellibranches et Gastropodes). – In: Savornin, J. et al.: La région d'Oudjda. – Notes et Mémoirs, Service Min. Carte Géologique du Maroc, 16: 31–100. Pl. 1–6, Rabat.

Davis, C.H. (1913): New species from the Santa Lucia Mountains, California, with a discussion of the Jurassic age of the Slate's Springs.– Journ. Geol., 21, 5: 453–458, fig. 1–7.

Dechaseaux, C. (1936): Pectinidés Jurassiques de l'Est du Bassin de Paris. Révision et biogéographie. – Ann. Paléont., 25: 1–148, Pl. 1–10, Paris.

Defrance, M.J.L. (1825): Mémoire géologique sur les terrains de la Normandie de M. de Caumont. – Mém. Soc. Linnéene Normandie, 2: 507, Caen.

De Gregorio, A. (1884): Nota intorno ad alcune nuove conchiglia mioceniche de Sicilia. – Naturalista Siciliano, 3: 119–120, Palermo.

Dhondt, A. (1971): Systematic revision of *Entolium*, *Propeamussium* (Amusiidae) and *Syncyclonema* (Pectinidae, Bivalvia, Mollusca) of the European boreal Cretaceous. – Bull. Inst. Roy. Scis. Nat. Belg., 47, 32: 1–95, pl. 1–4, Bruxelles.

–,– (1972): Systematic revision of the Chlamydinae of the European Cretaceous. Part 1. *Camptonectes*. – Bull. Inst. Roy. Scis. Belg., Scis. Terre, 48, 3: 1–60, Bruxelles.

Diener, C. (1908): Ladinic, Carnic and Noric faunas of Spiti. – Mem. Geol. Surv. India, Palaeontologia Indica, (Ser. 15), 5, 3: 1–157. Pl. 1–24, Calcutta.

Dietl, G. & Etzold, A. (1977): The Aalenian at the Type Locality. – Stuttgarter Beitr. Naturkde., (B), Geol. Paläont., 30: 1–13, Stuttgart.

Digregorio, J.H. (1972): Neuquén. – In: Leanza, A.F. (Ed.): Geología Regional Argentina. – Acad. Nac. Cienc. (Argentina), pp. 439–505, Córdoba.

–,– (1978): Estratigrafía de las acumulaciones mesozoicas. – In: Geología y Recursos Naturales del Neuquén. – Relatorio, 7° Congreso Geológico Argentino, pp. 37–65, Buenos Aires.

Digregorio, J.H. & Uliana, M.A. (1980): Cuenca Neuquina. – In: Turner, J. (Ed.): Segundo Simposio de Geología Regional Argentina. II. – Acad. Nac. Cienc. (Argentina), pp. 985–1032, Córdoba.

Dijkstra, H.H. (1990): Three new pectinacean species from the Indonesian archipelago collected during the Siboga expedition (1899–1900) with additional information and corrections on the previous report (Mollusca: Propeamussiidae, Pectinidae). – Beaufortia, 40,1: 1–14. Amsterdam.

–,– (1991): A contribution to the knowledge of the pectinacean Mollusca (Bivalvia: Propeamussiidae, Entoliidae, Pectinidae) from the Indonesian Archipelago. – Zool. Verh., 271: 1–57, Leiden.

–,– (1995): Bathyal Pectinoidea (Bivalvia: Propeamussiidae, Entoliidae, Pectinidae) from New Caledonia and adjacent areas. – In: Bouchet, P. (Ed.): Résultats des Campagnes Musorstom, vol. 14. – Mém. Mus. Nation. Hist. Natur., 167: 9–73, Paris.

Douglas, J.A. & Arkell, W.J. (1932): The stratigraphical distribution of the Cornbrash: II. The North-Eastern Area. – Quart. Journ. Geol. Soc. London, 88, 2: 112–170, Pl. 10–12, London.

Douvillé, H. (1897): Essai de classification systématique des pectinidés. – Bull. Soc. Géol. France, (3), 25, 3: 202–203, Paris.

Dubar, G. (1925): Etudes sur le Lias des Pyrénées Françaises. – Mém. Soc. Géol. Nord, 9, 1: 1–332, pl. 1–7, Lille.

–,– (1931): Lias et Jurassique du Bastan (Haute Vallée de la Bidassoa, Espagne). – Bull. Soc. Géol. France, (4), 30: 589–608, pl. 40–41, Paris.

–,– (1948): Etudes paléontologiques sur le Lias du Maroc. La fauna Domérienne du Djebel Bou-Dahar, près de Béni-Tajjite. Etude suivie de celle de quelques Mollusques d'autres gisements marocains. – Notes et Mémoirs, Service Min. Géol. Maroc, 68: 1–250, Pl. 1–30, Lille.

Duff, K.L. (1978): Bivalvia from the English Lower Oxford Clay (Middle Jurassic). – Palaeontogr. Soc. Monogr., 132, 553: 1–137, Pl. 1–13, London.

Dumortier, E. (1864): Etudes paléontologiques sur les dépots Jurassiques du Bassin du Rhone. Première partie. Infra-Lias. – F. Savy, 189 p., 30 pl., Paris.

–,– (1869): Etudes paléontologiques sur les dépots Jurassiques du Bassin du Rhone. Troisième partie. Lias moyen. – F. Savy, 349 p., 45 pl., Paris.

–,– (1874): Etudes paléontologiques sur les dépots Jurassiques du Bassin du Rhone. Quatrième partie. Lias supérieur. – F. Savy, 335 p., 42 pl., Paris.

Eichwald, E.I. v. (1866–1869): Lethaea Rossica, ou paléontologie de la Russie, v. 2, Période moderne. – 1304 pp., 40 pl., Stuttgart.

Emmrich, A. (1853): Geognostische Beobachtungen aus den östlichen bayerischen und den angränzenden österreichischen Alpen. - Jahrb. k.k. Geol. Reichsanst. Wien, 4, 2: 326–394, Wien.

Enay, R. (1980): Paléogéographie et ammonites jurassiques: "Rhythmes fauniques" et variations du niveau marin; voies d'echanges, migrations et domaines biogéographiques. - Mém. Soc. Géol. France, hors série, 10: 261–281.

Ernst, W. (1923): Zur Stratigraphie und Fauna des Lias im nordwestlichen Deutschland. Erster Teil. - Palaeontographica, 65, 1–3: 1–95, Taf. 1–6, Stuttgart.

Escobar T., F. (1980): Paleontología y bioestratigrafía del Triásico superior y Jurásico inferior en el área de Curepto. Provincia de Talca. - Bol. Inst. Investigac. Geol. Chile, 35: 1–78, Lám. 1–5, Santiago de Chile.

Etallon, A. (1862): Etudes paléontologiques sur les terrains jurassiques du Haut-Jura. Monographie de l'étage Corallien. 2$^{e}$ partie. - Mém. Soc. Emul. Doubs.: 53–241. Besançon.

Eudes-Deslongchamps, J. A. (1860): Essai sur les Plicatules fossiles des terrains du Calvados et sur quelques autres genres voisins ou démembrès de ces coquilles. - Mém. Soc. Linnéene Normandie, 11: 1–164, Pl. 7–20.

Fang Zong-jie (1978): On a new subgenus of Pectinidae (Lamellibranchia). - Acta Paleontol. Sinica, 17, 4: 461–466, Pl.1.

Fantini Sestini, N. (1966): The geology of the Upper Djadjerud and Lar Valleys (North Iran). II. Palaeontology. Upper Liassic Molluscs from Shemshak Formation. - Riv. Ital. Paleont. Stratigr., 72, 3: 795–852, 4 tav., Milano.

Feruglio, E. (1934): Fossili Liassici della Valle del Rio Genua (Patagonia). - Giorn. Geol., Ann. Reale Museo Geolog. Bologna, (2), 9: 1–64, Tav. 1–5, Bologna.

Fischer, J.C. (1969): Géologie, paléontologie et paléoécologie du Bathonien au Sud-Ouest du Massif Ardennais. - Mém. Mus. Nation. Hist. Natur., (N.S. C) Scis. de la Terre, 20: 1–321, Pl. 1–21, Paris.

Fischer, P.H. (1880-1887): Manuel de conchyliologie et de paléontologie conchyliologique. - F. Savy, xxv + 1369 p., 23 pl., Paris.

Fleming, C.A. (1962): New Zealand biogeography: A palaeontologist's approach. - Tuatara, 10, 2: 53–108, Wellington.

-,- (1964): History of the Bivalve Family Trigoniidae in the South-West Pacific. - Austral. Journ. Sci., 26, 7: 196–204.

-,- (1967): Biogeographic change related to Mesozoic orogenic history in the southwest Pacific. - Tectonophysics, 4, 4–6: 419–427, Amsterdam.

-,- (1975): The Geological History of New Zealand and its Biota. - In: Kuschel, G. (Ed.): Biogeography and Ecology in New Zealand. - Monogr. Biolog., 27: 1–86, W. Junk, The Hague.

-,- (1987): New Zealand mesozoic Bivalves of the Superfamily Trigoniacea. - N. Zeal. Geol. Surv. Paleont. Bull., 53: 1–104, pl. 1–11, Wellington.

Frebold, H. (1957): The Jurassic Fernie Group in the Canadian Rocky mountains and foothills. - Memoir, Geol. Surv. Canada, 287: 1–197, Pl. 1–44, Ottawa.

-,- (1964): Illustrations of Canadian Fossils. Jurassic of Western and Arctic Canada. - Paper, Geol. Surv. Canada, 63, 4: 1–107, Pl. 1–51, Ottawa.

-,- (1966): Upper Pliensbachian Beds in the Fernie Group of Alberta. - Paper, Geol. Surv. Canada, 66, 27: 1–9, Pl. 1, Ottawa.

Freneix, S. (1980): Bivalves néocrétacés de Nouvelle-Calédonie. Signification biogéographique, paléobiogéographique, paléoécologique. - Ann. Paléont., Invertébres, 66, 2: 67–134, Paris.

Freneix, S., Breton, G. & Dubus, B. (1985): Le Kimméridgien de Merrey-sur-Arce (Aube) et sa faune oligospecifique a *Placunopsis radiata arcensis* nov. subsp.: révision du genre *Placunopsis* (Placunopsidae, nov. fam., Bivalvia). - Bull. Trim. Soc. Géol. Normandie et Amis Muséum du Havre, 72, 4: 21–35, Le Havre.

Fürsich, F.T. (1982): Upper Jurassic bivalves from Milne Land, East Greenland. - Grønl. Geol. Unders. Bull., 144: 1–126, København.

Fürsich, F.T. & Palmer, T.J. (1979): Development of relief on a Middle Jurassic cemented sea floor: origin of submarine pseudo-anticlines in the Bathonian of Normandy. - Sedimentology, 26: 441–452.

-,- (1982): The first true anomiid bivalve?. - Palaeontology, 25, 4: 897–903, London.

Fürsich, F.T. & Werner, W. (1989a): Taxonomy and ecology of *Juranomia calcibyssata* gen. et sp. nov. - A widespread anomiid bivalve from the Upper Jurassic of Portugal. - Geobios, 22, 3: 325–337, Lyon.

-,- (1989b): The upper Jurassic Bivalvia of Portugal Part II. Pteriomorphia (Pterioida exclusive Ostreina). - Comun. Serv. Geol. Portugal, 74: 105–164, Pl. 1–22, Lisboa.

Girty, G.H. (1903): The Carboniferous Formations and faunas of Colorado. - U.S. Geol. Surv., Prof. Pap., 16: 1–546, Pl. 1–10, Washington.

Goldfuss, G.A. (1826–1844): Petrefacta Germaniae. - Verlag. lithogr. Anstalt Arns and Co. Theil I: 1–252, Taf. 1–71 (1826–1833); Theil II: 1–312, Taf. 72–165 (1833–1841); Theil III: 1–128, Taf. 166–200 (1841–1844), Düsseldorf.

Gottsche, C. (1878): Ueber jurassische Versteinerungen aus der argentinischen Cordillere. - Palaeontographica, Suppl. 3, 2, 3: 1–50, Taf. 1–8, Cassel.

-,- (1925): Contribuciones a la Paleontología de la República Argentina. Sobre fósiles jurásicos de la Cordillera Argentina (Paso del Espinacito, prov. de San Juan). - Actas Acad. Nac. Cienc., 8, 3–4: 229–283, Lám. 1–8, Córdoba.

Grant-Mackie, J.A. (1959): Hokonui stratigraphy of the Awakino-Mahoenui area, southwest Auckland. - N. Zeal. Journ. Geol. Geophys., 2: 755–787, Wellington.

-,- (1994): Mesozoic Bivalvia from Clerke and Mermaid Canyons, northwest Australian continental slope. - Journ. Austral. Geol. Geophys., 15, 1: 119–125.

Groeber, P. (1918): Estratigrafía del Dogger en la República Argentina (Estudio sintético comparativo). - Bol. Direcc. Gen. Minería, Geol. Hidrol.(Argentina) (B), 18: 1–85, Lám. 1–5, Buenos Aires.

-,- (1924): Descubrimiento del Triásico marino en la República Argentina. - Comunic. Mus. Hist. Nat. Buenos Aires, 2, 9: 87–94, Lám. 1, Buenos Aires.

Groeber, P. (1925): Bemerkungen zur Stratigraphie des Lias von Piedra Pintada (Zaina-Yehua). – N. Jahrb. Miner., Geol. Paläont., Beil. Bd., (B) 52: 455–463, Taf. 5, Stuttgart.

–,– (1946): Observaciones geológicas a lo largo del meridiano 70. 1. Hoja Chos Malal. – Rev. Asoc. Geol. Argent., 1, 3: 177–208, 1 mapa, Buenos Aires.

Groeber, P., Stipanicic, P. & Mingramm, A. (1953): Jurásico. – In: Geografía de la República Argentina, II (1a. parte): Mesozoico. – Soc. Argent. Estud. Geogr., GAEA, pp. 143–347, Lám. 16–29, Buenos Aires.

Gulisano, C.A. (1981): El Ciclo Cuyano en el norte de Neuquén y sur de Mendoza. – Actas 8° Congr. Geol. Argent., 3: 579–592, Buenos Aires.

Gulisano, C. A. & Gutiérrez Pleimling, A. (1995a): The Jurassic of the Neuquén Basin. a) Neuquén Province. Field Guide. – Asoc. Geol. Argentina, (E), 2 [= Dirección Nacional del Servicio Geológico, Publ. 158]: 1–111, Buenos Aires.

–,– (1995b): The Jurassic of the Neuquén Basin. b) Mendoza Province. Field Guide. – Asoc. Geol. Argent., (E), 3 [= Dirección Nacional del Servicio Geológico, Publ. 159]: 1-104, Buenos Aires.

Gulisano, C. A. & Pando, G. A. (1981): Estratigrafía y facies de los depósitos jurásicos entre Piedra del Aguila y Sañicó, Departamento Collon Curá, Provincia del Neuquén. – Actas 8° Congr. Geol. Argent., 3: 553–577, Buenos Aires.

Gulisano, C.A., Gutiérrez-Pleimling, A.R. & Digregorio, R.E. (1984): Esquema estratigráfico de la secuencia jurásica del oeste de la provincia del Neuquén. – Actas 9° Congr. Geol. Argent., 1: 236–259, Buenos Aires.

Habe, T. (1951): Genera of Japanese Shells. – 326 pp., Tokyo.

–,– (1977): Systematics of Mollusca in Japan. Bivalvia and Scaphopoda. – Hokuryukan, 372 pp., Tokyo. [Japanese]

Hall, J. (1852): Geology and palaeontology of the country traversed by the expedition to Utah and notes upon some of the fossils collected on the route. – In: Stansbury, H.: An expedition to the valley of the Great Salt Lake of Utah. – App. E: 401–414, Pl. 1–4, London and Philadelphia.

Hallam, A. (1971): Facies analysis of the Lias in West Central Portugal. – N. Jahrb. Geol. Paläont., Abh., 139, 2: 226–265, Stuttgart.

–,– (1975): Jurassic Environments. – Cambridge University Press, Cambridge Earth Science Series, 269 pp., Cambridge.

–,– (1977a): Jurassic bivalve biogeography. – Paleobiology, 3, 1: 58–73. Chicago, Ill.

–,– (1977b): Biogeographic evidence bearing on the creation of Atlantic seaways in the Jurassic. – North Amer. Paleont. Convent. 2, Milwaukee Pub., Mus. Spec. Publ. Biol. Geol., 2: 23–34, Milwaukee.

–,– (1983): Early and mid-Jurassic molluscan biogeography and the establishment of the central Atlantic seaway. – Palaeogeogr., Palaeoclimat., Palaeoecol., 43: 181–193, Amsterdam.

Haller, M. J., Lapido, O. R., Lizuain, A. & Page, R. F. N. (1981): El mar Titono-neocomiano en la evolución de la Cordillera Nordpatagónica. – In: Volkheimer, W. & Musacchio, E.A. (Eds.): Cuencas sedimentarias del Jurásico y Cretácico de América del Sur, 1, pp. 221–237, Buenos Aires.

Harper, E.M. & Palmer, T.J. (1993): Middle Jurassic cemented pectinids and the missing right valves of *Eopecten*. – Journ. Mollusc. Stud., 59: 63–72.

Harper, E.M. & Skelton, P.W. (1993): The Mesozoic Marine Revolution and epifaunal bivalves. – Scripta Geol., Spec. Issue, 2: 127–153, Leiden.

Hayami, I. (1957a): *Radulonectites*, a new pectinid genus, from the Liassic Kuruma Group in central Japan. – Transact. Proc. Paleont. Soc. Japan., N.S., 27: 89–93, Pl. 16.

–,– (1957b): Liassic *Chlamys*, "*Camptonectes*" and other pectinids from the Kuruma Group in Central Japan. – Transact. Proc. Paleont. Soc. Japan, N.S., 27: 119–127, Pl. 20.

–,– (1959a): Lower Liassic Lamellibranch fauna of the Higashinagano Formation in west Japan. – Journ. Faculty Scis., University of Tokyo, (Sect. 2), 12(1): 31–84, Pl. 5–8, Tokyo.

–,– (1959b): Bajocian pelecypods of the Aratozaki formation in northeast Japan. Studies on the Dogger pelecypods in Japan, 1. – Japan. Journ. Geol. Geogr., 30: 53–70, Pl. 5, Tokyo.

–,– (1959c): Pelecypods of the Mizunuma Jurassic in Miyagi Prefecture. With some stratigraphical remarks. (Studies on Liassic Pelecypods in Japan, 10). – Transact. Proc. Palaeont. Soc. Japan, (N.S.), 34: 66–77, pl. 7.

–,– (1960): Jurassic Inoceramids in Japan. – Journ. Fac. Scies., University of Tokyo, (Sect. 2), 12, 2: 277–328, pl. 15–18, Tokyo.

–,– (1961): On the Jurassic Pelecypod faunas in Japan. – Journ. Fac. Scis., University of Tokyo, (Sect. 2), 13, 2: 243–343, Pl. 14, Tokyo.

–,– (1972): Lower Jurassic Bivalvia from the environs of Saigon. – Geology and Paleontology of Southeast Asia, 10: 179–230, Pl. 33–38.

–,– (1975): A systematic survey of the Mesozoic Bivalvia from Japan. – Bull. Univ. Mus., Univ. Tokyo, 10: 1–249, pl. 1–10, Tokyo.

–,– (1985): Range chart of selected bivalve species of Japanese Jurassic. – 1985 Circum-Pacific Jurassic Field Conference III: 44–50, Tsukuba.

–,– (1987): Geohistorical Background of Wallace's Line and Jurassic Marine Biogeography. – In: Taira, A. & Tashiro, M. (Eds.): Biogeography and Plate Tectonic Evolution of Japan and Eastern Asia. – pp. 111–133, Tokyo.

Hayami, I. & Okamoto, T. (1987): Geometric regularity of some oblique sculptures in pectinid and other bivalves: recognition by computer simulations. – Paleobiology, 12, 4: 433–449, Chicago.

Hayami, I., Maeda, S. & Ruiz Fuller, C. (1977): Some Late Triassic bivalvia and gastropoda from the Domeyko Range of north Chile. – Transact. Proc. Palaeont. Soc. Japan, (N.S.), 108: 202–221, Pl. 28–30.

Healey, M. (1908): The fauna of the Napeng Beds or the Rhaetic Beds of Upper Burma. – Mem. Geol. Surv. India, Palaeontol. Indica (N.S.), 2, 4: 1–88, pl. 1–9, Calcutta.

Herrmannsen, A.N. (1846–1852): Indicis generum malacozoorum primordia. – T. Fischer, v. 1: 637 pp. (1846–1847); v. 2: 717 pp. (1847–1849); suppl.: 140 pp. (1852), Cassel.

Hicks, G. R. F. & Marshall, B. A. (1985): Sex selective predation of deep-sea, meiobenthic copepods by pectinacean bivalves and its influence on copepod sex ratios. - N. Zeal. Journ. Mar. Freshwat. Res., 19: 227–231.

Hillebrandt, A. v. (1980): Paleozoogeografía de Jurásico marino (Lías hasta Oxfordiano) en Suramérica. - Deutsche Forsch. and Instituto de Colaboración Científica, pp. 123–134 (2 lám.), Bonn - Tübingen.

-,- (1981): Kontinentalverschiebung und die paläozoogeographischen Beziehungen des südamerikanischen Lias. - Geol. Rdsch., 70, 2: 570–582, Stuttgart.

Hillebrandt, A. v. & Schmidt-Effing, R. (1981): Ammoniten aus dem Toarcium (Jura) von Chile (Südamerika). Die Arten der Gattungen *Dactylioceras*, *Nodicoeloceras*, *Peronoceras* und *Collina*. - Zitteliana, 6: 1–74, Taf. 1–8, München.

Hodges, P. (1991): The relationship of the Mesozoic bivalve *Atreta* to the Dimyidae. - Palaeontology, 34, 4: 963–970, London.

Hölder, H. (1953): *Oxytoma scanica* (Lundgren) in der schwäbischen *Planorbis*-Zone. - N. Jahrb. Geol. Paläont., Monatsh. 1953, 8: 358–364, Stuttgart.

-,- (1978): Über die Pectiniden-Gattung *Parvamussium* im Jura. - Stuttgarter Beitr. Naturkde., (B, Geologie und Paläontologie), 38: 1–37, Stuttgart.

-,- (1990): Über die Muschelgattung *Placunopsis* (Pectinacea, Placunopsidae) in Trias und Jura. - Stuttgarter Beitr. Naturkde., (B, Geologie und Paläontologie), 165: 1–63, Stuttgart.

Hudson, N. (1983): Stratigraphy of the Ururoan, Temaikan and Heterian Stages; Kawhia Harbour to Awakino Gorge, South-West Auckland. - Ms. Sci. Thesis, University of Auckland, 168 p., pl. 1–2. (Unpubl.)

Hupe, L.H. (1854): Fauna Chilena - Moluscos. - In: Gay, C.: Historia Física y Política de Chile. Zoología. Tomo octavo. - Impr. Maule y Rénou, 407 p. Atlas II, Impr. E. Thunot, pl. M1-M8+C1-C6, Paris.

Ichikawa, K. (1958): Zur Taxionomie und Phylogenie der triadischen "Pteriidae" (Lamellibrancha) mit besonderer Berücksichtigung der Gattungen *Claraia*, *Eumorphotis*, *Oxytoma* and *Monotis*. - Palaeontographica (A), 111, 5–6: 131–212, Pl. 21–24, Stuttgart.

Imlay, R.W. (1964): Marine Jurassic Pelecypods from Central and Southern Utah. - U.S. Geol. Surv., Prof. Pap., 483-C: 1–42, Pl. 1–4, Washington.

-,- (1967): The Mesozoic Pelecypods *Otapiria* Marwick and *Lupherella* Imlay, new genus, in the United States. - U.S. Geol. Surv., Prof. Pap., 573-B: 1–11, pl. 1–2. Washington.

Iordan, M. (1966): Contributii la orizontarea Doggerului din Zona Svinita. [= Contributions to the horizons-settling of the Dogger in the Svinita Zone]. - Dari de Seama ale Sedintelor, 52,1: 255–273, pl. 1–5, Bucarest. [Roman.]

Iredale, T. (1929): Mollusca from the continental shelf of Eastern Australia. N° 2. - Records of the Australian Museum, 17, 4: 157–189, pl. 38–41, Sydney.

-,- (1939): Great Barrier Reef expedition 1928–1929. - Brit. Mus. (Nat. Hist.), Sci. Reports, 5, 6: 209–425, 7 pl., London.

Jaitly, A.K. (1988): Some Middle Jurassic clams from Kala Dongar, Pachchham Island, Kachchh, Gujarat. - Indian Minerals, 42, 2: 117–125.

Jaitly, A. K., Fürsich, F.T. & Heinze, M. (1995): Contributions to the Jurassic of Kachchh, western India. IV. The bivalve fauna. Part I. Subclasses Palaeotaxodonta, Pteriomorphia, and Isofilibranchia. - Beringeria, 16: 147–257, 23 pl., Würzburg.

Jankicevic, J., Rabrenovic, D. & Radulovic, V. (1983): Stratigraphic and palaeontological characteristics of the Liassic of Zabrde (Stara Planina). - Ann. Géol., Pénins. Balkan., 47: 161–181, Pl. 1–4, Beograd. [Russ., Engl. abstr.]

Jaworski, E. (1915): Beiträge zur Kenntnis des Jura in Süd-Amerika. Teil II. Spezieller, paläontologischer Teil. - N. Jahrb. Miner., Geol. Paläont., Beil. Bd., 40, 2: 364–456, Taf. 5–8, Stuttgart.

-,- (1922): Die marine Trias in Südamerika. - N. Jahrb. Miner., Geol. Paläont., Beil. Bd., 47: 93–200, Taf. 4–6, Stuttgart.

-,- (1925): Contribución a la paleontología del Jurásico Sudamericano. - Publ., Direcc. Nac. Geol. Miner. (Argent.), 4: 1–160, Lám. 1–2, Buenos Aires.

-,- (1926a): La fauna del Lias y Dogger de la Cordillera Argentina en la parte meridional de la provincia de Mendoza. - Actas Acad. Nac. Cienc., 9, 3–4: 137–316, Lám. 1–4, Córdoba.

-,- (1926b): Beiträge zur Paläontologie und Stratigraphie des Lias, Doggers, Tithons und der Unterkreide in der Kordilleren im Süden der Provinz Mendoza (Argentinien). Teil I. Lias und Dogger. - Geol. Rdsch., 17a: 373–427, Taf. 10–13, Berlin.

Jekelius, E. (1915): Die mesozoischen Faunen der Berge von Brassó. I. Die Liasfauna von Keresztényfalva. - Mitt. Jahrb. k. ungar. Reichsanst., 23, 2: 27–113, Taf. 5–8, Budapest.

Johnson, A.L.A. (1984): The palaeobiology of the bivalve families Pectinidae and Propeamussiidae in the Jurassic of Europe. - Zitteliana, 11: 1–235, Taf. 1–11, München.

-,- (1985): The rate of evolutionary change in European Jurassic scallops. - Spec. Pap. Palaeont., 33: 91–102, London.

Joly, H. (1907): Les fossiles du Jurassique de la Belgique avec description stratigraphique de chaque étage. I Pt. Infralias. - Mém. Mus. Roy. Hist. Natur. Belg., 5: 1–156, 5 pl., Bruxelles.

-,- (1936): Les fossiles du Jurassique de la Belgique avec description stratigraphique de chaque étage. Deuxième partie: Lias inférieur. - Mém. Mus. Roy. Hist. Natur. Belg., 79: 1–245, Pl. 1–3, Bruxelles.

Kalishevich, T. G., Zaklinskaya, E. D. & Serova, M. Y. (1981): Razvitie organicheskogo mira Tikhookeanskogo poyasa na rubezhe Mezozoya i Kaïnozoya (foraminifery, mollyuski i palinoflora Severo-Zapadnogo sektora). - Izd-vo "Nauka" 164 p., Tabl. 1–37, Moskva. [Russ.]

Kanjilal, S. (1979): Jurassic *Camptonectes* (Bivalvia) from the Habo Hill, District Kutch (Gujarat, W. India). - Journ. Mollusc. Stud., 45, 1: 115–124.

Kasum-Zade, A. A. & Romanov, L. F. (1986): Rod *Velata* Quenstedt, 1858 v yure yuga SSR. - In: Paleontologo-stratigraficheskie issledovaniya Mezozoya i Kajnozoya Mezhdurech'ya Dnestr-prut. - "Shtiintsa" (Akademiya Nauk Moldavskoj SSR): 11–24, Pl. 1–3, Kishinev. [Russ.]

Kauffman, E.G. (1973): Cretaceous Bivalvia. – In: Hallam, A. (Ed.): Atlas of Palaeobiogeography. - Elsevier Sci. Publ. Co., pp. 353–383, Amsterdam.

Kelly, S.R.A. (1984): Bivalvia of the Spilsby Sandstone and Sandringham Sands (Late Jurassic – Early Cretaceous) of eastern England. Part I. – Palaeontogr. Soc. Monogr., 137, 566: 1–100, Pl. 1–20, London.

–,– (1995): New trigonioid bivalves from the Early Jurassic to earliest Cretaceous of the Antarctic Peninsula region: systematics and Austral paleobiogeography. – Journ. Paleont., 69, 1: 66–84, Tulsa.

Kelly, S.R.A., Dhondt, A.V. & Zakharov, V.A. (1984): *Boreionectes* Zakharov 1965 (Bivalvia: Pectinidae) – a synonym of *Macleamia* (Crickmay 1930). – Journ. Paleont., 58, 1: 109–114, Tulsa.

–,– (1986): *Mcleamia* Crickmay, 1930 (Bivalvia: Pectinidae). – Journ. Paleont., 60, 1: 191, Tulsa.

Kelly, S.R.S., Cantrill, D.I., Doubleday, P.A. & MacDonald, D.I.M. (1993): New Jurassic macrobiota and biostratigraphy from Alexander Island, Antarctica. – In: Abstracts of Poster Communications. – Arkell International Symposium on Jurassic Geology, 2 p., London.

Kidwell, S.M., Fürsich, F.T. & Aigner, T. (1986): Concept framework for the analysis and classification of fossil concentrations. – Palaios 1, 3: 228–238.

Kiparisova, L.D., Bychkov, Yu.M. & Polubotko, I. (1966): Pozdnetriasovye dvustvorchatye mollyuski Severo–Vostoka SSSR. – Sev.-Vost. Geol. Uprav. (VSEGEI), 312 p., Magadan. [Russ.]

Kobayashi, T. & Ichikawa, K. (1949): *Tosapecten* gen. nov. and other Upper Triassic Pectinidae from the Sakawa Basin, in Shikoku, Japan. – Japan. Journ. Geol. Geogr., 21: 163–171, Pl. 5, Tokyo.

–,– (1950): On the Upper Triassic Kochigatani Series in the Sakawa Basin in Japan and its Pelecypod-Faunas. 3. Triassic *Oxytoma* from the Sakawa Basin in Shikoku, Japan. – Journ. Fac. Scis., Univ. Tokyo, (sec. 2, Geol., Mineralogy, Geography, Seismology), 7, 3–5: 217–229, Pl. 2–3, Tokyo.

Kobayashi, T. & Tamura, M. (1983): The Arcto-Pacific Realm and the Trigoniidae in the Triassic Period. – Proc. Japan Acad., (B), 59, 7: 207–210.

Kochanova, M. (1961): Niekol'ko paleontologicky'ch lokalít spodného Liasu z oblasti Cierneho Vrchu pri Ciernej Lehote y Strázovskej hornatine. – Geol. Práce, Zpr., 22: 99–126, Pl. 1–4, Bratislava. [Czech, Germ. abstr.]

–,– (1967): K problému hranice rét-hetang v Západny'ch Karpatoch. [= Zur Rhaet/Hettang-Grenze in den Westkarpaten]. – Sb. Geol. ViedRad Západné Karpaty, 7: 8–102, Tab. 1–6, Bratislava. [Czech, Germ. abstr.]

Koshelkina, Z.V. (1962): Polevoj atlas Rukovodyashchick Yurskikh otlozhenij Vilyujskoj sineklyzy i Priverkhoyanskogo kraego progiba. – Severo-Vostochnyj Kompleksnyj Nauchno-Isledovatel'kyj Institut, Sibirskogo Otdelleniya, Akademii Nauk SSSR, 133 p., Magadan. [Russ.]

Krumbeck, L. (1913): Obere Trias von Buru und Misol. (Die Fogi-Schichten und Asphaltschiefer West-Burus und der Athyridenkalk des Misol-Archipels). – In: Boehm, G.: Beiträge zur Geologie von Niederländisch-Indien. II. Abteilung. 1. Abschnitt. – Palaeontographica, Suppl., 4: 1–161, Taf. 1–11, Stuttgart.

Kuhn, O. (1935): Die Fauna des untersten Lias (Gibbosus-Zone) aus dem Sendelbach im Hauptsmoorwald östlich Bamberg. – N. Jahrb. Miner., Geol. Paläont., Beil.Bd. 73, b: 465–493, Taf. 18, Stuttgart.

–,– (1936): Die Fauna des Amaltheentons (Lias δ) in Franken. – N. Jahrb. Miner., Geol. Paläont., Beil. Bd. 75, b: 231–311, Taf. 8–13, Stuttgart.

–,– (1938): Die Fauna des Dogger der Frankenalb (Mit Nachträgen zum übrigen Jura). – Nova Acta Leopoldina (N.F.), 6, 37: 125–170. Pl. 1–6, Halle.

Lamarck, J.B.P.A. de M. de (1819): Histoire naturelle des animaux sans vertèbres, 6. – 343 pp., Verdière, Paris.

Lamy, E. (1939): Révision des *Plicatula* vivants du Muséum National d'Histoire Naturelle de Paris. – Journ. Conchyliolog., 83, 1: 5–26, Paris.

Lanquine, A. (1929): Le Lias et le Jurassique des Chaînes Provençales, recherches stratigraphiques et paléontologiques. I. Le Lias et le Jurassique Inférieur. – Bull. Serv. Carte Géol. France, 32, 173: 41–425, Pl. 1–12 + A–H,. Paris.

Laube, G.C. (1867): Die Bivalven des Braunen Jura von Balin. – Denkrschr. Akad. Wiss. Wien., Math. nat. Kl. 27: 11–61, pl. 1–5, Wien.

Leanza, A.F. (1942): Los pelecípodos del Lías de Piedra Pintada, en el Neuquén. – Rev. Museo La Plata (n.s.) Paleontología, 2, 10: 143–206, Lám. 1–19, La Plata.

Leanza, H.A. (1993): Jurassic and Cretaceous Trigoniid Bivalves from West-Central Argentina. – Bull. Amer. Paleont., 105, 343: 1–95, pl. 1–17, Ithaca.

Legarreta, L. & Uliana, M.A. (1996): The Jurassic succession in west-central Argentina: stratal patterns, sequences and paleogeographic evolution. – Palaeogeogr., Palaeoclimat., Palaeoecol., 120, 3–4: 303–330, Amsterdam.

Legarreta, L., Gulisano, C. A. & Uliana, M. A. (1993): Las secuencias sedimentarias Jurásico-Cretácicas. – In: Ramos, V.A. (Ed.): Geología y Recursos Naturales de Mendoza. – Relatorio, 12° Congreso Geológico Argentino, pp. 87–114, Buenos Aires.

Lentini, F. (1974): I molluschi del Lias inferiore di Longi (Sicilia nord-orientale). – Boll. Soc. Paleont. Ital., 12, 1: 23–75, Tav. 12–19, Modena.

Lesta, P. & Ferello, R. (1972): Región extraandina de Chubut y Norte de Santa Cruz. – In: Leanza, A. (Ed.): Geología Regional Argentina. – pp. 601–653, Academia Nacional de Ciencias (Argentina), Córdoba.

Lesta, P., Ferello, R. & Chebli, G. (1980): Chubut Extraandino. – In: Turner, J. (Ed.): Segundo Simposio de Geología Regional. Argentina II. – pp. 1307–1387, Academia Nacional de Ciencias (Argentina), Córdoba.

Leymerie, A. (1878): Description géologique et paléontologique des Pyrenées de la Haute-Garonne. – E. Privat, Libr., edit., Atlas pl. 1–20 + A-Z5, Toulose.

Li Xiaochi & Grant-Mackie, J. A. (1994): New Middle Jurassic - Lower Cretaceous bivalves from southern Tibet. - Journ. Southeast Asian Earth Scis., 9, 3: 263-276.

Lizuain, A. (1980): Las formaciones suprapaleozoicas y jurásicas de la Cordillera Patagónica, provincias de Rio Negro y Chubut. - Rev. Asoc. Geol. Argent., 35, 2: 174-182, Buenos Aires.

Lo Forte, G. L., 1996. Los depósitos jurásicos de la Alta Cordillera de Mendoza. - In: Ramos, V.A. (Ed.): Geología de la región del Aconcagua, provincias de San Juan y Mendoza. - An. Subsecr. Mineria Nac., Direcc. Nacion. Servic. Geol., 24, 5: 139-178, Buenos Aires.

Losacco, U. (1942): Un Nuovo genere aaleniano di Aviculidae della Sabina. - Riv. Ital. Paleont., 48, 1: 9-16. Tav. 1.

Lucyas, M. (1979): The Pectinacea from the European coasts. - Conchiglia (Shell), 11, 120-121: 3-6.

Lundgren, B. (1881): Undersökningar öfver molluskfaunan i Sveriges äldre mesozoiska bildningar. - Acat Univ. Lund, 17, 3: 1-57, Taf. 1-6.

MacFarlan, D. A. B. (1992): Triassic & Jurassic Rhynchonellacea (Brachiopoda) from New Zealand & New Caledonia. - Roy. Soc. New Zeal. Bull., 31: i-x, 1-310, Wellington.

MacNeil, F.S. (1967): Cenozoic Pectinids of Alaska, Iceland and other northern regions. - U.S. Geol. Surv., Prof. Pap., 553: 1-57, Pl. 1-25, Washington.

Manceñido, M. O. (1978): Studies of Early Jurassic Brachiopoda and their distribution, with special reference to Argentina. - Tesis Ph., Dept. Geol., Univ. Wales, 481 p., 108 pl., Swansea (unpubl.).

-,- (1981): A revision of Early Jurassic Spiriferinidae (Brachiopoda) from Argentina. - In: Volkheimer, W. & Musacchio, E. A. (Eds.): Cuencas sedimentarias del Jurásico y Cretácico de América del Sur. - 2: 625-659, Comité Sudamericano del Jurásico y Cretácico, Buenos Aires.

-,- (1983): A new terebratulid genus from western Argentina and its homoeomorphs (Brachiopoda, Early Jurassic). - Ameghiniana, 20, 3-4: 347-365, Buenos Aires.

-,- (1991): The succession of Early Jurassic brachiopod faunas from Argentina: correlations and affinities. - In: MacKinnon, D.I., Lee, D. E. & Campbell, J.D. (Eds.): Brachiopods through Time. - Proc. 2nd Internat. Brachiopod Congr., Dunedin, 1990, pp. 397-404, A.A. Balkema, Rotterdam.

Manceñido, M.O. & Damborenea, S.E. (1984): Megafauna de Invertebrados paleozoicos y mesozoicos. - In: Ramos, V.A. (Ed.): Geología y recursos naturales de la Provincia de Rio Negro. - Relatorio, 9º Congr. Geol. Argent., pp. 413-465, Buenos Aires.

-,- (1991): Corallophilous micromorphic brachiopods from the Lower Jurassic of west central Argentina. - In: MacKinnon, D.I., Lee, D. E. & Campbell, J. D. (Eds.): Brachiopods through Time. - Proc. 2nd Internat. Brachiopod Congr., Dunedin, 1990, pp. 89-96, A.A. Balkema, Rotterdam.

Mansuy, H. (1912): Géologie des environs de Luang-Prabang. - Mém. Serv. Géol. l'Indochine, 1, 4: 1-32, pl. 5-7, Hanoi-Haiphong.

-,- (1914): Gisement Liasique des schistes de Trian (Cochinchine). - Mém. Serv. Géol. l'Indochine, 3, 2: 37-39, Pl. 4, Hanoi-Haiphong.

Marincovich, J. jr. (1993): Danian Mollusks from the Prince Creek Formation, Northern Alaska, and Implications for Arctic Ocean Paleogeography. - Paleont. Soc. Mem. 35 (Suppl. Journ. Paleont. 67, 5): 1-35.

Marwick, J. (1935): Some new genera of the Myalinidae and Pteridae of New Zealand. - Transact. Proc., Roy. Soc. N. Zeal., 65, 3: 295-303, pl. 34-36, Wellington.

-,- (1953a): Divisions and Faunas of the Hokonui System (Triassic and Jurassic). - Palaeont. Bull., N. Zeal. Geol. Surv. 21: 1-142, Pl. 1-17, Wellington.

-,- (1953b): Faunal Migrations in New Zealand Seas during the Triassic and Jurassic. - N. Zeal. Journ. Sci. Technol., (B) 34, 5: 317-321, Wellington.

-,- (1956): Three Fossil Mollusca from the Hokonui System (Triassic and Jurassic). - Transact. Roy. Soc. N. Zeal., 83, 3: 489-491, Pl. 18, Wellington.

Matthews, S.C. (1973): Notes on open nomenclature and on synonymy lists. - Palaeontology, 16, 4: 713-719, London.

McLearn, F.H. (1924): New pelecypods from the Fernie Formation of the Alberta Jurassic. - Proc. Transact. Roy. Soc. Canada, 18, 4: 39-61. Ottawa.

-,- (1949): Jurassic Formations of Maude Island and Alliford Bay, Skidegate Inlet, Queen Charlotte Islands, British Columbia. - Bull. Geol. Surv. Canada, 12: 1-19, Ottawa.

Meek, F.B. (1864): Check list of the invertebrate fossils of North America. Jurassic Formation. Notes and Explanations. - Smithsonian Miscellaneous Collection, 7: 27-29, 39-40.

-,- (1865): Description of fossils from the auriferous slates of California. - Geol. Surv. Calif., Geology, 1: 477-482, Philadelphia.

Meek, F.B. & Hayden, F.V. (1865): Palaeontology of the upper Missouri. Invertebrates. - Smithson. Contr. Knowl., 14, 172: 1-135, pl. 1-5, Washington.

Meischner, D. (1968): Perniciöse Epökie von *Placunopsis* auf *Ceratites*. - Lethaia, 1, 2: 156-174, Oslo.

Milova, L.V. (1969): Novye ranneyurskie dvustvorchatye molluski bassejna reki bol'shogo Anyuya. - In: Shilo, N.A. (Ed.): Inotseramy yury i mela Severo-Vostoka SSSR. - Akademiya Nauk SSSR, Sibirskoye Otdeleniye, Severo-Vostochenyj Kompleksnoyj, Trudy, 32: 177-189, pl. 1-3, Magadan. [Russ.]

-,- (1976): Stratigrafiya i dvustvorchatye mollyuski triasovo-yurskikh otlozhenii Severnogo Priokhot'ya. - Tr. Sev.-Vost. Kompleksn. Inst. Dal'nevost. Tsentr. Akad. Nauk SSSR, 65, 110 p., Izd,vo 'Nauka', Moskva. [Russ.]

-,- (1983): Gettangsie i Sinemyurskie otlozheniya bassejna r. Viligi. - Materialy po Geologii i Poleznym Iskolaemym Severo-Vostoka SSSR, Byp. 26: 45-52, Magadan.

-,- (1985): Novye Plinsbakhskie dvustvorchatye mollyuski Severnogo Priokhot'ya [= New Pliensbachian bivalve mollusks of North

Priokhotye]. - In: Pokhialaynen, V.P. (Ed.): Dvustvorchatye y golovonogie mollyuski mezozoya Severo-Vostoka SSSR [= Bivalve and cephalopod mollusks of North-East of USSR]. - pp. 42-56, Magadan.

Milova, L.V. (1988): Ranneyurskie dvustvorchatye Mollyuski Severo-Vostoka SSSR. - Akademiya Nauk SSSR, Dal'nevostochnoe Otdelenie, Severo-Vostochnyj Kompleksnyj Nauchno-Islaedovatel'skij Institut, pp. 60-128, pl. 1-24, Vladivostok. [Russ.]

Monari, S. (1994): I bivalvi giurassici dell'Appennino umbro-marchigiano. - Studi Geol. Camerti, vol. spec. "Biostratigrafia dell'Italia centrale": 157-187.

Moore, C. (1867): On abnormal conditions of secondary deposits when connected with the Somersetshire and South Wales coal-basin; and on the age of the Sutton and Southerndown Series. - Quart. Journ. Geol. Soc. London, 23, 5: 449-568, Pl. 14-17, London.

Moore, D.R. (1970): A new genus and species of Dymyidae from the Caribbean coast of Mexico. - Journ. Conchyliol., 107, 4: 137-142.

Moore, E.J. (1984): Tertiary marine pelecypods of California and Baja California: Propeamussiidae and Pectinidae. - U.S. Geol. Surv., Prof. Pap., 1228-B: 1-112, Pl. 1-42, Washington.

Möricke, W. (1894): Versteinerungen des Lias und Unteroolith von Chile. - N. Jahrb. Miner., Geol. Paläont., Beil.Bd., 9: 1-100, Taf. 1-6, Stuttgart.

Morris, J. & Lycett, J. (1853-1855): A Monograph of the Mollusca from the Great Oolite, Chiefly from Minchinhampton and the Coast of Yorkshire. Part II, Bivalves. - Palaeont. Soc. Monogr.: 80, pl. 1-8; Part III, Bivalves: 81-147, pl. 9-15, London.

Müller, C.F. (1776): Zologiae Danicae Prodromus, seu Animalium Daniae et Norvegiae Indigenarum, characteres, nomina et synonyma imprimis popularium. - 282 pp., Copenhagen.

Nakazawa, K. (1961): Early and Middle Triassic pelecypod-fossils from the Maizuru Zone, Southwest Japan. - Mem. Coll. Sci., University of Kyoto, (B), 27, 3, Geology and Mineralogy, 2: 249-291, Pl. 12-14, Kyoto.

Nauss, A.L. & Smith, P.L. (1988): *Lithiotis* (Bivalvia) bioherms in the Lower Jurassic of east-central Oregon, U.S.A. - Palaeogeogr., Palaeoclimat., Palaeoecol., 65, 3-4: 253-268, Amsterdam.

Newberry, J.S. (1861): Paleontology. - In: Lieutenant Ives's Report on the Colorado River of the West. - pp. 116-129, Gov. Printing Office, Washington, D.C.

Newell, N.D. (1938): Late Paleozoic pelecypods: Pectinacea. - Publ. Kansas Geol. Surv., 10, 1: 1-123.

Newell, N.D. & Boyd, D.W. (1970): Oyster-like Permian Bivalvia. - Amer. Mus. Natur. Hist. Bull., 143, 4: 219-281.

-,- (1985a): Notes on Micro-Fabric in Upper Paleozoic Scallops. - Amer. Mus. Novit., 2816: 1-6, New York.

-,- (1985b): Permian Scallops of the Pectinacean Family Streblochondriidae. - Amer. Mus. Novit., 2831: 1-13, New York.

-,- (1987): Iteration of ligament structures in pteriomorphian bivalves. - Amer. Mus. Novit., 2875: 1-11, New York.

-,- (1995): Pectinoid bivalves of the Permian-Triassic crisis. - Bull. Amer. Mus. Natur. Hist., 227: 1-95, New York.

Newell, N.D. & Merchant, F.E. (1939): Discordant valves in pleurothetic pelecypods. - Amer. Journ. Sci., 237, 3: 175-177, Pl. 1, New Haven, Conn.

Newton, C.R. (1988): Significance of "Tethyan" Fossils in the American Cordillera. - Science, 242 ,4877: 385-391.

Newton, C.R., Whalen, M.T., Thompson, J.B., Prins, N. & Delalla, D. (1987): Systematics and Paleoecology of Norian (Late Triassic) Bivalves from a Tropical Island Arc: Wallowa Terrane, Oregon. - Paleont. Soc. Mem., 22 (Journ. Paleont., 61, 4, suppl.): 1-83.

Nitzopoulus, G. (1974): Faunistisch-ökologische, stratigraphische und sedimentologische Untersuchungen am Schwammstotzen-Komplex bei Spielberg am Hahnenkamm (Ob. Oxfordien, Südliche Frankenalb). - Stuttgarter Beitr. Naturkde., (B), 16: 1-143, Stuttgart.

Nullo, F.E. (1983): Descripción geológica de la Hoja 45c, Pampa de Agnia, Provincia del Chubut. - Bol., Serv. Geol. Nac. (Argentina), 199: 1-94, Lám. 1-10, 1 mapa geol., Buenos Aires.

Nutsubidze, K.S. (1966): Nizhneyurskaya fauna Kavkaza. - Trudy Geol. Inst. Akad. Nauk Gruzins SSR, (N.S.), 8: 1-212, Tabl. 1-61, 1 fold. tab., Tbilisi. [Russ.]

Okuneva, T.M. (1989): Norijskie pektinidy (dvustvorchatye mollyuski) yuzhnykh rajonov Vostoka SSSR. - Ezhegodnik Vsesoyuznogo Paleontologicheskogo Obshchestva, 32: 145-161, Tav. 1-3, Leningrad. [Russ.]

Oppel, A. (1856): La formation jurassique de l'Angleterre, de la France et du sud-ouest de l'Allemagne. - Mém. Soc. Hist. Natur. Wurtemberg, 12.

Orbigny, A. d' (1843-1847): Paléontologie Française. Terrains Crétacés. Tome troisième. Lamellibranches. - A. Bertrand (Ed.), Texte 807 p., Atlas pl. 237-489, Paris.

-,- (1859): Prodrome de paléontologie stratigraphique universelle des animaux mollusques et rayonnés faisant suite au cours élémentaire de paléontologie et géologie stratigraphiques. - V. Masson, 1: 1-394; 2: 1-428, Paris.

Oyama, K. (1944): Classification of the genus *Propeamussium*. - Venus, 13, 5-8: 240-254. [Japan.]

-,- (1951): Amusiinae in Japan. - Illustrated Catalogue of Japanese Shells, 13: 79-89.

Pálfy, J., McFarlane, R.B., Smith, P.L. & Tipper, H.W. (1990): Potential for ammonite biostratigraphy of the Sandilands Formation, Queen Charlotte Islands, British Columbia. - In: Current Research, Part F, Geol. Surv. Canada, Pap., 90-1F: 47-50.

Paris, E.T. & Richardson, L. (1916): Some Inferior-Oolite Pectinidae. - Quart. Journ. Geol. Soc. London, 71, 3: 521-535, Pl. 44-45, London.

Parkinson, J. (1811): Organic Remains of a Former World. - 3: 1-479, 22 pl., London.

Parona, C.F. (1889): Studio monografico della fauna Raibliana della Lombardia. - Premiata Tipographia Fratelli Fusi, 156 pp., 13 pl., Pavia.

-,- (1890): I fossili del Lias inferiore di Saltrio in Lombardia. - Atti Soc. Ital. Sci. Natur., 33: 1-37, Pl. 1-3, Milano.

Pérez d'A., E. (1982): Bioestratigrafía del Jurásico de Quebrada Asientos, Norte de Potrerillos, Región de Atacama. - Bol. Serv. Nacion. Geol. Miner. (Chile), 37: 1-149, Lám. 1-20, Santiago.

Pérez d'A., E. & Reyes, B.R. (1994): Antecedentes sobre el género *Weyla* Böhm, 1922 (Mollusca; Bivalvia) en Chile. - Actas 7° Congreso Geológico Chileno, 1: 519-523, Concepción.

Peron, A. (1907): Etudes paléontologiques sur les terrains du Département de l'Yonne. Les Pélécypodes rauraciens et séquaniens. - Bull. Soc. Scient. Yonne, 59: 33-266, Pl. 1-11.

Petrova, G.T. (1947): Klass Lamellibranchiata. - In: Krimholz, G. (Ed.): Atlas rukovodyashchikh form iskopaemoj faunj SSSR. Tom VIII. Nizhnij i srednij otdely Yurskoj Sistemy. - 102-141, Pl. 8-20, USSR Ministry of Geology, Moscow. [Russ.]

Philippi, E. (1899a): Beiträge zur Morphologie und Philogenie der Lamellibranchier. - Z. Deutsch. Geol. Ges., 50, 4: 597-622, Taf. 19, Berlin.

-,- (1899b): Ueber zwei neue Zweischaler-Arten von paläozoischen Habitus aus deutschen Muschelkalk. - Z. Deutsch. Geol. Ges., 51: 62-67, Berlin.

-,- (1900): Beiträge zur Morphologie und Phylogenie der Lamellibranchier. II. Zur Stammesgeschichte der Pectiniden. - Z. Deutsch. Geol. Ges., 52, 1: 64-117, Berlin.

Philippi, R. (1899): Los Fósiles Secundarios de Chile. - F. A. Brockhaus, 104 p., 42 lám, Santiago de Chile.

Phillips, J. (1829): Illustrations of the geology of Yorkshire. - Wilson ed., 192 p., York.

-,- (1871): Geology of Oxford and the Valley of the Thames. - Clarendon Press, 523 p., 17 pl., Oxford.

Piatnitzky, A. (1936): Estudio geológico de la región del rio Chubut y del rio Genua. - Bol. Inform. Petrol., 13, 137: 83-118, Buenos Aires.

Polubotko, I.V. (1968a): Nekotorye pozdnetriasovye *Lima* i *Plicatula* Severo-Vostoka SSSR. - In: Markovskii, V.P. (Ed.): Novye vidy drevnikh rastenii i bespozvonochnykh SSSR. Vypusk II. Chast' I. - VSEGEI, Izd-vo 'Nedra', pp. 224-227, Tabl. 53, Moskva. [Russ.]

-,- (1968b): Dvustvorchatye Mollyuski nizhneï i sredneï yury. - In: Efimova, A. et al.: Polevoï Atlas yurskoï fauny i flory Severo-Vostoka SSSR. - Magadans. Knizh. Izd-vo, pp. 29-50, 59-99, Tabl. 1-8, 21-32, 39-42, 59-66, 70-78, 82-93, Magadan. [Russ.]

Polubotko, I.V. & Milova, L.V. (1986): Sinemyurskie i Plinsbakhskie Pektinidy severo-vostoka SSSR i ikh stratigraficheskoe znachenie. - In: Biostratigrafiya mezozoya Sibiri i Dal'nego Vostoka. - Trudy Inst. Geol. Geophys. Sib. Br. Acad. Sci. USSR, Byp. 648: 118-126, Tab. 15-16, Novosibirsk. [Russ.]

Polubotko, I.V. & Repin, Y.S. (1984): Early Jurassic bivalves of the North East USSR and their biostratigraphic significance. - Report 2, IGCP Project 171, Circum Pacific Jurassic, Spec. Pap., 6: 21-23.

-,- (1988): Lower and Middle Jurassic of the North-East. - In: Westermann, G.E.G. & Riccardi, A.C. (Eds.): Jurassic Taxa Ranges and Correlation Charts for the Circum Pacific. 1. Soviet Union. - Newsl. Stratigr., 19: 1-17, Stuttgart.

Pompeckj, J.F. (1901): Ueber Aucellen und Aucellen-ähnliche Formen. - N. Jahrb. Miner., Beil. Bd. 14: 319-368, Taf. 15-17.

Poulton, T.P. (1991): Hettangian through Aalenian (Jurassic) guide fossils and biostratigraphy, northern Yukon and adjacent Northwest Territories. - Geol. Surv. Canada, Bull., 410: 1-95, Ottawa.

Prinz, P. (1985): Stratigraphie und Ammonitenfauna der Pucara-Gruppe (Obertrias - Unterjura) von Nord Peru. - Palaeontographica (A), 188, 4-6: 153-197, Taf. 1-4, Stuttgart.

Quenstedt, F.A. (1856-1858): Der Jura. - Laupp & Siebeck, 842 p., 100 Taf., Tübingen.

-,- (1867): Handbuch der Petrefaktenkunde. - Laupp & Siebeck, 982 p., 86 Taf., 2nd ed., Tübingen.

Quilty, P.G. (1978): Late Jurassic bivalves from Ellsworth Land, Antarctica: their systematics and paleogeographic implications. - N. Zeal. Journ. Geol. Geophys., 20, 6: 1033-1080, Wellington.

-,- (1983): Bajocian bivalves from Ellsworth Land, Antarctica. - N. Zeal. Journ. Geol. Geophys., 26, 4: 395-418. Wellington.

Radulovic, V. (1982): Liassic Lamellibranchiata from Southwestern Slopes of Stara Planina, East Serbia. - Ann. Géol. Pénins. Balkan., 46: 293-324, pl. 1-7, Beograd. [Russ.]

Radulovic, V. & Mitrovic-Petrovic, J. (1984): Biostratigraphic and paleontological characteristics of Middle Jurassic fauna at Laz (eastern Serbia). - Ann. Géol. Pénins. Balkan., 48: 95-122, Pl. 1-5, Beograd.

Rémond de Corbineau, A. (1867): Paleontolojía de Chile. - An. Univ. Chile, 29, 3: 99-141, Santiago de Chile.

Riccardi, A.C. (1983): The Jurassic of Argentina and Chile. - In: Moullade, M. & Nairn, A.E.M. (Eds.): The Phanerozoic Geology of the World. - The Mesozoic B, pp. 201-263. Elsevier, Amsterdam.

-,- (1984): Las asociaciones de amonitas del Jurásico y Cretácico de la Argentina. - Actas 9° Congr. Geol. Argent., 4: 559-595, Buenos Aires.

Riccardi, A.C. & Damborenea, S.E. (Eds.) (1993): Léxico Estratigráfico de la Argentina. Volumen IX. Jurásico. - Asoc. Geol. Argent., (B), (Didáctica y Complementaria), 21: 1-477, Buenos Aires.

Riccardi, A.C. & Gulisano, C.A. (1992): Unidades limitadas por discontinuidades. Su aplicación al Jurásico andino. - Rev. Asoc. Geol. Argent., 45, 3-4: 346-364, Buenos Aires.

Riccardi, A.C., Damborenea, S.E., Manceñido, M.O. & Ballent, S.C. (1988): Hettangiano y Sinemuriano marinos en Argentina. - Actas 5° Congr. Geol. Chil., 2: C359-C373, Santiago de Chile.

Riccardi, A. C., Damborenea, S. E. & Manceñido, M. O. (1990): Lower Jurassic of South America and Antarctic Peninsula. - In: Westermann, G.E.G. & Riccardi, A.C. (Eds.): Jurassic taxa ranges and correlation charts for the Circum-Pacific. 3. South America and Antarctic Peninsula. - Newsl. Stratigr., 21, 2, pp. 75-103.

Riccardi, A. C., Damborenea, S. E., Manceñido, M. O. & Ballent, S. C. (1991): Hettangian and Sinemurian (Lower Jurassic) biostratigraphy of Argentina. - Journ. South Amer. Earth Scis., 4, 3: 159-170, Oxford.

Riccardi, A. C., Gulisano, C. A., Mojica, J., Palacios, O., Schubert, C. & Thomson, M. R. A. (1992): Western South America and Antarctica. - In: Westermann, G. E. G. (Ed.): The Jurassic of the Circum-Pacific. - pp. 365-379, Cambridge University Press, Cambridge.

Riccardi, A.C., Damborenea, S.E. & Manceñido, M.O. (1993): Invertebrados Mesozoicos. - In: Ramos, V. (Ed.): Geología y Recursos Naturales de Mendoza. Relatorio. - 12° Congr. Geol. Argent., pp. 329-339, Buenos Aires.

RICCARDI, A.C., DAMBORENEA, S.E., MANCEÑIDO, M.O., SCASSO, R., LANÉS, S. & IGLESIA LLANOS, M.P. (1997): Primer registro de Triásico marino fosilífero de la Argentina. - Rev. Asoc. Geol. Argent., 52, 2: 228–234, Buenos Aires.

ROBBIANO, J.A. (1971): Contribución al conocimiento estratigráfico de la sierra del Cerro Negro, Pampa de Agnia, provincia de Chubut, República Argentina. - Rev. Asoc. Geol. Argent., 26, 1: 41–56, Buenos Aires.

RÖDING, P.F. (1798): Museum Boltenianum sive Catalogus cimeliorum e tribus regnis naturae quae olim collegerat Joa. Fried. Bolten, M.D.p.d., pars Secunda. - Typis Johan Christi Trapii, 119 pp., Hamburg.

RÖMER, F.A. (1836-1839): Die Versteinerungen des Norddeutschen Oolithen-Gebirges. - Hahn, 218 pp., pl. 1–16 (1836); Ein Nachtrag, 59 pp., pl. 17–20 (1939), Hannover.

ROLLIER, L. (1915): Fossiles nouveaux ou peu connus des terrains secondaires (Mésozoïques) du Jura et des contrées environnantes. Cinquième partie. - Mém. Soc. Paléont. Suisse, 41,1: 445–500, pl. 29–32, Genève.

-,- (1917): Fossiles nouveaux ou peu connus des terrains secondaires (Mésozoïques) du Jura et des contrées environnantes. Sixième partie. - Mém. Soc. Paléont. Suisse, 42, 1: 501–696, Pl. 33–40, Genève.

ROMANOV, L.F. (1985): Yurkic Pektinoidy Yuga SSSR. - Shtiintsa, Kishinev, 231 p. [Russ.]

ROSENKRANTZ, A. (1942): The Lower Jurassic rocks of East Greenland. Part II. The Mesozoic sediments of the Kap Hope area southern Liverpool Land. - Meddel. Grønl., 110, 2: 1–56, pl. 1–4, København.

ROTHPLETZ, A. (1886): Geologisch-palaeontologische Monographie der Vilser Alpen, mit besonderer Berücksichtigung der Brachiopoden-Systematik. - Palaeontographica, 33, 1–3: 1–180, Taf. 1–17, Stuttgart.

SACCO, F. (1897): I molluschi dei terreni Terziarii del Piemonte e della Liguria. Parte XXIV. (Pectinidae). - Carlo Clausen, 116 p., 21 Tav., Torino.

SALOMON, W. (1900): Ueber *Pseudomonotis* und *Pleuronectites*. - Z. Deutsch. Geol. Ges., 52: 348–359, Pl. 14, Berlin.

-,- (1902): Die Familienzugehörigkeit der *Pleuronectites*. - Zbl. Miner., Geol. Paläont., 1902, 1: 19–23, Stuttgart.

SATO, T. & WESTERMANN, G.E.G. (1991): 4. Japan and South-East Asia. - In: WESTERMANN, G.E.G. & RICCARDI, A.C. (Eds.): Jurassic taxa ranges and correlation charts for the circum-Pacific. - Newsl. Stratigr., 24, 1-2: 81–108, Berlin-Stuttgart.

SAURIN, E. (1935): Etudes géologiques sur l'Indochine du sud-est (Sud Annam-Cochinchine-Camdodge oriental). - Bull. Serv. Géol. Indoch., 22,1: 1–419, pl. 1–15, Hanoi.

SCHÄFLE, L. (1929): Über Lias- und Doggeraustern. - Geol. Paläont. Abh., (N.F.), 17, 2: 1–88, Taf. 1–6, Jena.

SCHEIN-FATTON, E. (1988): Un Pectinacea (Bivalvia) très primitif: *Bathypecten vulcani*, du site hydrothermal de 13° N (Pacifique oriental). - In: Actes du Colloque Hydrothermalisme, Biologie et Écologie (Paris, 1985). - Oceanol. Acta, vol. spec., 8: 83–98, Paris.

-,- (1989): Pectinidae (Mollusca, Bivalvia) bathyaux et abyssaux des campagnes Biogas (Golfe de Gascogne). Systématique et biogéographie. - Ann. Inst. Océanogr., (N.S.), 65, 2: 59–125, Paris.

SCHLOTTHEIM, E.F. v. (1813): Beiträge zur Naturgeschichte der Versteinerungen in geognostischer Hinsicht. - Miner. Taschenb., 7, 1: 3–134, Taf. 1–4, Frankfurt am Main.

-,- (1820-1823): Die Petrefactenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung einer Sammlung versteinerter und fossiler Ueberreste des Thier -und Pflanzenreichs der Vorwelt. - Becker'sche édit., Texte: 1–726; Atlas: 1–37, Gotha.

SCHMID, F. (1949): Orientierte Anheftung von *Ostrea vesicularis* LAMARCK, *Dimyodon nilssoni* HAGENOW und *Crania parisiensis* DEFRANCE. - Mitt. Geol. Staatsinst. Hamburg, 19: 53–56, Taf. 12–13, Hamburg.

SCHMIDTILL, E. (1926): Zur Stratigraphie und Faunenkunde des Doggersandsteins im Nördlichen Frankenjura. B. Spezieller Teil. - Palaeontographica, 68, 1-3: 1–109, Taf. 1–6, Stuttgart.

SCHWEIZER, V.B. (1969): Zur Lebensweise und Entwicklung von *Plicatula spinosa* SOWERBY (Lamellibranchiata). - N. Jahrb. Geol. Paläont., Monatsh., 1969, 1: 40–45, Stuttgart.

SEILACHER, A. (1954): Okologie der triassischen Muschel *Lima lineata* (SCHLOT.) und ihrer Epöken. - N. Jahrb. Geol. Paläont., Monatsh., 1954, 4: 163–183, Stuttgart.

SEY, I. I. (1984): Pozdneplisbakhkie dvustvorchatye mollyuski Bureniskogo progiba. - In: POYARKOVA, Z. N., ZONOVALOV, V. P. & VASIL'KOVSKIJ, N. R. (Eds.): Novye Dannye po detal'noj biostratigrafii Fanerozoya Dal'nego Vostoka. - Akad. Nauk SSSR, Dal'nevostochyj Nauchnyj Tsentr., pp. 86–96, Tabl. 16–17, Vladivostok. [Russ.]

SEY, I.I. & KALACHEVA, E.D. (1980): Biostratigrafiya nishne- i sredneyurskikh otlozhenij Dal'nego Vostoka. - Trudy VSEGEI, 285: 1–187, Nedra.

-,- (1984): Distinguishing features of Jurassic marine faunas of the Far East of the USSR. - Report 2, IGCP Project 171, Circum Pacific Jurassic, Spec. Pap., 6: 11–13.

-,- (1985): Scheme of biostratigraphy of the marine deposits of the northern part of the Far East. - Geol. Geophys., 5: 136–138. [Russ.]

-,- (1988): Ammonites and bivalves of the Far East. - In: WESTERMANN, G.E.G. & RICCARDI, A.C. (Eds.): Jurassic taxa ranges and correlations charts for the Circum-Pacific. 1. Soviet Union. - Newsl. Stratigr., 19, 1-2, pp. 35–65, Stuttgart.

SEY, I.I. & POLUBOTKO, I.V. (1992): Eastern Russia. Bivalves. - In: WESTERMANN, G.E.G. (Ed.): The Jurassic of the Circum-Pacific. - pp. 620–635 (Pl. 120–127), Cambridge University Press, New York.

SHA JINGENG & FÜRSICH, F.T. (1994): Bivalve faunas of eastern Heilongjiang, northeastern China. II. The Late Jurassic and Early Cretaceous buchiid fauna. - Beringeria, 12: 3–93, Würzburg.

SHA JINGENG & GRANT-MACKIE, J.A. (1996): Late Permian to Miocene bivalve assemblages from Hohxil, Qinghai-Xizang Plateau, China. - Journ. Roy. Soc. N. Zeal., 26, 4: 429–455, Wellington.

SHARPE, D. (1850): On the Secondary District of Portugal which lies on the North of the Tagus. - Quart. Journ. Geol. Soc. London, 6: 135–201, Pl. 14–26, London.

SHOPOV, V.L. (1966): New data about the biozone of *Pseudopecten aequivalvis* (J. SOWERBY). - C. R., Acad. Bulg. Sci., 19, 11: 1083–1085, Sofia.

Shopov, V.L. (1970): Bivalviïnite zoni na dolnata yura v Bylgariya. [= Bivalvian Zones in the Lower Jurassic in Bulgaria]. - Izv. Geol. Inst., (ser. Stratigr. Litol.) 19: 15–39. [Russ.]

Sirna, G. (1966): Lamellibranchi nelle Dolomie del Lias Inferiore di Villetta Barrea (Abruzzo). - Geologica Romana, 5: 157–164, Roma.

Skwarko, S. K. (1974): Jurassic fossils of Western Australia, 1: Bajocian Bivalvia of the Newmarracarra Limestone and the Kojarena Sandstone. - Bull. Bureau Miner. Resourc., Geol. Geophys., 150: 1–53, Pl. 21–26, Canberra.

Smith, A.G. & Briden, J.C. (1977): Mesozoic and Cenozoic paleocontinental maps. - Cambridge University Press, 63 p.

Smith, P.L., Beyers, J.M., Carter, E.S., Jakobs, G.K., Pálfy, J., Pessagno, E. & Tipper, H.W. (1994): 5. North America. 5.1. Lower Jurassic. - In: Westermann, G.E.G. & Riccardi, A.C. (Eds.): Jurassic taxa ranges and correlation charts for the circum-Pacific. - Newsl. Stratigr., 31, 1: 33–70, Stuttgart.

Smith, W. (1817): Stratigraphical System of Organized Fossils, with Reference to the Specimens of the Original Geological Collection in the British Museum. - 113 pp., London.

Sobetskii, V.A. & Maslennikova, L.N. (1982): Klass Bivalvia – Dvustvorchatye. - In: Sobetskii, V.A., (Ed.): Atlas bespozvonochnykh pozdnemelovykh morei Prikaspiiskoi vpadiny. - Tr. Paleontol. Inst., Akad. Nauk SSSR, 187: 50–166, Tabl. 6–16 + 30–32, Moskva. [Russ.]

Sokolov, D.N. (1946): Algunos fósiles suprajurásicos de la República Argentina. - Rev. Soc. Geol. Argent., 1, 1: 7–16, 1 pl., Buenos Aires.

Sowerby, J. (1812–1822): The Mineral Conchology of Great Britain. - I: i–vii, 9–236, pl. 1–102 (18121814). II: 1–239, pl. 103–203 (1815–1818). III: 1–186, pl. 204–306 (1818–1821). IV: 1–104, pl. 307–327 (1821–1822).

Speden, I.G. (1967): Revision of *Syncyclonema* (Upper Cretaceous) and comparison with other small pectinid bivalves and *Entolium*. - Postilla, 110: 1–36, Pl. 1–7, New Haven.

-,- (1970): Three new inoceramid species from the Jurassic of New Zealand. - N. Zeal. Journ. Geol. Geophys., 13, 3: 825–851, Wellington.

-,- (1971): Geology of Papatowai Subdivision, South-East Otago. - Bull., N. Zeal. Geol. Surv., 81: 1–166, 2 maps, Wellington.

Speden, I.G. & Keyes, I.W. (1981): Illustrations of New Zealand Fossils. - N. Zeal. Dept. Scient. Industr. Res. (DSIR), (Information Series), 150: 1–109, Wellington.

Staesche, K. (1926): Die Pectiniden des Schwäbischen Jura. - Geol. Palaeont. Abh., (N.F.), 15, 1: 1–136, Taf. 1–6, Jena.

Stanley, S.M. (1970): Relation of Shell Form to Life Habits in the Bivalvia (Mollusca). - Memoir, Geol. Soc. Amer., 125: 1–296, Boulder, Colorado.

Stanton, T.W. (1899): Mesozoic fossils of the Yellowstone National Park. - U.S. Geol. Surv. Monogr., 32, 2: 600–640, pl. 72–76.

Stephenson, L.W. (1934): The genus *Diploschiza* from the Upper Cretaceous of Alabama and Texas. - Journ. Paleont., 8, 3: 273–280, Pl. 38.

-,- (1935): Further notes on the Cretaceous pelecypod genus *Diploschiza*. - Journ. Paleont., 9, 7: 588–592, Pl. 70.

Stevens, G.R. (1973): Cretaceous Belemnites. - In: Hallam, A. (Ed.): Atlas of Palaeobiogeography. - Elsevier Publ. Co., pp. 385–401, Amsterdam.

-,- (1977): Mesozoic biogeography of the South-West Pacific and its relationship to plate tectonics. - International Symposium on Geodynamics of the S.W. Pacific (Ed. Technip) (1976), pp. 309–326, Paris.

-,- (1978): Jurassic. Paleontology. - In: Suggate, R.P., Stevens, G.R. & Te Punga, M.T. (Eds.): The geology of New Zealand. - N. Zeal. Geol. Surv., 1: 215–228, Wellington.

-,- (1980): Southwest Pacific faunal palaeobiogeography in Mesozoic and Cenozoic times: a review. - Palaeogeogr., Palaeoclimat., Palaeoecol., 31, 2-4: 153–196, Amsterdam.

-,- (1989): The nature and timing of biotic links between New Zealand and Antarctica in Mesozoic and early Cenozoic times. - In: Crame, J.A. (Ed.): Origins and Evolution of the Antarctic Biota. - Geol. Soc. Spec. Publ., 47: 141–166.

-,- (1990): The Influences of Palaeogeography, Tectonism and Eustasy on Faunal Development in the Jurassic of New Zealand. - In: Pallini, G., Cecca, F., Cresta, S. & Santantonio, M. (Eds.): Atti del Secondo Convegno Internazionale Fossili, Evoluzione, Ambiente (Pergola 1987), pp. 441–457.

Stevens, G.R. & Speden, I.G. (1978): New Zealand. - In: Moullade, M. & Nairn, A. (Eds.): The Phanerozoic Geology of the World. II. The Mesozoic, A. - Elsevier, pp. 251–328, Amsterdam.

Stewart, R.B. (1930): Gabb's California Cretaceous and Tertiary Type Lamellibranchs. - Acad. Nat. Sci. Philadelphia, Spec. Publ., 3: 1–314, 17 pl.

Stoliczka, F. (1861): Über die Gastropoden und Acephalen der Hierlatz-Schichten. - Sitzungsber. math.-naturwiss. Cl. kais. Akad. Wiss., 43: 157–204, Taf. 1–7, Wien.

-,- (1870–1871): Cretaceous fauna of southern India. v. 3. The Pelecypoda, with a review of all known genera of this Class, fossil and recent. - Geol. Surv. India, Palaeontol. Indica, (6), 3: 1–537, 50 pl., Calcutta.

Stoppani, A. (1860–1865): Geologie et paléontologie des couches à *Avicula contorta* en Lombardie. - Paléont. Lombardie, 3: 1–267, Milano.

Sundberg, F.A. (1989): *Propeamussium* species (Bivalvia: Propeamussiidae) from the upper Cretaceous of Southern California. - Journ. Paleont., 63, 1: 53–63. Lawrence, Kansas.

Szente, I. (1995a): Bivalvia from the Bathonian (Middle Jurassic) of the Mecsek Mts., Hungary. - Ann. Univ. Scis. Budapest, Sect. Geol., 30: 93–109 and 221–224, Budapest.

-,- (1995b): Bivalves from a Middle Jurassic submarine high (Bajocian, Som Hill, Bakony Mts., Hugary). - Hantkeniana (Géczy Jubilee Volume), 1: 59–66, Budapest.

Szente, I. & Vörös, A. (1992): A Pliensbachian (Early Jurassic) Bivalvia Fauna from the Harsány-hegy: First Record of the Domerian Substage from the Villány Hills (southern Hungary). - Fragmenta Mineralogica et Palaeontologica, 15: 95–106, Budapest.

Tamura, M. (1973): Two species of Lower Cretaceous *Parvamussium* from Kyushu, Japan, and Sarawak, Borneo. Contributions to the Geology and Palaeontology of Southeast Asia, CX. - Geol. Palaeont. Southeast Asia, 11: 119–124, pl. 17.

Tate, R. (1876): Class Lamellibranchiata. – In: Tate, R. & Blake, J.: The Yorkshire Lias. – J. Van Voorst, pp. 357–412, Pl. 11–14, 16, London.

Tawney, E.B. (1866): On the Western limit of the Rhaetic Beds in South Wales and on the position of the "Sutton Stone". – Quart. Journ. Geol. Soc. London, 22, 2: 69–93, pl. 3–4, London.

Tebble, N. (1966): British Bivalve Seashells. A Handbook for Identification. – Roy. Scott. Mus. , 212 p., Edinburgh.

Teppner, W. v. (1922): Fossilium catalogus 1: Animalia. – In: Diener, C. (Ed.), Pars 15: Lamellibranchiata tertiaria "Anisomyaria", II: 67–296. – W. Junk, Berlin.

Terquem, O. (1855): Paléontologie de l'étage inférieur de la formation liasique de la province de Luxembourg, Grand-Duché (Hollande), et de Hettange, du Département de la Moselle. – Mém. Soc. Géol. France (2), 5, 2: 219–343, Pl. 12–26, Paris.

Terquem, O. & Piette. E. (1865): Le Lias inférieur de l'Est de la France comprénant la Meurthe, la Moselle, le Grand-Duché de Luxembourg, la Belgique et la Meuse. – Mém. Soc. Géol. France, (2), 8, 1: 1–175, 18 pl., Paris.

Thevenin, A. (1908): Types du Prodrome de paléntologie stratigraphique universelle de d'Orbigny. Liasien. – Ann. Paléont., 3, 1: 25–40, Pl. 11–12, Paris.

Thiele Cartagena, R. (1967): El Triásico y Jurásico del Departamento de Curepto en la provincia de Talca. – Publ., Univ. Chile, Fac. Cienc. Físic. Matem., Dept. Geol., 28: 27–46, Lám. 1–7, 2 mapas, Santiago de Chile.

Thomson, R.C. & Smith, P.L. (1992): Pliensbachian (Lower Jurassic) biostratigraphy and ammonite fauna of the Spatsizi area, north-central British Columbia. – Geol. Surv. Canada, Bull., 437: 1–87, Ottawa.

Tilmann, N. (1917): Die Fauna des unteren und mittleren Lias in Nord- und Mittel-Peru. – N. Jahrb. Miner., Geol. Paläont., Beil. Bd., 41: 628–712, Taf. 21–26, Stuttgart.

Tokuyama, A. (1959): Late Triassic Pteriacea from the Atsu and Mine Series, West Japan. – Japan. Journ. Geol. Geogr., 30: 1–19, pl. 1, Tokyo.

Tornquist, A. (1898): Der Dogger am Espinazito-Pass, nebst einer Zusammenstellung der jetzigen Kenntnisse von der Argentinischen Juraformation. – Paläont. Abh., 4, 2: 135–204, Taf. 1–10, Jena.

Toula, F. (1910): Schichten mit *Gervilleia* ("*Perna*") *Bouéi* v. Hauer, am Gaumannmüllerkogel an der Weissenbacher Strasse. (Im Randgebirge der Wienerbucht). – Jahrb. K.K. Geol. Reichsanst., 59, 2: 383–406, Pl. 12, Wien.

Trauth, F. (1909): Die Grestener Schichten der österreichischen Voralpen und ihre Fauna. Eine stratigraphisch-paläontologische Studie. – Beitr. Paläont. Geol. Oesterreich-Ungarn u.d. Orients [= Mitt. Geol. Pal. Inst. Univ. Wien], 22, 1: 1–78, Taf. 1–2. 2: 79–142, Taf. 3–4, Wien u. Leipzig.

Trechmann, C.T. (1923): The Jurassic rocks of New Zealand. – Quar. Journ. Geol. Soc. London, 79, 3: 246–286, Pl. 12–18, London.

Troedsson, G. (1951): On the Höganäs Series of Sweden (Rhaeto-Lias). – Lunds. Univ. Arsskrift. (N.F. Avd. 2), 47, 1 = Kungl. Fysiogr. Sällsk. Handl. (N.F.), 62, 1: 1–268, Pl. 1–24, Lund.

Trümpy, R. (1949): Der Lias der Glarner Alpen. – Denkschr. Schweiz. Naturforsch. Ges., 79, 1: 1–192, Pl. 1–4, Zürich.

Tsankov, V. & Bonchev, E. (1933): Liaskata fauna oty Kalotina. [= La faune liasique de Kalotina – Bulgarie du l'Ouest]. – Rev. Soc. Géol. Bulgarie 4, 3: 221–242, pl. 1–2, Sofia. [Bulg.]

Ugarte, F. (1955): Estudio geológico de la zona Coihueco – Cerro de la Brea (provincia de Mendoza). – Rev. Asoc. Geol. Argent., 10, 3: 137–177, Buenos Aires.

Uliana, M.A. & Biddle, K.T. (1988): Mesozoic-Cenozoic paleogeographic and geodynamic evolution of southern South America. – Rev. Brasil. Geocienc., 18, 2: 179–190.

Ushanov, S.A. & Yasamanov, N.A. (1984): Global reconstructions of the climate and ocean currents in the Phanerozoic. – 27th Internat. Geol. Congr., Palaeoceanography Coll. 03, Reports, 3: 58–76, Moscow.

Verneuil, E. de & Collomb, E. (1853): Coup d'oeil sur la constitution géologique de quelques provinces de l'Espagne. – Bull. Soc. Géol. France (2), 10, 1: 61–147, 162–166, Pl. 1–3, Paris.

Verrill, A.E. (1897): A study of the family Pectinidae, with a revision of the genera and subgenera. – Transact., Connecticut Acad. Arts Scis., 10, 1: 41–96, pl. 16–21, New Haven.

Vokes, H.E. (1967): Genera of the Bivalvia: a systematic and bibliographic catalogue. – Bull. Amer. Paleont., 51, 232: 105–394, New York.

–,– (1979): Observations on the genus *Dimya* (Mollusca: Bivalvia) in the Cenozoic faunas of the western Atlantic region. – Tulane Stud. Geol. Paleont., 15, 2: 33–53.

–,– (1980): Genera of the Bivalvia: a systematic and bibliographic catalogue (revised and updated). – Paleont. Res. Inst., 307 p., Ithaca.

Volkheimer, W. (1978): Descripción geológica de la hoja 27b, Cerro Sosneado. Provincia de Mendoza. – Bol., Serv. Geol. Nacion. (Argentina), 151: 1–85, 4 lám., 1 mapa, Buenos Aires.

Volkheimer, W., Manceñido, M.O. & Damborenea, S.E. (1978a): Zur Biostratigraphie des Lias in der Hochkordillere von San Juan, Argentinien. – Münst. Forsch. Geol. Paläont., 44/45: 205–235, Münster.

–,– (1978b): La Formación Los Patos (nov. form.), Jurásico inferior de la Alta Cordillera de la Provincia de San Juan (República Argentina), en su localidad tipo (rio de Los Patos Sur). – Rev. Asoc. Geol. Argent., 32,4: 300–311, Buenos Aires.

Vörös, A. (1971): The Lower and Middle Jurassic Bivalves of the Villány Mountains. – Ann. Univ. Sci. Budapest R. Eötvös, Sec. Geol., 14 (1970): 167–208, Budapest.

Vyalov, O.S. & Korobkov, I.A. (1939): On the stratigraphy of Pectinidae from the lower Tertiary of Central Asia. – Bull. Acad. Sci. URSS, Géol., 1939, 3: 32–43, pl. 1, 2.

Waagen, L. (1907): Die Lamellibranchiaten der Pachycardientuffe der Seiser Alm nebst vergleichend paläontologischen und phylogenetischen Studien. – Abh. k.k. Geol. Reichsanst., 18, 2: 1–180, Taf. 25–34, Wien.

Wahnish, E. (1942): Observaciones geológicas en el Oeste del Chubut. Estratigrafía y fauna del Liásico en los alrededores del rio Genua. – Bol., Serv. Geol. Nacion., 51: 1–73, 1 mapa, Buenos Aires.

Waller, T.R. (1971): The glass scallop *Propeamussium*, a living relict of the past. – Amer. Malacol. Union, Ann. Rep., 1970, pp. 5–7.

–,– (1972a): The Pectinidae (Mollusca: Bivalvia) of the Eniwetok Atoll, Marshall Islands. – The Veliger, 14, 3: 221–264, Pl. 1–8, Berkeley.

–,– (1972b): The Functional Significance of Some Shell Microstructures in the Pectinacea (Mollusca: Bivalvia). – 24th Internat. Geol. Congr., sect. 7, Paleontology: 48–56.

–,– (1978): Morphology, morphoclines and a new classification of the Pteriomorphia (Mollusca: Bivalvia). – In: Yonge, C. M. & Thompson, T. E. (Eds.): Evolutionary systematics of bivalve molluscs. – Phil. Transact. Roy. Soc. London, (B), 284, 1001: 345–365, London.

–,– (1984): The ctenolium of scallop shells: functional morphology and evolution of a key family-level character in the Pectinacea (Mollusca: Bivalvia). – Malacologia, 25, 1: 203–219.

–,– (1986): A new genus and species of scallop (Bivalvia Pectinidae) from off Somalia and the definition of a new Tribe Decatopectinini. – Nautilus, 100, 2: 39–46.

–,– (1993): The evolution of "*Chlamys*" (Mollusca: Bivalvia: Pectinidae) in the tropical western Atlantic and eastern Pacific. – Amer. Malacol. Bull., 10, 2: 195–249.

Waller, T.R. & Marincovich, L. jr. (1992): New species of *Camptochlamys* and *Chlamys* (Mollusca: Bivalvia: Pectinidae) from near the Cretaceous/Tertiary boundary at Ocean Point, North Slope, Alaska. – Journ. Paleont., 66, 2: 215–227, Lawrence.

Wang Yi-gang (1988): China. – In: Westermann, G. E. G. & Riccardi, A. C. (Eds.): Jurassic taxa ranges and correlation charts for the Circum-Pacific. – Newsl. Stratigr., 19, 1-2: 95–130, Stuttgart.

Wang Yi-gang & Sun Dong-li (1983): A survey of the Jurassic System of China. – Canad. Journ. Earth Scis., 20, 11: 1646–1656.

Watson, H. (1930): On the anatomy and affinities of *Plicatula*. – Proc. Malacol. Soc. London, 19, 1: 25–31, pl. 5, London.

Weaver, C. (1931): Paleontology of the Jurassic and Cretaceous of West Central Argentina. – Mem., Univ. Washington, 1: 1–469. Pl. 1–62, Washington.

Wen, S. (1982): Jurassic Bivalvia of Xizang. – In: Palaeontology of Xizang. Book IV. – pp. 225–254, Pl. 1–10. [Chin., Engl. abstr.]

Wen, S., Lan, X., Chen, J., Zhang, Z., Chen, C. & Gu, C. (1976): Fossil Lamellibranchia from the Mount Jolmo Lungma Region. – In: A Report of Scientific Expedition in the Mount Jolmo Lungma Region (1966–1968). – Palaeontology, Fasc., 3: 1–170, pl. 1–40, Science Press, Peking. [Chin.]

Westermann, G. E. G. & Riccardi, A. C. (1982): Ammonoid fauna from the early Middle Jurassic of Mendoza Province, Argentina. – Journ. Paleont., 56, 1: 11–41, Tulsa, Okl.

–,– (1985): Middle Jurassic ammonite evolution in the Andean province and emigration to Tethys. – In: Bayer, U. & Seilacher, A. (Eds.): Sedimentary and Evolutionary Cycles. – Lect. Notes Earth Scis., 1: 6–34, Springer-Verlag, Heidelberg.

Whidborne, G.F. (1883): Notes on some fossils, chiefly Mollusca, from the Inferior Oolite. – Quart. Journ. Geol. Soc. London, 39, 4: 487–540, Pl. 15–19, London.

White, C.A. (1880): Contributions to invertebrate paleontology n° 7; Jurassic fossils from the Western Territories. – U.S. Geol. Surv. Terr. (Hayden), 12th Annual Report, 1878, 1: 143–153, pl. 37–38.

Whiteaves, J.F. (1884): On the fossils of the coal-bearing deposits of the Queen Charlotte Islands collected by Dr. G.M. Dawsonn in 1878. – Geol. & Nat. Hist. Surv. Canada, Mesozoic Fossils 1, 3: 191–262, pl. 21–33, Montreal.

Whitfield, R.P. (1880): Paleontology of the Black Hills of Dakota. – In: Newton, H. & Jenney, W.P.: Report on the geology and resources of the Black Hills of Dakota. U.S. Geog. Geol. Surv. Rocky Mtn. Region (Powell, ed.), pp. 325–468, Pl. 1–16, Washington.

–,– (1885): Brachiopoda and Lamellibranchia of the Raritan Clays and Greensand Marls of New Jersey. – Monogr., U.S. Geol. Surv., 9.

Willard, B. (1966): The Harvey Bassler collection of Peruvian fossils. – Lehigh Univ., 255 p., Bethlehem.

Wilson, V. (1948): East Yorkshire and Lincolnshire. – Inst. Geol. Scis., Brit. Region. Geol.: 1–94, Pl. 1–8, London.

Yamani, S. A. (1983): Die Bivalvenfauna der Schwammkalke von Biburg (Oberoxford, Südliche Frankenalb). – Mitt. Bayer. Staatssamml. Palaeontol. Histor. Geol., 23: 3–33, München.

Yin, J. & Fürsich, F. T. (1991): Middle and Upper Jurassic bivalves from the Tanggula Mountains, W-China. – Beringeria, 4: 127–192, Würzburg.

Yonge, C.M. (1973): Functional morphology with particular reference to hinge and ligament in *Spondylus* and *Plicatula* and a discussion on relations within the superfamily Pectinacea (Mollusca: Bivalvia). – Phil. Transact. Roy. Soc. London, B. Biol. Scis., 267,883: 173–208. London.

–,– (1975): The status of the Plicatulidae and the Dimyidae in relation to the superfamily Pectinacea (Mollusca: Bivalvia). – Journ. Zoology, London, 176, 4: 545–553, London.

–,– (1977): Form and evolution in the Anomiacea (Mollusca, Bivalvia) *Pododesmus*, *Anomia*, *Patro*, *Enignomia* (Anomiidae), *Placunanomia*, *Placuna* (Placunidae Fam. nov.). – Phil. Transact. Roy. Soc. London, 276 B: 453–527.

–,– (1981): On adaptive radiation in the Pectinacea with a description of *Hemipecten forbesianus*. – Malacologia, 21, 1-2: 23–34, Philadelphia.

Young, G. & Bird, J. (1822, 1828): A geological survey of the Yorkshire coast: describing the strata and fossils occurring between the Humber and the Tees, from the German Ocean to the plain of York. – Whitby (1st ed., 1822): 235 pp., 17 pl.; (2nd ed., 1828), 364 p., 17 pl., London.

Zakharov, V.A. (1962): New Monotidae of Lower Lias from Okhotsk Sea coast and their stratigraphic importance. [= Novye Monotidae nizhnego leïasa s poberezhyya Okhotskogo morya i ikh stratigraficheskoe znachenie.]. – Geol. i Geofiz. (Sibirsk. Otdel.), 1962, 3: 23–31, Tabl. 1, Novosibirsk. [Russ., Engl. abstr.]

–,– (1965): New Upper Jurassic and Lower Cretaceous Camptonectid (Pectinidae, Bivalvia) from Arctic Siberia. – In: Saks, V.N. (Ed.): Stratigraphy and Paleontology of the Mesozoic deposits of Northern Siberia. – pp. 72–80, Nauka, Moscow. [Russ.]

Zhang, Z., Lu, L. & Wen, S. (1979): Lamellibranchiata. – In: Palaeontological Atlas of Northwest China (Fascicle Qinghai) (I). – Nanjing Institute of Geology and Palaeontology and Qinghai Institute of Geosciences, Geol. Publ. House, pp. 218–314, 370–393, pl. 58–96, Beijing. [Chin.]

Zieten, C.H. v. (1830–1833): Die Versteinerungen Württembergs, oder naturgetreue Abbildungen der in den vollständigsten Sammlungen, namentlich der in dem Kabinet des Oberamtsarztes Dr. Hartmann befindlichen Petrefacten, mit Angabe der Gebirgs-Formationen, in welchen dieselben vorkommen und deren Fundorten. – Unsere Zeit, 1 (1830): 1–16, pl. 1–12; 2 (1831): 17–32, pl. 13–24; 3 (1832): 33–64, pl. 25–48; 4 (1833): 65–102, pl. 49–62, Stuttgart.

Zittel, K.A. (1864): Fossile Mollusken und Echinodermen aus NeuSeeland. – In: Hochstetter, F. v., Hörnes, M. & Hauer, F.R. v.: Paläontologie von Neu-Seeland. Beiträge zur Kenntniss der Fossilen Flora und Fauna der Provinzen Auckland und Nelson. – Reise der Oesterreichischen Fregatte Novara um die Erde, in 1857-59, unter den Befehln des Commodore B. von Wüllerstorf-Urbair. – Geol. 1. Band, 2 Abt.: 15–68, Taf. 6–15.

## Explanation of plates

(All specimens are coated with amonium chloride. Figures natural size except where otherwise indicated. Specimens from author's collection except where otherwise indicated)

### Plate 1

Figs. 1–3: *Otapiria pacifica* Covacevich & Escobar, Arroyo Malo.
1: MLP 22261, Sinemurian; complete specimen. 1a: dorsal view; 1b: left valve; 1c: right valve; 1d: anterior view; 1e: ventral view.
2: MLP 22379, Hettangian; left valve, X 2.
3: MLP 22260, Sinemurian; latex cast of several isolated valves.
Figs. 4–5: *Otapiria neuquensis* Damborenea.
4: MLP 27824, Arroyo Las Chilcas, Early Pliensbachian, Lanés' collection, slab with five shells.
5: MLP 19997, Puesto Araya, Early Pliensbachian, complete specimen, 5a: left valve; 5b: right valve; 5c: dorsal view.
Figs. 6–8: *Palmoxytoma* cf. *cygnipes* (Young & Bird), Arroyo Malo, Hettangian.
6: MLP 27544-b, external mould of left valve.
7: MLP 27544-a, external mould of left valve.
8: MLP 22253, 8a: right valve internal mould. 8b: whole specimen, composite mould of left valve and internal mould of right valve.
Figs. 9–11: *Meleagrinella* sp., Arroyo La Laguna, Toarcian, X 2.
9: MLP 25000-a, left valve composite mould.
10: MLP 25001, left valve internal mould.
11: MLP 25000-b, left valve internal mould.
Figs. 12–20: *Parvamussium pumilum* (Lamarck), early Toarcian.
12: MLP 17477-c, upper Rio Salado; right valve exterior, X 2.
13: MLP 17477-a, upper Rio Salado; right valve exterior.
14: MLP 15448, Cordillera del Viento, Gulisano's collection; internal mould.
15: MLP 23848-b, Arroyo Serrucho; internal mould, X 2.
16: MLP 15539-a, Arroyo Ñiraico, Gulisano's collection; left valve, X 2.
17: MLP 23848-a, Arroyo Serrucho; internal mould, X 2.
18: MLP 23818-b-c, Cerro Puchenque; left valve external mould and internal mould, X 2
19: MLP 23839, Arroyo Serrucho; right valve internal mould, X 2.
20: MLP 23818-a, Cerro Puchenque; left valve external mould and internal view, X 2.

### Plate 2

Figs. 1–15: *Kolymonectes weaveri* Damborenea, Pliensbachian.
1: Holotype, MLP 23686, south of Cerro Roth; complete specimen with valves displaced. 1a: left valve internal mould, right valve external mould, X 1.5; 1b: counterpart of same specimen, X 1.5; 1c: latex cast of 7b, X 1.5; 1d: same as 1b, X 1.
2: Paratype, MLP 23688-i, south of Cerro Roth; specimen with both valves.
3: Paratype, MLP 23690-n, south of Cerro Roth; latex cast of right valve, X 2.
4: Paratype, MLP 23804, Chacay Melehue, Clavijo's collection; specimen with both valves, right valve view, X 2.
5: Paratype, MLP 23734, Piedra Pintada; left valve, X 2.
6: Paratype, MLP 23807, Chacay Melehue, Clavijo's collection; displaced left and right valves of same specimen, latex cast, X 1.5.
7: Paratype, MLP 23691-o, south of Cerro Roth; latex cast of left valve, X 2.

8: Paratype, MLP 23687-ef, south of Cerro Roth; left valve external mould and right valve internal mould of same specimen, X 2.
9: Paratype, MLP 6001-m, Subida a Sañicó, FRENGUELLI's collection; two left valves, X 2.
10: Paratype, MLP 26560, Puesto Araya, left valve with *Harpax rapa* (BAYLE & COQUAND) as epizoan, see also Text-fig. 45b.
11: Holotype of *Pecten* (*Variamussium*) *personatus* var. *coloradoensis* WEAVER, BMW SA 155/1029 (= cast MLP 22355), North of Catan Lil, Neuquén, WEAVER's collection; external mould of left valve. Specimen figured by WEAVER (1931, pl. 28, fig. 164).
12: Paratype, MLP 23717, Cañadon La Pintada; small valve showing shell damage, X 2.
13: Paratype, MLP 23811, Arroyo Lista Blanca, CLAVIJO's collection; latex cast of left valve.
14: Paratype, MLP 23743, Piedra Pintada; right valve, X 2.
15: Paratype, MLP 23732-a, Piedra Pintada; right valve, X 2.
Figs. 16–19: *Kolymonectes* sp., Arroyo Malo, Sinemurian.
16: MLP 25003, right valve internal mould, X 2.
17: MLP 25002, left valve internal mould, X 2.
18: MLP 25004, left valve external mould, X 2.
19: MLP 25005, right valve internal mould, X 2.

## Plate 3

Figs. 1–14: *Entolium* (*Entolium*) cf. *lunare* (RÖMER).
1: MLP 6670, Cerro La Brea, UGARTE's collection, Pliensbachian; internal mould, X 2.
2: MLP 24903, Cerro Puchenque, Pliensbachian; internal view, latex cast.
3: MLP 24921, Arroyo Las Chilcas, Sinemurian; internal mould, X 2
4: MLP 24950, Arroyo Las Chilcas, Sinemurian; internal view of right valve, latex cast, X 2.
5: MLP 24901, Cerro Puchenque, Pliensbachian; 5a: internal mould, X 2; 5b: latex cast.
6: MLP 24902-b, Cerro Puchenque, Pliensbachian; internal view, latex cast, X 2.
7: MLP 24909-a, Puesto Araya, early Pliensbachian; composite mould.
8: MLP 17486-b, upper Rio Salado, Pliensbachian; specimen with both valves; 8a: anterior view; 8b: lateral view.
9: MLP 17486-a, upper Rio Salado, Pliensbachian; internal mould.
10: MLP 24944, Arroyo Serrucho, Pliensbachian; internal mould.
11: MLP 27869, Puesto Araya, LANÉS' collection, specimen with both valves, 11a: lateral view, 11b: posterior view.
12: MLP 24972, Estancia Santa Isabel, Pliensbachian; hinge region of left valve, latex cast, X 2.
13: MLP 24926, Arroyo Las Chilcas, Sinemurian; hinge region of right valve, latex cast, X 2.
14: MLP 24902-c, Cerro Puchenque, Pliensbachian; hinge region of left valve, latex cast, X 2.

## Plate 4

Figs. 1–3: *Entolium* (*Entolium*) *disciforme* ? (SCHUEBLER).
1: MLP 24965-b, Cerro Roth, Pliensbachian, external view.
2: MLP 6021-a, Cerro Roth, LEANZA's collection. 2a: internal mould; 2b: same, X 2.
3: MLP 5828-a, Piedra Pintada, old MLP collection; internal view, X 2
Figs. 4–8: *Entolium* (*Entolium*) *disciforme* (SCHUEBLER), Toarcian.
4: MLP 24826-b, Cerro Granito; internal mould.
5: MLP 24821, Poti Malal; external view.
6: MLP 24823, Poti Malal; external view.
7: MLP 24824, Poti Malal; pavement with many specimens, X 0.5.
8: Field photograph of bedding plane at Poti Malal with well-preserved specimen, approx. X 0.75.

## Plate 5

Figs. 1–8: *Entolium mapuche* n. sp.
1: Paratype, MLP 24842-a, Cerro Del Vasco, Pliensbachian. 1a: external mould; 1b: internal mould; 1c: latex cast of 1b, X 2.
2: Holotype, MLP 24861, left valve, Arroyo Serrucho, early Toarcian; 2a: internal mould; 2b: latex cast, X 2.
3: Paratype, MLP 15536-a, Arroyo Ñiraico, GULISANO's collection. 3a: latex cast, X 1; 3b: internal mould, X 2.
4: Paratype, MLP 15544, Arroyo Ñiraico, GULISANO's collection. 4a: internal mould; 4b: latex cast, X 2.
5: Paratype, MLP 27575, Arroyo Serrucho, early Toarcian, MANCEÑIDO's collection, internal mould.
6: Paratype, MLP 24864-k, Arroyo Serrucho, Toarcian; internal mould, X 2.
7: Paratype, MLP 24868-u, Arroyo Serrucho, Toarcian; internal mould, X 2.
8: Paratype, MLP 24869, Arroyo Serrucho, Toarcian; specimen with both valves, internal mould. 8a: X 2; 8b: X 1.

## Plate 6

Figs. 1-3: *Eopecten* cf. *velatus* (Goldfuss), Arroyo Malo.
1: MLP 27546, Hettangian, left valve.
2: MLP 22256, Hettangian; left valve internal mould.
3: MLP 22383, early Sinemurian; left valve internal mould.
Figs. 4–6: *Eopecten* sp., Arroyo Serrucho, Toarcian.
4: MLP 19687-a, left valve; 4a: dorsal view; 4b: lateral view.
5: MLP 19687-c, right valve external mould.
6: MLP 19687-b, left valve.
Figs. 7–8: *Camptonectes* ? cf. *subulatus* (Münster), Sinemurian.
7: MLP 24988, Arroyo Las Chilcas; right valve internal mould.
8: MLP 24990, Arroyo Malo; latex cast of right valve internal mould, X 2.
Figs. 9–10: *Camptonectes* (*Camptonectes*) *auritus* (Schlotheim), early Toarcian.
9: MLP 22350, Arroyo Serrucho; latex cast of right valve, X 1.5.
10: MLP 22349, Arroyo Serrucho; latex cast of right valve, X 1.5.
Fig. 11: *Camptonectes* (*Camptonectes*) *auritus* ?, MLP 23647, Portezuelo Ancho, late Pliensbachian; left valve, X 2.
Figs. 12–20: *Radulonectites sosneadoensis* (Weaver), late Pliensbachian.
12: MLP 22339, Arroyo Serrucho; interior of right valve, latex cast.
13: Holotype, BMW SA 153/1136 (= cast MLP 22353), Rio Atuel, Mendoza, Weaver's collection; left valve; figured in Weaver 1931, pl. 28, fig. 169.
14: MLP 22326, Cerro del Vasco; left valve.
15: MLP 25041, Puesto Araya, left valve with bivalve epizoan, latex cast.
16: MLP 22321, south of Cerro Roth; right valve, X 2.
17: MLP 22327, Carrán Curá; right valve; 17a: internal mould; 17b: internal view.
18: MLP 22333, Estancia Santa Isabel; left valve, latex cast.
19: MLP 22334, Estancia Santa Isabel; left valve.
20: MLP 6033, Cañadón Los Chilenos, Leanza's collection; figured by Leanza 1942, pl. 10, fig. 2; left valve, latex cast, X 2.

## Plate 7

Figs. 1–10: *Agerchlamys wunschae* (Marwick), Pliensbachian.
1: MLP 23658, Arroyo Ñireco, right valve with *Harpax rapa* (Bayle & Coquand) as epizoic. 1a: external mould; 1b: latext cast, see also Text-fig. 45c.
2: MLP 23655, Arroyo Lonqueo, interior of right valve, latex cast; 2a: X 2; 2b: X 1.
3: MLP 6029, Subida a Sañicó, Leanza's collection; figured by Leanza 1942, pl. 7, fig. 4; left valve external mould, distorted, X 2.
4: MLP 23654, Arroyo Lonqueo, interior of right valve, latex cast.
5: MLP 23659, Arroyo Ñireco, interior of right valve, latex cast.
6: MLP 23660, Arroyo Ñireco, left valve with plicatuloidean as epizoic, and a young valve, latex cast.
7: MLP 23656, south of Cordillera del Viento, left valve with epizoic serpulid tube, latex cast.
8: MLP 27909, Arroyo Las Chilcas, Lanés' collection, right valve exterior, latex cast.
9: MLP 26559-a, southern Cordillera del Viento, right valve, 9a: external mould, 9b: latex cast.
10: MLP 26559-b, southern Cordillera del Viento, right valve internal mould.
Figs. 11–17: *Pseudopecten* aff. *equivalvis* (Sowerby), late Pliensbachian.
11: MLP 23675-h, Estancia Santa Isabel; right valve, latex cast, X 2.
12: MLP 23670, Estancia Santa Isabel, left valve latex cast, X 2.
13: MLP 23674, Estancia Santa Isabel, latex cast, X 2.
14: MLP 23677, Estancia Santa Isabel, latex cast, X 2.
15: MLP 23674, Estancia Santa Isabel, latex cast, X 3.
16: MLP 23672, Estancia Santa Isabel, internal mould, X 2.
17: MLP 23667, Cerro Puchenque, left valve internal mould, X 2.

## Plate 8

Figs. 1–8: "*Chlamys*" *textoria* (Schlotheim), Pliensbachian.
1: MLP 23609, Estancia Santa Isabel; right valve. 1a: latex cast; 1b: external mould.
2: MLP 23611, Estancia Santa Isabel; right valve. 2a: internal mould; 2b: latex cast, internal view; 2c: external mould.
3: MLP 23607, Portezuelo Ancho; right valve. 3a: internal mould; 3b: external mould.
4: MLP 23633, Arroyo Serrucho; right valve internal mould.

5: MLP 22330, Cerro Puchenque; latex cast, right valve.
6: MLP 23593, Cerro Puchenque; latex cast, right valve.
7: MLP 23630, Arroyo Serrucho; internal view of right valve, latex cast.
8: MLP 23642, Vuta Pucún Leufú; stereopair of latex cast showing details of ornament.

Figs. 9–15: *Praechlamys* cf. *valoniensis* (DEFRANCE), early Sinemurian.
9: MLP 25006, Arroyo Las Chilcas; left valve external mould, X 1.5.
10: MLP 25009, Arroyo Malo; right valve external mould, X 1.5.
11: MLP 25010-a, Arroyo Malo; right valve exterior, latex cast, X 2.
12: MLP 25011-a, Arroyo Malo; right valve exterior, latex cast.
13: MLP 25010-b, Arroyo Malo; right valve exterior, latex cast, X 2.
14: MLP 25007, Arroyo Las Chilcas; external mould showing details in ornament, X 2.
15: MLP 25011-b, Arroyo Malo; right valve interior, latex cast.

## Plate 9

Figs. 1–15: *Asoella asapha* (LEANZA).
1: MLP 28020, Arroyo Las Chilcas, late Sinemurian, left valve inernal mould (top) and external mould of right valve (bottom), X 2.
2: MLP 28021-a, Arroyo Las Chilcas, late Sinemurian, right valve external mould, X 2.
3: MLP 28015, Arroyo Las Chilcas, late Sinemurian, right valve external mould, X 2.
4: MLP 28021-b, Arroyo Las Chilcas, late Sinemurian, right valve external mould, X 2.
5: MLP 28012, Arroyo Las Chilcas, late Sinemurian, right valve external mould, X 2.
6: MLP 28011, Arroyo Las Chilcas, late Sinemurian, right valve external mould with external mould of umbonal region of left valve, X 2.
7: MLP 28020, Arroyo Las Chilcas, late Sinemurian, left valve internal mould (same as Fig. 1a), X 4.
8: MLP 28024-a, Arroyo Las Chilcas, late Sinemurian, left valve, X 2.
9: MLP 28013, Arroyo Las Chilcas, late Sinemurian, left valve internal mould, X 2.
10: MLP 28021-c, Arroyo Las Chilcas, late Sinemurian, right valve external mould with fragment of shell, X 2.
11: MLP 24984-b, Arroyo Las Chilcas, Early Pliensbachian; right valve, X 2. 7a: latex cast; 7b: internal mould.
12: MLP 28004, Piedra Pintada, Pliensbachian, left valve, X 2.
13: MLP 24985-a, Arroyo Las Chilcas, Early Pliensbachian; right valve internal mould, X 2.
14: MLP 24982, Subida a Sañicó, Early Pliensbachian; right valve, X 3; 9a: internal mould; 9b: latex cast.
15: MLP 28006, Puesto Araya, early Pliensbachian, left valve internal mould, X 2.

Figs. 16–20: *Ochotochlamys* sp., Cañadón Cerro Negro, Pliensbachian.
16: MLP 27592, specimen with both valves slightly displaced, 16a: latex cast, X 2, 16b: natural moulds, X 2, 16c and 16d: same, X 1.
17: MLP 27591, right valve internal mould, latex cast, X 2.
18: MLP 27594, right valve, X 2.
19: MLP 27590, right valve, X 2, 21a: natural mould, 21b: latex cast.
20: MLP 27595, left valve, latex cast, 22a and 22b: two views of same specimen with different light to show details or ornament.

## Plate 10

Figs. 1–17: *Harpax rapa* (BAYLE & COQUAND), Pliensbachian.
1: MLP 20687-c, Arroyo Ñireco; latex cast, external view of left (?) valve, X 2.
2: MLP 15326, south of Aluminé, CUERDA's collection; external view, latex cast.
3: MLP 16512, Arroyo Lonqueo, left valve, latex cast, X 2.
4: MLP 15326, south of Aluminé, CUERDA's collection; left valve, latex cast, X 2.
5: MLP 16514, Arroyo Lonqueo; latex cast, external view, X 2.
6: MLP 19654, Arroyo Serrucho; right valve, latex cast, X 2.
7: MLP 20687-b, Arroyo Ñireco; left valve, latex cast, X 2.
8: MLP 15326, south of Aluminé, CUERDA's collection; latex cast, external view, X 2.
9: MLP 20687-a, Arroyo Ñireco; latex cast, external view of left (?) valve.
10: MLP 16508, Cerro Puchenque, latex cast of right valve, X 2.
11: MLP 22318, Arroyo Lonqueo; latex cast of young specimen, X 2.
12: MLP 16517, Estancia Santa Isabel, latex cast, internal view of left valve, X 2.
13: MLP 16507, Cerro Puchenque; latex cast, internal view of right valve, X 2.
14: MLP 19643, Arroyo Serrucho; left valve internal mould, X 2.
15: MLP 15326, south of Aluminé, CUERDA's collection; latex cast, external view of left valve, X 2.
16: MLP 26561, Puesto Araya, as epizoan on external surface of right valve of *Weyla alata* (VON BUCH), left valve showing

xenomorphic sculpture (left) and inner view of attached right valve (right), see also Text-fig. 45a.
17: MLP 16518, Arroyo Lonqueo, stereoscopic pair showing detail in ornament pattern X 2.

## Plate 11

Figs. 1–8: *Terquemia ? andina* n. sp., Early Toarcian.
1: Holotype, MLP 17132-ab, upper Rio Salado; specimen with both valves, 1a: right valve, X 2; 1b: left valve, X 2; 1c: posterior view, X 2; 1d: right valve.
2: Paratype, MLP 22300-m, south of Cordillera del Viento; external mould showing spines, X 2.
3: Paratype, MLP 17132-d, upper Rio Salado; left valve.
4: Paratype, MLP 17132-c, upper Rio Salado; right valve.
5: Paratype, MLP 16504, Cerro Tricolor; complete specimen showing xenomorphic ornament, 5a: right valve; 5b: posterior view, X 2.
6: Paratype, MLP 16506, Cerro Tricolor; right valve, X 2.
7: Paratype, MLP 22290-a, south of Cordillera del Viento; left valve.
8: Paratype, MLP 27570, southern Cordillera del Viento, right valve with xenomorphic ornament.

Figs. 9–12: *Placunopsis* cf. *striatula* (Oppel), Pliensbachian.
9: MLP 24310, Puesto Araya; latex cast, left valve external view.
10: MLP 24312, Estancia Santa Isabel; latex cast, left (?) valve internal view.
11: MLP 27543, southern Cordillera del Viento, latex cast, left (?) valve external view.
12: MLP 24311, Estancia Santa Isabel; latex cast, left (?) valve internal view; 12a: X 3; 12b: detail of hinge region, X 3.

Figs. 13–15: *Atreta* cf. *intusstriata* (Emmrich), Cerro Roth, Pliensbachian.
13: MLP 12205, underside of *Collignonastraea* ? sp. with many epizoic specimens; 13a; 13b: detail of some specimens, X 2. See diagram on Text-fig. 47.
12: MLP 18294, specimen attached to *Thamnasteria* sp., X 2
13: MLP 12204, specimens attached to *Collignonastraea* sp., X 2


1a


1b


2


4


1c


1d


3


1e


5a


5b


5c


6


7


8a


8b

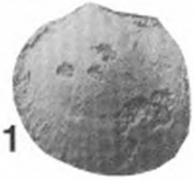

9


10


12


13


14


11


15


16


17


18


19


20


1a


1b


1c

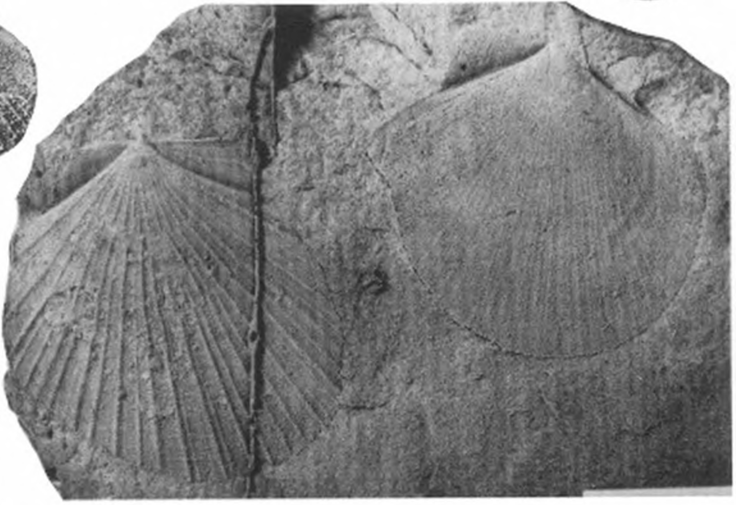

1d


2


3


4


5


6


7


8


9


10


11


12


13


14


15


16


17

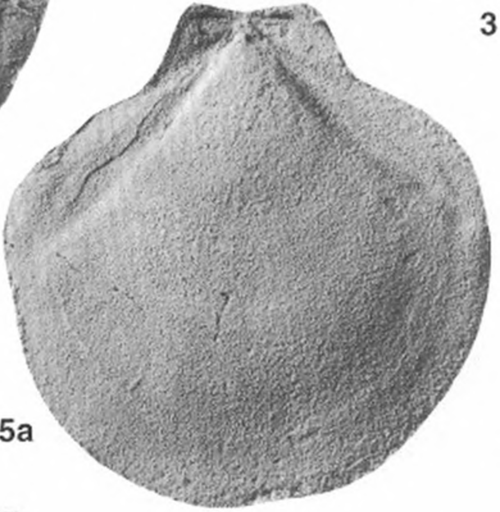

18


19

1

2

3



5a

4

6

5b

7

8a

8b

9

10

11a

11b

12

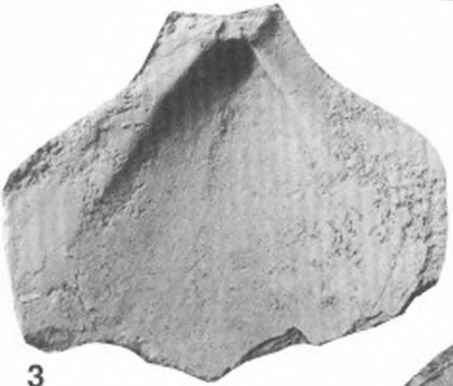
13

14

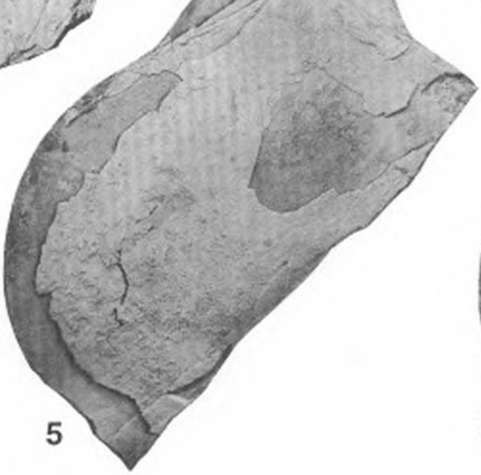
1

2a

2b



3

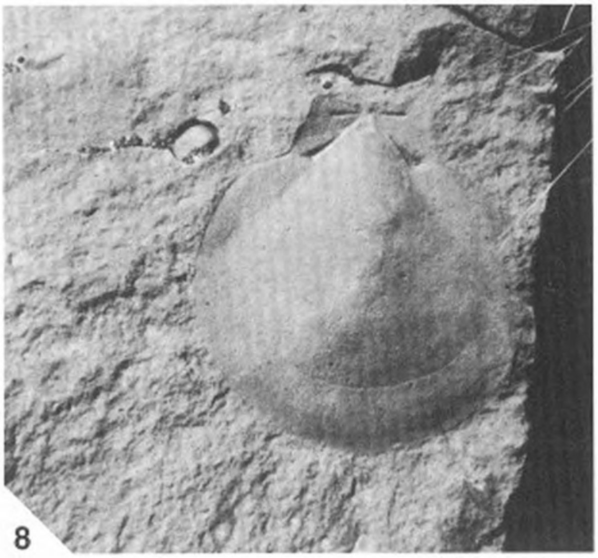


5

6

4

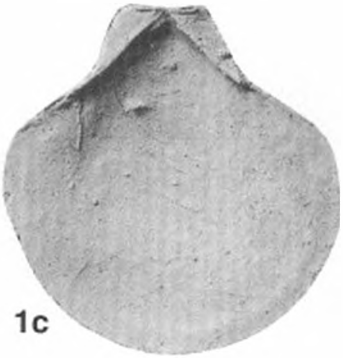
7



8


1a


1b

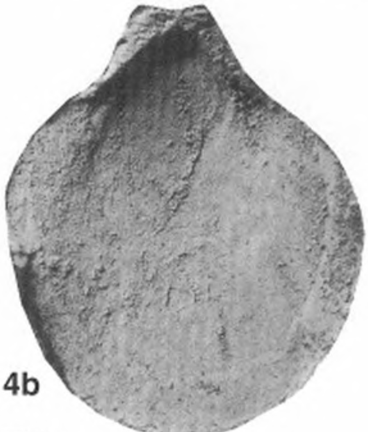

1c

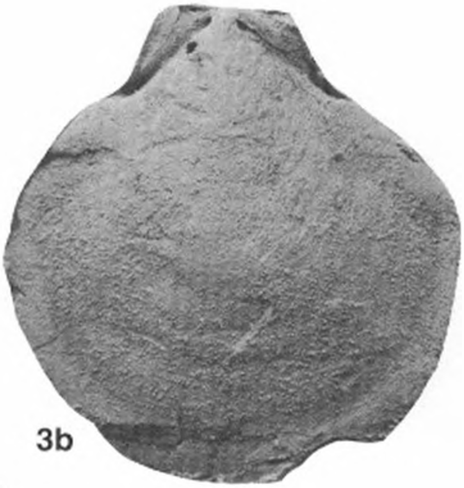

2a


2b


3a


4a

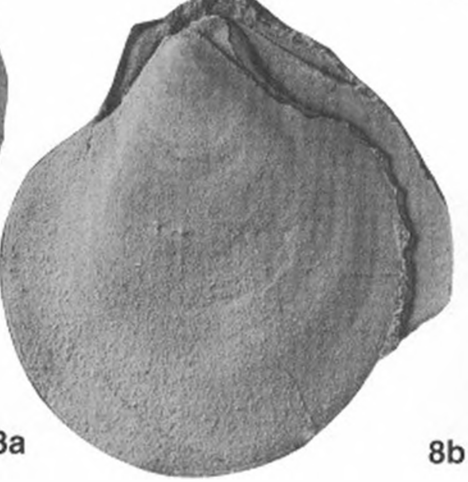

4b


3b


5


6

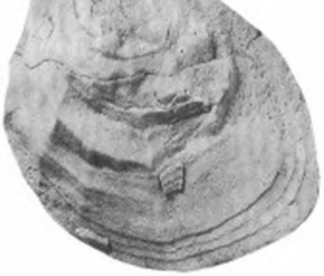

7


8a


8b


1


2


3


4a
4b


5


6


7


8


9


10

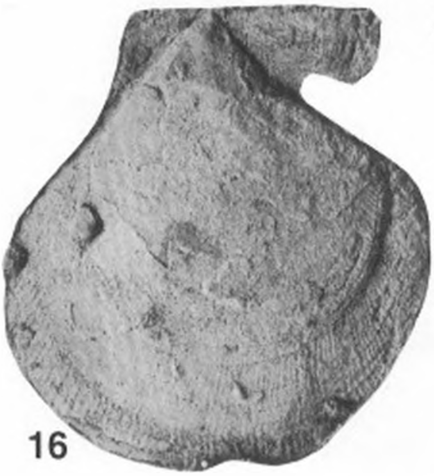

11


12


13


14


15

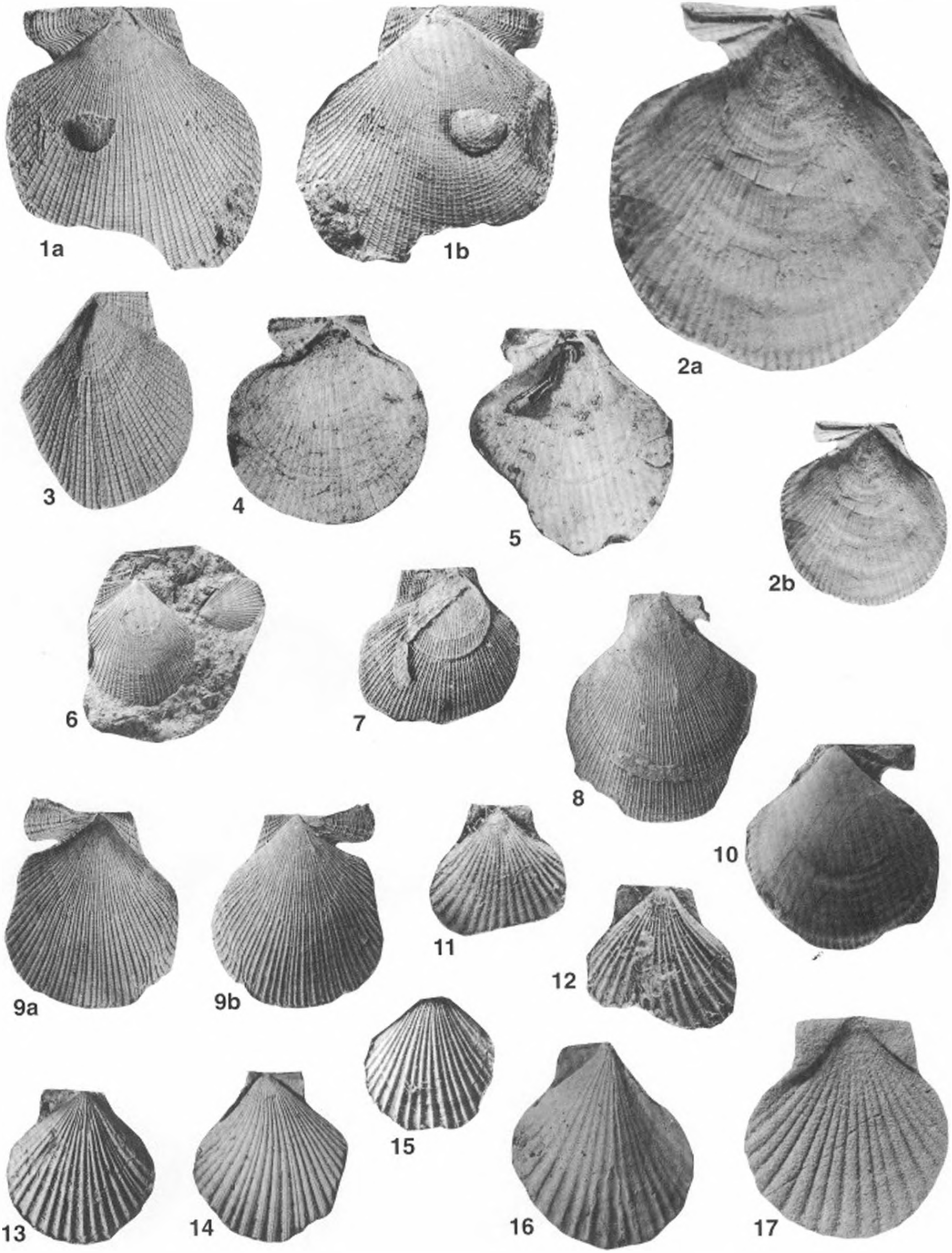

16


17a
17b


18


19


20



Susana Ester Damborenea: Early Jurassic bivalves of Argentina, Part 3.


1a


1b


2a


2b


3a


3b


2c


4

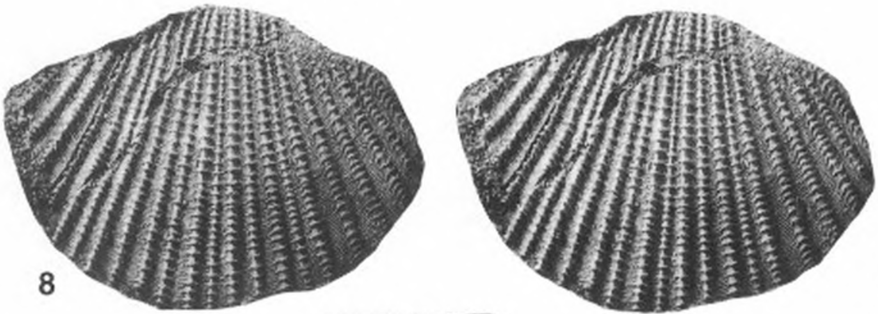

5


7


9


10


6


8


11


13

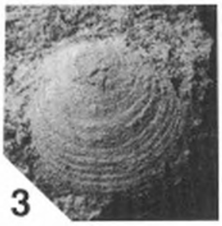

12


14


15

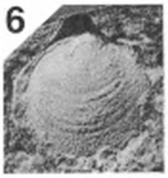

1


2


3


4


5


6


7

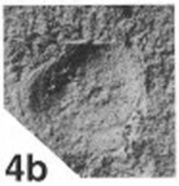

8


9


10


12


14a

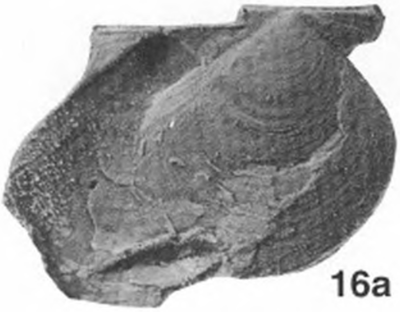

14b


11a


11b

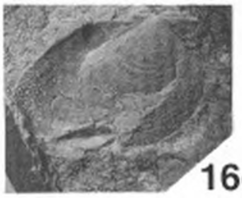

13

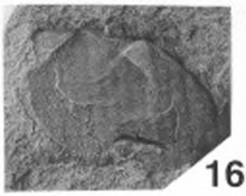

15

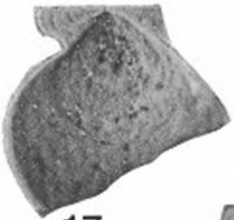

16a


16b


18


16c

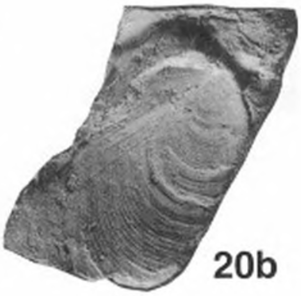

16d

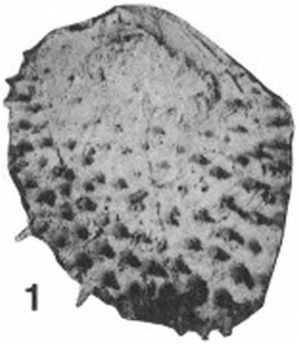

17


19a

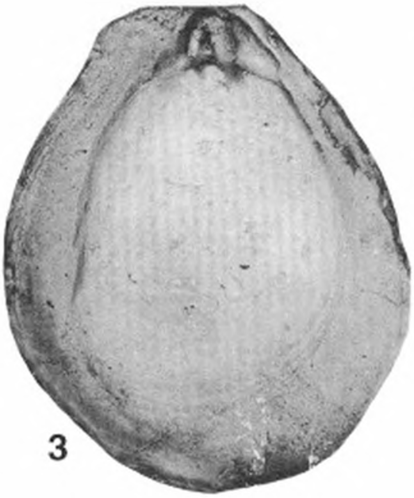

19b


20a


20b


1


2


3


4


5


6


7


8


9


10


15

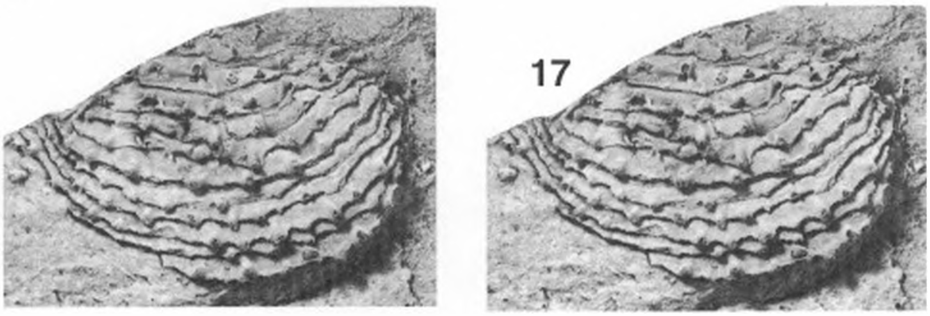

11

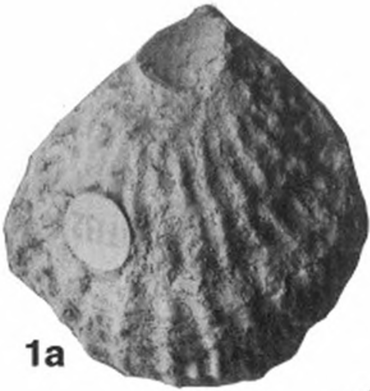

12


13


14

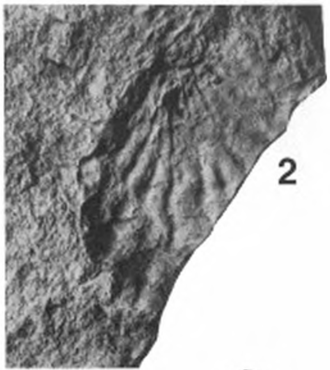

16


17


1a


1b


1c


2


7


1d


3


5a


5b


6


4


8


9


11


12a

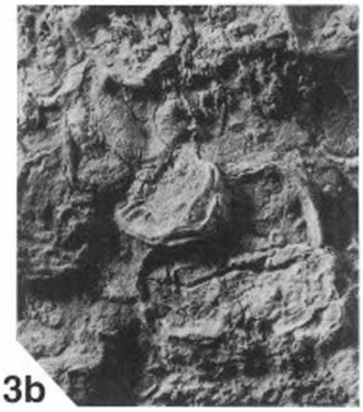

10

12b


14


13a


15


13b