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Jurassic evolution of Southern Hemisphere marine palaeobiogeographic units based on benthonic bivalves

Susana E. Damborenea *

Departamento Paleontología Invertebrados, Museo de Ciencias Naturales, 1900 La Plata, Argentina

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Abstract

The distribution of benthonic Jurassic bivalve genera in the Southern Hemisphere is analysed here. For this region, palaeobiogeographic units (biochoremas) are quantitatively characterized according to their biologic contents (mainly levels of endemism). Their evolution through time is followed from the latest Triassic to the earliest Cretaceous. The Tethyan Realm is undoubtedly the most mature and persistent through time, with three subordinate units: an Australian unit restricted to the Late Triassic, a North Andean unit, which appears sporadically as an endemic centre, and an East African unit which is recognisable from Bajocian times onwards. From Late Triassic times, a South Pacific Realm has been recognised, with a Maorian Province mostly based on the distribution of monotoid genera. A South Andean unit is also recognisable through most of the Jurassic, and its reference either to the South Pacific unit or to the Tethyan Realm is a matter of debate. Being a transitional biogeographic setting between Tethyan and South Pacific first-order units, it is included in the South Pacific unit due to the common presence of antitropical (didemic) genera. The East African unit is included within the Tethyan Realm during the Jurassic, but during Early Cretaceous times, it splits into two units, one of which was regarded as part of the "South Temperate Realm" by Kauffman. The rank of all these units changed with time. Throughout the Jurassic, the ecotone between South Pacific and Tethyan palaeobiogeographic units fluctuated in position with time. The approximate latitudinal location of the ecotonal boundary area and its shift through time are recognised on the basis of faunal composition along the Andean region.

Keywords: Palaeobiogeography; Bivalves; Jurassic; Southern Hemisphere; Endemism; Antitropical distribution; South Pacific; Tethyan

1. Introduction

The history of large-scale biogeographic patterns is increasingly attracting the attention of biologists, since it is evident that many biogeographic phenomena develop over long periods of time. Thus, the origin, establishment and evolution of palaeobiogeographic units of any rank or biochoremas (biochores in the sense of Makridin, 1973, and Westermann, 2000a) are of special interest. These units are dynamic and change in range and rank through time. Those based on benthonic faunas do not necessarily have a coincident history with those based on pelagic taxa. These aspects are clearly exemplified by the history and evolution of Southern Hemisphere biogeographic units during Jurassic times.

Mainly as a consequence of the unevenness of land mass distribution on the Earth, the northern–southern asymmetry in some aspects of marine fauna distribution patterns is well known at different times (see discussion in Crame, 1996b, 2000). Nevertheless, three major biogeographic units based on benthonic invertebrates (one low-latitude and two high-latitude) are recognised for Permian (see Shi and Grunt, 2000, and references therein), Triassic (e.g. Stevens, 1980), Cretaceous (e.g. Fleming, 1963; Kauffman, 1973; Sohl, 1987; Stevens, 1980) and Cainozoic times (e.g. Fleming, 1963; Hayami, 1989). In contrast, the hemispherical asymmetry of biogeographic units during most of the Mesozoic has led many authors to recognise only two first order palaeobiogeographic units for the Jurassic, mainly on the basis of the distribution of ammonites: the Boreal and Tethyan Realms (Hallam, 1969, 1971, 1977; Stevens, 1980,

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* Corresponding author.
E-mail address: sdambore@museo.fcnym.unlp.edu.ar (S.E. Damborenea).

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1990; Doyle, 1987; Challinor et al., 1992; Hillebrandt et al., 1992; and many others, see discussion and references in Westermann, 2000a,b). As Kauffmann (1973) aptly expressed, "poor knowledge of south temperate [*bivalve*] faunas has led many authors to assume no "anti-Boreal" Realm existed south of Tethys during the Mesozoic" and he demonstrated that this is clearly not true for the Cretaceous, although he admitted that "this was possibly true in the Early Jurassic". In fact, lack of data and proper analysis for the Southern Hemisphere pervades also studies of other fossil groups (see, for instance, Dommergues et al., 2001).

This twofold division hinders the determination of the possible role that the austral regions may have had in the origin and diversification of the biota (see Crame, 1997) during the Jurassic. Widespread phenomena like austral endemism or antitropicality are either ignored or their relative importance is disregarded. Some authors who work on Southern Hemisphere faunas (especially bivalves) have challenged this twofold division (see Stevens, 1980, and references therein; Crame, 1986, 1987, 1992, 1993; Damborenea, 1993, 1996; Enay and Cariou, 1997, and references therein), but their attempts were dismissed by some authors (Hallam, 1994a, b; Westermann, 2000a, b) , while others adhered to a threefold division, at least for some periods of time within the Jurassic. In fact, several marine palaeobiogeographic units of low rank have been proposed for the Southern Hemisphere Jurassic on the basis of the known distribution of different marine organisms. The relationships, rank and history of these units were recently reviewed by Enay and Cariou (1997) and Westermann (2000b).

This paper is an attempt to recognise the development and evolution of biochoremas based on benthonic bivalve endemism in the Southern Hemisphere. There is no space here to discuss in detail either the processes involved or the possible causes of the observed diversification of the recognised biogeographic units, or the complexities of nomenclature involved, and thus all these issues are deliberately avoided or only mentioned without further discussion. The paper is then mainly limited within the first rationale of those listed by Rosen (1992), i.e. the determination of palaeobiogeographical patterns with delimitation of provinces and realms, as a starting point for further discussion.

Global studies on the distribution of Mesozoic bivalves have largely been based on data from Cox et al. (1969) (for instance, Kauffman, 1973; Hallam, 1977). Those databases had a poor coverage of the Southern Hemisphere, but there is now a wealth of recently published information from this region which certainly adds substantial evidence and can be used in this context. Palaeobiogeographic provinces based on bivalves were recently analysed quantitatively for the European Tethyan and Proto-Atlantic (Liu, 1995; Liu et al., 1998). In contrast, there are no updated comprehensive palaeobiogeographic analyses based on bivalves for the Southern Hemisphere, although several contributions related to palaeobiogeographic issues using these organisms are available for the South Pacific (Stevens, 1967, 1977, 1980, 1989, 1990; Hayami, 1984, 1987; Grant-Mackie et al., 2000), Antarctica (Crame, 1987, 1992, 1996a, b) and the South American margin of the Pacific (Damborenea and Manceñido, 1979, 1988; Hillebrandt, 1981; Hallam, 1983; Damborenea, 1993, 1996).

2. Database

Occurrences of Jurassic bivalve species were compiled from various published sources as well as the author's own data, and plotted stage by stage. To frame the analysis, data from latest Triassic and earliest Cretaceous were added. The study area is restricted to the palaeo-Southern Hemisphere, but the database was compiled on a global scale, not only to provide the necessary framework for the detailed analysis of southern regions, but also to adequately recognise patterns of general distribution and endemism.

Data were then gathered within wide areas, each containing a large variety of habitats. Eleven such areas were chosen for the present analysis (located in Fig. 1). On the whole, they represent a wide coverage of the Southern Hemisphere Jurassic seas, but some important gaps still exist, limited by the availability of data (Table 1). A brief description and list of main data sources are given in Appendix A.

Both the amount and quality of data are, unsurprisingly, very uneven, but although this precludes serious detailed quantitative analysis at the moment, the database provides enough information to obtain a broad framework. The species' distribution data compiled were systematically and stratigraphically updated as far as possible and dubious records were excluded. For this analysis, data were processed at the genus-group level and according to the

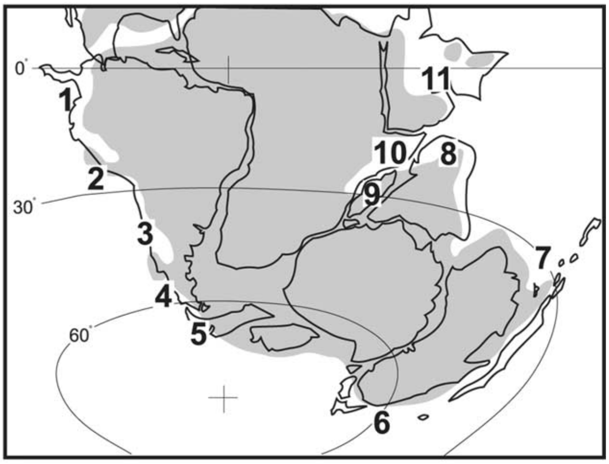

Fig. 1. Location of the geographic units used in this study. 1, NW South America; 2, Perú and northernmost Chile; 3, Central Argentina and Chile; 4, Southern Argentina and Chile; 5, Antarctica; 6, New Zealand–New Caledonia; 7, Western Australia; 8, Western India; 9, Madagascar; 10, Mozambique and eastern Africa; 11, Arabia and Iran. Base map for the Early Jurassic, continent palaeopositions based on Smith and Briden (1977) and Scotese (1991, 1997), palaeogeography compiled from many sources.

Table 1
Overview of the Norian to Berriasian bivalve data from the study areas. Total number of genus-level taxa are given for each time-interval and each region.

Regions	NE South America (1)	Perú and northern Chile (2)	Central Argentina and Chile (3)	Southern Argentina and Chile (4)	Antarctica (5)	New Zealand–New Caledonia (6)	W Australia–New Guinea (7)	Western India (8)	Madagascar (9)	Mozambique and E Africa (10)	Arabia and Iran (11)
Tithonian–Berriasian	16		74	27	27	11		14			
Oxfordian–Kimmeridgian		5	9		31	24	6	31	9	64	6
Bathonian–Callovian			31			23		120	35	57	10
Aalenian–Bajocian		33	69		16	44	24	8	4	26	10
Pliensbachian–Toarcian	5	66	97	33		25	5		16	17	27
Hettangian–Sinemurian	15	54	70		5	6					
Norian–Rhaetian	12	47	11			23	17				11

following seven time-intervals: Norian–Rhaetian, Hettangian–Sinemurian, Pliensbachian–Toarcian, Aalenian–Bajocian, Bathonian–Callovian, Oxfordian–Kimmeridgian and Tithonian–Berriasian. Admittedly, this implies a loss of detail in the information for some regions, but on the other hand, it allows the use of some occurrences with uncertain stratigraphic provenance. The age slice including Tithonian and Berriasian has the extra drawback that in this way any fact related to the Jurassic–Cretaceous boundary may be not noticed in this study. Within the general aims of this paper, though, this arrangement is satisfactory and gives enough information to recognise biogeographic units and describe their overall trends through time.

3. Methods

From the many methods that can be used to recognise palaeobiogeographic units, a traditional approach based on endemism has been followed, using the set of rules for their definition, rank and nomenclature proposed by Westermann (2000a). Bivalve genera were classified according to their palaeobiogeographic affinities, following basically Kauffman (1973), Stevens (1980) and Damborenea (1993), as follows (see examples in Fig. 2):

- *Pandemic*: Widespread bivalves, truly cosmopolitan forms. It is interesting to note that many genera traditionally referred to as “cosmopolitan” have not been reported from the Southern Hemisphere during the time-interval considered. These include, for instance, *Atrina*, *Cirtopinna*, *Ctenoides*, *Limopsis*, *Linotrigonia*, *Malletia*, *Martesia*, *Megalodon*, *Mytiloides*, *Palaeomya*, *Paratancredia*, *Procardia*, *Septifer*. Other so-called “cosmopolitan” genera are present only in the northern regions of the Southern Hemisphere (1, 2, 8, 9, 10, and 11 of this study) but are not known from the southernmost areas. Examples are *Hippopodium*, *Neomegalodon*, *Pinguiastarte* and *Rollieria*. All the genera mentioned with such distributions were excluded from the list of “cosmopolitan” taxa for this analysis.
- *Endemic*: These are the key elements to recognise and characterise biogeographic units. For this study, only true endemics (from each region compared at the global scale) were counted as such.
- *Low-latitude or Tethyan*.
- *High-latitude*:
  - ○ Austral (= Maorian or palaeoaustral).
  - ○ Boreal.
  - ○ Didemic, antitropical or bipolar, restricted to high-latitudes and present in both hemispheres, being absent from the low-latitude intervening areas (Crame, 1993; Damborenea, 1993; Sha, 1996).
- *Trans-temperate* (Kauffman, 1973): This category includes taxa common in temperate regions, but with a distribution not latitudinally limited, and at the same time, not pandemic. For instance, bivalves with the so-called “Pacific” distribution, i.e. along the margins of the palaeo-Pacific ocean both in low and medium (sometimes even high) palaeolatitudes, absent from other areas.

Only pandemic and endemic taxa can be objectively defined, reference of some genera to either of the other categories is necessarily a matter of debate. This is not a serious drawback in this context, however, since these last categories are only accessory elements in this study. From the nearly 500 bivalve genera known from this time-interval, 52% are here regarded as low-latitude, 21% as high-latitude, 6% as trans-temperate and 21% as pandemic (Fig. 3).

Since geographic ranges of taxa change through time, sometimes this results in a different categorization for the same taxon. For instance, a genus may be endemic to a certain region during a stage and then become widespread.

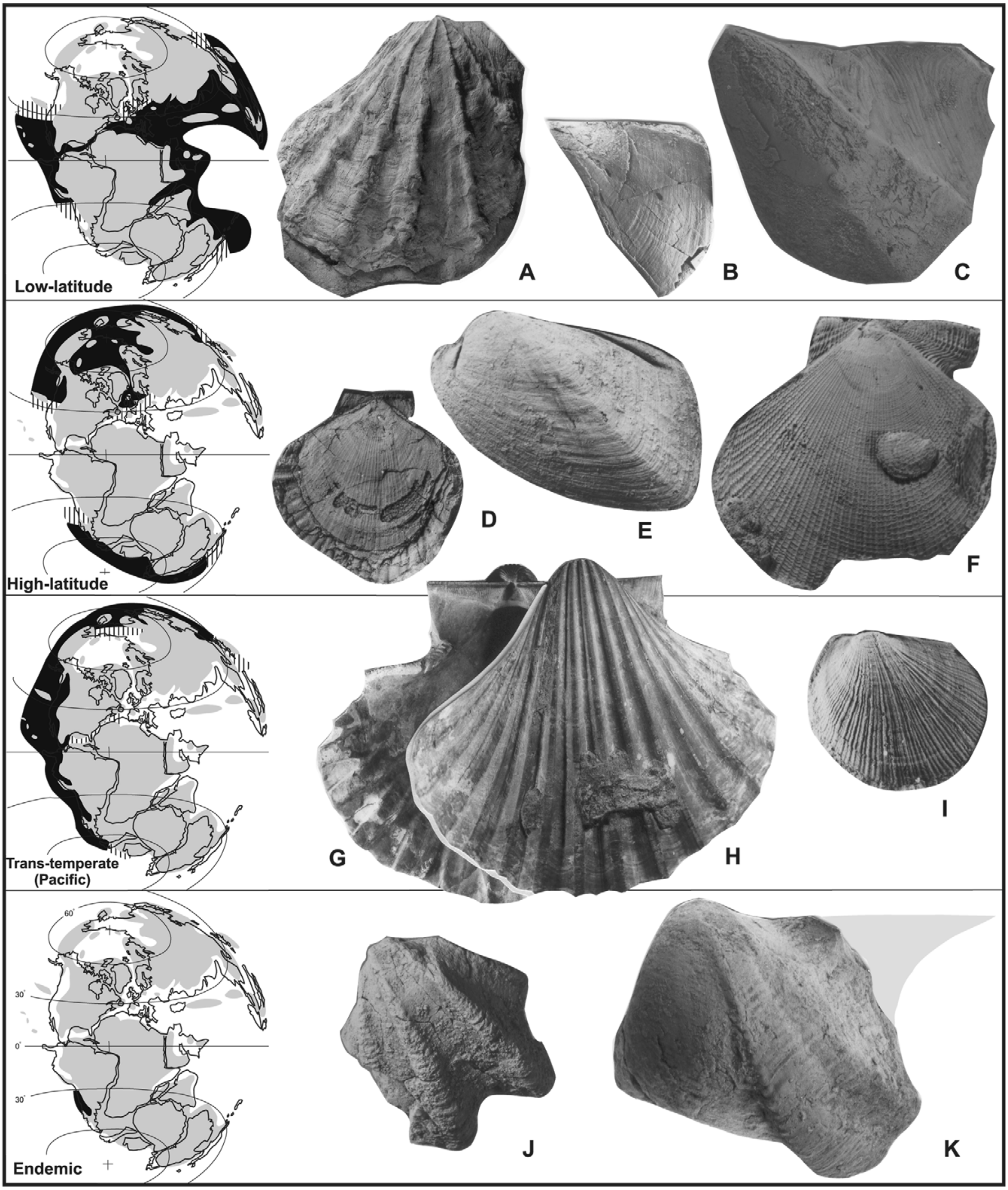

Fig. 2. Some examples of Early Jurassic bivalves from the Central Argentina region (3) according to generic palaeobiogeographic affinities. Specimens housed at La Plata Natural Sciences Museum (MLP) and National Geological Survey, Argentina (DNGM). (A)–(C) Low-latitude; (A) *Ctenostreon raricostatum* (BAYLE AND COQUAND), MLP 28428, Pliensbachian, Piedra Pintada, ×0.44; (B) *Lycettia hypertrigona* DAMBORENEA, MLP 16308, Pliensbachian, Piedra Pintada, ×0.7; (C) *Gervillaria pallas* (LEANZA), MLP 19079, Pliensbachian, Nueva Lubecka, ×0.8. (D)–(F) High-latitude; (D) *Kolymonectes weaveri* DAMBORENEA, MLP 23804a, Pliensbachian, Chacay Melehue, ×1; (E) *Kalentera* nov. sp., MLP 24294, Early Pliensbachian, Atuel river, ×1; (F) *Agerchlamys wunschae* (MARWICK) and epizoic *Harpax rapa* (BAYLE AND COQUAND), MLP 23658, Pliensbachian, arroyo Ñireco, ×1. (G)–(I) Trans-temperate (Pacific); (G), (H) *Weyla alata angustecostata* (PHILIPPI), internal and external views of right valve, MLP 19076, Early Toarcian? Sierra de Agnia, ×0.34; (I) *Otapiria neuquensis* DAMBORENEA, MLP 16480, Pliensbachian, Piedra Pintada, ×2. (J)–(K) Endemic, J, *Groeberella neuquensis* (GROEBER), DNGM 7340, Pliensbachian, Nueva Lubecka, ×1; (K) *Gervilletia turgida* (LEANZA), MLP 6260, Pliensbachian, Piedra Pintada, ×0.6.

An example is *Kalentera*, which was endemic to the Maorian Province in Late Triassic times but became antitropical during the Early Jurassic. Similarly, *Gryphaea* was restricted to high-latitudes during the Triassic but later became pandemic. Conversely, a previously widespread taxon may have a temporarily restricted distribution. The recognition of these subtle changes is highly dependent on a very detailed knowledge of recorded distributions, and is thus not always easy to establish in the fossil record. Nevertheless, these changes were herein recognised and taken into account as far as possible.

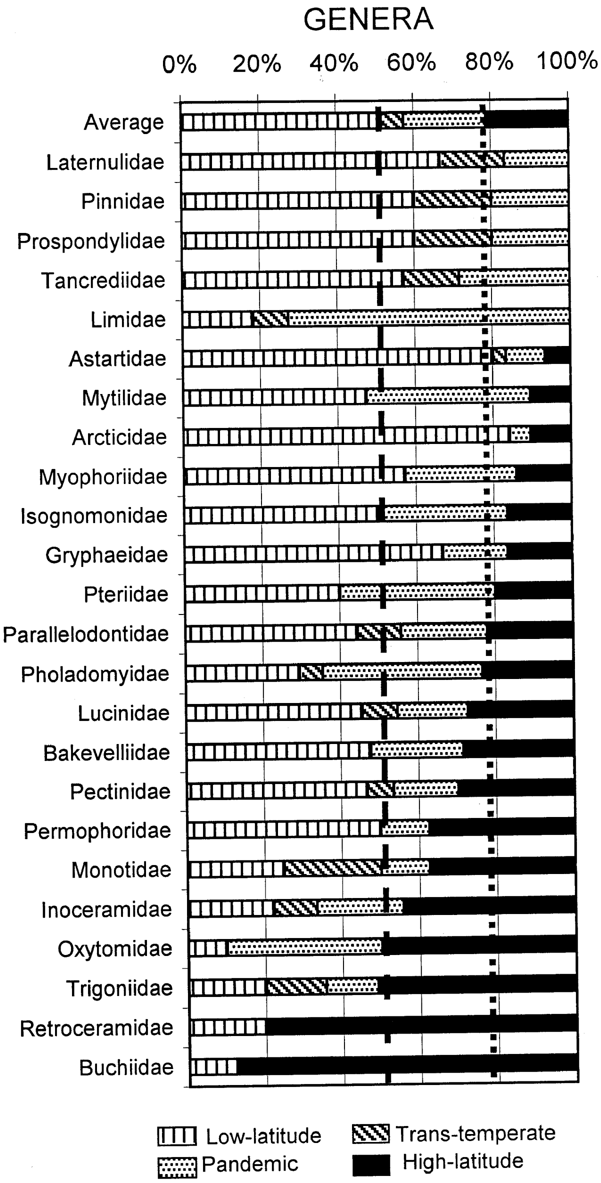

Fig. 3. Percentage of genera with different palaeobiogeographic affinities in selected bivalve families. Average composition for the whole time-interval at the top, broken lines indicate average percentage of low-latitude (long dashes) and high-latitude (short dashes) genera.

4. Biogeographic units and their evolution

The percentage of cosmopolitan bivalve genera, even restricted as mentioned above, was high worldwide during most of the Jurassic (about 21% for the whole Jurassic), leaving only a few endemic taxa (16%) as diagnostic of palaeobiogeographic units. It is interesting to note here that for the whole Jurassic endemic genera are proportionately equally abundant in high-latitude and in low-latitude regions.

For the following analysis, percentage of endemism was calculated excluding cosmopolitan forms (see Kauffman, 1973) and including only strictly endemic taxa. In the following discussion, all the percentages quoted are calculated over total minus cosmopolitan genera. At different times through the Jurassic, endemism within the different areas of the Southern Hemisphere varied, and was used here to recognise palaeobiogeographic units.

A summary of the results regarding the percentage of endemic genera in each of the units is presented in Table 2. These percentages are low according to normalised scales based on species' distribution (see discussion in Westermann, 2000a), but are of the same order as those used by other authors to define palaeobiogeographic units on the basis of bivalve genera (e.g. Kauffman, 1973), and they allow the recognition of units of different rank. Nevertheless, taking into account the nature of the database, no attempt is made here to establish a table of minimum values for each rank. It is interesting to note that the distinction between Tethyan and Boreal Realms based on bivalves in the Northern Hemisphere rests on only a few taxa. According to Liu (1995), for instance, for the Pliensbachian, only the presence of *Hippopodium* and *Meleagrinella* is characteristic of the Boreal Realm and *Weyla* and *Lithiotis* of the Tethyan Realm in Europe (note that these taxa were not even endemic).

Five basic biochoremas and two of higher rank can be recognised according to the distribution and percentage of endemic taxa (Fig. 4). Some of the basic units are here regarded as belonging to the Tethyan Realm, while others can be grouped in another high rank unit which, following Westermann's (2000b) recommendations, is called South Pacific (Challinor, 1991 = Austral Realm in Damborenea, 1993). Overall endemism for this high rank unit is over 60% during the latest Triassic, between 15% and 30% for the Early Jurassic, and over 30% for Middle and Late Jurassic. These fluctuations suggest its change in rank through time.

All units are further characterised by other aspects, such as the presence and relative abundance of high-latitude or strictly low-latitude taxa (Table 2), overall diversity, and the presence/absence of certain higher rank taxonomic groups. Antitropical (or didemic) taxa were also common within monotoids, pectinoids, inoceramoids and other bivalve groups and add character to some of these units.

On a worldwide scale, this implies the presence of three first order units during the Jurassic based on bivalve data:

Table 2
Percentages of endemic, low-latitude, high-latitude and trans-temperate genera and subgenera (calculated excluding cosmopolitan taxa) for the palaeobiogeographic units recognised here for each time-slice. Units not recognizable at a given time are indicated by 0 in the endemic portion of the table (lack of endemic taxa) or no figures (insufficient data).

Taxa	Endemic					Low-latitude					High-latitude					Trans-temperate				
First order units:	Tethyan			South Pacific		Tethyan			South Pacific		Tethyan			South Pacific		Tethyan			South Pacific	
Subordinate palaeobiogeographic units	East African	Australian	North Andean	South Andean	Maorian	East African	Australian	North Andean	South Andean	Maorian	East African	Australian	North Andean	South Andean	Maorian	East African	Australian	North Andean	South Andean	Maorian
Tithonian–Berriasian	14		0	14	8	72			72	50	14			3	17	0			11	25
Oxfordian–Kimmeridgian	13	0	0	50	13	73			50	43	7			0	31	7			0	13
Bathonian–Callovian	8			18	20	88			55	40	0			27	20	4			0	20
Aalenian–Bajocian	17	0	9	15	17	66		82	56	44	0		9	19	28	17		0	11	11
Pliensbachian–Toarcian	0	0	9	7	22			53	46	0			19	27	44			19	20	33
Hettangian–Sinemurian			0	14	0				52					24					10	
Norian–Rhaetian		50	14	0	47		50	52		6		0	24		29		0	10		18

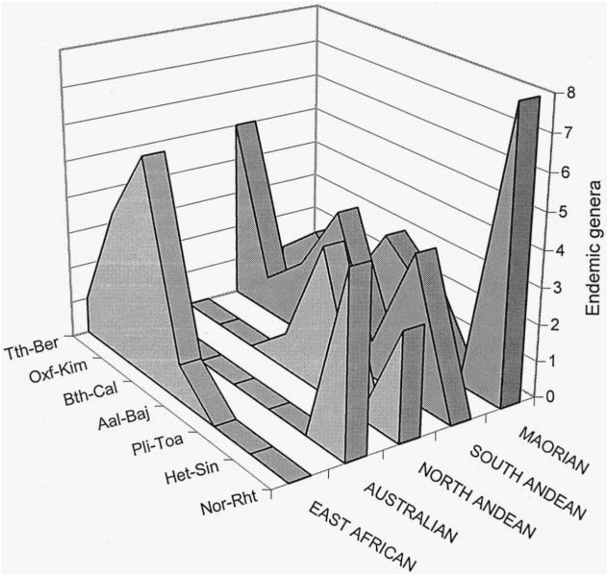

Fig. 4. Number of endemic genera through time in the recognised palaeobiogeographical units.

Boreal, Tethyan and South Pacific. The distribution of bivalves and the corresponding proposed palaeobiogeographic zonation is evidently not symmetrical to the palaeoequator. In fact, in view of the unbalanced distribution of land/water masses and the related uneven oceanic current patterns (which are mostly hypothetic at this stage), such a palaeobiogeographic asymmetry is only to be expected. The data analysed here do not support the alternative of overstressing this asymmetry to the point of reducing the palaeobiogeographic zonation for the Jurassic to only two first order units.

At the family level, all the three first order palaeobiogeographic units are well characterised. During the Jurassic and Early Cretaceous, most genera of Anomiidae, Burmesiidae, Ceratomyopsidae, Cuspidariidae [Dattidae], Diceratidae, Dicerocardiidae, Isoarcidae, Lithiotidae, Mactromyidae, Malleidae, Megalodontidae, Myalinidae, Myopholadidae, Myophoricardiidae, Mysidiellidae, Ostreidae, Pergamidiidae, Protocardiidae, Ptychomyidae, Pulvinitidae, Requieniidae, Sowerbyidae and Unicardiopsidae are restricted to low-latitudes and characterise the Tethyan Realm. To these, a group of families with more than average low-latitude taxa (Fig. 3) should be added: Laternulidae, Pinnidae, Prospondylidae, Tancrediidae, Astartidae, Arcticidae, Myophoriidae and Gryphaeidae. The first four of these have no high-latitude taxa, and the others contain less than average high-latitude genera.

Families strictly restricted to high-latitudes in the Jurassic are fewer; among them Asoellidae, Minetrigoniidae and Palaeopharidae are present in both Boreal and South Pacific Realms whereas Sportellidae and Yoldiidae are known only from the Boreal Realm. There is a consistent group of families which have more than average high-latitude taxa and at the same time less than average low-latitude genera (Fig. 3), all of them diverse and abundant in both Boreal and South Pacific Realms: Monotidae, Inoceramidae, Oxytomidae, Trigoniidae, Retroceramidae and Buchidae. It should be pointed out here that updated systematic knowledge of bivalve faunas is still very uneven in the Southern Hemisphere and that future revisions are likely to alter this picture slightly.

As these basic units change with time in rank, geographic spread and even realm to which they are assigned, the discussion below will follow a stratigraphic order (Figs. 5 and 6) and will be restricted to the Southern Hemisphere.

4.1. Late Triassic

Three basic units can be recognised: the South Pacific Realm contains the Maorian Province, whilst all the other regions belong to the Tethyan Realm, with an Australian Province and a North Andean endemic centre (Fig. 5(A)).

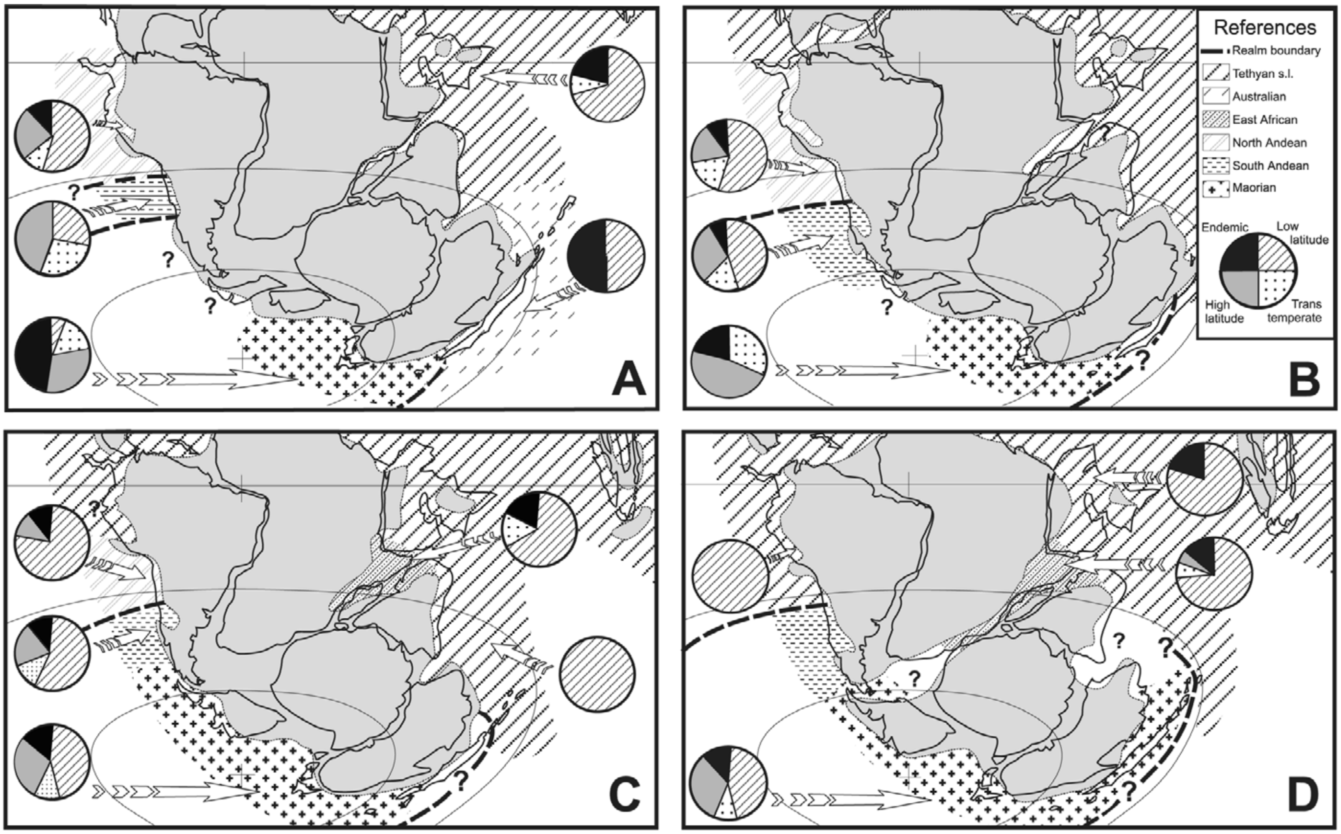

Fig. 5. Palaeobiogeographic maps for four time-slices: (A) latest Triassic; (B) Toarcian; (C) Bajocian and (D) Oxfordian. Thick broken lines show the approximate position of ecotone between Tethyan and South Pacific Realms for each time-slice. Pie diagrams represent percentage of genera according to palaeobiogeographic affinities. Base maps for the Late Triassic, Early, Middle and Late Jurassic, continent palaeopositions based on Smith and Briden (1977) and Scotese (1991, 1997), palaeogeography compiled from many sources.

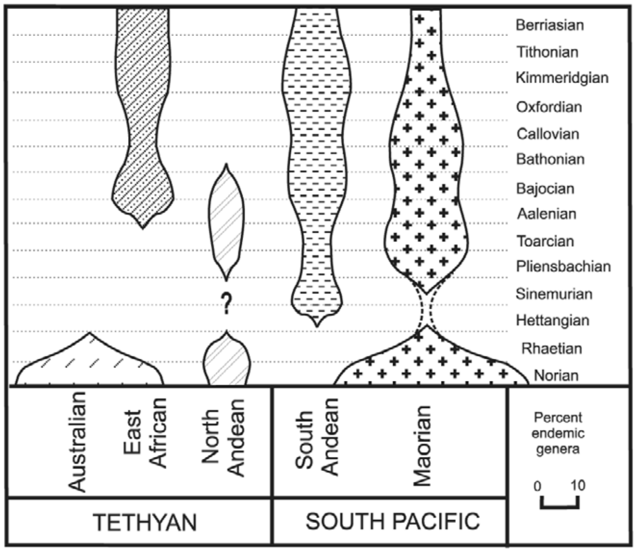

Fig. 6. A summary of the evolution of the biogeographic units here recognised according to their percentage of endemism.

The Maorian Province (Diener, 1916) presents very high endemism: the genera *Caledogonia*, *Heslingtonia*, *Hokonuia*, *Kalentera*, *Maorimonotis*, *Ouamouia*, *Torastarte* and *Triaphorus* are endemic to New Zealand–New Caledonia (region 6 here) during this time. This province is very well characterised during the Middle and Late Triassic, not only by the percentage of endemics (47%), but also by the abundance (29%) of genera with antitropical or austral distribution, such as *Eomonotis*, *Inflatomonotis*, *Maoritrigonia*, *Minetrigonia* and *Phaenodesmia*. Strictly low-latitude genera are very few (6%).

An Australian Province is also well characterised by several endemic genera (50%), such as *Gervillancea*, *Guineana*, *Krumbeckiella*, *Prosogyrotrigonia* and *Somareoides*. Low-latitude genera are equally numerous, but high-latitude and trans-temperate forms are absent.

A North Andean endemic centre extends along the Andes from Venezuela to northern Chile. The endemic genera *Isopristes*, *Perugonia* and *Schizocardita* are abundant elements of the Late Triassic fauna from Peru and northern Chile (totalling 14%), and some genera with high-latitude distribution are also present (24%).

The central Argentina–Chile area represents a transitional zone, with no endemic taxa but with a high percentage (43%) of high-latitude genera, including *Gryphaea*, *Liostrea* and *Phaenodesmia*. The abundance of trans-temperate taxa (28%) is mainly due to genera distributed along the eastern margins of the palaeo-Pacific in both the hemispheres. Reference of this transitional area to the Tethyan or the South Pacific Realm is still doubtful.

Extensive areas without Late Triassic outcrops or reliable palaeontologic data in the key regions prevent adequate discussion of the boundary between realms at this time.

4.2. Early Jurassic

At the beginning of the Jurassic, the percentage of endemism is low for all the regions. This is not restricted to the Southern Hemisphere, but is also true at a global scale: Liu (1995) concluded that provinciality in the Northern Hemisphere during Hettangian, Sinemurian and Toarcian was unrecognisable. Although it is difficult to point a definite cause, this situation is probably a consequence of the end-Triassic extinction. Some authors have indicated that endemic bivalve taxa were relatively more vulnerable to mass extinction events (Hallam and Miller, 1988). Our data clearly show this pattern for the end Triassic extinction, and it is also evident that the biota and endemic centres took some time to recover (see discussion in Hallam, 1996). For instance, the lack of endemic genera makes the Maorian unit difficult to recognise during Hettangian and Sinemurian times, when, possibly apart from *Torastarte*, no endemic bivalves are present in New Zealand–New Caledonia. It is interesting to note that, based on the available data, the low-latitude regions of the Southern Hemisphere also contain no endemic genera. On the other hand, in transitional zones, such as the South Andean areas (2 and 3 here), an endemic centre appeared during Sinemurian times, with a few endemic genera (14%), such as *Gervilletia* (Fig. 2(K)), *Groeberella*, *Lywea* and *Quadratojaworskiella*. This endemic centre is regarded here as part of the South Pacific Realm despite the relatively high proportion of low-latitude taxa, due to the common occurrence of genera with antitropical or austral distributions (24%), such as *Agerchlamys* (Fig. 2(F)), *Asoella*, *Harpax*, *Kalentera* (Fig. 2(E)), *Palaeopharus* and *Kolymonectes* (Damborenea, 1998, 2002).

By Pliensbachian–Toarcian times (Fig. 5(B)), the Maorian unit (= South West Pacific Province in Hallam, 1977) had recovered, having 22% of endemic genera, including *Torastarte* and *Pseudaucella* (Grant-Mackie et al., 2000) and 44% of high-latitude genera. A South Andean endemic centre persists (see Fig. 6) with a low percentage of endemics (7%), including *Groeberella* (Fig. 2(J)) but with a high percentage of high-latitude taxa (27%), which include *Asoella*, *Harpax*, *Kolymonectes* (Fig. 2(D)), *Palaeopharus*, *Ochotochlamys*, *Praebuchia*? and *Radulonectites* (Damborenea and Manceñido, 1992; Damborenea, 1993, 2002). This interval is characterised by the highest percentages of high-latitude taxa for the whole Jurassic in this region and also the highest levels of trans-temperate (mainly east Pacific) taxa (see Table 2). A North Andean endemic centre within the Tethyan Realm is again discernible (9% of endemic genera), with its southern limit extending farther south than earlier in the Lower Jurassic (see discussion below and Fig. 7). The peculiar genera *Lithiotis* and *Opisoma*, characteristic of the Jurassic tropics during Pliensbachian times (see discussions in Geyer, 1977; Hillebrandt, 1981; Hayami, 1984; Nauss and Smith, 1988; Aberhan and Hillebrandt, 1999), extended to northern Chile during the Toarcian, but are absent further south in the South Andean unit.

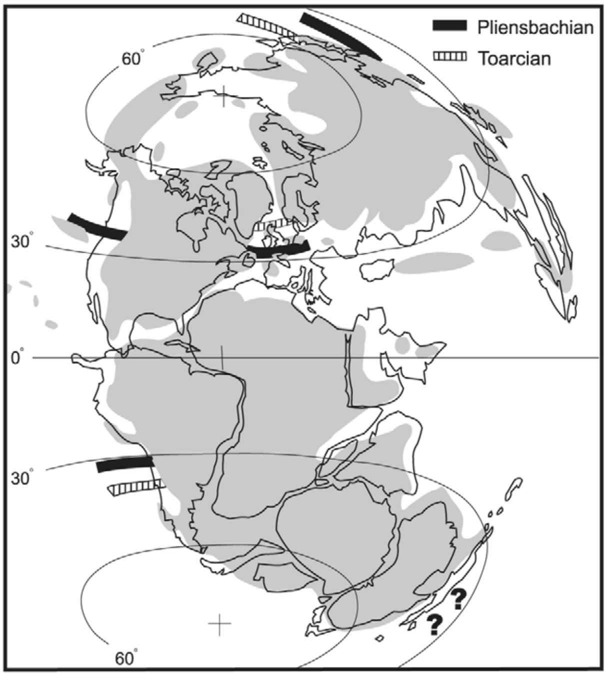

Fig. 7. Shift of the ecotone between the Tethyan and high-latitude units based on bivalves during the Early Jurassic (Pliensbachian–Toarcian) in a global context. Data from Smith and Tipper (1986), Smith (1989) and Aberhan (1998, 1999) for western North America; Hayami (1990) for northeastern Asia; Liu (1995) and Lui et al. (1998) for Europe; Damborenea (1996) for South America. Base map for the Early Jurassic, continent palaeopositions based on Smith and Briden (1977) and Scotese (1991, 1997), palaeogeography compiled from many sources.

Cox (1965) mentioned that the presence of the species *Weyla ambongoensis* (THEVENIN) in Toarcian beds of eastern Africa: “affords a somewhat meagre evidence that a faunal subprovince comprising the western part of the present Indian Ocean region and extending over northern Africa had come into existence”. Nevertheless, data from this area are scarce, and no endemic bivalve genera have been reported so far for the Early Jurassic.

4.3. Middle Jurassic

During Middle Jurassic (Fig. 5(C)) and early Late Jurassic times, the Southern Hemisphere bivalve benthonic faunas maintain their high proportion of cosmopolitan genera, always above 60% of all the taxa, but still some endemic and high-latitude genera are present.

The two South Pacific subunits maintain their level of endemism between 15% and 20% for the whole Middle Jurassic (see Table 2), although at the same time they experienced the proportional increase of low-latitude taxa. The influx of low-latitude genera reaches 44% for the

Maorian and 56% for the South Andean units, and is only exceeded during the Tithonian–Berriasian. Based on this evidence, many authors (see Grant-Mackie et al., 2000) concluded that the Maorian Province ceased to exist in the early Middle Jurassic. Nevertheless, a palaeogeographic unit is here still recognised (though probably with lower rank) throughout the Middle Jurassic. There are two alternatives to name this unit for Middle and Late Jurassic times: it can either be regarded as an extension of the Maorian Province, or it can be called Austral as the origin of the Austral Province recognized by Kauffman (1973) for Early Cretaceous times. The first alternative is followed here, but regardless of how we choose to call it, the continuity of an austral biogeographic unit from Triassic (Maorian Province) to Cretaceous (Austral Province) is evident from the results of this study. This unit is recognised on the basis of the following endemic genera: *Haastina* (Bajocian), *Malagasitrigonia* (Aalenian–Bajocian), *Kanakimya* (Aalenian–Bajocian?) and *Moewakamya* (Bathonian–Oxfordian). Endemic genera include *Anditrigonia* (Bajocian–Tithonian), *Andivaugonia* (Bajocian–Callovian), *Eoanditrigonia* (Bajocian–Callovian), *Neuquenitrigonia* (Bajocian), *Lambertrigonia* (Callovian) for the South Andean unit. High-latitude taxa in these two units are proportionately fewer; they include *Retroceramus* (Bajocian–Oxfordian) and *Scaphogonia* (Bajocian–Tithonian) for both units, *Praebuchia*? (Aalenian) for the South Andean, and *Fractoceramus* (Bajocian) and *Hijitrigonia* (Bajocian) for the Maorian unit. Again, probably as a consequence of the end Pliensbachian extinction event, endemism in the Maorian unit drops from 22% at the late Early Jurassic to 17% at the early Middle Jurassic. In this connection, Aberhan and Fürsich (2000) have pointed out that the Pliensbachian–Toarcian extinction event affected the endemic bivalve species more than others in the Andean region.

A new East African unit (= Provincia Etiopico-Indo-Malgascia in Ficcarelli, 1968; Ethiopian Province in Hallam, 1977) appears to be recognisable from Bajocian times on the basis of its endemic genera: *Indolucina* (Bajocian–Oxfordian), *Agrawalimya* (Bathonian–Callovian), *Indocorbula* (Bathonian–Callovian), *Indomya* (Bathonian–Callovian), *Indoweyla* (Bathonian–Callovian), and *Venilicyprina* (Bathonian–Callovian). This unit contains, however, a high percentage of strictly low-latitude genera (66% for Aalenian–Bajocian and 88% for Bathonian–Callovian times) and lacks high-latitude genera. For these reasons, it is here regarded as part of the Tethyan Realm at this time.

The North Andean endemic centre is still faintly discernible during the Aalenian, with the presence of the endemic *Gervilleiognoma*. Species of *Heterostrea*, a genus strictly restricted to low-latitude areas in both hemispheres, extend not only to southern Perú but also to northern Chile, pushing further south the boundary between Tethyan and South Pacific units. Published data from younger times are very scarce and incomplete, not allowing their use in this context.

4.4. *Late Jurassic*

The general situation observed for Bathonian–Callovian times is generally maintained for the Late Jurassic (Fig. 5(D)). The Maorian unit is extended geographically to include the Antarctic and South Atlantic Plateau regions, and even some western Pacific localities (Timor, Sula, Buru, Ceram; see Hayami, 1984), but is somewhat less strongly recognisable, and its rank should be lowered, since its overall endemism at the generic level diminishes to 13% during Oxfordian–Kimmeridgian and to only 8% during Tithonian–Berriasian times. Endemic genera include *Moewakamya* (Oxfordian), *Jeletzkiella* (Oxfordian–Kimmeridgian) and *Praeaucellina* (Tithonian–Berriasian), whilst *Malayomaorica* (Oxfordian–Kimmeridgian) has an austral distribution reaching Australia–New Guinea. *Retroceramus*, *Scaphogonia*, *Lyapinella*? and *Anopaea* are high-latitude genera, mostly didemic in distribution.

On the other hand, the South Andean unit maintains its levels of endemism. The apparently very high percentage of endemism for the Oxfordian–Kimmeridgian is due to the small number of taxa reported so far and this figure is not statistically significant. Endemic genera include the trigonioideans *Anditrigonia* (Bajocian–Tithonian), *Antutrigonia* (Tithonian–Berriasian), *Notoscabrotrigonia* (Tithonian) and *Splenditrigonia* (Tithonian–Berriasian), and *Retroceramus* and *Scaphogonia* represent the high-latitude taxa.

The East African unit maintains a percentage of endemic taxa between 13% and 14%, including *Africomiodon* and *Eoseebachia* (Oxfordian–Kimmeridgian), with a very high percentage (over 70%) of low-latitude taxa. It is interesting to note here that the influence of high-latitude taxa in this area steadily increases towards the end of the Jurassic.

4.5. *Early Cretaceous*

By the end of the Jurassic and beginning of the Cretaceous, the situation changes and antitropical bivalve genera are again well established at least within inoceramoids and monotoids (Crame, 1986, 1993). According to Kauffman (1973), recognition of a relatively mature “South Temperate Realm” is clear, with well-defined “Austral” and “East African” Provinces as subordinate biogeographic units by the beginning of the Cretaceous. The change of the East African unit from the Tethyan (during most of the Jurassic) to the South Pacific Realm is indicated by the relatively high percentage (14%) of high-latitude taxa during Tithonian–Berriasian times, possibly as a direct consequence of the opening of the Mozambique channel. Kauffman (1973) includes the East African Province within the Indo-Pacific Region in the Early Cretaceous, according to its content of southern Pacific bivalve lineages, but with a geographic range now restricted to southern Africa, Madagascar and Mozambique. To the north, a transition zone developed (India, Arabia, NE Africa) with strong Tethyan influence (the north Indian Ocean Subprovince in Kauffman, 1973).

During the Early Cretaceous (Berriasian), the South Andean unit contains a few endemic trigoniodeans, such as *Antutrigonia*, *Splenditrigonia*, and *Transitrigonia*. *Anopaea* is a genus with didemic distribution, and during the Berriasian, it is present in New Zealand and Antarctica, whilst the endemic *Praeaucellina* lingers from Tithonian times in the Maorian unit. According to Kauffman (1973), the Austral Province of the Indo-Pacific Region (South Temperate Realm) was strongly developed at the beginning of the Cretaceous, including Australia, New Zealand and New Guinea.

From Middle Cretaceous time onwards, the North Andean unit is clearly recognisable as a Caribbean Subprovince/Province (Kauffman, 1973), and an Austral Realm was proposed by Fleming (1963) on the basis of bivalve and gastropod distribution.

5. Transitional zones

Transitional zones occurred between the Tethyan and South Pacific first order units. To study the evolution of these ecotones requires a very detailed set of data and is outside the scope of this paper. Nevertheless, some broad features will be pointed out, since it is interesting to compare them with the evolution of Boreal/Tethyan ecotones. The evolution of the boundary between Tethyan and Boreal Realms has been the subject of many contributions, most of them based on the distribution of ammonite taxa (e.g. Imlay, 1965; Hallam, 1969, 1981; Fürsich and Sykes, 1977; Hayami, 1990; Dommergues and Meister, 1991; Hillebrandt et al., 1992; Hallam, 1994b), and on the basis of bivalve distribution was recently followed in Europe by Liu (1995). All the data indicate that a northward migration from Pliensbachian to Bathonian times took place, and that the Bathonian can be recognised as the time of the greatest Tethyan spread during the Jurassic. The boundary then shifted southwards during the Callovian, when the distinctiveness of the Boreal bivalve fauna strongly increased and was maximum at the Oxfordian (Liu, 1995). The Callovian and Early Oxfordian marked the widest spread of the Boreal Realm according to Hallam (1971).

From the possible transitional zones located in palaeotemperate regions of the Southern Hemisphere, the relationship between Maorian-type and other faunas in the western Pacific was studied by Hayami (1984). In the eastern Pacific, the South Andean ecotone has been recognised for Early Jurassic times (Fig. 7) and described in detail (Damborenea, 1996). Based on species' distribution along the eastern palaeo-Pacific margin, a southward shift of this boundary of about 8–10° latitude has been proposed for the Hettangian–Toarcian interval. It is interesting to compare these observations with the evolution of the boundary areas between Tethyan and Boreal Realms in the Jurassic. To make this comparison, the boundary areas proposed on the basis of bivalve distribution (Hayami, 1984; Smith and Tipper, 1986; Smith, 1989; Hayami, 1990; Liu, 1995; Damborenea, 1996; Liu et al., 1998; Aberhan, 1998, 1999), which are not always coincident with the limits proposed on the basis of ammonites, have been plotted in Fig. 7 for the Pliensbachian and Toarcian. The results show a high congruence between the behaviour of the boundary in both hemispheres during the Early Jurassic: the southward shift in the Southern Hemisphere is matched by an equivalent northward shift in the Northern Hemisphere (Fig. 8). There are not yet detailed enough data from the Southern Hemisphere to follow this comparison for later Jurassic times. It is interesting to point out, though, that the greatest expansion of low-latitude bivalve faunas in the Southern Hemisphere occurred during Middle Jurassic times (see also Grant-Mackie, 2000), and that the northward shift of the Maorian/Tethyan boundary during Late Jurassic times in western Pacific regions, albeit somewhat complicated by the tectonic history of the area (Hayami, 1984, 1987), roughly corresponds with the widest expansion of the Boreal Realm in the Northern Hemisphere. These coincidences suggest that the main faunal shifts are related in their origin.

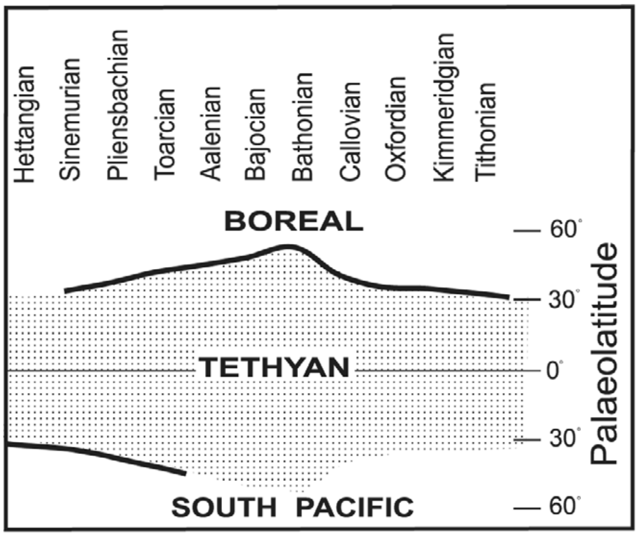

Fig. 8. Approximate palaeolatitude variation of the Tethyan/Boreal and Tethyan/South Pacific ecotones through the Jurassic, indicating possibly symmetrical expansion of Tethyan Realm during Middle Jurassic. Data compiled from various sources (see discussion in text). Solid lines: average positions proposed by different authors on the basis of bivalve distribution.

6. Brief comparison with data from other organisms

Since this analysis is only based on one group of organisms, it is interesting to compare the results with those obtained using other groups, with the aim of meaningfully evaluating the evolution of palaeobiogeographic patterns during the Jurassic. Nevertheless, most other benthonic invertebrate groups (gastropods, corals and echinoderms) are still insufficiently known to be used in palaeobiogeography for the Jurassic at a global scale. From the scattered available data, it is evident that some groups of restricted tropical affinities, such as reef building corals and certain sponges like *Stylothalamia*, are completely absent from the Southern Hemisphere low-latitude areas belonging to the South Pacific palaeobiogeographic unit as understood in this paper (Hillebrandt, 1981; Crame, 1987; Beauvais, 1992). Gastropods have been used to recognise palaeobiogeographic units for the Cretaceous (Sohl, 1987), but are poorly known on a global scale from Jurassic and Triassic. Within these limitations, Tong and Erwin (2001) noted that the relationships between Triassic Tethyan and American gastropods are weak, even at the generic level. Brachiopods from austral regions do show a considerable degree of endemism which supports the recognition of a Maorian Province during the Late Triassic and Early Jurassic (MacFarlan, 1992; Manceñido and Dagys, 1992); the endemism extends during Middle and Late Jurassic in New Zealand-New Caledonia (MacFarlan in Grant-Mackie et al., 2000).

As expected (see discussion in Masse, 1992), there are important differences between the results obtained in this study and the palaeobiogeographic units recognised on the basis of pelagic organisms. One of the most interesting questions that needs further discussion is the observed differences in the first order palaeobiogeographic units for the Southern Hemisphere between those based on bivalves as here described and those based on ammonites. According to the pattern of ammonite distribution, most authors consistently recognise only two realms (Boreal and Tethyan) for the Jurassic (see references in Cecca, 1999; Westermann, 2000b; Grant-Mackie et al., 2000). Hillebrandt (1981) and Hillebrandt et al. (1992) distinguished an Eastern Pacific and an Indo-SW Pacific Subrealm during some lapses of time within the Early and Middle Jurassic, but they admit that for the Late Jurassic, lack of data severely constrains the discussion of ammonite provincialism in circum-Pacific regions. Dommergues et al. (2001) recently reviewed the distribution of Early Jurassic ammonoids trying to match different morphologic sets previously recognised with analytical distribution patterns, defined by considering the distribution and abundance of species, but they did not use data from the southern high-palaeolatitude regions. In fact, a different picture seems to be emerging as new data are known. Riccardi (1991) found a nearly continuous presence of endemic ammonites from Pliensbachian to Oxfordian in South America, with a sharp increase during Aalenian, and almost no endemics during Kimmeridgian–Berriasian. Westermann (1996) recognised a high proportion of endemic taxa for the Bajocian of New Zealand, with a marked increase in Andean affinities for the Bathonian–Callovian (see Grant-Mackie et al., 2000, for references). According to Enay and Cariou (1997), an austral ammonite fauna of low diversity became progressively better established around east and south Gondwana from Oxfordian times.

Knowledge of Jurassic radiolarians from the Southern Hemisphere is just emerging (see Kiessling and Scasso, 1996; Aita et al. in Grant-Mackie et al., 2000), but clearly points to non-Tethyan affinities for the Late Jurassic faunas from Antarctica and the Waipapa Terrane (New Zealand). These data support a palaeolatitudinal zonation for Late Jurassic radiolarian faunas in the Southern Hemisphere, with a distinct austral palaeobiogeographic unit (which is not symmetrical with the boreal one), characterised by low endemism and dominated by *Parvicingula–Praeparvicungula* (Kiessling and Scasso, 1996).

Only Boreal and Tethyan Realms are also recognised on the basis of the belemnite distribution (Stevens, 1973) but according to Challinor et al. (1992) a South Pacific Province (referred to the Tethyan Realm) may be distinguished in the Jurassic. Belemnitina (which define the Boreal Realm) are dominant in Boreal regions throughout the Jurassic but are also known in South America–New Zealand–New Caledonia up to the Middle Jurassic (Challinor et al., 1992; Doyle et al., 1997).

Brief references to palaeoclimate and palaeogeography can be made to explain these differences. According to Golonka and Ford (2000), greenhouse conditions prevailed during the Sinemurian–Toarcian, with a warm, humid environment, and moderate temperatures into high-latitudes with no evidence of significant continental glaciation. Based on several evidences, Price (1999) concluded that the extent of polar ice during the Mesozoic was probably only one-third the size of the present-day. Kiessling and Scasso (1996) suggested that Antarctic surface waters may have been warmer on average than those in equivalent northern high-latitudes, according to the distribution of Pantanelliidae radiolarians. During the Jurassic, climates are said to have been milder, temperatures more equable across latitude, but with some seasonality due to the different day lengths through the year. This may have been a particularly important factor affecting marine benthonic biota at high-latitudes. Pelagic taxa are probably less affected by seasonality than benthonic inhabitants of littoral environments, such as bivalves. But apart from climate, purely geographic factors, affecting the ocean circulation patterns, may have had considerable influence. For instance, the distribution of land and sea during the Jurassic in high-latitude regions; whilst in boreal regions there was a polar ocean, nearly completely surrounded by land or shallow seas, the austral regions were part of the proto-Pacific ocean, which was continuous with the eastern Tethys. Enay and Cariou (1997) emphasized that the lack of such geographical trap in austral regions explains why the austral ammonite faunas were never as distinct from the Tethyan as the Boreal ones. In addition, an important migration route for benthonic organisms since the Early Jurassic, the Hispanic Corridor (Damborenea and Manceñido, 1979; Smith, 1989; Boomer and Ballent, 1996; etc.), remained as a barrier for most pelagic animals until Late Middle or even Late Jurassic times (Elmi, 1993; Damborenea, 2000; Aberhan, 2001).

Regarding the evidence from terrestrial organisms, Balme (in Grant-Mackie et al., 2000) indicated that there is general agreement that latitudinal zonations based on megafossil plant distribution existed in the Jurassic, but these do not support the existence of substantial climatic barriers.

7. Conclusions

A preliminary, hierarchical, palaeobiogeographic framework is proposed for the Southern Hemisphere Jurassic based on the distribution of bivalve genera. Two first order palaeobiogeographic units (Realms or Subrealms) are recognised for this region:

- *Tethyan Realm*
- *South Pacific Realm/Subrealm*: This unit, though not symmetrical with the Boreal Realm of the Northern Hemisphere, is clearly recognisable according to bivalve data.

The following five basic units are characterised according to the content of endemic genera and subgenera:

- *North Andean* [Endemic centre]: Though data are very few, it is distinctive sporadically as an endemic centre during the Late Triassic and Pliensbachian–Bajocian. The geographic range varies also with time, but roughly includes areas 1 and 2 of the present study during the Norian–Rhaetian and Pliensbachian–Toarcian, but only area 2 (due to lack of data) for Aalenian–Bajocian.
- *East African* [Endemic centre → Subprovince → Province]: Includes Madagascar, Mozambique and western India (areas 8, 9 and 10 here) during the Jurassic. On the basis of bivalve endemic genera, it begins to be recognisable as an endemic centre by Middle Jurassic times (Bathonian–Callovian), forming the origin of the East African Province, well established at the beginning of the Cretaceous.
- *Australian* [Province → vanishes]: Includes Australia, New Guinea and surrounding areas (area 7 here). Well characterised during the Late Triassic, it is not recognisable during the Jurassic.
- *Maorian* [Province → Subprovince]: Very well characterised during the Late Triassic, it is almost not recognisable at the beginning of the Jurassic, but recovers quickly (though never attains the same levels of endemism) and from Pliensbachian times maintains an almost steady amount of endemic taxa, declining again at the end of the Jurassic. In the Early Cretaceous, it is known as Austral Province. The geographic range varies, apart from New Zealand–New Caledonia (area 6) it included Antarctica (area 5) at some intervals.
- *South Andean* [Endemic centre → Subprovince]: From the Hettangian it is recognisable as an endemic centre, from Middle Jurassic (Bajocian) onwards, it maintains a moderate level of endemism and can be regarded as a subprovince. It includes areas 3 and 4.

The North Andean and Australian units are included within the Tethyan Realm, whilst the Maorian and South Andean units are grouped together in the South Pacific first order unit. The East African units begins to develop as part of the Tethyan Realm, but near the end of the Jurassic, it begins to experience the increasing influence of South Pacific faunas, especially in its southernmost areas (southern Africa and Madagascar)

Although significant progress has been made on understanding the distribution of Southern Hemisphere bivalves during the Jurassic, many unsolved questions still remain. This paper is a contribution to Southern Hemisphere bivalve palaeobiogeography, to be complemented (and hopefully integrated) with Northern Hemisphere schemes.

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Appendix A

A.1Brief description of regions and data sources

1 *NW South America* (Venezuela, Colombia, northernmost Perú) (Geyer, 1973, 1979; Guzmán, 1984, and references therein): Though rich faunas are known to occur, the published information from this region is very scarce and cannot be compared with the other data sets, being confined to Norian to Toarcian and Tithonian–Berriasian.

2 *Perú and Northern Chile*: Comprises most of Perú and the northernmost regions of Chile (up to about 26° S present-day latitude) References: listed in Damborenea (1996); and Jaworski (1915, 1922), Körner (1937), Cox (1949, 1956), Harrington (1961), Pérez and Reyes (1977, 1983, 1985, 1986, 1991), Hayami et al. (1977), Westermann et al. (1980), Chong and Hillebrandt (1985), Riccardi et al. (1990a, b), Pérez et al. (1987), Romero et al. (1995), Aberhan and Hillebrandt (1996, 1999), Rubilar (1998).

3 *Central Argentina and Chile*: Comprises what is regionally known as the Neuquén basin. References: listed in Damborenea (1996); and Burckhardt (1900a, b, 1903), Haupt (1907), Jaworski (1914, 1915), Stehn (1923), Fuenzalida Villegas (1937), Leanza (1941), Lambert (1944), Sokolov (1946), Levy (1967), Thiele Cartagena (1967), Cecioni and Westermann (1968), Hallam et al. (1986), Damborenea (1990), Leanza and Garate-Zubillaga (1987),

Riccardi (1988), Riccardi et al. (1990a, b, c, 1997), Lo Forte (1988), Damborenea et al. (1992), Leanza (1993), Malchus and Aberhan (1998), Rubilar (1998), Damborena (2002) and unpublished data. Well documented for the whole time-interval of the present study.

4 *Southern Argentina and Chile*: References: listed in Damborenea (1996); and Feruglio (1936), Leanza (1968), Riccardi (1977), Olivero (1988) and unpublished data. Very few data known, only from Pliensbachian–Toarcian and Tithonian–Berriasian, Damborena (2002).

5 *Western Antarctica*: References: Stevens (1967), Thomson and Willey (1972), Thomson (1975a, b, 1981, 1982), Willey (1975a, b, c), Jones and Plafker (1976), Quilty (1978, 1982, 1983), Edwards (1980), Crame (1981, 1982a, b, 1983, 1984, 1985, 1996a), Jeletzky (1983), Medina and Ramos (1983), Thomson and Tranter (1986), Riccardi et al. (1990c), Doyle et al. (1990), Thomson and Damborenea (1993), Crame et al. (1993), Crame and Kelly (1995), Kelly (1995). This region comprises mainly the Antarctic Peninsula and adjacent areas. The few data available from the Falkland Plateau have been included here.

6 *New Zealand–New Caledonia*: References: Trechmann (1918, 1923), Marwick (1935, 1953, 1956), Avias (1953), Fleming (1959, 1962, 1964, 1987), Grant-Mackie (1960, 1976a, b, 1978a, b, c, d, 1980a, b), Speden (1970), Stevens (1978), Freneix et al. (1974), Speden and Keyes (1981), Begg and Campbell (1985), Crampton (1988), Grant-Mackie and Silberling (1990), Damborenea and Manceñido (1992), Damborenea (1993) and unpublished data (in Hudson, 1999). Very well documented for the whole time-interval of the present study.

7 *Western Australia, New Guinea and Sula Islands*: References: Etheridge (1910), Whitehouse (1924), Teichert (1940), Skwarko (1967, 1973, 1974, 1981a, b, 1983), Coleman and Skwarko (1967), Skwarko et al. (1976), Sato et al. (1978), Grant-Mackie (1994).

8 *Western India*: References: Kitchin (1903), Cox (1935b, 1937a, 1940, 1952), Agrawal (1956a, b), Kanjilal and Singh (1973, 1980), Singh and Kanjilal (1974, 1977, 1982), Agrawal and Rai (1978), Kanjilal (1979a, b, 1980a, b, 1981), Singh and Rai (1980), Singh et al. (1982), Jaitly and Singh (1983), Pandey and Agrawal (1984), Jaitly (1986a, b, c, 1988, 1989, 1992), Jaitly et al. (1995), Pandey et al. (1996), Fürsich and Heinze (1998), Fürsich et al. (2000). No data for Late Triassic and Early Jurassic are available.

9 *Madagascar*: References: Newton (1889, 1895), Douvillé (1904), Thevenin (1908), Barrabé (1929), Besairie (1930), Nicolaï (1950–1951). Reliable data only from Pliensbachian times onwards.

10 *Mozambique and eastern Africa*: References: Weir (1930, 1938), Cox (1935a), and references therein, (1937a, b), Venzo (1949), Jaboli (1952), Desio et al. (1960), Cox (1965), Ficcarelli (1968), Jordan (1971). Reliable data only from Pliensbachian times onwards.

11 *Arabia and Iran*: References: Fischer (1915), Cox (1936), Arkell (1956), Fantini-Sestini (1966), Kalantari (1981), Lewy (1982), Hautmann (2001). Data are few and very uneven, bivalves from this region are in need of revision.

References to Appendix A

Aberhan, M., Hillebrandt, A.v., 1996. Taxonomy, ecology, and palaeobiogeography of *Gervilleioperna* (*Gervilleiognoma*) *aurita* n. subgen. n. sp. (Bivalvia) from the Middle Jurassic of northern Chile. Paläontologisches Zeitschrift 70 (1/2), 79–96.

Aberhan, M., Hillebrandt, A.v., 1999. The bivalve *Opisoma* in the Lower Jurassic of northern Chile. Profil 16, 149–164.

Agrawal, S.K., 1956a. Deux lamellibranches intéressants de la Série de Katrol dans le Kutch (Inde). Bulletin de la Société Géologique de France 6 (6), 13–19.

Agrawal, S.K., 1956b. Contribution à l'étude stratigraphique et paléontologique du Jurassique du Kutch (Inde). Annales du Centre d'Études et de Documentation Paléontologiques 19, 1–188.

Agrawal, S.K., Rai, J.N., 1978. On a new species of *Prorokia* Böhm from the Jurassic of Kutch (Gujarat, India). Journal of the Geological Society of India 19, 373–375.

Arkell, W.J., 1956. Jurassic Geology of the World. Oliver and Boyd Ltd., Edinburgh–London, 806 pp.

Avias, J., 1953. Contribution à l'étude stratigraphique et paléontologique des formations antécrétacées de la Nouvelle Calédonie centrale. Sciences de la Terre 1 (1–2), 1–276.

Barrabé, L., 1929. Contribution à l'étude stratigraphique et pétrographique de la partie médiane du pays Sakalave (Madagascar). Mémoire de la Société Géologique de France (n.s.) 5 (12), 1–270.

Begg, J.G., Campbell, H.J., 1985. *Etalia*, a new Middle Triassic (Anisian) bivalve from New Zealand, and its relationship with other pteriomorphs. New Zealand Journal of Geology and Geophysics 28 (4), 725–741.

Besairie, H., 1930. Recherches géologiques à Madagascar. Contribution à l'étude des ressources minérales. Imprimerie H. Basuyau and Cie., Toulouse, 272 pp.

Burckhardt, C., 1900a. Profils géologiques transversaux de la Cordillère Argentino-Chilienne. Stratigraphie et tectonique. Anales del Museo de La Plata, Sección Geológica y Mineralógica 2, 1–136.

Burckhardt, C., 1900b. Coupe géologique de la Cordillère entre Las Lajas et Curacautin. Anales del Museo de La Plata, Sección Geológica y Mineralógica 3, 1–100.

Burckhardt, C., 1903. Beiträge zur Kenntnis der Jura- und Kreideformation der Cordillere. Palaeontographica 50 (1–3), 1–144.

Cecioni, G., Westermann, G.E.G., 1968. The Triassic/Jurassic marine transition of coastal Central Chile. Pacific Geology 1, 41–75.

Chong, D.G., Hillebrandt, A.v., 1985. El Triásico preandino de Chile entre los 23º 30' y 26º 00' de lat. Sur. Actas 4º Congreso Geológico Chileno (Antofagasta) 1, 162–210.

Coleman, P.J., Skwarko, S.K., 1967. Lower Triassic and Middle Jurasic fossils at Enanty Hill, Mingenew, Perth Basin, West Australia. Bulletin of the Bureau of Mineral Resources, Geology and Geophysics (Australia) 92, 197–214.

Cox, L.R., 1935a. Jurassic Gastropoda and Lamellibranchia. In: MacFadyen, W., et al. (Eds.), The Mesozoic Palaeontology of British Somaliland (Part II of the Geology and Palaeontology of British Somaliland) 8, pp. 148–197.

Cox, L.R., 1935b. The Triassic, Jurassic and Cretaceous Gastropoda and Lamellibranchia of the Attock District. Memoirs of the Geological Survey of India, Paleontologia Indica N.S. 20 (5), 1–27.

Cox, L.R., 1936. Fossil Mollusca from Southern Persia (Iran) and Bahrein Island. Memoirs of the Geological Survey of India, Paleontologia Indica, N.S. 22 (2), 1–69.

Cox, L.R., 1937a. Notes on Jurassic Lamellibranchia. II. On *Indogrammatodon*, a new subgenus from the Jurassic of the Indo-African province. Proceedings of the Malacological Society of London 22, 194–198.

Cox, L.R., 1937b. Notes on Jurassic Lamellibranchia. III. On a new Trigonia and other species from Tanganyika Territory. Proceedings of the Malacological Society of London 22, 198–204.

Cox, L.R., 1940. The Jurassic lamellibranch fauna of Kuchh (Cutch). Memoirs of the Geological Survey of India. Palaeontologia Indica, Series 9, 3 (3), 1–157.

Cox, L.R., 1949. Moluscos del Triásico superior del Perú (Upper Triassic Mollusca from Perú). Boletín del Instituto Geológico del Perú 12, 1–50.

Cox, L.R., 1952. The Jurassic lamellibranch fauna of Cutch (Kachh). No. 3, families Pectinidae, Amusiidae, Plicatulidae, Limidae, Ostreidae and Trigoniidae (Supplement). Memoirs of the Geological Survey of India. Palaeontologia Indica 9, 3 (4), 1–128.

Cox, L.R., 1956. Jurassic Mollusca from Peru. Journal of Paleontology 30 (5), 1179–1186.

Cox, L.R., 1965. Jurassic Bivalvia and Gastropoda from Tanganyika and Kenya. Bulletin of the British Museum (Natural History) 1 (Geology Suppl.), 1–213.

Crame, J.A., 1981. The occurrence of *Anopaea* (Bivalvia: Inoceramidae) in the Antarctic Peninsula. Journal on Molluscan Studies 47, 206–219.

Crame, J.A., 1982a. Late Mesozoic bivalve biostratigraphy of the Antarctic Peninsula region. Journal of the Geological Society, London 139, 771–778.

Crame, J.A., 1982b. Late Jurassic inoceramid bivalves from the Antarctic Peninsula and their stratigraphic use. Palaeontology 25 (3), 555–603.

Crame, J.A., 1983. The occurrence of the upper Jurassic bivalve *Malayomaorica malayomaorica* (Krumbeck) on the Orville Coast, Antarctica. Journal on Molluscan Studies 49, 61–76.

Crame, J.A., 1984. Preliminary bivalve zonation of the Jurassic–Cretaceous boundary in Antarctica. Memoria III Congreso Latinoamericano de Paleontología (Mexico), Universidad Nacional Autónoma de Mexico, pp. 242–254.

Crame, J.A., 1985. Lower Cretaceous inoceramid bivalves from the Antarctic Peninsula region. Palaeontology 28 (3), 475–525.

Crame, J.A., 1996a. A new oxytomid bivalve from the Upper Jurassic–Lower Cretaceous of Antarctica. Palaeontology 39 (3), 615–628.

Crame, J.A., Kelly, A.R., 1995. Composition and distribution of the inoceramid bivalve genus *Anopaea*. Palaeontology 38 (1), 87–103.

Crame, J.A., Pirrie, D., Crampton, J.S., Duane, A.M., 1993. Stratigraphy and regional significance of the Upper Jurassic–Lower Cretaceous Byers Group, Livingston Island, Antarctica. Journal of the Geological Society, London 15, 1075–1087.

Crampton, J.S., 1988. Comparative anatomy of the bivalve families Isognomonidae, Inoceramidae, and Retroceramidae. Paleontology 31 (4), 965–996.

Damborenea, S.E., 1990. Middle Jurassic inoceramids from Argentina. Journal of Paleontology 64 (5), 736–759.

Damborenea, S.E., 1993. Early Jurassic South American pectinaceans and circum-Pacific palaeobiogeography. Palaeogeography, Palaeoclimatology, Palaeoecology 100 (1/2), 109–123.

Damborenea, S.E., 1996. Palaeobiogeography of Early Jurassic bivalves along the southeastern Pacific margin. 13º Congreso Geológico Argentino y 3º Congreso de Exploración de Hidrocarburos (Buenos Aires), Actas 5, 151–167 (includes references).

Damborenea, S.E., 2002. Early Jurassic bivalves of Argentina. Part 3: Superfamilies Monotoidea, Pectinoidea, Plicatuloidea and Dimyoidea. Paleontographica A265, 1–119.

Damborenea, S.E., Manceñido, M.O., 1992. A comparison of Jurassic marine benthonic faunas from South America and New Zealand. Journal of the Royal Society of New Zealand 22 (2), 131–152.

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. Cambridge University Press, Cambridge, pp. 300–307.

Desio, A., Rossi-Ronchetti, C., Invernizzi, G., 1960. Il Giurassico dei dintorni di Jefren in Tripolitania. Rivista Italiana di Paleontologia e Stratigraphia 66, 65–118.

Douvillé, H., 1904. Sur quelques fossiles de Madagascar. Bulletin de la Societé Géologique de France 4 (4), 207–217.

Doyle, P., Crame, J.A., Thomson, M.R.A., 1990. Late Jurassic–Early Cretaceous macrofossils from Leg 113, Hole

692B, eastern Weddell Sea. Proceedings of the Ocean Drilling Program, Scientific Results 113, 443–447.

Edwards, C.W., 1980. Early Mesozoic marine fossils from central Alexander Island. Bulletin of the British Antarctic Survey, 49 (for 1979), 33–58.

Etheridge Jr., J., 1910. Oolitic fossils of the Greenough River district, Western Australia. Bulletin, Geological Survey of Western Australia 36 (3), 29–50.

Fantini-Sestini, N., 1966. The geology of the Upper Djadjerud and Lar Valleys (North Iran). II. Palaeontology. Upper Liassic Molluscs from Shemdhak Formation. Rivista Italiana di Paleontologia 72 (3), 795–852.

Feruglio, E., 1936. Palaeontographia Patagonica. Memorie del'Instituto Gelogico della Universitá di Padova 11, 1–384.

Ficcarelli, G., 1968. Fossili giuresi della serie sedimentaria del Nilo Azzurro meridionale. Rivista Italiana di Paleontologia 74 (1), 23–50.

Fischer, E., 1915. Jura und Kreideversteinerungen aus Persien. Beiträge zur Paläontologie und Geologie des Österreichs-Ungarns und des Orients 27, 207–273.

Fleming, C.A., 1959. *Buchia plicata* (ZITTEL) and its allies, with a description of a new species, *Buchia hochstetteri*. New Zealand Journal of Geology and Geophysics 2 (5), 889–904.

Fleming, C.A., 1962. New Zealand biogeography: a palaeontologist's approach. Tuatara 10 (2), 53–108.

Fleming, C.A., 1964. History of the bivalve family Trigoniidae in the Southwest Pacific. The geological background to an Australian "living fossil". Australian Journal of Science 26 (7), 196–204.

Fleming, C.A., 1987. New Zealand Mesozoic Bivalves of the Superfamily Trigoniacea. New Zealand Geological Survey Palaeontological Bulletin 53, 1–104.

Freneix, S., Grant-Mackie, J.A., Lozes, J., 1974. Présence de Malayomaorica (Bivalvia) dans le Jurassique supérieur de la Nouvelle Calédonie. Bulletin de la Société Géologique de France 16 (4), 457–464.

Fuenzalida Villegas, H., 1937. Las capas de Los Molles. Boletín del Museo Nacional de Historia Natural (Santiago de Chile) 16, 66–98.

Fürsich, F.T., Heinze, M., 1998. Contributions to the Jurassic of Kachchh, Western India. VI. The bivalve fauna. Part III. Subclass Palaeoheterodonta (Order Trigonioida). Beringeria 21, 151–168.

Fürsich, F.T., Heinze, M., Jaitly, A.K., 2000. Contributions to the Jurassic of Kachchh, Western India. VIII. The bivalve fauna. Part IV. Subclass Heterodonta. Beringeria 27, 63–146.

Geyer, O.F., 1973. Das präkretazische Mesozoikum von Kolumbien. Geologisches Jahrbuch B (5), 1–155.

Geyer, O.F., 1979. Zur Paläogeographie mesozoischer Ingressionen und Transgressionen in Kolumbien. Neues Jahrbuch für Geologie und Paläontologie, Monatshefte 1976, 6, 349–368.

Grant-Mackie, J.A., 1960. On a new *Kalentera* (pelecypoda: Cypricardiacea) from the Upper Triassic of New Zealand. New Zealand Journal of Geology and Geophysics 3 (1), 74–80.

Grant-Mackie, J.A., 1976a. The Upper Triassic bivalve Monotis in the southwest Pacific. Pacific Geology 11, 47–56.

Grant-Mackie, J.A., 1976b. Upper Jurassic fossils from the Waipapa Group of Tawharanui Peninsula, north Auckland, New Zealand. New Zealand Journal of Geology and Geophysics 19 (1), 21–34.

Grant-Mackie, J.A., 1978a. Subgenera of the Upper Triassic bivalve Monotis. New Zealand Journal of Geology and Geophysics 21 (1), 97–111.

Grant-Mackie, J.A., 1978b. Status and identity of the New Zealand Upper Triassic *bivalve Monotis salinaria* var. *richmondiana* ZITTEL, 1866. New Zealand Journal of Geology and Geophysics 21 (3), 375–402.

Grant-Mackie, J.A., 1978c. Systematics of New Zealand *Monotis* (Upper Triassic Bivalvia) – Subgenus *Entomonotis*. New Zealand Journal of Geology and Geophysics 21 (4), 483–502.

Grant-Mackie, J.A., 1978d. Systematics of New Zealand *Monotis* (Upper Triassic Bivalvia): subgenus *Maorimonotis*. Journal of the Royal Society of New Zealand 8 (3), 293–322.

Grant-Mackie, J.A., 1980a. Systematics of New Zealand *Monotis* (Upper Triassic Bivalvia) – subgenus *Inflatomonotis*. New Zealand Journal of Geology and Geophysics 23, 629–637.

Grant-Mackie, J.A., 1980b. Systematics of New Zealand *Monotis* (Upper Triassic Bivalvia) – subgenus *Eomonotis*. New Zealand Journal of Geology and Geophysics 23, 639–663.

Grant-Mackie, J.A., 1994. Mesozoic Bivalvia from Clerke and Mermaid Canyons, northwest Australian continental slope. AGSO Journal of Australian Geology and Geophysics 15 (1), 119–125.

Grant-Mackie, J.A., Silberling, N.J., 1990. New data on the Upper Triassic bivalve Monotis in North America, and the new subgenus *Pacimonotis*. Journal of Paleontology 64 (2), 240–254.

Guzmán, G., 1984. Los grifeidos infracretácicos *Aetostreon couloni* y *Ceratostreon boussingaulti*, de la Formación Rosablanca, como indicadores de oscilaciones marinas. Publicaciones Geológicas, Ingeominas (Colombia), 1–16.

Hallam, A., Biró-Bagóczky, L., Pérez, E., 1986. Facies analysis of the Lo Valdés Formation (Tithonian-Hauterivian) of the High Cordillera of central Chile, and the palaeogeographic evolution of the Andean Basin. Geological Magazine 123 (4), 425–435.

Haupt, O., 1907. Beiträge zur Fauna des oberen Malm und der unteren Kreide in der argentinischen Kordillere. Neues Jahrbuch für Geologie und Paläontologie, B.B. 23, 187–236.

Hautmann, M., 2001. Taxonomy and phylogeny of cementing Triassic bivalves (Families Prospondylidae, Plicatulidae, Dimyidae and Ostreidae). Palaeontology 44 (2), 339–373.

Harrington, H.J., 1961. Geology of parts of Antofagasta and Atacama Provinces, northern Chile. Bulletin of the American Association of Petroleum Geologists 45 (2), 169–197.

Hayami, I., Maeda, S., Ruiz Fuller, C., 1977. Some Late Triassic Bivalvia and Gastropoda from the Domeyko range of north Chile. Transactions and Proceedings of the Palaeontological Society of Japan, N.S. 108, 202–221.

Hudson, N., 1999. The middle Jurassic of New Zealand. A study of the lithostratigraphy and biostratigraphy of the Ururoan, Temaikan and Lower Heterian stages (?Pliensbachian to ?Kimmeridgian). Ph. D. Thesis, University of Auckland, 399 pp. (unpublished).

Jaboli, D., 1952. Fossili giurassici dell'Harar (Africa Orientale). Brachiopodi, Lamellibranchi e Gasteropodi. Accademia Nazionale Lincei, 4, Documentazione Paleontologici 1, 1–100.

Jaitly, A.K., 1986a. Revised morphotaxonomic description of six Middle Jurassic pholadomyoid clams from Kala Dongar, Pachchham Island, District Kachchh, Gujarat. Indian Minerals 40 (1), 39–46.

Jaitly, A.K., 1986b. *Indomya*, a new subgenus of *Pholadomya* from the Middle Jurassic of Kachchh, Western India (Bivalvia: Pholadomyidae). The Veliger 28 (4), 457–459.

Jaitly, A.K., 1986c. Middle Jurassic limids from Kaladongar, Pachchham Island, Kachchh, Gujarat. Quarterly Journal of the Geological, Mineralogical and Met. Society of India 58 (1), 42–52.

Jaitly, A.K., 1988. Some Middle Jurassic clams from Kala Dongar, Pachchham Island, Kachchh, Gujarat. Indian Minerals 42 (2), 117–125.

Jaitly, A.K., 1989. Some rare veneroid clams from Middle Jurassic rocks of Kala Dongar, Pachchham Island, District Kachchh (Gujarat). Proceedings of the Indian Natural Sciences Academy 55A (3), 570–577.

Jaitly, A.K., 1992. Neocrassinid bivalves (Heterodonta) from the Middle Bathonian (Jurassic) of Kachchh, Western India. Paläontologisches Zeitschrift 66 (1/2), 67–79.

Jaitly, A.K., Singh, C.S.P., 1983. A new species of *Pronoella* FISCHER (Bivalvia) from the Bathonian (Middle Jurassic) rocks of Kaladongar, Pachchham Island, Kachchh. Journal of the Geological Society of India 24, 476–478.

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.

Jaworski, E., 1914. Beiträge zur Kenntnis des Jura in Süd-Amerika. Teil I. Allgemeiner Teil. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie B.B. 37, 285–342.

Jaworski, E., 1915. Beiträge zur Kenntnis des Jura in Süd-Amerika. Teil II. Spezieller, paläontologischer Teil. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie B.B. 40 (2), 364–456.

Jaworski, E., 1922. Die marine Trias in Südamerika. In: Steinmann, G. (Ed.), Beiträge zur Geologie und Paläontologie von Südamerika. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, B.B. 47, 93–200.

Jeletzky, J.A., 1983. Macroinvertebrate paleontology, biochronology, and paleoenvironments of Lower Cretaceous and upper Jurassic rocks, Deep Sea Drilling Hole 511, eastern Falkland Plateu. Initial Reports of the Deep Sea Drilling Project 71, 951–975.

Jones, D.L., Plafker, J., 1976. Mesozoic megafossils from DSDP Hole 327A and Site 330 on the Eastern Falkland Plateau. Initial Reports of the Deep Sea Drilling Project 36, 845–855.

Jordan, R., 1971. Megafossilien des Jura aus dem Antalo-Kalk von Nord-Äthiopien. Geologischen Jahrbuch 116, 141–171.

Kalantari, A., 1981. Iranian fossils. Ministry of Oil, National Iranian Oil Company (Tehran). Geological Laboratories Publication 9, 1–35.

Kanjilal, S., 1979a. Jurassic *Camptonectes* (Bivalvia) from the Habo Hill, District Kutch (Gujarat, W. India). Journal of Molluscan Studies 45 (1), 115–124.

Kanjilal, S., 1979b. Studies on some less known bivalves from the Jurassic rocks of Habo Hill, Kutch. Bulletin of Earth Science 7, 23–32.

Kanjilal, S., 1980a. Notes on two new species of Bivalvia from the Jurassic rocks of Habo Hill in Kutch. Journal of the Geological Society of India 21, 249–252.

Kanjilal, S., 1980b. Studies on Jurassic nuculids (Bivalvia) from the Habo Hill, District Kutch, Gujarat. In: Proceedings of the 3rd Indian Geological Congress, Poona, 1980, pp. 331–346.

Kanjilal, S., 1981. On some pteriomorph and heterodont Bivalvia from the Jurassic rocks of Habo Hill, District Kutch (Gujarat), W. India. Proceedings of the Indian National Science Academy B 46, 264–286.

Kanjilal, S., Singh, C.S.P., 1973. A new nuculanid genus from the Callovian of Kutch (Gujarat), India. Proceedings of the Malacological Society of London 40 (6), 469–471.

Kanjilal, S., Singh, C.S.P., 1980. Studies on the Jurassic oxytomids (Bivalvia) from the Habo Hill in Kutch, W. India. Journal of the Palaeontological Society of India 23/24, 16–22.

Kelly, S.R.A., 1995. New trigonioid bivalves from the Early Jurassic to earliest Cretaceous of the Antarctic Peninsula region: systematics and austral paleobiogeography. Journal of Paleontology 69 (1), 66–84.

Kitchin, F.L., 1903. The Jurassic fauna of Cutch, the Lamellibranchiata; No. 1, Genus *Trigonia*. Memoirs of the Geological Survey of India, Palaeontologia Indica 9, 3 (2), 1–122.

Körner, K., 1937. Marine (Cassianer-Raibler) Trias am Nevado de Acrotambo (Nord-Peru). Palaeontographica A, 86 (5/6), 145–237.

Lambert, L.R., 1944. Algunas trigonias del Neuquén. Revista del Museo de La Plata (n.s.) Paleontología 2 (14), 357–397.

Leanza, A.F., 1941. Apuntes estratigráficos sobre la región cruzada por el curso inferior del arroyo Carrín-Curá, en el Neuquén (Patagonia). Notas del Museo de La Plata, Geología 6 (13), 203–213.

Leanza, A.F., 1968. Anotaciones sobre los fósiles jurásico-cretácicos de Patagonia Austral (colección Feruglio) conservados en la Universidad de Bologna. Acta Geologica Lilloana (Tucumán) 9, 121–179.

Leanza, H.A., 1993. Jurassic and Cretaceous Trigoniid Bivalves from West-Central Argentina. Bulletins of American Paleontology 105 (343), 1–95.

Leanza, H.A., Garate-Zubillaga, J.I., 1987. Fauna de Trigonias (Bivalvia) del Jurásico y Cretácico inferior de la Provincia del Neuquén, Argentina, conservadas en el Museo Juan Olsacher de Zapala. In: Volkheimer, W. (Ed.), Bioestratigrafía de los sistemas regionales del Jurásico y Cretácico de América del Sur, 1. Mendoza, pp. 201–255.

Levy, R., 1967. Revisión de las Trigonias de Argentina. Parte IV. Los Megatrigoniinae de Argentina y su relación con *Anditrigonia* gen. nov. Ameghiniana 5 (4), 135–144.

Lewy, Z., 1982. *Gryphaeligmus* n. gen. (Bivalvia; Malleidae) from the Bathonian of the Middle East. Journal of Paleontology 56 (3), 811–815.

Lo Forte, G.L., 1988. La fauna de trigonias (Mollusca; Bivalvia) del Tithoniano-Neocomiano de la Quebrada Blanca, Alta Cordillera de Mendoza. Actas, 5to. Congreso Geológico Chileno (Santiago de Chile) 2, C277–C293.

Malchus, N., Aberhan, A., 1998. Transitional gryphaeate/exogyrate oysters (Bivalvia: Gryphaeidae) from the Lower Jurassic of northern Chile. Journal of Paleontology 72 (4), 619–631.

Marwick, J., 1935. Some new genera of the Myalinidae and Pteridae of New Zealand. Transactions and Proceedings of the Royal Society of New Zealand 65 (3), 295–303.

Marwick, J., 1953. Divisions and faunas of the Hokonui system (Triassic and Jurassic). New Zealand Geological Survey, Palaeontological Bulletin 21, 1–142.

Marwick, J., 1956. Three Fossil Mollusca from the Hokonui System (Triassic and Jurassic). Transactions of the Royal Society of New Zealand 83 (3), 489–491.

Medina, F.A., Ramos, A.M., 1983. Geología de las inmediaciones del refugio Ameghino (64°26'S, 58°59'W), Tierra de San Martín, Península Antártica. Instituto Antártico Argentino, Contribución 229, 1–14.

Newton, R.B., 1889. Notes on fossils from Madagascar, with descriptions of two new species of Jurassic Pelecypoda from that island. Quarterly Journal of the Geological Society of London 45, 331–338.

Newton, R.B., 1895. On a collection of fossils from Madagascar obtained by Rev. R. Baron. Quarterly Journal of the Geological Society of London 51, 72–91.

Nicolaï, M., 1950–1951. Paléontologie de Madagascar. XXIX. Étude de quelques gisements fossilifères du sud-ouest de Madagascar. Annales de Paléontologie 36, 141–168; 37, 1–46.

Olivero, E.B., 1988. Cefalópodos y bivalvos titonianos y hauterivianos de la Formación Lago La Plata, Chubut. Ameghiniana 24 (3/4), 181–202.

Pandey, D.K., Agrawal, S.K., 1984. Bathonian–Callovian molluscs of Gora Dongar, Pachchham 'Island'. The Quarterly Journal of Geological, Mining and Metallurgical Society of India 56 (4), 176–197.

Pandey, D.K., Fürsich, F.T., Heinze, M., 1996. Contributions to the Jurassic of Kachchh, Western India. V. The bivalve fauna. Part II. Subclass Anomalodesmata. Beringeria 18, 51–87.

Pérez, E., Reyes, R., 1977. Las trigonias jurásicas de Chile y su valor cronoestratigráfico. Boletín del Instituto de Investigaciones Geológicas de Chile 30, 1–58.

Pérez, E., Reyes, R., 1983. Las especies del género *Anditrigonia* LEVY, 1967, en la colección Philippi. Revista Geológica de Chile 18, 15–41.

Pérez, E., Reyes, R., 1985. Presencia de *Linotrigonia* VAN HOEPEN (Bivalvia; Trigoniidae) en el Kimmeridgiano del norte de Chile. Revista Geológica de Chile 25–26, 135–143.

Pérez, E., Reyes, R., 1986. Presencia de *Buchotrigonia* (Syrotrigonia) COX, 1952 (Bivalvia; Trigoniidae) en Sudamérica y descripción de dos especies nuevas. Revista Geológica de Chile 28/29, 77–93.

Pérez, E., Reyes, R., 1991. El Orden Trigonioida (Mollusca; Bivalvia) en el Mesozoico de Sudamérica. Resúmenes Ampliados, 6to. Congreso Geológico Chileno, 72–76.

Pérez, E., Biro, L., Reyes, R., 1987. Nuevos antecedentes sobre *Virgotrigonia* ALLEMAN, 1985 (Bivalvia; Trigoniidae) y presencia de *V. hugoi* (LEANZA) en Chile. Revista Geológica Chilena 30, 35–45.

Quilty, P.G., 1978. Late Jurassic bivalves from Ellsworth Land, Antarctica: their systematics and paleogeographic implications. New Zealand Journal of Geology and Geophysics 20 (6), 1033–1080.

Quilty, P.G., 1982. Tectonic and Other Implications of Middle-Upper Jurassic Rocks and Marine Faunas from Ellsworth Land, Antarctica. In: Craddock, C. (Ed.), Antactic Geoscience. The University of Wisconsin Press, Madison, pp. 669–678.

Quilty, P.G., 1983. Bajocian bivalves from Ellsworth Land, Antarctica. New Zealand Journal of Geology and Geophysics 26 (4), 395–418.

Riccardi, A.C., 1977. Berriasian invertebrate fauna from the Springhill Formation of Southern Patagonia. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 155 (2), 216–252.

Riccardi, A.C., 1988. The Cretaceous System of Southern South America. Geological Society of America, Memoir 168, 1–161.

Riccardi, A.C., Damborenea, S.E., Manceñido, M.O., 1990a. 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. Newsletters on Stratigraphy 21 (2), pp. 75–103.

Riccardi, A.C., Westermann, G.E.G., Damborenea, S.E., 1990b. Middle 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. Newsletters on Stratigraphy 21 (2), pp. 105–128.

Riccardi, A.C., Leanza, H.A., Volkheimer, W., 1990c. Upper 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. Newsletters on Stratigraphy 21 (2), pp. 129–147.

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. Revista de la Asociación Geológica Argentina 52 (2), 228–234.

Romero, L., Aldana, M., Rangel, C., Villavicencio, E., Ramírez, J., 1995. Fauna y flora fósil del Perú. Boletín del Instituto Geológico Minero y Metalúrgico, Serie D: Estudios Especiales 17, 1–332.

Rubilar A. 1998. La Superfamilia Ostreacea en Chile y su importancia cronoestratigráfica, paleogeográfica y paleoecológica (Triásico superior-Jurásico). Tesis Doctoral, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, 363 pp. (unpublished).

Sato T., Westermann, G.E.G., Skwarko, S.K., Hasibuan, F., 1978. Jurassic biostratigraphy of the Sula Islands, Indonesia. Bulletin of the Geological Survey of Indonesia 4 (1), 1–28.

Singh, C.S.P., Kanjilal, S., 1974. Some fossil mussels from the Jurassic rocks of Habo Hill in Kutch, Gujarat, western India. Indian Journal of Earth Sciences 1 (1), 113–125.

Singh, C.S.P., Kanjilal, S., 1977. *Habonucula*, a new Nuculid (Bivalvia) genus from Jurassic rocks of Kutch (Gujarat), W. India. Journal of the Geological Society of India 18 (4), 189–193.

Singh, C.S.P., Kanjilal, S., 1982. On some Jurassic astartid bivalves from the Habo Hill in Kutch. Journal of the Palaeontological Society of India 27, 49–61.

Singh, C.S.P., Rai, J.N. 1980. Bathonian-Callovian fauna of Western Bela Island (Kutch). Part I. Bivalve families Cardiidae, Neomiodontidae, Corbulidae. Journal of the Palaeontological Society of India 23/24, 71–80.

Singh, C.S.P., Jaitly, A.K., Pandey, D.K., 1982. A New Middle Jurassic Bivalve Genus, *Agrawalimya*, from Kachchh (Gujarat), India. The Veliger 24 (3), 273–275.

Skwarko, S.K., 1967. Mesozoic Mollusca from Australia and New Guinea. Bureau of Mineral Resources, Geology and Geophysics, Bulletin 75, 1–101.

Skwarko, S.K., 1973. First report of Domerian (Lower Jurassic) marine Mollusca from New Guinea. Bulletin, Bureau of Mineral Resources, Geology and Geophysics 140, 105–112.

Skwarko, S.K., 1974. Jurassic fossils of Western Australia, 1: Bajocian Bivalvia of the Newmarracarra Limestone and the Kojarena Sandstone. Bulletin, Bureau of Mineral Resources, Geology and Geophysics 150, 1–53.

Skwarko, S.K., 1981a. A new upper Mesozoic trigoniid from western Papua New Guinea. Bulletin, Bureau of Mineral Resources, Geology and Geophysics 209, 53–55.

Skwarko, S.K., 1981b. *Spia*, a new Triassic Bakevellid bivalve from Papua New Guinea. Bulletin, Bureau of Mineral Resources, Geology and Geophysics 209, 63–64.

Skwarko, S.K., 1983. *Somareoides hastatus* (SKWARKO), a new Late Triassic bivalve from Papua New Guinea. Bulletin, Bureau of Mineral Resources, Geology and Geophysics 217, 67–68.

Skwarko, S.K., Nicholl, R., Campbell, K.S.W., 1976. The Late Triassic molluscs, conodonts and brachiopods of the Kuta Formation, Papua New Guinea. Journal of Australian Geology and Geophysics 1, 219–230.

Sokolov, D.N., 1946. Algunos fósiles suprajurásicos de la República Argentina. Revista de la Sociedad Geológica Argentina 1 (1), 7–16.

Speden, I.G., 1970. Three new inoceramid species from the Jurassic of New Zealand. New Zealand Journal of Geology and Geophysics 13 (3), 825–851.

Speden, I.G., Keyes, I.W., 1981. Illustrations of New Zealand Fossils. New Zealand Department of Scientific and Industrial Research, DSIR Information Series, Wellington 150, 109 pp.

Stehn, E., 1923. Beiträge zur Kenntnis des Bathonien und Callovien in Südamerika. Neues Jahrbuch für Mineralogie, Geologie und Paläontologie B.B. 48, 52–158.

Stevens, G.R., 1967. Upper Jurassic fossils from Ellsworth Land, West Antarctica, and notes on Upper Jurassic biogeography of the South Pacific region. New Zealand Journal of Geology and Geophysics 10 (3), 345–393.

Stevens, G.R., 1978. Jurassic. Paleontology. In: Suggate, R.P., Stevens, G.R., Te Punga, M.T (Eds.), The geology of New Zealand. New Zealand Geological Survey 1, pp. 215–228.

Teichert, C., 1940. Marine Jurassic in the North-West Basin, Western Australia. Journal of the Royal Society of Western Australia 26, 17–27.

Thevenin, A., 1908. Paléontologie de Madagascar. V. Fossiles Liassiques. Annales de Paléontologie 3 (3), 105–143.

Thiele Cartagena, R., 1967. El Triásico y Jurásico del Departamento de Curepto en la provincia de Talca. Publicación, Universidad de Chile, Facultad de Ciencias Físicas y Matemáticas, Departamento de Geología 28, 27–46.

Thomson, M.R.A., 1975a. Fossils from the South Orkney Islands: I. Coronation Island. Bulletin of the British Antarctic Survey 40, 15–21.

Thomson, M.R.A., 1975b. Upper Jurassic Mollusca from Carse Point, Palmer Land. Bulletin of the British Antarctic Survey 41/42, 31–42.

Thomson, M.R.A., 1981. Late Mesozoic stratigraphy and invertebrate palaeontology of the South Orkney Islands. Bulletin of the British Antarctic Survey 54, 65–83.

Thomson, M.R.A., 1982. Late Jurassic fossils from Low Island, South Shetland Islands. Bulletin of the British Antarctic Survey 56, 25–35.

Thomson, M.R.A., Damborenea, S.E., 1993. A new Middle Jurassic fauna from Antarctica. In: Arkell International Symposium on Jurassic Geology, Abstracts of Poster Communications, 1 p.

Thomson, M.R.A., Tranter, T.H., 1986. Early Jurassic fossils from central Alexander Island and their geological setting. Bulletin of the British Antarctic Survey 70, 23–39.

Thomson, M.R.A., Willey, L.E., 1972. Upper Jurassic and Lower Cretaceous *Inoceramus* (Bivalvia) from south-east Alexander Island. Bulletin of the British Antarctic Survey 29, 1–19.

Trechmann, C.T., 1918. The Trias of New Zealand. Quarterly Journal of the Geological Society of London 73, 165–246.

Trechmann, C.T., 1923. The Jurassic rocks of New Zealand, with an Appendix on Ammonites from New Zealand by L.F. Spath. Quarterly Journal of the Geological Society of London 79, 246–312.

Venzo, S., 1949. Il Batoniano a Trigonia dell'Oltregiuba settentrionale e del Borana sud-orientale (Africa Orientale) con osservazioni stratigrafiche sulla regione. Palaeontographia Italica 45, 111–177.

Weir, J., 1930. Mesozoic Brachiopoda and Molluaca from Mombasa. Monographs of the Geological Department of the Hunterian Museum, Glasgow University 4, 73–102.

Weir, J., 1938. The Jurassic faunas of Kenya with description of some Brachiopoda and Mollusca. Monographs of the Geological Department of the Hunterian Museum, Glasgow University 5, 21–60.

Westermann, G.E.G., Riccardi, A.C., Palacios, O., Rangel, C., 1980. Jurásico Medio en el Perú. Boletín del Instituto de Geología, Minería y Metalogenia de la República de Perú D (9), 1–47.

Whitehouse, F.W., 1924. Some Jurassic fossils from Western Australia. Journal of the Royal Society of Western Australia 11 (1), 1–13.

Willey, L.E., 1975a. Upper Jurassic and lower Cretaceous Grammatodontinae (Bivalvia) from southern Alexander Island. Bulletin of the British Antarctic Survey 41/42, 1–22.

Willey, L.E., 1975b. Upper Jurassic and lowest Cretaceous Trigoniidae (Bivalvia) from south-eastern Alexander Island. Bulletin of the British Antarctic Survey 41/42, 77–85.

Willey, L.E., 1975c. Upper Jurassic and lower Cretaceous Pinnidae (Bivalvia) from southern Alexander Island. Bulletin of the British Antarctic Survey 41/42, 121–131.

References

Aberhan, M., 1998. Paleobiogeographic patterns of pectinoid bivalves and the Early Jurassic tectonic evolution of Western Canadian Terranes. Palaios 13, 129–148.

Aberhan, M., 1999. Terrane history of the Canadian Cordillera: estimating amounts of latitudinal displacement and rotation of Wrangellia and Stikinia. Geological Magazine 136 (5), 481–492.

Aberhan, M., 2001. Bivalve palaeobiogeography and the Hispanic Corridor: time of opening and effectiveness of a proto-Atlantic seaway. Palaeogeography, Palaeoclimatology, Palaeoecology 165 (3/4), 375–394.

Aberhan, M., Fürsich, F.T., 2000. Mass origination versus mass extinction: the biological contribution to the Pliensbachian–Toarcian extinction event. Journal of the Geological Society. London 157, 55–60.

Aberhan, M., Hillebrandt von, A., 1999. The bivalve *Opisoma* in the Lower Jurassic of northern Chile. Profil 16, 149–164.

Beauvais, L., 1992. Corals of the circum-Pacific region. In: Westermann, G.E.G. (Ed.), The Jurassic of the Circum-Pacific. Cambridge University Press, New York, pp. 324–327.

Boomer, I., Ballent, S., 1996. Early-Middle Jurassic ostracod migration between the northern and southern hemispheres: further evidence for a proto Atlantic–Central America connection. Palaeogeography, Palaeoclimatology, Palaeoecology 121 (1/2), 53–64.

Cecca, F., 1999. Palaeobiogeography of Tethyan ammonites during the Tithonian (latest Jurassic). Palaeogeography, Palaeoclimatology, Palaeoecology 147 (1/2), 1–37.

Challinor, A.B., 1991. Belemnite succession and faunal provinces in the southwest Pacific, and the belemnites of Gondwana. Journal of Australian Geology and Geophysics 12, 301–325.

Challinor, A.B., Doyle, P., Howlett, P.J., Nal'nyaeva, T.I., 1992. Belemnites of the circum-Pacific region. In: Westermann, G.E.G. (Ed.), The Jurassic of the Circum-Pacific. Cambridge University Press, New York, pp. 334–341.

Cox, L.R., 1965. Jurassic Bivalvia and Gastropoda from Tanganyika and Kenya. Bulletin of the British Museum (Natural History) 1 (Geology Suppl.), 1–213.

Cox, L.R., et al., 1969. Mollusca 6. Bivalvia. In: Moore, R.C. (Ed.), Treatise on Invertebrate Paleontology, Part N. University of Kansas Press and Geological Society of America, Kansas, pp. 952.

Crame, J.A., 1986. Late Mesozoic bipolar bivalve faunas. Geological Magazine 123 (6), 611–618.

Crame, J.A., 1987. Late Mesozoic bivalve biogeography of Antarctica. Proceedings of the Sixth Gondwana Symposium. Columbus, Ohio, pp. 93–102.

Crame, J.A., 1992. Evolutionary history of the polar regions. Historical Biology 6, 37–60.

Crame, J.A., 1993. Bipolar molluscs and their evolutionary implications. Journal of Biogeography 20, 145–161.

Crame, J.A., 1996a. Evolution of high-latitude molluscan faunas. In: Taylor, J.D. (Ed.), Origin and Evolutionary Radiation of the Mollusca. Oxford University Press, Oxford, pp. 119–131.

Crame, J.A., 1996b. Antarctica and the evolution of taxonomic diversity gradients in the marine realm. Terra Antarctica 3 (2), 121–134.

Crame, J.A., 1997. An evolutionary framework for the polar regions. Journal of Biogeography 24, 1–9.

Crame, J.A., 2000. Evolution of taxonomic diversity gradients in the marine realm: evidence from the composition of Recent bivalve faunas. Paleobiology 26, 188–214.

Damborenea, S.E., 1993. Early Jurassic South American pectinaceans and circum-Pacific palaeobiogeography. Palaeogeography, Palaeoclimatology, Palaeoecology 100 (1/2), 109–123.

Damborenea, S.E., 1996. Palaeobiogeography of Early Jurassic bivalves along the southeastern Pacific margin. 13º Congreso Geológico Argentino y 3º Congreso de Exploración de Hidrocarburos (Buenos Aires). Actas 5, 151–167.

Damborenea, S.E., 1998. The Bipolar Bivalve *Kolymonectes* in South America 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. University of Calgary Press, Calgary, pp. 143–155.

Damborenea, S.E., 2000. Hispanic Corridor: its evolution and the biogeography of bivalve molluscs. In: Hall, R.L., Smith, P.L. (Eds.), Advances in Jurassic Research, GeoResearch Forum 6. pp. 369–380.

Damborenea, S.E., 2002. Early Jurassic bivalves of Argentina. Part 3: Superfamilies Monotoidea, Pectinoidea, Plicatuloidea and Dimyoidea. Palaeontographica A265, 1–119.

Damborenea, S.E., Manceñido, M.O., 1979. On the palaeogeographical distribution of the pectinid genus *Weyla* (Bivalvia, Lower Jurassic). Palaeogeography, Palaeoclimatology, Palaeoecology 27 (1/2), 85–102.

Damborenea, S.E., Manceñido, M.O., 1988. *Weyla*: semblanza de un bivalvo Jurásico andino. Actas 5º Congreso Geológico Chileno, Santiago de Chile 2, C13–C25.

Damborenea, S.E., Manceñido, M.O., 1992. A comparison of Jurassic marine benthonic faunas from South America and New Zealand. Journal of the Royal Society of New Zealand 22 (2), 131–152.

Diener, C., 1916. Die marinen Reiche der Trias-Periode. Denkschriften, Akademie der Wissenschaften. Wien 92, 405–549.

Dommergues, J.L., Meister, C., 1991. Area of mixed marine faunas between two major paleogeographical realms, exemplified by the Early Jurassic (Late Sinemurian and Pliensbachian) ammonites in the Alps. Palaeogeography, Palaeoclimatology, Palaeoecology 86 (3/4), 265–282.

Dommergues, J.L., Laurin, B., Meister, C., 2001. The recovery and radiation of Early Jurassic ammonoids: morphologic versus paleobiogeographical patterns. Palaeogeography, Palaeoclimatology, Palaeoecology 165 (3/4), 195–213.

Doyle, P., 1987. Lower Jurassic – Lower Cretaceous Belemnite biogeography. Palaeogeography, Palaeoclimatology, Palaeoecology 61 (3/4), 237–245.

Doyle, P., Kelly, S.R.A., Pirrie, D., Riccardi, A.C., 1997. Jurassic belemnite distribution patterns: implications of new data from Antarctica and Argentina. Alcheringa 21, 219–228.

Elmi, S., 1993. Les voies d'échange faunique entre l'Amérique du Sud et la Téthys alpine pendant le Jurassique inférieur et moyen. Documents des Laboratoires de Géologie de Lyon 125, 139–149.

Enay, R., Cariou, E., 1997. Ammonite faunas and palaeobiogeography of the Himalayan belt during the Jurassic: Initiation of a Late Jurassic austral ammonite fauna. Palaeogeography, Palaeoclimatology, Palaeoecology 134 (1–4), 1–38.

Ficcarelli, G., 1968. Fossili giuresi della serie sedimentaria del Nilo Azzurro meridionale. Rivista Italiana di Paleontologia 74 (1), 23–50.

Fleming, C.A., 1963. The Nomenclature of Biogeographic Elements in the New Zealand Biota. Transactions of the Royal Society of New Zealand General 1 (2), 13–22.

Fürsich, F.T., Sykes, R.M., 1977. Palaeobiogeography of the European Boreal Realm during Oxfordian (Upper Jurassic) times: a quantitative approach. Neues Jahrbuch für Geologie und Paläontologie Adhandlungen 172, 271–329.

Geyer, O.F., 1977. Die "*Lithiotis*-Kalke" im Bereich der unterjurassischen Tethys. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 153, 304–340.

Golonka, J., Ford, D., 2000. Pangean (Late Carboniferous-Middle Jurassic) paleoenvironment and lithofacies. Palaeogeography, Palaeoclimatology, Palaeoecology 161 (1/2), 1–34.

Grant-Mackie, J.A., Aita, Y., Balme, B.E., Campbell, H.J., Challinor, A.B., MacFarlan, D.A.B., Molnar, R.E., Stevens, G.R., Thulborn, R.A., 2000. Jurassic palaeobiogeography of Australasia. In: Wright, A.J., Young, G.C., Talent, J.A., Laurie, J.R. (Eds.), Palaeobiogeography of Australasian Faunas and Floras, Memoir of the Association of Australasian Palaeontologists, 23, pp. 311–353.

Hallam, A., 1969. Faunal realms and facies in the Jurassic. Palaeontology 12 (1), 1–18.

Hallam, A., 1971. Provinciality in Jurassic faunas in relation to facies and palaeogeography. In: Middlemiss, F.A., Rawson, P.F., Newall, G. (Eds.), Faunal Provinces in Space and Time. Geological Journal Special Issue, 4, pp. 129–152.

Hallam, A., 1977. Jurassic bivalve biogeography. Paleobiology 3 (1), 58–73.

Hallam, A., 1981. Relative importance of plate movements, eustasy, and climate in controlling major biogeographical changes since the Early Mesozoic. In: Nelson, G., Rosen, D.E. (Eds.), Vicariance Biogeography: A Critique. Columbia University Press, New York, pp. 303–340.

Hallam, A., 1983. Early and mid-Jurassic molluscan biogeography and the establishement of the central Atlantic seaway. Palaeogeography, Palaeoclimatology, Palaeoecology 43, 181–193.

Hallam, A., 1994a. An outline of Phanerozoic Biogeography. Oxford University Press, Oxford (246 p.).

Hallam, A., 1994b. Jurassic climates as inferred from the sedimentary and fossil record. In: Allen, J., Hoskins, B., Sellwood, B., Spicer, R., Valdes, P. (Eds.), Palaeoclimates and Their Modelling with Special Reference to the Mesozoic Era. Chapman and Hall, London, pp. 70–88.

Hallam, A., 1996. Recovery of the marine fauna in Europe after the end-Triassic and early Toarcian mass extinctions. In: Hart, M.B. (Ed.), Biotic Recovery from Mass Extinction Events. Geological Society Special Publication, 102, pp. 231–236.

Hallam, A., Miller, A.I., 1988. Extinction and survival in the Bivalvia. In: Larwood, G.P. (Ed.), Extinction and Survival in the Fossil Record. Systematics Association, Special Volume 34, pp. 121–138.

Hayami, I., 1984. Jurassic Marine Bivalve Faunas and Biogeography in Southeast Asia. Geology and Palaeontology of. Southeast Asia 25, 22–237.

Hayami, I., 1987. Geohistorical background of Wallace's line and Jurassic marine biogeography. In: Taira, A., Tashiro, M. (Eds.), Historical Biogeography and Plate Tectonic Evolution of Japan and Eastern Asia. Terra Sci. Publ. Co., Tokyo. pp. 111–133.

Hayami, I., 1989. Outlook of the post-Paleozoic historical biogeography of pectinids in the western Pacific region. The University Museum, The University of Tokyo, Nature and Culture 1, 3–25.

Hayami, I., 1990. Geographic distribution of Jurassic faunas in eastern Asia. In: Ichikawa, K., Mizutani, S., Hara, I., Hada, S., Yao, A. (Eds.), Pre-Cretaceous Terranes of Japan. Publication of IGCP Project 224, Osaka, pp. 361–369.

Hillebrandt von, A., 1981. Kontinentalverschiebung und die paläozoogeographischen Beziehungen des südamerikanischen Lias. Geologische Rundschau 70, 570–582.

Hillebrandt von, A., Westermann, G.E.G., Callomon, J.H., Detterman, R.L., 1992. Ammonites of the circum-Pacific region. In: Westermann, G.E.G. (Ed.), The Jurassic of the Circum-Pacific. Cambridge University Press, New York, pp. 342–359.

Imlay, R.W., 1965. Jurassic marine faunal differentiation in North America. Journal of Paleontology 39 (5), 1023–1038.

Kauffman, E.G., 1973. Cretaceos Bivalvia. In: Hallam, A. (Ed.), Atlas of Palaeobiogeography. Elsevier, Amsterdam, pp. 353–383.

Kiessling, W., Scasso, R., 1996. Ecological perspectives of Late Jurassic radiolarian faunas from the Antarctic Peninsula. In: Riccardi, A.C.

(Ed.), Advances in Jurassic Research. GeoResearch Forum 1/2. pp. 317–326.

Liu, C., 1995. Jurassic bivalve palaeobiogeography of the Proto-Atlantic and the application of multivariate analysis methods in palaeobiogeography. Beringeria 16, 3–123.

Liu, C., Heinze, M., Fürsich, F.T., 1998. Bivalve provinces in the Proto-Atlantic and along the southern margin of the Tethys in the Jurassic. Palaeogeography, Palaeoclimatology, Palaeoecology 137, 127–151.

MacFarlan, D.A.B., 1992. Triassic and Jurassic Rhynchonellacea (Brachiopoda) from New Zealand and New Caledonia. The Royal Society of New Zealand, Bulletin 31 (310 p.).

Makridin, V.P., 1973. The principles of discrimination and nomenclature of subdivisions in the paleogeographic zoning of marine basins. Paleontological Journal 7 (2), 127–131.

Manceñido, M.O., Dagys, A.S., 1992. Brachiopods of the circum-Pacific region. In: Westermann, G.E.G. (Ed.), The Jurassic of the Circum-Pacific. Cambridge University Press, New York, pp. 328–333.

Masse, J.P., 1992. The Lower Cretaceous Mesogean benthic ecosystems: palaeoecologic aspects and palaeobiogeographic implications. Palaeogeography, Palaeoclimatology, Palaeoecology 91, 331–345.

Nauss, A.L., Smith, P.L., 1988. *Lithiotis* (Bivalvia) bioherms in the Lower Jurassic of East-central Oregon, U.S.A. Palaeogeography, Palaeoclimatology, Palaeoecology 65, 253–268.

Price, G.D., 1999. The evidence and implications of polar ice during the Mesozoic. Earth-Science Reviews 48, 183–210.

Riccardi, A.C., 1991. Jurassic and Cretaceous marine connections between the Southeast Pacific and Tethys. Palaeogeography, Palaeoclimatology, Palaeoecology 87, 155–189.

Rosen, B.R., 1992. Empiricism and the biogeographical black box: concepts and methods in marine palaeobiogeography. Palaeogeography, Palaeoclimatology, Palaeoecology 92, 171–205.

Scotese, C.R., 1991. Jurassic and Cretaceous plate tectonic reconstructions. Palaeogeography, Palaeoclimatology, Palaeoecology 87 (1–4), 493–501.

Scotese, C.R., 1997. Paleogeographic Atlas. PALEOMAP Progress Report 90–0497, Department of Geology. University of Texas at Arlington, Arlington, Texas (37 p.).

Sha, J., 1996. Antitropicality of the Mesozoic bivalves. In: Pang, Z.H., et al. (Eds.), Advances in Solid Earth Sciences. Science Press, Peking, pp. 90–98.

Shi, G.R., Grunt, T.A., 2000. Permian Gondwana-Boreal antitropicality with special reference to brachiopod faunas. Palaeogeography, Palaeoclimatology, Palaeoecology 155 (3/4), 239–263.

Smith, A.G., Briden, J.C., 1977. Mesozoic and Cenozoic paleocontinental maps. Cambridge University Press, Cambridge (63 p.).

Smith, P.L., 1989. Paleobiogeography and Plate Tectonics. Geoscience Canada 15, 261–279.

Smith, P.L., Tipper, H.W., 1986. Plate tectonics and paleobiogeography: Early Jurassic (Pliensbachian) endemism and diversity. Palaios 1, 399–412.

Sohl, N.F., 1987. Cretaceous gastropods: contrasts between Tethys and the temperate provinces. Journal of Paleontology 61 (6), 1085–1111.

Stevens, G.R., 1967. Upper Jurassic fossils from Ellsworth Land, West Antarctica, and notes on Upper Jurassic biogeography of the South Pacific region. New Zealand Journal of Geology and Geophysics 10 (3), 345–393.

Stevens, G.R., 1973. Jurassic belemnites. In: Hallam, A. (Ed.), Atlas of Palaeobiogeography. Elsevier, Amsterdam, pp. 259–274.

Stevens, G.R., 1977. Mesozoic biogeography of the South-West Pacific and its relationship to plate tectonics. International Symposium on the Geodynamics of the S.W. Pacific. Ed. Technip, Paris, pp. 309–326.

Stevens, G.R., 1980. Southwest Pacific faunal palaeobiogeography in Mesozoic and Cenozoic times: a review. Palaeogeography, Palaeoclimatology, Palaeoecology 31 (2–4), 153–196.

Stevens, G.R., 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. Geological Society Special Publication 47. pp. 141–166.

Stevens, G.R., 1990. The influences of palaeogeography, tectonism and eustasy on faunal development in the Jurassic of New Zealand. Atti del Secondo Convegno Internazionale Fossili, Evoluzione, Ambiente; Pergola 1987. pp. 441–457.

Tong, J., Erwin, D.H., 2001. Triassic gastropods of the southern Qinling mountains, China. Smithsonian Contributions to Paleobiology 92, 1–47.

Westermann, G.E.G., 1996. New Mid-Jurassic Ammonitina from New Zealand: implications for biogeography and oceanography. In: Riccardi, A.C. (Ed.), Advances in Jurassic Research. GeoResearch Forum 1/2. pp. 179–185.

Westermann, G.E.G., 2000a. Biochore classification and nomenclature in paleobiogeography: an attempt at order. Palaeogeography, Palaeoclimatology, Palaeoecology 158, 1–13.

Westermann, G.E.G., 2000b. The marine faunal realms of the Mesozoic: review and revision under the new guidelines for biogeographic classification and nomenclature. Palaeogeography, Palaeoclimatology, Palaeoecology 163, 49–68.