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A micropalaeontological study of two Jurassic sequences in the Neuquén Basin, central-west Argentina

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Abstract. An example of application of calcareous microfossils to palaeoenvironmental reconstruction is presented. Foraminifers and Ostracoda from across the Aalenian-Bajocian boundary at the Picún Leufú section and Mid Callovian at the María Rosa Curicó section, both in Neuquén Basin, in central western Argentina, are analysed. The resulting data are presented as the following parameters: faunal density and specific diversity in both groups; test composition and vertical distribution of morphogroups in foraminifers; carapace morphology, adult valves to carapaces ratio and population age-structures in Ostracoda. Conclusions from the microfossils agree with those proposed by other authors based on sedimentological and palynological data. Additionally, two new Jurassic species (Middle Callovian) are described as new: the attached foraminifer *Ammovertellina simeonae* sp. nov. and the ostracod *Cytherella mediodepressa* sp. nov.

Resumen. Estudio micropaleontológico de dos secuencias de la cuenca Neuquina, centro oeste de Argentina. Se analizan las asociaciones de foraminíferos y ostrácodos en las secciones Picún Leufú (límite Aaleniano-Bajociano) y María Rosa Curicó (Caloviano medio), ambas en la cuenca Neuquina. Los datos fueron organizados de acuerdo a los siguientes parámetros: densidad faunística y diversidad específica en ambos grupos; composición de la conchilla y distribución vertical de morfogrupos en foraminíferos; morfología del caparazón, relación en adultos entre valvas y caparazones y estructura poblacional en ostrácodos. Las conclusiones obtenidas a partir de los microfósiles coinciden con aquéllas provenientes de estudios sedimentológicos y palinológicos. Se describen como nuevos para el Caloviano medio, el foraminífero adherido *Ammovertellina simeonae* sp. nov. y el ostrácodo *Cytherella mediodepressa* sp. nov.

Key words. Calcareous microfossils. Palaeoenvironmental interpretation. Jurassic. Neuquén Basin. Argentina.

Palabras clave. Microfósiles calcáreos. Interpretación paleoambiental. Jurásico. Cuenca Neuquina. Argentina.

Introduction

Foraminifera are an order of single-celled aquatic protists, which have a protective shell enclosing the soft body. They live on the sea floor or amongst the marine plankton. Ostracods are small bivalved crustaceans found today in all marine, brackish and fresh water aquatic environments. Both groups have a long and well-documented fossil record and are particularly useful in palaeoenvironmental analysis.

The present contribution aims to provide palaeoecological information about two Jurassic localities, across the Aalenian-Bajocian boundary and Mid Callovian, of the Neuquén basin, in central western Argentina, based on the analysis of benthic foraminifer and ostracod assemblages. The study demonstrates once again the importance of both groups of calcareous microfossils in palaeoenvironmental reconstructions.

Geological setting and ammonite biostratigraphy

The Neuquén Basin, in central-western Argentina, has provided most of the Jurassic micropalaeontological assemblages known at present in this country. The abundant and diverse microfaunas are associated with well-known ammonite zones and have been described and figured in several papers (Musacchio 1979; Ballent 1985, 1987, 1991, 1999; Kielbowicz 1987; Simeoni 1985, 2001). An integrated dinoflagellate and spore-pollen zonation of the area has been presented by Quattrocchio and Sarjeant (1992) and Quattrocchio *et al.* (1996). The area of study is located approximately 35 km south of Zapala city, central-south Neuquén province (figure 1).

The first section to be investigated is part of the Picún Leufú profile and comprises the upper 220 m of the Los Molles Formation which encompasses the

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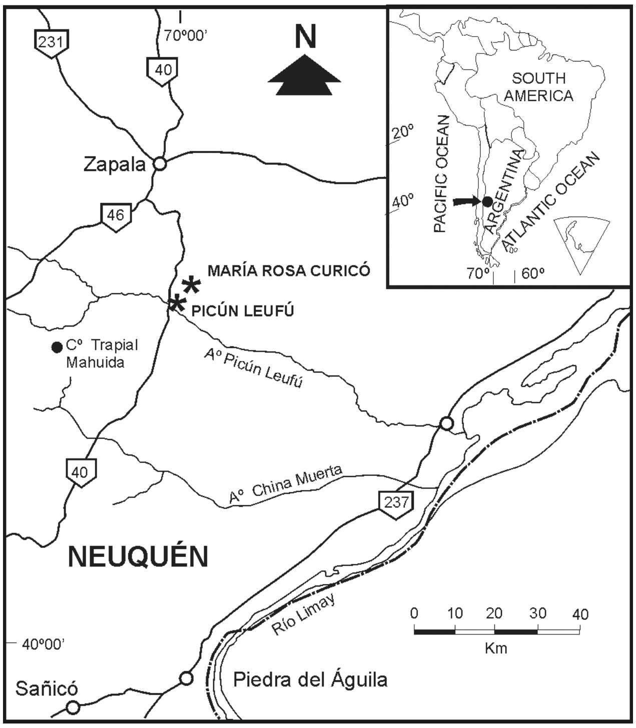


Figure 1. Location map showing the position of fossiliferous sections in Neuquén Province, Argentina / *Mapa de localización de las secciones fosilíferas en la provincia del Neuquén, Argentina.*

Aalenian-Bajocian boundary in this region, near the south-eastern margin of the basin. The section is downstream of the arroyo Picún Leufú, near the junction of arroyo Picún Leufú and Ruta Nacional 40 and is mainly composed of greenish and greyish shallow marine siltstones with sporadic intercalated shallow marine sandstones; fluvial sandstones are more frequent towards the top of the section. These levels are transitional to the Lajas Formation (figures 1 and 2). Contemporary ammonoids found in the same levels correspond to the *Puchenquia malarguensis* Zone which has been correlated with the late *gigantea* and early *discites* Zones and are considered to be late Aalenian to early Bajocian in age (cf. Riccardi *et al.*, 1999).

The second locality, María Rosa Curicó (see figures 1 and 3), is 4 km north-east of the junction of arroyo Picún Leufú and Ruta Nacional 40 (150 m west from the pithead of the same name). It comprises some 40 m of greenish and brownish marine siltstones with sporadic intercalated sandstones referred to the Lotena Formation. The section coincides with those described by Dellapé *et al.*, 1979 as the middle term (Unit D-E, p. 492) of the Lotena Formation in Picún Leufú area. Contemporary ammonoids correspond to the *Rehmannia patagoniensis* Horizon which has been referred to the Middle Callovian (cf. Riccardi *et al.*, 1999). In this area, the continental conglomerates of the Quebrada del Sapo Formation overlie the Lotena Formation.

Material and methods

The studied material consisted of 35 samples from the Picún Leufú section (figure 2) and 8 samples from the María Rosa Curicó section (figure 3). The samples were processed with concentrated hydrogen peroxide, washed through a 74 µm sieve, and oven dried. Specimens were picked out manually. Generic and specific determinations were performed and the resulting data were analyzed taking into account the parameters referred to below. Because of the low numbers involved, the results must be treated with some caution. Particularly in the case of ostracods, the number of specimens is low. However, the general trends of their distribution through the studied sections may be observed and the results are useful to arrive at paleoenvironmental conclusions.

Foraminifers

1) *Faunal density and specific diversity.* The faunal density is the number of specimens in 10 grams of sample for the Picún Leufú section and in approximately 5 grams of sample for the María Rosa Curicó section; the specific diversity corresponds to the number of species per sample. Figures 2 and 3 show the relation between these two parameters for the studied sections.
2) *Species richness.* One of the most used measure is the α index first described by Fisher *et al.*, 1943. One advantage of this index is that values can be read off a base graph by plotting the number of species against the number of specimens (cf. Murray, 1973). According to this author, $\alpha=5$ is a boundary separating normal marine environment ($\alpha>5$) from abnormal environments ($\alpha<5$). Hyposaline and hypersaline environments all have low diversity. Normal shelf seas and normal marine lagoons have diversity values of $\alpha>5$. In the case of the María Rosa Curicó section, the number of specimens is too low to calculate this parameter (100 individuals has been chosen as the minimum acceptable for use in numerical analyses by Murray, 1973).
3) *Test composition-percentage of relative abundance.* In the present accounts foraminifers have been grouped within their natural divisions, based primarily upon wall structure (cf. Loeblich and Tappan, 1987). These are:

Calcareous: lagenids, polymorphinids, miliolids, spirillinids, involutinids and others. Polymorphinids belongs to the lagenid group, but are separated here since their response to environmental conditions is different from other lagenids.

Agglutinated: all have the ability to create their own test by cementing grains of clastic material from their immediate environment.

The distribution of the major foraminiferal groupings, showing relative abundance in number of specimens is indicated in the figures 2 and 3.

4) *Triangular plot of suborders.* Modern forms with hard tests fall into six suborders, Textulariina (agglutinated), Miliolina (porcellaneous) and Spirillinina, Lagenina, Robertinina and Rotaliina (hyaline wall) (cf. Loeblich and Tappan, 1987). They lend themselves to plotting on a triangular diagram (cf. Murray, 1973) and they prove to be particularly useful for differentiating shallow-water environments. Figure 4 shows triangular plots for the studied sections, where the fossil suborder Involutinina is also included.

5) *Calcareous/agglutinating ratio.* Referred to the percentage of calcareous and agglutinated specimens for each sample. Figure 3 shows the curve for the María Rosa Curicó section.

6) *Relationship with the substrate.* Substrates range from firm surfaces, such as rocks, shells, seaweeds or plants, to soft unconsolidated sediment. Benthic foraminifers are epifaunal: living on or above the sediment surface; semi-infaunal: living partly below and partly above the sediment surface and infaunal: living within the sediment Those which move around are said to be free living, when they are attached are said to be sessile and those living in association with plants are described as phytal (cf. Murray, 1991).

7) *Vertical distribution of morphogroups.* Benthic foraminifers show a good correlation between the test form and the environment in which they live, as well as a general relationship between feeding habit and test morphology. Foraminiferal morphogroups with inferred microhabits and feeding strategies have been used in Recent environments, for example, by Jones and Charnock, 1985 and Bernhard, 1986 and for the Mesozoic by Koutsoukos and Hart, 1990; Nagy, 1992, Tyszka, 1994 and Nagy *et al.*, 1995, among others.

Ostracods

1) *Faunal density and specific diversity.* The number of specimens in 10 grams of sample has been counted; the specific diversity corresponds to the number of species per sample. Figure 2 shows the relation between these two parameters for the studied section.

2) *Relative percentage ostracod distribution.* Cytherurids (Cytheroidea) are here separately considered since they are clearly the dominant group within the analysed section.

3) *Carapace morphology.* The size, shape and sculpture of benthic ostracods broadly reflect the stability, grain size of the substrate on, or in which, they live.

4) *Percentage of total specimens.* The percentage of the total individuals is made up by the most abundant species (or most abundant 2, 3 or 4 species). In most marine environments this figure is less than 50%, while in brackish and freshwater the percentage is much higher, usually 70 to 90%.

5) *Ratio between adult valves and carapaces.* Fluctuations in the percentage of articulated adult carapaces have been used as a palaeoenvironmental indicator (cf. Oertli, 1971, Whatley, 1988). If a high percentage of adult specimens are articulated, the same have not been subject to any great amount of *post-mortem* transportation which indicates rapid burial before biological activity and/or tissue decay can bring about disarticulation. However, the morphology of the species (degree of overlap, type of hinge, etc.) and other biological reasons of the species must be considered (cf. Whatley, 1988).

6) *Ostracod population age-structures.* Ostracods like all crustaceans grow discontinuously. The juvenile valves as well as the adults are frequently preserved fossil, and the extent to which all or any of the instars of the ontogeny of a species may be encountered together, depends mainly on the taphonomy of the assemblage, particularly post moulting or *post-morten* transportation. The level of current or wave energy must be less than that required to remove the smallest instar stage. Whatley (1983) outlined the application of this technique to the recognition of palaeoenergy levels and the allochthonous components of mixed faunas. This author, on studies of Recent faunas, typified different environments by three different population age structures.

7) *Presence/absence.* Since ostracods are scarce through the María Rosa Curicó section, simple presence/absence in the different samples is showed in figure 3. Additionally, main groups of ostracods are mentioned.

Full systematics of the Aalenian-Bajocian ostracods and foraminifers are given in Ballent, 1991 and 1999, respectively. Appendix A includes the systematic descriptions of the two new species proposed in this paper. All species recognized are listed in Appendix B. Figures 5 and 6 illustrate some selected Middle Callovian microfossil species referred to in the text. The figured specimens are deposited in the Museo de Ciencias Naturales de La Plata- Sección Micropaleontología (MLP-Mi).

Results

Picún Leufú section

Foraminifers. The foraminiferal microfaunas recovered from across the Aalenian-Bajocian boundary at the Picún Leufú section are abundant, diverse and well preserved; calcareous forms are represented by forty-eight species but agglutinated by only three species (see Appendix B).

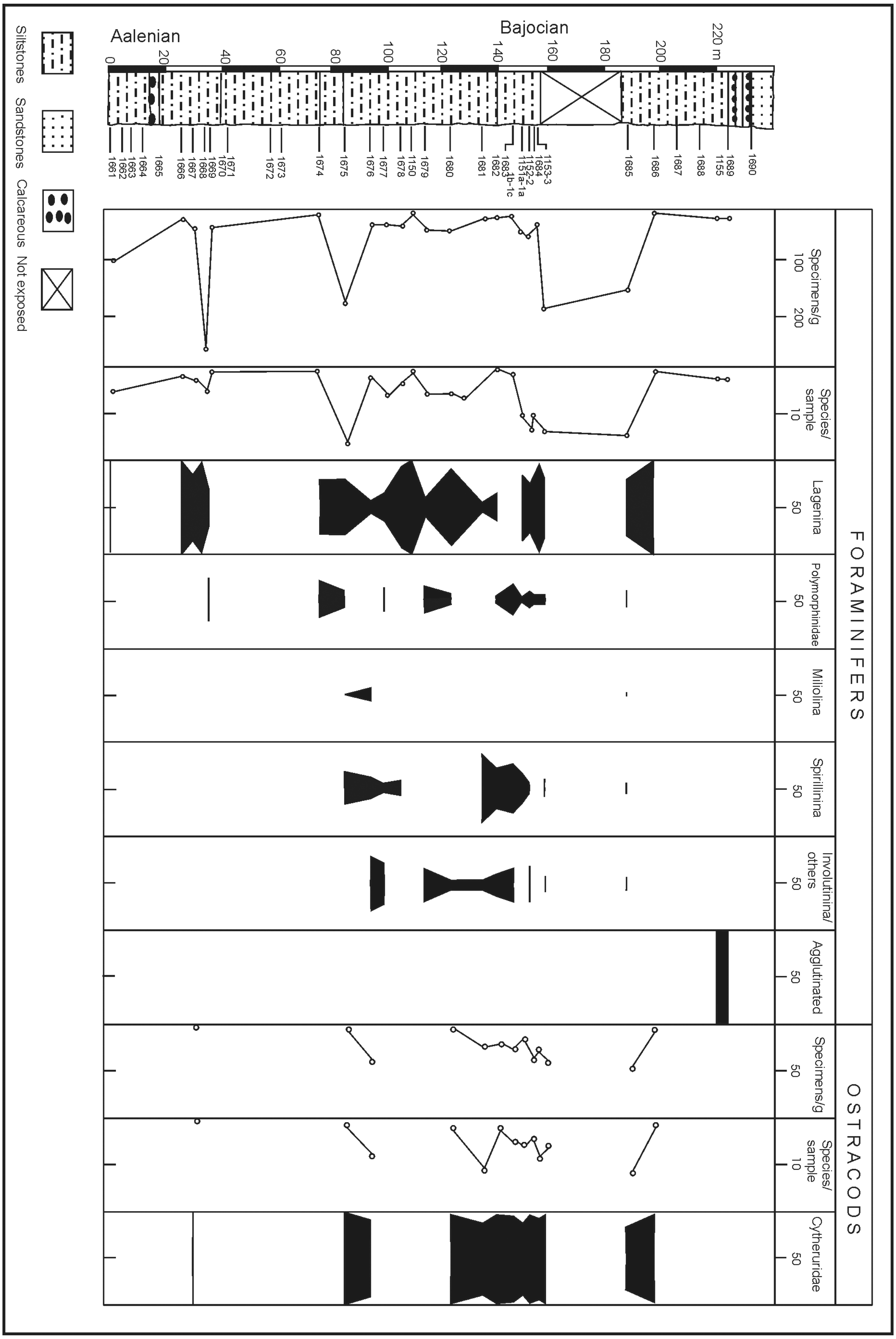


Figure 2. Stratigraphical column and microfossil samples at the Picún Leufú section. Faunal density, specific diversity and test composition-percentage in foraminifers; faunal density, specific diversity and cytherurid percentage in ostracods / *Columna estratigráfica y muestras con microfósiles de la sección Picún Leufú. Densidad faunística, diversidad específica y porcentaje de composición de la pared en foraminíferos. Densidad faunística, diversidad específica y porcentaje de cytherúridos en ostrácodos.*

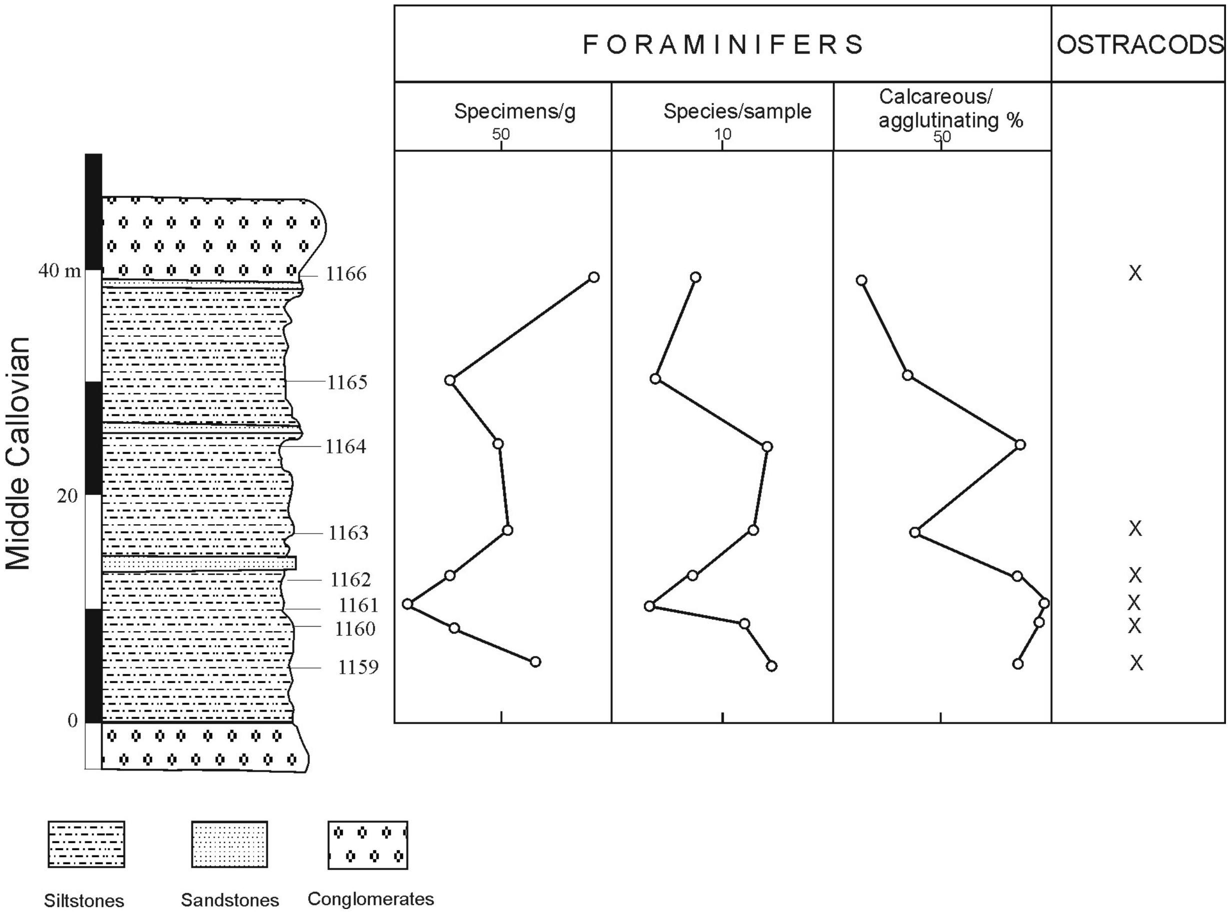


Figure 3. Stratigraphical column and microfossil samples at the María Rosa Curicó section. Faunal density, specific diversity, calcareous/agglutinating ratio in foraminifers and occurrence of ostracods/ *Columna estratigráfica y muestras con microfósiles de la sección María Rosa Curicó. Densidad faunística, diversidad específica, relación calcáreos/aglutinados en foraminíferos y ocurrencia de ostrácodos.*

A. *Faunal density and specific diversity, species richness, test composition-percentage of relative abundance, triangular plots of suborders.* In the lower part of the section (samples 1661, 1666-1669) the diversity varies between 2 and 5 species. The number of specimens (mainly *L. quenstedti decorata*) is particularly high in samples 1661 and 1668 (more than 200 specimens) (see figure 2). The α index is close to 1.

In the middle part of the section (samples 1674-1686), as shown in figure 2, the diversity is moderate (between 1-8 species) being the maximum (up to 16 species) in samples 1675, 1153/3 and 1685. In these samples the α index reaches a value close to 5. The curves of faunal density and specific diversity show parallel trends (see figure 2). Plots for samples 1675, 1676 and 1685 on a triangular diagram are indicated in figure 4A. In the upper part of the section (samples 1155-1689), according to figure 2, only small multilocular agglutinated forms are represented.

B. *Relationship with the substrate, vertical distribution of morphogroups.* In the lower part of the section, mainly ornamented lagenids represented by species of biconvex, planispiral coiled and biumbonate forms, such as *Lenticulina muensteri* (Roemer) and *L. subalata* (Reuss) and flattened planispiral forms like *L. quenstedti decorata* Ballent, *L. varians* (Bornemann), *Astacolus aivinus* Ballent and *A. dorbignyi* (Roemer) have been recovered. In the middle part of the section, lagenids are diverse and abundant. The commonest forms are the elongate flattened *Ichthyolaria lignaria* (Terquem), *Frondicularia franconica* Gümbel, *Citharina heteropleura* (Terquem), *Planularia beierana* (Gümbel), *Lingulina longiscata* (Terquem) and the elongate inflated *Nodosaria mutabilis* Terquem and *N. opalini* Bartenstein; coiled forms are also present. Polymorphinids, mainly *Eoguttulina liassica* (Strickland), spirillinids [(*Spirillina infima* (Strickland)], and involutinids (*Trocholina unica* Ballent) occur in flood abundance at certain levels. The miliolid *Cornuspira liasina* Terquem appears sporadically in some samples (see figure 2). In the upper part of the section, only free small multilocular agglutinated forms are represented; the elongated uniserial

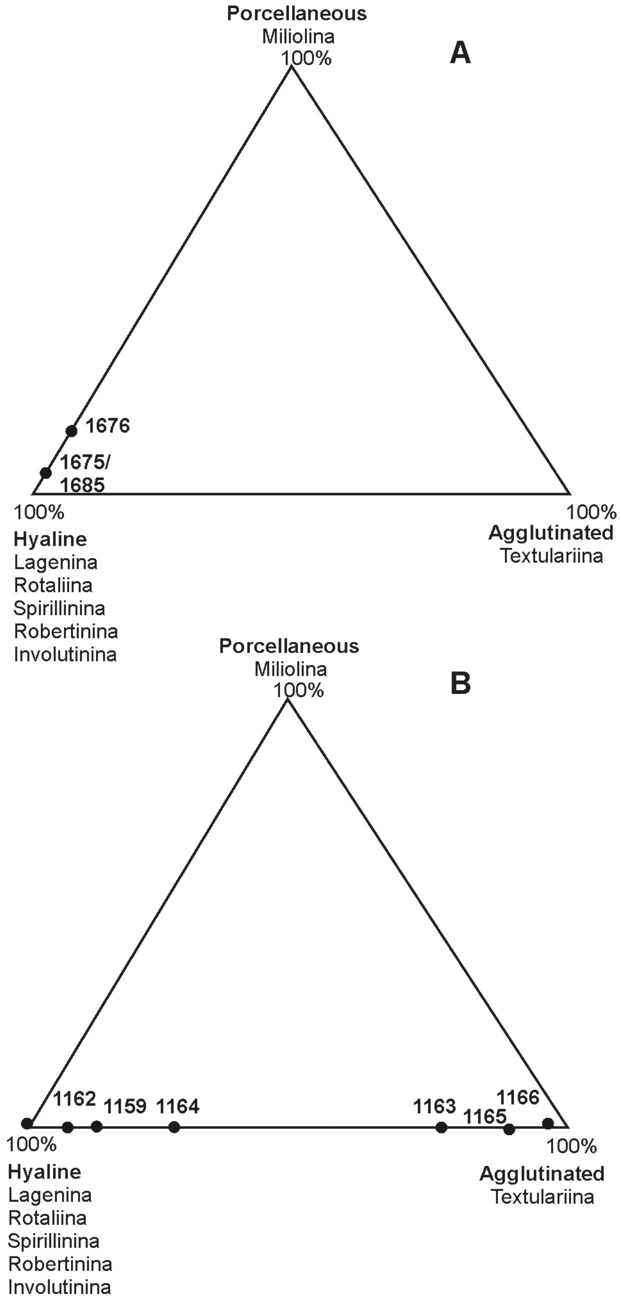


Figure 4. Triangular diagrams of wall structure and suborders (modified from Murray, 1991) / *Diagramas triangulares de relación composición de la pared y subórdenes (modificado de Murray, 1991).* **A,** Picún Leufú section/ *sección Picún Leufú*; **B,** María Rosa Curicó section / *sección María Rosa Curicó.*

Reophax liasica Franke and the planispiral *Ammobaculites agglutinans* (d'Orbigny) and *A. fontinensis* (Terquem).

Ostracods

A. *Faunal density and specific diversity, relative percentage ostracod distribution, carapace morphology.* Of thirty five samples, thirteen contained ostracods. As shown in figure 2, they are very scarce in the lower part of the section. However, they are well represented in the middle part (samples 1680-1686) where the Cytheroidea, especially the Cytheruridae are clearly dominant. This family is represented by species characterized by small and delicate carapaces with a flattened ventral surface and merodont hinge. From a total of twenty species recognized, sixteen are Cytheroidea of which fifteen belong to the Cytheruridae (see Taxonomic Appendix). Platycopids, cyprids and bairdiids are subordinate.

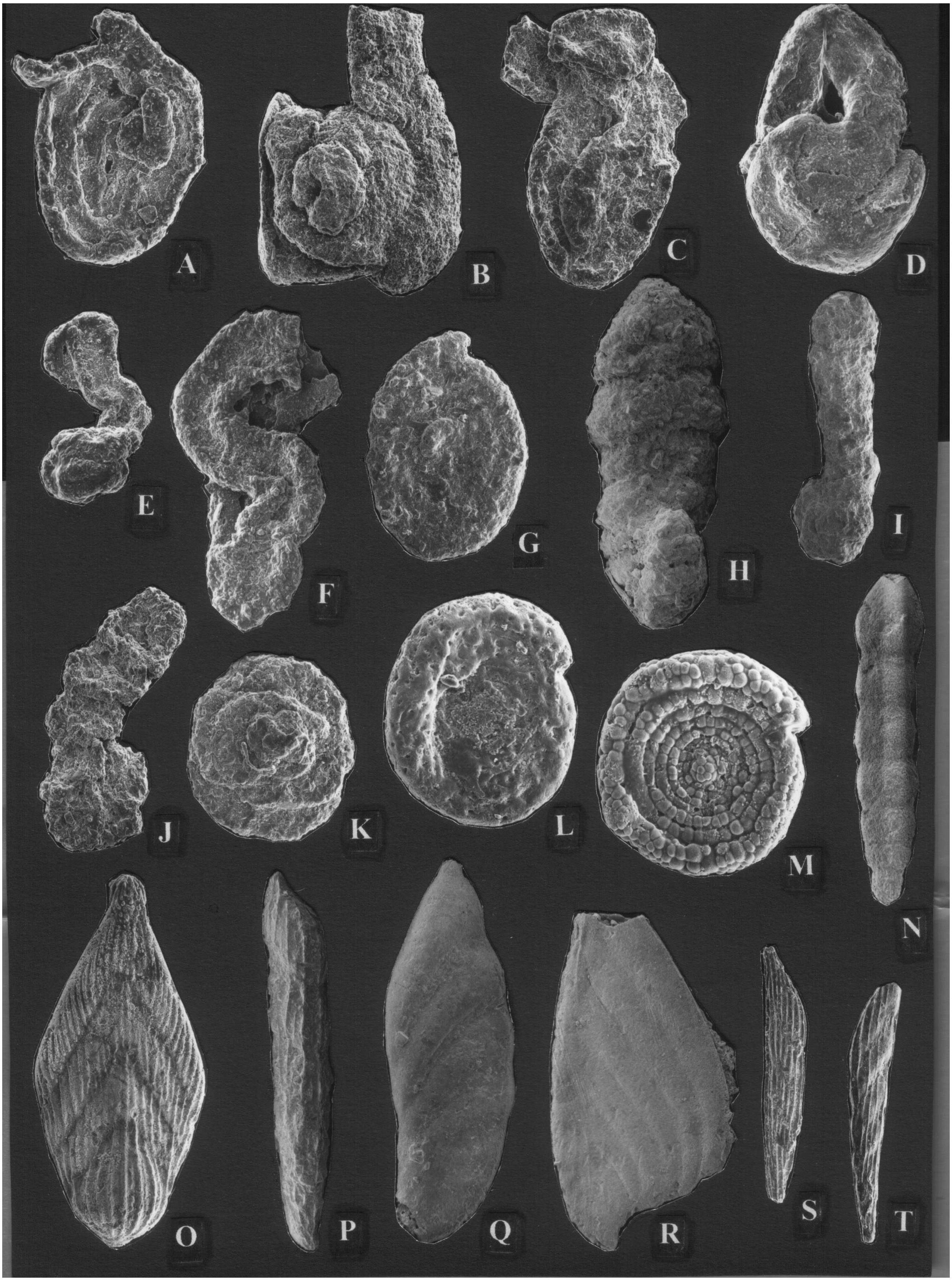
B. *Percentage of the total specimens, ratio between adult valves and carapaces, ostracod population age-structures.* In the middle part of the section, the percentage of the total individuals made up by the three most abundant species (*Paradoxorhyncha neuquenensis*, *Procytherura celtica* and *Eucytherura pichia*, all cytherurids) reaches near 50% of the total of specimens. Adults of both sexes and juvenile instars of the species are present. Cytherurids are mainly encountered as valves.

María Rosa Curicó section

Foraminifers. The foraminiferal microfauna is relatively diverse and very well preserved. Calcareous forms are represented by thirty species and agglutinated by seven species (see Appendix B).

A. *Faunal density and specific diversity, species richness, test composition-percentage of relative abundance, triangular plots of suborders.* The diversity is moderate being the maximum (14 species) in sample 1159 which also contains a few specimens of spirillinids represented by *Spirillina infima* (Strickland) and *S. tenuissima* Gümbel. Agglutinated forms are particularly abun-

Figure 5. Middle Callovian foraminifers/ *Foraminíferos del Caloviano medio.* **A-F,** ***Ammovertellina simeonae*** nov. sp., all from María Rosa Curicó section, level 1166, 75x / *todos de la sección María Rosa Curicó*, nivel 1166, 75x. **A,** Holotype/*holotipo* MLP-Mi 1275; **B,** paratype/*paratipo* MLP-Mi 1276; **C,** paratype/*paratipo* MLP-Mi 1277; **D,** Paratype /*paratipo* MLP-Mi 1278; **E,** paratype/*paratipo* MLP-Mi 1280; **F,** paratype/ *paratipo* MLP-Mi 1279; **G,** ***Glomospirella*?** sp., MLP-Mi 1296, 50x; **H-I,** ***Ammobaculites alaskensis*** Tappan. **H,** MLP-Mi 630, 55x; I, MLP-Mi 1290, 25x; **J,** ***A. irregulariformis*** Bartenstein and Brand, MLP-Mi 1302, 50x; **K,** ***Tritaxis*** cf. ***T. fusca*** Williamson, MLP-Mi 1289, 75x; **L,** ***Spirillina infima*** (Strickland), MLP-Mi 1292, 175x; **M,** ***S. tenuissima*** Gümbel, MLP-Mi 1293, 175x; **N,** ***Lingulonodosaria nodosaria*** (Reuss), MLP-Mi 641, 120x; **O,** ***Frondicularia nikitini*** Uhlig, MLP-Mi 1304, 100x; **P,** ***Marginulina*** sp. B, MLP-Mi 636, 90x; **Q,** ***Vaginulinopsis epicharis*** Loeblich and Tappan, MLP-Mi 640, 100x; **R,** ***Citharina heteropleura*** (Terquem), MLP-Mi 631, 80x; **S-T,** ***C. rollerii*** Musacchio, 50x, S, MLP-Mi 1305; **T,** MLP-Mi 1306.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dant towards the top of the section (figure 3). The curves of faunal density and specific diversity show parallel trends (see figure 3). Plotting on a triangular diagram are indicated in figure 4.B. Values lie on the Hyaline-Textulariina side due to the lack of Miliolina.

B. Calcareous/agglutinating ratio, relationship with the substrate, vertical distribution of morphogroups.

The calcareous/agglutinated ratio is very low (6.25%) in sample 1166 (figure 3). Lagenids are clearly the dominant group; broad palmate to subtriangular compressed planispiral to uniserial forms such as *Citharina*, *Citharinella*, *Vaginulina*, *Frondicularia* and *Planularia* species are the most abundant in terms of number of specimens. Elongated, straight to arcuate uniserial or planispiral-uniserial forms such as *Lingulonodosaria*, *Prodentalina*, *Dentalina* and *Marginulina* species count in fewer specimens. Lenticulinids are poorly represented and very small in size. All lagenids are recognized as megalospherics. The elongate planispiral *Ammobaculites alaskensis* Tappan is clearly the most common. The only attached agglutinated species *Ammovertellina simeonae* sp. nov. is common in sample 1166.

Ostracods

Presence/absence

From the eight samples, six contained ostracods. They are not abundant and are represented by eleven species; cytheroids include species of *Monoceratina*, *Eucytherura*, *Procytherura* and "*Progonocythere*", the cytherelloids, a new species of *Cytherella* and cypridoids with *Paracypris* (see Appendix B).

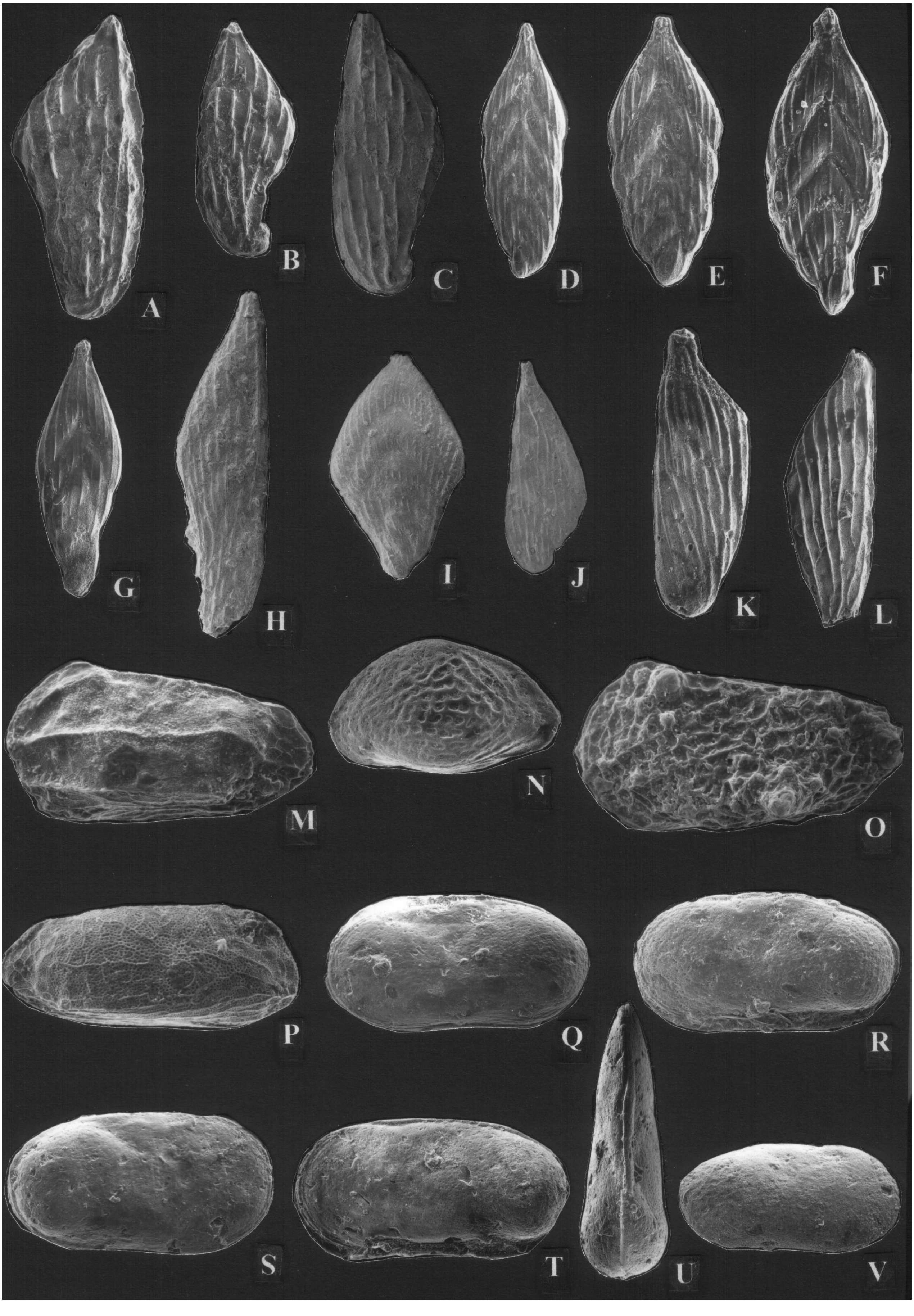
Palaeoecological comments from the analized parameters

Picún Leufú section

The dominance and diversity of lagenids suggest normal marine shelf conditions. This corresponds to Group A1 of Jurassic foraminiferal assemblages classification proposed by Gordon (1970). Jurassic lagenids seem to have preferred normal marine shelf conditions, particularly in areas of argillaceous sedimentation (Copestake and Johnson, 1989). However, the exclusive abundant presence of coiled biconvex tests (i. e. *Lenticulina*), often fragmentary, is particularly common in the lowest levels of the studied section.

Morris (1982) stated that *Lenticulina muensteri* has a better hydrodynamic stability compared with coiled and flat forms because of its better "operational sphericity", defined as the square root of the volume of the shell, divided by the volume of a circumscribed sphere. Nini *et al.* (1995, p. 296) presuppose that the biconvex lenticulines, on the whole wall adapted to live in high hydrodynamic energy, formed part of the epifauna and colonized more exposed niches compared to the flat, infaunal forms and, after the death of the organism, their shells were reworked by bottom currents or by wave energy. According to Cubaynes *et al.* (1991), a higher percentage of large, stout, tightly coiling *Lenticulina* indicates a decrease of water depth and an increase of the hydrodynamic energy. Tyszka (1994) analysed the response of Middle Jurassic foraminifers to dysoxic/anoxic conditions in the Polish Carpathians. This author included the biconvex (lenticular) tests lenticulines-like in Morphogroup C-8 characterized by an epifaunal to deep infaunal life position. After taphonomical studies, this author (p. 74) concluded that the discoidal lenticulinar shape seems to be very efficient with respect to different kinds of substrates. A keeled, biconvex discoidal shape may be advantageous for a horizontal orientation and allowing stability in shallow "soupy" ground. On the other hand, in an almost vertical position, its streamlined periphery enables easy down/upward migrations. Such advantages of shape, together with *Lenticulina*'s inferred opportunism, could be decisive for surviving and/or recolonization following fluctuations of the redox boundary. According to Bernhard (1986), oxygenated deposits contain usually higher percentages of spherical, lenticular, biumbilicate forms. Planispiral-biconvex *Lenticulina* prefers epifaunal habitats

Figure 6. Middle Callovian. Foraminifers / *Caloviano medio. Foraminíferos.* **A-C,** ***Citharina serratocostata*** (Gümbel), **A,** MLP-Mi 1299, 75x; B, MLP-Mi 1298, 75x; **C,** MLP-Mi 633, 65x; **D-F,** ***Citharinella anceps*** (Terquem), **D,** MLP-Mi 634, 50x; **E,** MLP-Mi 1294, 75x; **F,** MLP-Mi 1295, 75x; **G,** ***C. compara*** Loeblich and Tappan, MLP-Mi 1297, 75x; **H, J,** ***Vaginulina flabelloides*** (Terquem), 43x, **H,** MLP-Mi 638, **J,** MLP-Mi 639; **I,** ***Citharinella latifolia*** Loeblich and Tappan, MLP-Mi 635, 65x; **K,** ***Vaginulina*** cf. ***V. pasquetae*** Bizón, MLP-Mi 1307, 100x; **L,** ***V. macilenta*** (Terquem), MLP-Mi 1300, 75x. Ostracods/*ostrácodos.* **M,** ***Eucytherura*** sp., MLP-Mi 1073, 175x; **N,** ***"Progonocythere" neuquenensis*** Musacchio, MLP-Mi 1074, 75x; **O,** ***Eucytherura leufuensis*** Musacchio, MLP-Mi 727, 175x; **P,** ***Procytherura serangodes*** Ballent and Whatley, MLP-Mi 1076, 175x; **Q-V,** ***Cytherella mediodepressa*** sp. nov., 75x, **Q,** Holotype, MLP-Mi 616, female carapace, María Rosa Curicó section, level 1162, left lateral view/ *holotipo, caparazón femenino, vista lateral izquierda*; **R,** Paratype, MLP-Mi 724, female carapace, María Rosa Curicó section, level 1161, left lateral view/ *paratipo, caparazón femenino, vista lateral izquierda*; **S,** Paratype, MLP-Mi 1283, female carapace, María Rosa Curicó section, level 1162, right lateral view/ *paratipo, caparazón femenino, vista lateral derecha*; **T-U,** Paratype, MLP-Mi 1284, male carapace, María Rosa Curicó section, level 1163/*paratipo, caparazón masculino*, **T,** left lateral view/*vista lateral izquierda*, **U,** dorsal view/*vista dorsal*; **V,** Paratype, MLP-Mi 1286, juvenile carapace, María Rosa Curicó section, level 1162, right lateral view/*paratipo, caparazón juvenil, vista lateral derecha.*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in modern environments (Murray, 1973, 1991). The very low α index =1 indicates low diversity, although an elevated number of specimens of large and stout *Lenticulina*.

Tyszka (1994) included elongated inflated forms in Morphogroup C-5, elongated flattened forms in Morphogroups C-6a and C-6b and elongated flattened with longitudinal ribs in the Morphogroup C-6c, all of them characterized by an infaunal life position. According to this author (p. 60), elongated tests may reflect an adaptation to an infaunal habitat, especially elongated forms with straight periphery, which appear to be good burrowers.

Polymorphinids occur in flood abundance at certain levels. Brouwer (1969) considered *Eoguttulina liassica* to be a possible indicator of lagoonal or shallow marine environments, based on analogy with modern day *Guttulina* distributions. According to Shipp (1989), the significance of this group is not clear, but as they often occur in large numbers, there may be some factor, such as salinity or clarity of water, affecting their distribution. Koutsoukos and Hart (1990) referred to small Cretaceous polymorphinids from Brazil, having mobile habit occurring mostly in low diversity assemblages, of variable density, in fine-grained pelitic sediment on the shelf. Spirillinids, with the planispiral *Spirillina* and involutinids, with the conical trochospiral *Trocholina*, also occur in flood abundances at certain levels. Gordon (1970) and Shipp and Murray (1981) have interpreted the floods of spirillinids as indicative of shallowing. The occurrence of *Spirillina* in modern lagoons, principally on algae, and the presence of the conical Recent *Patellina*, as a vagrant phytal genus are referred to by Morris (1982) and Nagy (1992). Particularly in samples 1675, 1153/3 and 1685, the diversity value of α index close to 5 suggests: a) self-sea of normal salinity, b) normal marine lagoon, and c) hypersaline marsh. Plots on a triangular diagram (figure 4.A) referred to samples 1675, 1676 and 1685 lie on the Hyaline-Porcellaneous side; values of the rest of the samples lie on 100% Hyaline. These values suggest: a) most shelf seas, b) normal marine lagoons, c) hypersaline lagoons. The absence of either evaporites or desiccation cracks at these levels favours the first mentioned conditions (a and b).

Small agglutinated forms (*Reophax* and *Ammobaculites*) are the only specimens present to the top of the section. Foraminiferal associations represented predominantly or exclusively by small, simple agglutinating species are equivalent to Gordon's (1970) Type A2 of shelf assemblage and it has been consistently associated with regions of low oxygen levels and lowered pH, leading to unavailability of calcium carbonate, in both fossil and Recent environments. Such conditions are characteristic of two different environments: marginal marine areas of reduced salinity (marshes, estuaries, deltas) and deep marine areas (below the carbonate compensation depth). With reference to the former environment, examples have been mentioned by Copestake and Johnson (1989) and Shipp (1989) from the Jurassic of Britain. The genera *Reophax* and *Ammobaculites*, uniserial elongated and planispiral respectively, are included in the Morphogroup 3 of Nagy (1992) who recognized agglutinated foraminiferal morphogroups in Jurassic North Sea deltas area. They are considered to have a preferentially infaunal habitat and interpreted as representative of a prodelta muddy environment. According to this author (p. 120), most specimens of *Ammobaculites fontinensis* are planispiral, while some tests are extended by an uncoiled uniserial portion. In its planispiral growth stage, the species was probably a mobile infaunal form similarly to *Haplophragmoides*, but changed its habitat and feeding strategy by becoming more passive in its uncoiled stage. Species of *Ammobaculites* were found living infaunally in estuarine sediments to a depth of 10-15 cm by Buzas (1974) who concluded that "perhaps *Ammobaculites* has less stringent oxygen requirements than other observed [forms]" (cf. Jones and Charnock, 1985). Similarly, in the late Jurassic-early Cretaceous of Dorset, *Ammobaculites* cf. *obliquus* (cf. Radley, 1993) is interpreted as being an environmentally tolerant opportunist, which inhabited muddy, brackish, lagoonal substrates or marginal mud-flats deposited under ephemeral dysaerobic conditions.

Within the ostracods, the composition of the cytheroid fauna points to an environment of deposition on the shelf with clear, well-oxygenated waters, while the presence of *Cytherelloidea*, a well-known warm water indicator (Sohn, 1962) indicates inner rather outer shelf in a subtropical or warmer environment. These characteristics agree with the relatively high diversity of the association and the circumstance that the percentage of the total individuals made up by the three most abundant species (*Paradoxorhyncha neuquenensis*, *Procytherura celtica* and *Eucytherura pichia*, all cytherurids) reaches near 50% of the total of specimens. Mesozoic cytherurids seem to have been confined to shelf depths, with many species also in marginal marine environments. They are today (and were) crawling forms dwelling on soft relatively fine-grained substrates. Their typical carapace with flattened ventral surface may have acted to facilitate locomotion and prevent its sinking into the sediment. The presence of adults of both sexes and of juvenile instars well back into the ontogeny of the species, can be interpreted as the product of a low energy regime, typified (in modern analogues) by Histogram of Type A of

Whatley (1983). The fact that certain species were encountered as articulated carapaces and others as valves, as demonstrated by Whatley, 1988 (p. 252) may be due to a biological reason rather than other taphonomical ones. There exists the strong possibility that the adductor muscles of some species contract on death while in others they relax.

María Rosa Curicó section

The dominance of lagenids suggests normal marine shelf conditions. This corresponds to Group 1, of the Jurassic foraminiferal assemblages of Gordon (1970). Jurassic lagenids seem to have preferred normal marine shelf conditions, particularly in areas of argillaceous sedimentation. Flattened subtriangular to palmate morphotypes have been characterized by an epifaunal to shallow infaunal inferred mode of life in a muddy substrate; similar characteristics have been inferred for elongate, straight to arcuate morphotypes, also living in a fine-grained sandy substrate. Predominance of megalospherics indicates relative stability of the environment. Under highly variable environmental conditions, sexual reproduction is advantageous; in stable environments, asexual reproduction instead provides a mechanism for successful preserving the population (cf. Hallock, 1985).

Koutsoukos and Hart (1990) included Cretaceous elongate agglutinated morphotypes with varied chamber arrangement and coiling mode, like *Ammobaculites* and *Haphophragmium* in Morphogroup AG-A, with an inferred infaunal mode of life, as deposit feeders (bacterial and detrital scavengers) and distributed in all marine biotopes, including paralic environments.

Nagy (1992) included *Ammovertellina* in Subgroup 4-b. Its flattened, irregular test consisting of a coiled initial stage followed by a straightened later stage, suggests a sessile mode of life on a firm surface, and a passive herbivorous or detritivorous feeding habit. In addition, all eight cytheroid ostracod recovered species are shelf dwellers.

Plotting these data on a triangular diagram, as indicated in figure 4.B, shows that these samples lie on the Hyaline-Textulariina side due to the lack of Miliolina. One group of samples (1159, 1160, 1161, 1162, 1164) lies close to the 100% Hyaline; the others (samples 1163, 1165, 1166) lie close to 100% Textulariina and suggest: a) normal marine marshes, b) most shelf seas, c) hyposaline lagoons. It seems to indicate energy regime fluctuations with probably hyposaline and of a higher energy regime towards the top of the section.

Discussion and conclusions

A micropalaeontological investigation of two Jurassic sequences in the Neuquén Basin, Argentina is presented in this paper.

Across the Aalenian-Bajocian boundary, at the Picún Leufú section, the almost exclusive presence of stout coiled biconvex and biumbonate *Lenticulina*-like tests which occur in the lowest levels suggests high energy and well oxygenated shallow waters. Abundance and diversity of lagenids, with floods of polymorphinids, spirillinids and involutinids in the middle part of the section, indicate shallow-marginal marine restricted environment, with clear and well oxygenated waters. Normal marine conditions are usually mixtures of Miliolina and Lagenina. Diversity values of α close to 5 agree with that condition. Also, the accompanying ostracod species point to an environment of deposition on the shelf with clear, well-oxygenated and temperate waters. Low diversity of exclusively small agglutinated specimens towards the top of the section suggests a restricted marginal environment, probably of reduced salinity and higher energy regime, than the underlying levels. *Ammobaculites* is a typical estuarine or deltaic genus and in our case, the sandy lithology probably reflects a deltaic influence. These conclusions agree with the final considerations from Gulisano and Hintenwimmer (1986) who analysed the sedimentary facies across the Aalenian-Bajocian boundary between the upper part of the Los Molles Formation and the lower part of the Lajas Formation in the same area. These authors interpreted them as transitional facies, from marginal marine to increased deltaic influence towards the top of the section. Palynological evidences (Martínez *et al.*, 2002) suggest a restricted nearly coastline environment of shallow waters and reduced salinity, under warm and humid conditions.

The dominance of lagenids, mainly as megalospheric generations, and shelf dwelling cytheroid ostracods, typify stable, normal-marine shelf conditions for the Middle Callovian at the María Rosa Curicó section. This probably becomes somewhat restricted and of a higher energy regime towards the top of the section, as suggested by the dominance of agglutinated taxa -mainly *Ammobaculites alaskensis*- and the presence of the attached *Ammovertellina simeonae* sp. nov. The characterization agrees with the depositional environment proposed by Dellapé *et al.* (1979) (normal marine) and Volkheimer and Quattrocchio (1981), who, from statistical palynological studies, demonstrated for this area, a palaeoenvironment near a coast with abundant vegetation.

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APPENDIX A. Systematic descriptions

(Following Loeblich and Tappan, 1987 for Foraminifera and Moore and Pitrat, 1961 for Ostracoda).

Orden FORAMINIFERIDA Eichwald, 1830
Suborder TEXTULARIINA Delage and Hérouard, 1896
Superfamily AMMODISCACEA Reuss, 1862
Family AMMODISCIDAE Reuss, 1862
Subfamily AMMOVERTELLININAE Saidova, 1981

Genus ***Ammovertellina*** Suleymanov, 1959

Type species. *Ammovertellina prima* Suleymanov, 1959, in Loeblich and Tappan, 1987, p. 50, plate 39, figs 1-7.

Ammovertellina simeonae sp. nov.
Figures 5.A-F

1995 *Tolypammina* sp. in Simeoni, plate 2, fig. 9.

Material and repository. Twenty specimens. MLP-Mi 1275 to 1282.
Derivatio nominis. Dedicated to Dr. Margarita Simeoni, micropalaeontologist of the Universidad Nacional de la Patagonia San Juan Bosco, Argentina, who first recorded and illustrated this species.
Holotype. MLP-Mi 1275, María Rosa Curicó, Neuquén Province, Argentina, level 1166, Mid Callovian, illustrated in Figure 5.A.
Paratypes. MLP-Mi 1276-1282, María Rosa Curicó, Neuquén Province, Argentina, level 1166.
Locality and level type. María Rosa Curicó, Neuquén Province, Argentina, level 1166.
Diagnosis. Attached species of *Ammovertellina* with flattened and irregular test, with distinctive coiled stages and uncoiling final stage with irregular growth closely turning back on the coiled portion.
Description. Test attached, with an undivided tubular second chamber which is at first streptospirally coiled, later becoming clearly planispiral and its final stage uncoiling with irregular growth, closeling turning back on its coiled stage. Wall finely agglutinated. Streptospiral stage irregular and distinctive; planispiral stage with two or three whorlds and raised spiral suture. Aperture at the open end of the tube.
Dimensions (in mm). Holotype: MLP-Mi 1275 length= 0.400; Figured paratypes: MLP-Mi 1276 Length= 0.470; MLP-Mi 1277 length= 0.460; MLP-Mi 1278 length= 0.450; MLP-Mi 1279 length= 0.500; MLP-Mi 1280 length= 0.300.
Geographical and stratigraphical occurrence. María Rosa Curicó section, Neuquén Province, Argentina, level 1166; Mid Callovian (*Rehmannia patagoniensis* Horizon).
Remarks. The flattened and irregular test of this new species suggests an attached mode of life on a firm substrate. Occasionally, a zigzag-like development of the uncoiling last portion of the test is present (see figure 5.F). The agglutinated wall is of fine white and well selected quartz grains. The type species, *A. prima* Suleymanov from the Palaeocene of Uzbeckistan, ex USSR, has more regular planispiral coiling and the later portion of the test turns closely back on itself at regular intervals with growth. *Lituotuba irregularis* Tappan (1955, p. 41, plate 9, figs 5-9) from the Upper Jurassic of northern Alaska is similar, but has a free test which lacks of the first streptospiral stage. Also, *A. irregularis* (Tappan) of Nagy and Johansen, 1991 (plate 3, figs 6-7) from the Upper Toarcian of the northern North Sea is closely similar to this new species, although it has a well-developed straight final stage free from the test.

Class OSTRACODA Latreille, 1806
Subclass PODOCOPA Müller, 1894
Order PLATYCOPIDA Müller, 1994
Suborder PLATYCOPINA Sars, 1866
Family CYTHERELLIDAE Sars, 1866

Genus **Cytherella** Jones, 1849

Type species. *Cytherina ovata* Roemer, 1840, in Moore and Pitrat, 1961, p. 382, fig. 309.

Cytherella mediodepressa sp. nov.
Figures 6.Q-V

1979 *Cytherella* sp. Musacchio, p. 256, plate III, fig. 1.

Material and repository. Twelve carapaces. MLP-Mi 616, 724, 1283-1288.
Derivatio nominis. From the characteristic depressed median dorsal area of the carapace.
Holotype. MLP-Mi 616, María Rosa Curicó, Neuquén Province, Argentina, level 1162, Mid Callovian, illustrated in Figure 6.Q.
Paratypes. MLP-Mi 724, María Rosa Curicó, level 1161; MLP-Mi 1283, 1285, 1286,1287, 1288, María Rosa Curicó, level 1162; MLP-Mi 1283, María Rosa Curicó, level 1663, Neuquén Province, Argentina.
Locality and level type. María Rosa Curicó, Neuquén Province, Argentina, level 1162.
Diagnosis. Medium species of *Cytherella* clearly swollen posteriorly and with depressed dorso- median area.
Description. Carapace medium in size, elongate subrectangular in lateral view, with both dorsal and ventral margins almost parallel. Depressed dorso-median area, above muscle scar depression. Anterior margin, broadly and regularly rounded; posterior margin rounded-truncate. Dorsal margin slightly and regularly arched in right valve; in the smaller left valve with a weak antero-median concavity. Ventral margin concave in the median third. Highest part of the valve at about half length. Compressed half anterior and distinctive swollen posteriorly. External surface smooth or with weak puncta distributed parallel to margins. Right valve larger than left and regularly overlapping along entirely periphery of the valve. In dorsal view, the carapace is subtriangular, truncate posteriorly and very compressed anteriorly with the maximum width at posterior third. Dimorphic, males are narrower than females in dorsal view. Internal features not observed.
Dimensions (in mm). Holotype MLP-Mi 616, female carapace, Length= 0.440, height= 0.240, width= 0.230; figured paratypes MLP-Mi 724, female carapace, length= 0.440, height= 0.240, width= 0.200; MLP-Mi 1283, female carapace, length= 0.440, Height= 0.250, Width= 0.250; MLP-Mi 1284, male carapace, length= 0.680, height= 0.230, width= 0.165; MLP-Mi 1286, juvenile carapace, length= 0.380, height= 0.190, width= 0.150.
Geographical and stratigraphical occurrence. María Rosa Curicó section, Neuquén Province, Argentina, levels 1160, 1161, 1162, 1163, 1166; Mid Callovian (*Rehmannia patagoniensis* Horizon).
Remarks. *Cytherella bensoni* Dingle (1984, p. 110, figs 5A-B, 6) from the offshore Albian Falkland Plateau, closely resembles this new species, although the former is larger (0.83mm in length) and higher anteriorly than the Argentinian species and with faint ridges and reticulation in posterior half of the carapace. *Cytherella* cf. *collapsa* Grekoff in Bate (1975 (p. 171, plate 1, fig. 11) from the Middle Callovian of Tanzania lacks the posterior swelling which is present in the present species.

APPENDIX B. Taxonomic appendix

Late Aalenian-Early Bajocian

Foraminifer species recognized

Reophax liasica Franke, 1936
Ammobaculites agglutinans (d'Orbigny, 1846)
(in Ellis and Messina, 1940)
Ammobaculites fontinensis (Terquem, 1870)
(in Ellis and Messina, 1940)
Trocholina unica Ballent, 1999
Spirillina infima (Strickland, 1846) *emend*. Barnard, 1952
Cornuspira liasina Terquem, 1866 (in Ellis and Messina, 1940)
Ichthyolaria lignaria (Terquem, 1866) (in Ellis and Messina, 1940)
Lingulonodosaria nodosaria (Reuss, 1863) (in Ellis and Messina, 1940)
Prodentalina pseudocommunis (Franke, 1936)
Prodentalina subsiliqua (Franke, 1936)
Falsopalmula sp. (in Ballent, 1999)
Nodosaria liassica Barnard, 1950
Nodosaria cf. *N. multicostata* (Bornemann, 1854)
Nodosaria mutabilis Terquem, 1870 (in Ellis and Messina, 1940)
Nodosaria opalini Bartenstein, 1937 (in Bartenstein and Brand, 1937)
Nodosaria pectinata (Terquem, 1870) (in Ellis and Messina, 1940)
Nodosaria sp. A (*in* Ballent, 1999)
Nodosaria sp. B (*in* Ballent, 1999)

Lingulina esseyana Deecke *sensu* Barnard, 1956
Lingulina longiscata (Terquem, 1870) (in Ellis and Messina, 1940)
Frondicularia franconica Gümbel, 1862 (in Ellis and Messina, 1940)
Tristix liasina (Berthelin, 1879)
Lenticulina dictyodes costata Brand and Ohmert, 1992
Lenticulina muensteri (Roemer, 1839) (in Ellis and Messina, 1940)
Lenticulina quenstedti decorata Ballent, 1997
Lenticulina quenstedti violetae Ballent, 1997
Lenticulina subalata (Reuss, 1854) (in Ellis and Messina, 1940)
Lenticulina varians (Bornemann, 1854)
Lenticulina sp. A (in Ballent, 1999)
Astacolus aivinus Ballent, 1999
Astacolus dorbignyi (Roemer, 1839) (in Ellis and Messina, 1940)
Astacolus scalptus (Franke, 1936)
Astacolus sp. (in Ballent, 1999)
Marginulina sp. (in Ballent, 1999)
Citharina heteropleura (Terquem, 1868) (in Ellis and Messina, 1940)
Citharina proxima (Terquem, 1868) (in Ellis and Messina, 1940)
Planularia beierana (Gümbel, 1862) (in Ellis and Messina, 1940)
Planularia lanceolata Schwager, 1865 (in Ellis and Messina, 1940)
Planularia sp. (in Ballent, 1999)
Vaginulina legumen (Linn,) *sensu* Cifelli, 1959
Vaginulina reversa (Blake, 1876) (in Ellis and Messina, 1940)
Lagena sp. (in Ballent, 1999)
Eoguttulina anglica Cushman and Ozawa, 1930
Eoguttulina liassica (Strickland, 1846) (in Ellis and Messina, 1940)
Eoguttulina polygona (Terquem, 1864) (in Ellis and Messina, 1940)
Eoguttulina sp. (in Ballent, 1999)
Eoguttulina ? sp. A (in Ballent, 1999)
Eoguttulina ? sp. B (in Ballent, 1999)
Globulina ? sp. (in Ballent, 1999)
Oolina sp. (in Ballent, 1999)
Reinholdella ? sp. (in Ballent, 1999)
Paalzowella feifeli (Paalzow, 1932)

Ostracod species recognized

Cytherelloidea sp. (in Ballent, 1991)
Paracypris redcarensis (Blake, 1876) (in Ballent, 1991)
Bairdiacypris triangularis Ainsworth, 1986
Bythocypris ? sp. (in Ballent, 1991)
Ektyphocythere australis Ballent, 1986
Eucytherura argentina Ballent, 1991
Eucytherura pichia (Ballent, 1991)
Eucytherura transversiplicata (Bate and Coleman, 1975)
Eucytherura sp. (in Ballent, 1991)
Eucytherura sp. = Ostracodo A (in Ballent,1991; see Boomer and Ballent, 1996)
Eucytherura sp. B (in Boomer and Ballent, 1996) = *Hemiparacytherida* sp. (in Ballent, 1991)
Oligocythereis? sp. = Ostracodo C (in Ballent,1991; see Boomer and Ballent, 1996)
Paradoxorhyncha neuquenensis (Ballent, 1991)
Procytherura bispinata Ballent, 1991
Procytherura celtica Ainsworth, 1986
Procytherura euglyphea Ainsworth, 1986
Procytherura serangodes Ballent and Whatley, 2000b
Procytherura sp.= Ostracodo B (in Ballent,1991; see Boomer and Ballent, 1996)
Grammanicythere sp. (in Ballent, 1991)
Ostracodo D (in Ballent, 1991).

Mid Callovian

Foraminifer species recognized

Ammovertellina simeonae sp. nov. (this paper, see APPENDIX A, systematic descriptions, figure 5.A-F)
Glomospirella? sp. (this paper, figure 5.G)
Ammobaculites agglutinans (d'Orbigny, 1846) (in Ellis and Messina, 1940)
Ammobaculites alaskensis Tappan, 1955 (figures 5.H-I)
Ammobaculites irregulariformis Bartenstein and Brand, 1951 (figure 5.J)
Haplophragmiun ? sp. (in Musacchio, 1979)
Tritaxis cf. *T. fusca* Williamson, 1858 (in Musacchio, 1979) (figure 5.K)
Spirillina infima (Strickland, 1846) *emend*. Barnard, 1952 (figure 5.L)
Spirillina tenuissima Gümbel, 1862 (in Ellis and Messina, 1940) (figure 5.M)
Spirillina? sp. (this paper)
Lingulonodosaria nodosaria (Reuss, 1863) (in Ellis and Messina, 1940) (figure 5.N)
Prodentalina cf. *P. ejuncida* Loeblich and Tappan, 1950a
Prodentalina intorta (Terquem, 1870) (in Ellis and Messina, 1940)
Prodentalina pseudocommunis (Franke, 1936)
Dentalina cf. *D. gracilistriata* Loeblich and Tappan, 1950b
Dentalina sp. 2 (in Musacchio, 1979)
Lingulina nodosaria (Terquem, 1870) (*sensu* Wernli, 1971)
Frondicularia nikitini Uhlig, 1883 (*sensu* Lutze, 1960) (figure 5.O)
Lenticulina muensteri (Roemer, 1839) (in Ellis and Messina, 1940)
Lenticulina sp. (this paper)
Astacolus hibrida (Terquem, 1870) (in Simeoni, 1995)
Marginulina sp. 1 (in Musacchio, 1979)
Marginulina sp. (in Musacchio, 1979)
Marginulina sp. B (in Ballent, 1985) (figure 5.P)
Vaginulinopsis epicharis Loeblich and Tappan, 1950a (figure 5.Q)
Citharina heteropleura (Terquem, 1868) (in Ellis and Messina, 1940) (figure 5.R)
Citharina rollerii Musacchio, 1979 (in Dellapé *et al*., 1979) (figures 5.S-T)
Citharina serratocostata (Gümbel, 1862) (*sensu* Gordon, 1961) (figures 6.A-C)
Citharinella anceps (Terquem, 1870) (in Ellis and Messina, 1940) (figures 6.D-F)
Citharinella compara Loeblich and Tappan, 1950b (figure 6.G)
Citharinella latifolia Loeblich and Tappan, 1950b (figure 6.I)
Planularia beierana (Gümbel, 1862) (in Ellis and Messina, 1940)
Planularia madagascariensis Espitalié and Sigal, 1963
Planularia cf. *P. listi* (Bornemann, 1854)
Vaginulina flabelloides (Terquem, 1868) (in Ellis and Messina, 1940) (figures 6.H, J)
Vaginulina macilenta (Terquem, 1868) (in Lutze, 1960) (figure 6.L)
Vaginulina cf. *V. pasquetae* Bizón, 1958 (figure 6.K)

Ostracod species recognized

Cytherella mediodepressa sp. nov. (this paper, see APPENDIX A, systematic descriptions, figures 6.Q-V)
Paracypris sp. 1 (in Musacchio, 1979)
Paracypris sp. 2 (in Musacchio, 1979)
Monoceratina sp. 1 (in Musacchio, 1979)
Monoceratina sp. 2 (in Musacchio, 1979)
Monoceratina sp. cf. *M. vulsa* (Jones and Sherborn) (in Ballent and Whatley, 2000a)
Eucytherura leufuensis Musacchio, 1979 (in Dellapé *et al*., 1979) (figure 6.O)
Eucytherura sp. (in Ballent and Whatley, 2000a) (figure 6.M)
Procytherura serangodes Ballent and Whatley, 2000b (figure 6.P)
Procytherura sp. B (in Ballent and Whatley, 2000b)
"*Progonocythere*" *neuquenensis* Musacchio, 1979 (in Dellapé *et al*., 1979) (figure 6.N)

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Pachycentrata, a replacement name for *Pachybatrachus* Báez and Rage, 1998 (Amphibia, Anura)

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Pachybatrachus taqueti is a hyperossified pipid frog from the Upper Cretaceous of In Beceten, Niger. It was originally described by Báez and Rage (1998) as a new genus and species related to the extant African pipines, *Hymenochirus* and *Pseudhymenochirus*. However, it was drawn to our attention that *Pachybatrachus* is a junior homonym, as the generic name was first proposed by Keferstein (1868) for an anuran species from Australia, *P. petersii*. Almost simultaneously, this generic name was also used by Mivart (1868). The latter author, unaware of Keferstein's paper, described *Pachybatrachus robustus* as the type species of a new anuran genus, based on material housed in the British Museum. Shortly after this, Mivart (1869) changed *Pachybatrachus* to *Clinotarsus*.

The new name *Pachycentrata*, in reference to the thick deposits of bone on the vertebral centra, is here proposed as a genus for the type species *Pachybatrachus taqueti* to replace Pachybatrachus (Báez and Rage, 1998). The new combination becomes *Pachycentrata taqueti*.

Acknowledgments

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