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OSTRACODS FROM THE GLOBAL STRATOTYPE SECTION FOR THE BASE OF THE AALENIAN STAGE, JURASSIC, AT FUENTELSAZ SECTION (CORDILLERA IBÉRICA, SPAIN)

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Abstract. The Toarcian/Aalenian Global Stratotype Section and Point (GSSP) have been recently placed in the Fuentelsaz section, northeastern Spain. This paper is part of a long-term project that attempts to describe for the first time the fossil ostracod assemblages present in the Toarcian-Aalenian boundary GSSP, and to assess their palaeobiogeographical significance. The study of the Late Toarcian-Early Aalenian Turmiel and Casinos formations at the Fuentelsaz section has produced a detailed stratigraphy and a large collection of stratigraphically constrained ostracod faunas. Twenty-benthic ostracod species have been identified and for the first time described in Spain. Higher part of the Mactra Subzone, Late Toarcian, have yielded abundant ostracod faunas, including mostly species of the genera *Praeschuleridea*, *Cytherelloidea* and *Kinkelinella*; fossiliferous marls of the Late Toarcian and part of the Early Aalenian and poorly fossiliferous marls at the beginning of the Opalinum Zone are dominated by *Praeschuleridea* and *Cytherelloidea*. The boundary between the Toarcian and Aalenian is not characterized by any radical change in the ostracod faunal composition. The Fuentelsaz sequence exhibits ostracod assemblages comparable to those recorded in western Europe, with many of their species having similar stratigraphical distributions.

Riassunto. Il Global Stratotype Section and Point (GSSP) del Toarciano/Aaleniano è stato recentemente definito nella sezione di Fuentelsaz, nel nordest della Spagna. Questo articolo fa parte di un progetto di più ampio respiro inteso a descrivere le associazioni ad ostracodi presenti nel GSSP, intorno al limite Toarciano-Aaleniano, nonché a individuare il loro significato paleobiogeografico. Lo studio delle formazioni Turmiel e Casinos nella sezione di Fuentelsaz, di età tardo Toarciano-base Aaleniano, ha consentito una ampia collezione di faune ad ostracodi calibrate stratigraficamente, nel contesto di una stratigrafia di grande dettaglio. Sono state identificate venti specie di ostracodi bentonici, descritti per la prima volta in Spagna. La parte superiore della Sottozona a Mactra, del Toarciano superiore, ha fornito una abbondante fauna ad ostracodi, comprendente soprattutto specie dei generi *Praeschuleridea*, *Cytherelloidea* e *Kinkelinella*. Le marne fossilifere del Toarciano superiore e di parte dell'Aaleniano inferiore e le marne scarsamente fossilifere all'inizio della Zona ad Opalinum sono dominate da *Praeschuleridea* e *Cytherelloidea*. Il limite tra Toarciano e Aaleniano non è caratterizzato da cambi radicali nella composizione faunistica degli ostracodi. La successione di Fuentelsaz contiene associazioni ad ostracodi confrontabili con quelle dell'Europa occidentale, e molte specie hanno distribuzione verticale simile.

Introduction

This study is part of a multidisciplinary project on the Global Boundary Stratotype Section and Point (GSSP) for the Aalenian Stage of the Fuentelsaz section, Castilian Branch of the Iberian Range, Spain (Cresta et al. 2001). The multidisciplinary research on the Toarcian-Aalenian boundary stratotype developed by the Aalenian Working Group (AWG) of the Universidad Complutense de Madrid (UCM), has comprised the analysis of the most characteristic fossil assemblages of ammonites, brachiopods, ostracods, bivalves, foraminifers, calcareous nannofossils and palynomorphs (García-Joral 1986; Goy & Ureta 1987, 1990, 1991; García-Joral et al. 1990; Martínez 1992; Goy et al. 1994, 1996, 1999; García-Joral & Goy 1995; Herrero & Canales 1997; Perilli 1997; Canales 2001). This paper is the first attempt to describe the Toarcian-Aalenian boundary ostracod faunas of Spain.

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The Fuentelsaz section is located approximately around 0.5 km to NNW of Fuentelsaz village (Latitude 41°4′48″N and Longitude 1°49′40″W; Coordinate Reference System ED50/Zone 30N; geological map sheet 464, 1:50.000-Gabaldón et al. 1983) and 170 km to NE of Madrid, Spain (Fig. 1). The chronostratigraphic scale of reference (Fig. 2) is based in the Grammoceratinae and Leioceratinae species succession of rich ammonite assemblages in the Fuentelsaz section (Goy & Ureta 1987). The Upper Toarcian and Lower Aalenian are represented by a well-preserved and complete succession consisting of marly-limestone rhythms and marl beds (Figs. 2, 3). Marls are dominant in the middle part of the section (Aalensis Zone, Opalinum Subzone and lower part of the Comptum Subzone) corresponding to the Turmiel Formation, while limestones prevail in the upper part of the Comptum Subzone, Opalinum Zone corresponding to the Casinos Formation (Gómez et al. 2003). The depositional environment in this time interval was represented by a fault-controlled subsiding block integrated in a N-S trending marine empiric carbonate platform well connected with the open sea until the late Comptum Biochrone. Facies pattern and biostratigraphic successions observed in the Fuentelsaz GSSP reveal a striking similarity to several outcrops of the NW Iberian Range (see García-Frank et al. 2008), where an important episode of extensional faulting has been recognized in the late Early Aalenian time interval. This tectonic pulse is represented by a drastic increase in the relative net accumulation rate (12 m/Ma) in the latest Comptum Biozone, and is especially well recorded at the Fuentelsaz section.

Institutional abbreviations. CAOC-UCM, Carmen Arias Ostracod Collection, Universidad Complutense de Madrid.

Previous Studies

The study of the late Toarcian marine ostracods from the Fuentelsaz section began with Arias (in Goy et

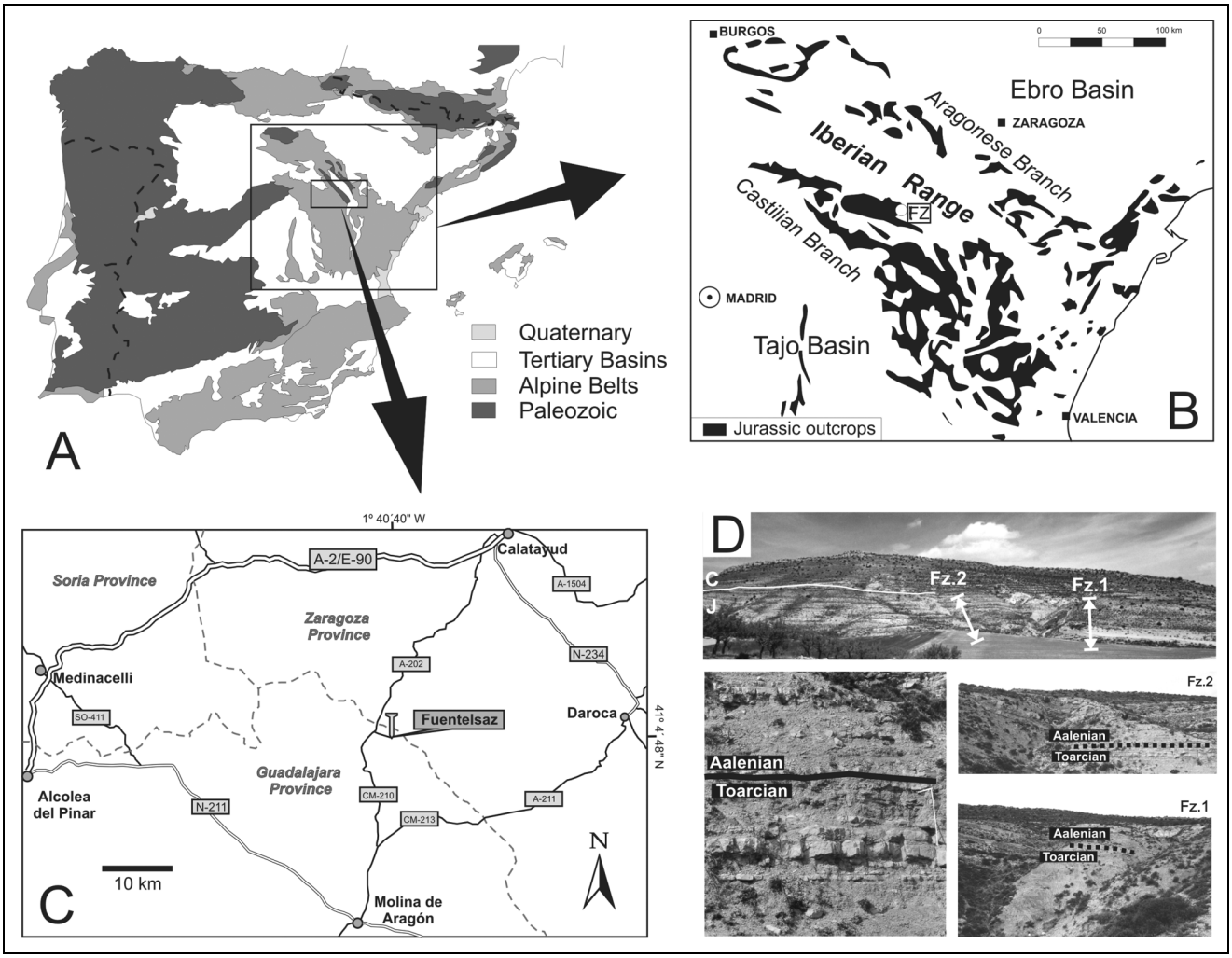


Fig. 1 - Location of Fuentelsaz GSSP with simplified geological map of the Iberian Peninsula (A), outcrop map of Jurassic rocks (black) in the Iberian Range (B), topographic map detailing the location of the GSSP (C), and field-view of the Fuentelsaz GSSP (D). Abbreviations: Fz. 1 = Fuentelsaz 1 section; Fz. 2 = Fuentelsaz 2 section.

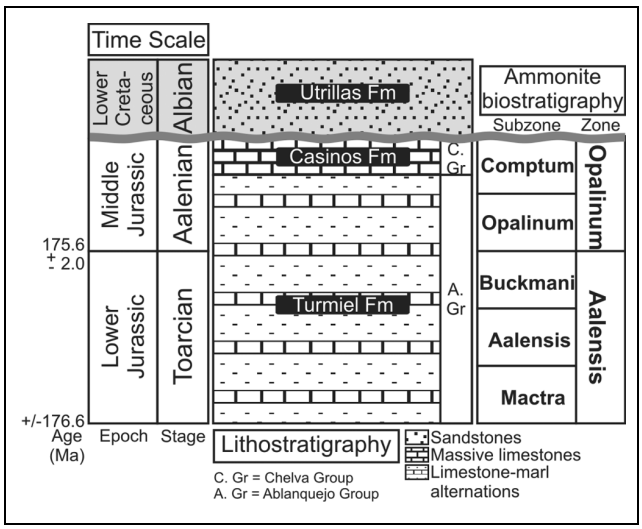


Fig. 2 - Ammonite biostratigraphy and lithostratigraphic units of the study area. The ammonite biostratigraphic scale used in this study is the one proposed by Henriques et al. (1996), based on data from the Iberian, Betic and Lusitanian basins (see also Sandoval et al. 2001), and the lithostratigraphy is based in Gómez et al. (2003). Radiometric ages from Gradstein & Ogg (2004).

al. 1994, 1996, 1999), where only a few species of the genera *Praeschuleridea*, *Cytherelloidea* and *Kinkelinella* were recorded from the Fuentelsaz section. In contrast to this panorama, ostracod faunas from western Europe (Germany and France) have been extensively studied. The analysis of the late Toarcian-early Aalenian marine ostracods of the Paris Basin began with Apostolescu (1959) and a series of papers included in the "Colloque sur le Lias Français" (Apostolescu 1961; Apostolescu et al. 1961; Bizon 1961; Champeau 1961; Magne & Malmoustier 1961; Magne et al. 1961) where a few new species of the families Protocytheridae and Cytheruridae were recorded from several parts of the Paris Basin. This study was followed by the paper of Bodergat & Donze (1988), who proposed a new biostratigraphical scale for the Toarcian sediments (including the Aalensis Zone) of the Paris Basin. A high proportion of ostracod species (five) with well-recorded ranges were identified in the Paris Basin; nevertheless, they have broad stratigraphical ranges that extend up through the Toarcian-Aalenian boundary in the rest of the European areas.

Most of the reports on Toarcian-Aalenian boundary German microfaunas have been concerned with Early Aalenian faunas (Plumhoff 1963). This author described the late Aalenian-early Bajocian ostracod fauna from the Gifhorn basin in northwestern Germany, including some species that had been previously restricted to the early Toarcian and twenty-one new species. Of the forty-seven species recovered from these areas, only five are recorded in Fuentelsaz. He pointed out that Late Aalenian ostracod fauna from northwestern Germany has common elements with Western European faunas. He proposed the first ostracod zonation that covered the Aalenian to earliest Bajocian interval. Since the 1930's, the majority of papers have tended to be more taxonomic in nature. The more important papers include those of Triebel & Bartenstein (1938) on the genus *Monoceratina*; Klingler & Neuweiler (1959) on the genus *Procytheridea*; Triebel & Klingler (1959) on the genera *Trachycythere, Aphelocythere* and *Otocythere*; Fischer's papers (1961a, b, c, 1962, 1963) on *Aphelocythere*, *Polycope*, *Monoceratina*, *Cytheropteron* and *Procytheridea*; Malz (1961, 1966) on the taxonomy, biostratigraphy and palaeoecology of the families Progonocytheridae and Healdiidae and Herrig's papers (1981a, b, c, 1982a, b) on Brachycytheridae, Cytherellidae, Cytherettidae, Cytheruridae, Paradoxostomatidae, Progonocytheridae and Trachyleberididae.

However, since its peak in 1950-1980's, there has been a steady decline in coverage rate. Late Toarcian marine ostracods from southern Germany have not been well documented, possibly because they are much scarcer than foraminifers, calcareous nannoplankton, and seemingly larger invertebrates in upper Toarcian-lower Aalenian sediments (Knitter 1983, 1984; Knitter & Ohmert 1983; Knitter & Riegraf 1984; Boomer 1994). Knitter (1983, 1984) listed thirty-seven ostracod species from twenty sections from the Late Toarcian of southern Germany. He updated the taxonomy of earlier works within his monograph, recording ten new species and proposing a first defined zonation based on ostracods, whose stratigraphy did not coincide with the ammonite divisions.

This was followed by a series of papers dealing with the generic and specific descriptions of a number of marine taxa from Baden-Württemberg area (Knitter & Ohmert 1983; Knitter & Riegraf 1984; Tröster 1987). A series of more recent studies, concerning the late Toarcian-Aalenian boundary microfaunas of the Wittnau section, Oberrhein area (proposed as a possible stratotype-section) give a detailed definition of the ostracod faunas across the Toarcian-Aalenian boundary (Ohmert & Rolf 1994; Ohmert et al. 1991, 1996). Of the thirty-five species recorded from the Wittnau section, twenty-one are also recorded in the Fuentelsaz section. Other recent works have been carried out on the Jurassic ostracod faunas (from the latemost Rhaetian to early Bajocian) along the Atlantic Continental Shelf, offshore west Ireland (Ainsworth 1986, 1989) which, in addition to comprehensive taxonomic works, concentrate on biostratigraphical aspects of the ostracods.

Material

Thirty-six marly samples of approximately 300 g each were analysed for the study. The sample processing consisted of drying,

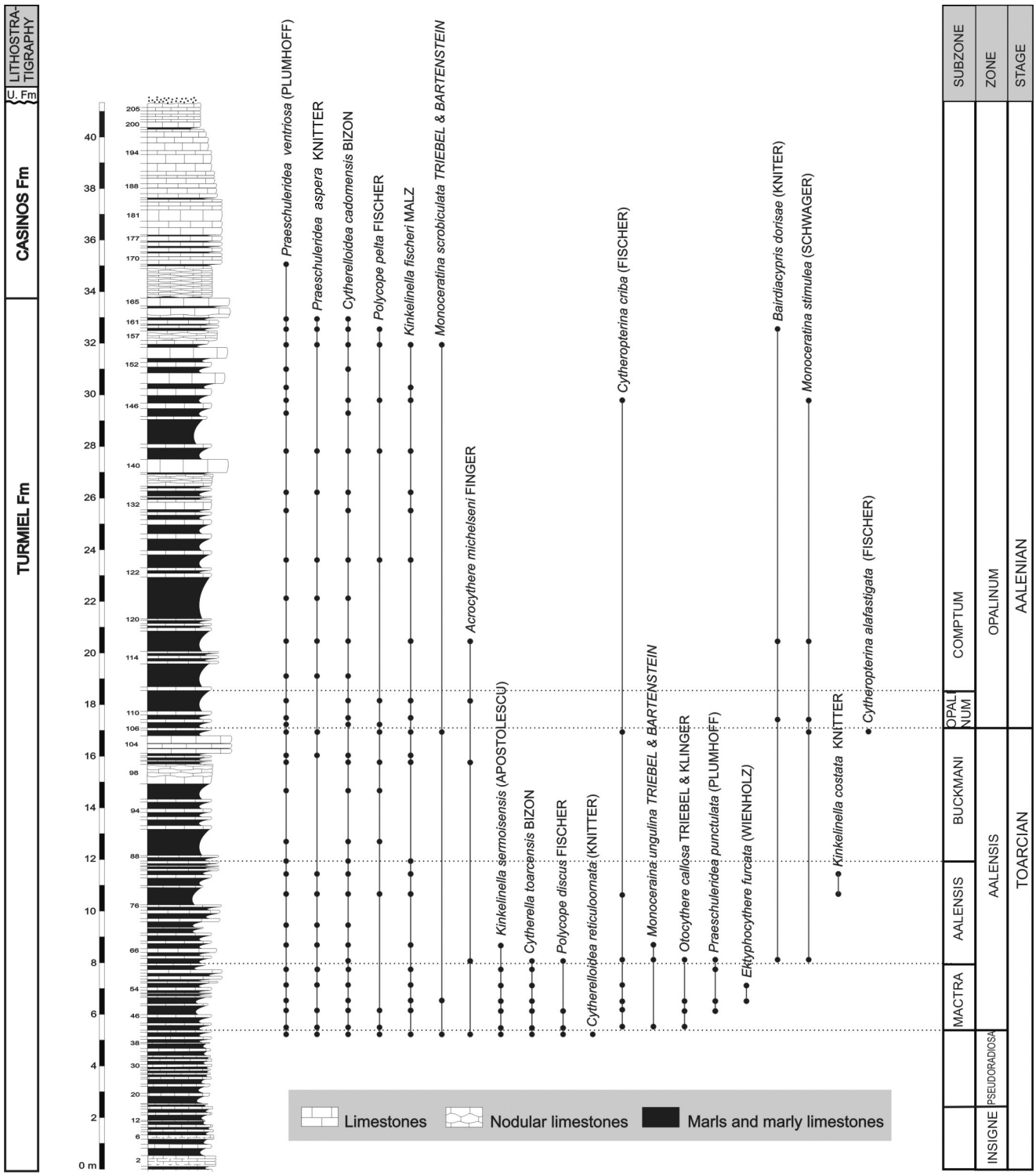


Fig. 3 - The Toarcian-Aalenian boundary section at Fuentelsaz, Cordillera Iberica. Detailed distribution of the ostracods in the Toarcian-Aalenian interval part of the section.

weighing out 300 g samples and dispersing in a solution of hydrogen peroxide, sodium hydroxide and water. The disintegrated samples were washed through sieves with mesh diameter of >60, 125, 250, 500 and 1000 µm. All ostracods from the >125 µm fraction to >1000 µm fraction were picked and mounted onto cardboard microscope slides. The fraction >60 µm was tested, revealing little influence on diversity and composition. During the study, a Zeiss binocular stereomicroscope was used, and a Scannig Electron Microscope (SEM-Jeol-JSM-6400 Centro de Microscopía Electrónica Luis Bru, Universidad Complutense de Madrid) was also used for more precise determinations and photomicrography. The majority of the twenty species recognised (11845 specimens) are largely dominated by cytheroids and cytherellids belonging to eight families and eleven genera.

All the studied material is deposited in the Paleontological collections of the Departamento de Paleontología, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, Madrid (Spain).

Systematic descriptions

Subclass **Ostracoda** Latreille, 1806

Suborder **Cladocopina** Sars, 1866

Order **Myodocopida** Sars, 1866

Family Polycopidae Sars, 1866

Genus *Polycope* Sars, 1866

Polycope discus Fischer, 1961a

Pl. 1, fig 1

* 1961a *Polycope discus* n. sp. Fischer, pp. 497-499, pl. 1 (inf).
1975 *Polycope* sp. 4044 - Michelsen, p. 263, pl. 40, fig. 564.
1983 *Polycope discus* Fischer - Knitter, p. 217, pl. 34, figs. 1-2.
? 1986 *Polycope transversiplicata* Ainsworth, pp. 289-290, pl. 1, figs. 2-4.
? 1986 *Polycope* sp. A Ainsworth, p. 290, pl. 1, fig. 5.
1987 *Polycope discus* Fischer - Tröster, p. 444, fig 1.
1999a *Polycope discus* Fischer - Arias & Lord, p. 78, pl. 1, fig. 4.

Diagnosis: See Fischer 1961a, fig. 498.
Material: See Tab. 1.

Dimensions (mm). Length 0.27-0.3; height 0.23-0.30 and width 0.12-0.19.

Remarks. The material referred to this species is as a rule poorly preserved and, therefore, has sometimes not been possible to see clearly the secondary, weak, transverse ridge ornamentation, which is characteristic of *Polycope discus* Fischer, 1961a.

Stratigraphic and geographic range. Denmark: lower Sinemurian (Michelsen 1975); southwest Ireland, Fastnet Basin: late Toarcian to Aalenian (Ainsworth 1986); Germany: Lias zeta (Fischer 1961a; Knitter 1983); Portugal: Toarcian, Bifrons to Levesquei zones (Boomer et al. 1998); Switzerland: late Toarcian, Variabilis Zone (Tröster 1987); Cordillera Ibérica: lower Toarcian, Bifrons Zone (Arias & Lord 1999a); Toarcian, from Pseudoradiosa Zone to Aalensis Zone, Aalensis Subzone, of the Fuentelsaz section.

Polycope pelta Fischer, 1961a

Pl. 1, fig. 2

1938 Ostracod (227) - Wischer, pl. 27, fig. 4.
1959 Ostracod sp. (227) E 103 (Wischer)- Apostolescu, p. 447, tb. 2.
* 1961a *Polycope pelta* n. sp. Fischer, p. 499, fig. 11.
1963 *Polycope pelta* Fischer - Plumhoff, p. 17, pl. 1, figs. 1-2.
? 1975 *Polycope minor* n. sp. Michelsen, p. 261, pl. 38, figs. 546-457, pl. 39 figs. 552-555.
1975 *Polycope pelta* Fischer - Michelsen, p. 262, pl. 40, figs. 570-573.
1979 *Polycope pelta* Fischer - Exton, p. 65, pl. 11, fig. 4.
? 1979 *Polycope* sp. 1 - Exton, p. 65, pl. 11, fig. 3.
? 1980 *Polycope minor* Michelsen - Sivhed, p. 58, pl. 12, fig. 118.
1981a *Polycope pelta* Fischer - Herrig, p. 679, pl. 2, figs. 1-5.
1983 *Polycope pelta* Fischer - Knitter, p. 217, pl. 34, fig. 3.
1984 *Polycope pelta* Fischer - Exton & Gradstein, p. 27, pl. 2, fig. 13.
1985 *Polycope pelta* Fischer - Riegraf, p. 71, pl. 1, fig. 4.
1986 *Polycope pelta* Fischer - Ainsworth, p. 289, pl. 1, fig. 1.
? 1986 *Polycope* cf. *minor* Michelsen - Ohm, p. 119, pl. 24, fig. 11.
1986 *Polycope pelta* Fischer - Ohm, p. 119, pl. 24, fig. 12.
1986 *Polycope* sp. B Ohm, p. 119, pl. 24, fig. 15.
1987 *Polycope pelta* Fischer - Tröster, pl. 4, fig. 2.
1992 *Polycope pelta* Fischer - Arias & Comas-Rengifo, p. 432, pl. 1, fig. 1.
1999a *Polycope pelta* Fischer - Arias & Lord, p. 78, pl. 1, fig. 4.

Diagnosis: See Fischer, 1961a, fig. 499.
Material: See Tab. 1.

Dimensions (mm). Length 0.27-0.49; height 0.23-0.38 and width 0.15-0.17.

Remarks. *Polycope pelta* Fischer, 1961a was originally described from the Pliensbachian to Aalenian of Baden-Württemberg (southern Germany). Nevertheless, its ambiguous description and the poor definition of its illustrations made difficult a more precise attribution. Thus, those forms described by Drexler (1958), Donze (1967), Exton (1979) (*Polycope* sp. 1) and Riegraf (1985) show a perfectly smooth carapace, whereas others exhibit a weak peripheral reticulation (Fischer 1961a; Michelsen 1975; Knitter 1983; Riegraf 1985; Ohm 1986) and finally, other forms which have a coarse ornamentation, such as the specimens recorded by Exton (1979), Ainsworth (1986) and Ohm (1986) could be assimilated into the present species. The species *Polycope minor* Michelsen, 1975, exhibits a weak ornamentation and its size is smaller than the present material.

Stratigraphic and geographic range. Denmark: late Sinemurian to late Pliensbachian (Michelsen 1975); southwest Ireland, Fastnet Basin: Toarcian and Aalenian (Ainsworth 1986); France: Toarcian and Aalenian (Apostolescu 1959); Germany: Hettangian to early Pliensbachian (Herrig 1981a); late Sinemurian to late Pliensbachian (Ohm 1986); Lias delta to the earliest Dogger (Fischer 1961a); Lias zeta to Dogger alfa (Knitter 1983); Domerian to early Toarcian (Riegraf 1985);

Tab. 1 - Range chart of the species recognized in the Fuentelsaz section.

Samples/Species	41	43	47	49	55	61	63	67	71	77	81	87	89	97	99	103	105	107	109	111	113	115	121	123	131	135	141	145	147	149	151	155	158	162	168
Polycope discus	1	2	1				1																												
Polycope pelta	1	2	1							1			1	1	2		4	2		1				1			1		2						
Cytherella toarcensis	9	70	23	4	5	3																													
Cytherelloidea cadomensis	30	57	66	24	240	200	120	15	80	167	78	200	120	20	50	29	90	78	34	23	34	80	89	115	167	154	20	6	179		5	120	89	12	
Cytherelloidea reticuloornata	1													1																					
Bairdiacypris dorisae							3										1	1				1													
Monoceratina scrobiculata	3		1													2																1			
Monoceratina stimulea							2										1	1				2							1						
Monoceratina unguilina		3					1	1								1																			
Cytheropteron alafastigatum																	1																		
Cytheropteron cribum		3	2	2	1		1			1							1												1						
Okocythere callosa		3	3	2			1																												
Eucytherura tricostata	1						1								1					1															
Ektyphocythere furcata			1	2																															
Kinkelinella costata										15	12																								
Kinkelinella fischeri	13		23	33	44	34	22	34		32	23	14			23	13	12		5	12		12		10	12	55	33			35	3			10	
Kinkelinella sermoisensis	15	15	23	24	34	45	23	12																											
Praeschulerideа aspera	60	34	22		55	14	10		60	55	78					5	70			30		12	5			54	7						30	16	1
Praeschulerideа punctulata			34	25		2	3																												
Praeschulerideа ventriosa	34	103	56	23	222	256	167	155	237	189	322	367	45	12	56	12	189	234	56	23	44	55	23	154	122	34	23	11	234	23	34	76	120	34	23

Aalenian, Opalinum Zone (Plumhoff 1963); Great Britain: Toarcian of the Mochras Borehole, Wales (Boomer 1991); Portugal: late Pliensbachian to late Toarcian, (Exton 1979; Boomer et al. 1998); Northern Switzerland: late Toarcian-early Aalenian, Opalinum Zone (Tröster 1987). Cordillera Ibérica: Toarcian, from Tenuicostatum to Bifron zones (Arias & Lord 1999a) and from Toarcian, Pseudoradiosa Zone, to Aalenian, Opalinum Zone, of the Fuentelsaz section.

Suborder **Platycopina** Sars, 1866

Superfamily Kloedenelloidea Ulrich & Bassler, 1908

Family Cytherellidae Sars, 1866

Genus *Cytherella* Jones, 1849

Cytherella toarcensis Bizon, 1960

Pl. 1, figs 3-5

1959 *Cytherella* sp. 1099b (Buck) - Apostolescu, p. 447, pl. 2, fig. 16.

PLATE 1

Fig. 1 *Polycope discus* Fischer, 1961: 1) Carapace in left view, adult. Aalensis Zone, Mactra Subzone (FZ-47.75).

Fig. 2 *Polycope pelta* Fischer, 1961: 2) Carapace in left view, adult. Aalensis Zone, Mactra Subzone. (FZ-47.79).

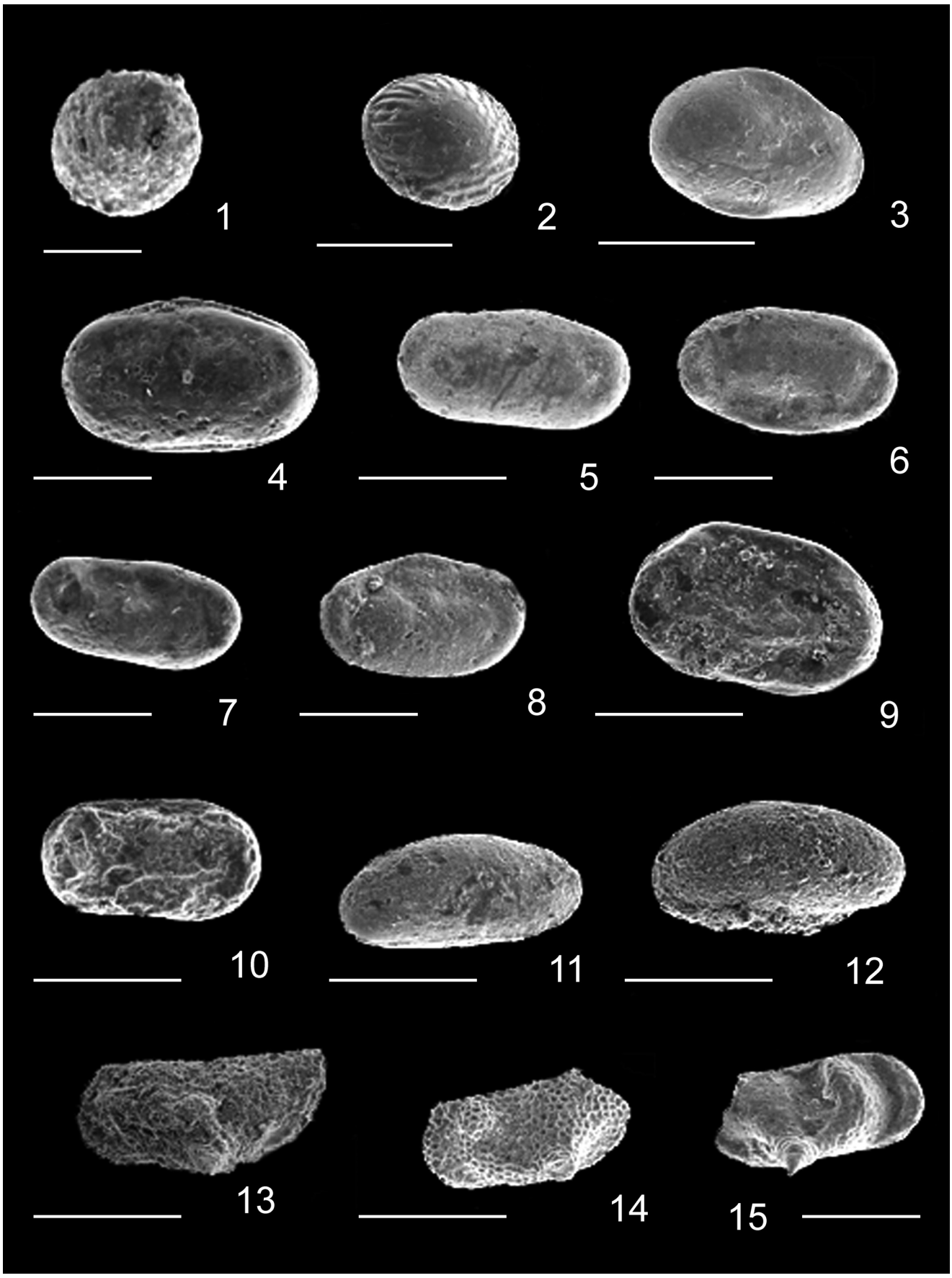
Figs. 3-5 *Cytherella toarcensis* Bizon, 1960: 3) Right valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.17); 4) Carapace in left view, adult. Aalensis Zone, Mactra Subzone. (FZ-41.23); 5) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.45).

Figs. 6-9 *Cytherelloidea cadomensis* Bizon, 1960: 6) Right valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.44); 7) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.6); 8) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.22); 9) Right valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.80).

Fig. 10 *Cytherelloidea reticuloornata* Knitter, 1983: 10) Carapace in left view, adult. Aalensis Zone, Mactra Subzone. (FZ-41.13).

Figs. 11-12 *Bairdiacypris dorisae* Knitter, 1983: 11) Carapace in right view, adult. Aalensis Zone, Aalensis Subzone. (FZ-63.2); 12) Carapace in right view, adult. Aalensis Zone, Aalensis Subzone. (FZ-63.5).

Fig. 13-15 *Monoceratina scrobiculata* Triebel & Bartenstein, 1938: 13) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.4); 14) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.13); 15) Right valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.11).
Scale bar 400 μm long.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*1960 *Cytherella toarcensis* n. sp. Bizon, p. 203, pl. 1, figs. 4a-c, pl. 2, figs. 2a-c.
1967 *Cytherella* sp A - Wienholz in Stoermer & Wienholz, pp. 543-544, pl. 1, figs. 3, 4.
? 1975 *Cytherella toarcensis* Bizon - Bate & Coleman, p. 5, pl. 1, figs. 5, 6, 10.
? 1978 *Cytherella toarcensis* Bizon - Lord, p. 200, pl. 3, tb. 1.
1979 *Cytherella toarcensis* Bizon - Exton, fig. 64, pl. 11, figs. 8-9.
1984 *Cytherella toarcensis* Bizon - Exton & Gradstein, p. 26, pl. 2, fig. 10.
1984 *Cytherella toarcensis* Bizon - Knitter & Riegraf, p. 95, pl. 4, fig. 4.
1985 *Cytherella toarcensis* Bizon - Bodergat et al., pp. 118-119, pl. 1, fig. 14.
1986 *Cytherella apostolescui* sp. nov. Ainsworth, pp. 290-291, pl. 1, figs. 6, 13.
1987 *Cytherella toarcensis* Bizon - Tröster, p. 445, pl. 4, fig. 4.
1988 *Cytherella toarcensis* Bizon - Bodergat & Donze, p. 1264, pl. 1, fig. 10.
?1989 *Cytherella* sp. A Ainsworth & Horton - Ainsworth, p. 125, pl. 1, figs. 2-4.
1991 *Cytherella praetoarcensis* sp. nov. - Boomer, p. 206-208, pl. 2, figs. 4, 5, 9.
1992 *Cytherella toarcensis* Bizon - Arias & Comas-Rengifo, p. 436-437, pl. 1, fig. 6-8.
1992 *Cytherella toarcensis* Bizon - Arias et al., pl. 2, fig. 12.
1999a *Cytherella toarcensis* Bizon - Arias & Lord, p. 78-79, pl. 1, fig. 4.

Diagnosis: See Bizon 1960, fig. 103.
Material: See Tab. 1

Dimensions (mm). Length 0.26-0.80; height 0.20-0.36 and width 0.15-0.20.

Remarks. *Cytherella toarcensis* Bizon, 1960 is similar in general lateral outline to *Cytherella lindseyensis* Lord, 1974 but its size is smaller and less ovoid in lateral outline. *Cytherella apostolescui* Ainsworth, 1986 and *Cytherella praetoarcensis* Boomer, 1991 can be distinguished by having a more elongated and subrectangular outline in lateral view (*Cytherella apostolescui* Ainsworth, 1986) and having a more suboval to subtriangular dorsal outline (*Cytherella praetoarcensis* Boomer, 1991).

Stratigraphic and geographic range. Southwest Ireland, Fastnet Basin: lower Toarcian and Aalenian (Ainsworth 1986); France: Bifrons and Jurense zones of Normandy (Bizon 1960); Falciferum to Aalensis Zones of Quercy (Bodergat et al. 1985; Bodergat & Donze 1988); Germany: late Toarcian to Aalenian (Knitter 1983; Knitter & Riegraf 1984; Riegraf 1985); Great Britain: Falciferum and Bifrons zones (Bate & Coleman 1975); Falciferum to Levesquei zones (Lord 1978), Falciferum to Variabilis zones at Mochras, Wales (Boomer 1991); Portugal: late Toarcian, Falciferum to Levesquei zones, and Aalenian at Zambujal (Exton 1979; Exton & Gradstein 1984; Boomer et al. 1998); Switzerland: late Toarcian and Aalenian (Tröster 1987); Cordillera Ibérica: late Pliensbachian and early Toarcian (Arias 1991, 1995; Arias & Comas-Rengifo 1992; Arias et al. 1992; Arias & Lord 1999a); late Toarcian, Pseudoradiosa and Aalensis zones, of the Fuentelsaz section.

Genus *Cytherelloidea* Alexander, 1929

Cytherelloidea cadomensis Bizon, 1960

Pl.1, figs 6-9

*1960 *Cytherelloidea cadomensis* n. sp.- Bizon, p. 204, pl. 1, fig. 6a; pl. 2, figs. 1-4.
1961 *Cytherelloidea* sp. 1 - Magne, Seronie-Vivien & Malmoustier, p. 395, pl. 14, fig. 3.
1967 *Cytherelloidea cadomensis* Bizon - Stoermer &Wienholz, p. 544, pl. 1, fig. 5.
1983 *Cytherelloidea cadomensis* Bizon - Knitter, p. 219, pl. 34, fig. 5.
1987 *Cytherelloidea cadomensis* Bizon - Tröster, pl. 4, fig. 5.

Diagnosis: See Bizon 1960: 204
Material: See Tab. 1

Dimensions (mm). Length 0.57-0.75; height 0.29-0.42 and width 0.15-0.17.

Remarks. *Cytherelloidea cadomensis* Bizon, 1960 differs from *Cytherelloidea circumscripta* (Blake, 1876) and *Cytherelloidea pulchella* (Apostolescu, 1959) by the presence of a strong marginal ridge. *Cytherelloidea drexlerae* Field, 1966 is similar in general outline but differs in the possession of two large posterior swellings and the absence of a shell surface ornamented by longitudinal ridges.

Stratigraphic and geographic range. France: late Toarcian (Magne et al. 1961); Northeastern Germany: late Toarcian-Aalenian (Stoermer & Wienholz 1967); Northern Switzerland: late Toarcian-early Aalenian, Opalinum Zone (Tröster 1987); Cordillera Ibérica: from late Toarcian, Pseudoradiosa Zone, to Aalenian, Opalinum Zone, of the Fuentelsaz section.

Cytherelloidea reticuloornata Knitter, 1983

Pl. 1, fig. 10

*1983 *Cytherelloidea reticuloornata* n sp. Knitter pp. 218-219, pl. 34, figs. 6a, 7, 7a.
1994 *Cytherelloidea reticuloornata* Knitter - Ohmert & Rolf, pl. 34, figs. 9-10.

Diagnosis: See Knitter 1983: 218.
Material: See Tab. 1.

Dimensions (mm). Length 0.25-0.50; height 0.15-0.42 and width 0.12-0.15.

Remarks. *Cytherelloidea circumscripta* (Blake, 1876) and *Cytherelloidea pulchella* (Apostolescu, 1959) are similar in shape to *Cytherelloidea reticuloornata* Knitter, 1983, but differ in the absence of a reticulate

ornamentation and the less well-rounded posterior margin.

Stratigraphic and geographic range. Southwestern Germany: Late Toarcian-Aalenian (Knitter 1983); Cordillera Ibérica: Late Toarcian, Pseudoradiosa Zone of the Fuentelsaz section.

Suborder **Podocopina**, Sars, 1866
Superfamily Bairdioidea Sars, 1888
Family Bairdiidae Sars, 1888
Genus *Bairdiacypris* Bradfield, 1935

Bairdiacypris dorisae (Knitter, 1983)

Pl. 1, figs 11-12

1961 ?*Isobythocypris* sp. I - Magne, Seronie-Vivien & Malmoustier, p. 366, pl. 13, fig. 4.
1975 *Bairdiacypris* sp. - Bate & Coleman, p. 5, pl. 9, fig. 13.
1983 *Bythocypris faba* n. sp. Knitter, p. 217, pl. 6, fig. 7.
* 1983 *Bythocypris dorisae* n. sp. Knitter, p. 55, pl. 11, fig. 2.
1985 *Bythocypris faba* - Riegraf, p. 76, pl. 2, figs. 7, 8.
1987 *Bythocypris dorisae* Knitter - Tröster, pl. 1, fig. 9.
1992 *Bythocypris dorisae* Knitter - Arias & Comas-Rengifo, p. 437, pl. 1, fig. 9.
1992 *Bythocypris* sp. Arias & Comas-Rengifo, p. 121, pl. 1, fig. 10.
1999a *Bythocypris dorisae* Knitter - Arias & Lord, pp. 83-84, pl. 2, fig. 6.

Diagnosis: See Knitter 1983: 217.
Material: See Tab. 1

Dimensions (mm). Length 0.25-0.60; height 0.13-0.32 and width 0.12-0.13.

Remarks. By being more slender, elongate in lateral view and because of its type of hinge this genus can be differentiated from the genus *Bythocypris*. *Bairdiacypris? sartriensis* Donze, 1985 bears a shallow resemblance to *Bairdiacypris dorisae* (Knitter, 1983) but differs in lacking the well-developed posterodorsal angle and in the possession of a more elongate carapace. *Bairdiacypris rectangularis* Ainsworth, 1989 resembles *Bairdiacypris dorisae* (Knitter, 1983) but can be distinguished by its more rectangular outline in lateral view and its more strongly concave ventral margin.

Stratigraphic and geographic range. France: middle and late Toarcian of Thouar (Magne et al. 1961); Germany: middle and late Toarcian (Knitter 1983, 1984; Riegraf 1985); Great Britain: early Toarcian, Falciferum Zone (Bate & Coleman 1975); Northern Switzerland: late Toarcian-early Aalenian, Opalinum Zone (Tröster 1987); Cordillera Ibérica: early Toarcian, Serpentinus and Bifrons zones (Arias 1991, 1995; Arias &Comas-Rengifo 1992; Arias & Lord 1999a) and from late Toarcian, Pseudoradiosa Zone, to early Aalenian, Opalinum Zone, of the Fuentelsaz section.

Superfamily Cytheroidea Baird, 1850
Family Bythocytheridae G.O. Sars, 1928
Genus *Monoceratina* Roth, 1928

Monoceratina scrobiculata Triebel and Bartenstein, 1938

Pl. 1, figs 13-15

* 1938 *Monoceratina scrobiculata* n. sp. Triebel & Bartenstein, pp. 508-509, pl. 2, figs. 5-6.
1962 *Monoceratina scrobiculata* Triebel & Bartenstein - Fischer, p. 335, pl. 19 figs. 10, 12.
1981b *Bythoceratina (Praebythoceratina) scrobiculata* (Triebel & Bartenstein) - Herrig, pp. 873-875, pl. 1, fig. 1.
1983 *Monoceratina scrobiculata* Triebel & Bartenstein - Knitter, p. 219, pl. 36, fig. 2.
1987 *Monoceratina scrobiculata* Triebel & Bartenstein - Tröster, pl. 5, fig. 18.

Diagnosis: See Triebel & Bartenstein, 1938, p. 508.
Material: See Tab. 1

Dimensions (mm). Length 0.60-0.70; height 0.25-0.42 and width 0.25-0.28.

Remarks. This species is similar to other species of the genus *Monoceratina* but it can be distinguished by its characteristic reticulate ornamentation and the presence of a shorter and blunt lateral spine.

Stratigraphic and geographic range. Germany: late Toarcian to Dogger (Triebel & Bartenstein 1938; Fischer 1962; Herrig 1981b; Knitter 1983); Cordillera Ibérica, Spain: from late Toarcian, Pseudoradiosa Zone, to early Aalenian, Opalinum Zone, of the Fuentelsaz section.

Monoceratina stimulea (Schwager, 1866)

Pl. 2; figs 1-2

* 1866 *Cythereis stimulea* n. sp. - Schwager, p. 276, fig. 1.
1938 *Monoceratina stimulea* (Schwager) - Triebel & Bartenstein, p. 505-506: 1-2.
1962 *Monoceratina stimulea* (Schwager) - Fischer, p. 334, pl. 19, figs. 8-9.
1983 *Monoceratina stimulea* (Schwager) - Knitter, p. 219, pl. 36, fig. 3.
? 1985 *Monoceratina stimulea* (Schwager) - Riegraf, p. 88, pl. 4, figs. 8-10.
1987 *Monoceratina stimulea* (Schwager) - Tröster, p. 446, pl. 5, fig. 19.
1999a *Monoceratina stimulea* (Schwager) - Arias & Lord, p. 91, pl. 4, fig. 1.

Diagnosis: See Schwager 1866, p. 276 and Triebel & Bartenstein 1938, p. 505.
Material: See Tab. 1

Dimensions (mm). Length 0.25-0.50; height 0.13-0.22 and width 0.15-0.17.

Remarks. This species is similar to *Monoceratina scrobiculata* Triebel and Bartenstein, 1938 but it can be distinguished by the lack of its typical reticulate ornamentation.

Stratigraphic and geographic range. Germany: late Toarcian to Malm (Schwager 1866; Triebel & Bartenstein 1938; Fischer 1962; Knitter 1983; Riegraf 1985); Great Britain: Thouarsense Zone at Ilminster (Boomer 1992); Switzerland: Aalenian (Tröster 1987); Cordillera Ibérica: Tenuicostatum Zone of Ablanquejo section (Arias & Lord 1999a) and late Toarcian to early Aalenian, Aalensis and Opalinum zones, of the Fuentelsaz section.

Monoceratina ungulina Triebel & Bartenstein, 1938

Pl. 2, fig. 3

* 1938 *Monoceratina ungulina* n. sp. Triebel & Bartenstein, p. 506, pl. 1, figs. 3-4.

1961 *Monoceratina ungulina* Triebel & Bartenstein - Apostolescu et al., p. 391, pl. 12, figs. 5 a-c.

1961 *Monoceratina ungulina* Triebel & Bartenstein - Magne, Seronie-Vivien & Malmoustier, pl. XII, figs. 5A-C.

1962 *Monoceratina ungulina* Triebel & Bartenstein - Fischer, p. 336, pl. 19, figs. 13-13a.

1962 *Monoceratina ungulina* Triebel & Bartenstein - Klingler, p. 106, pl. 14, fig. 46, tb. 7.

1963 *Monoceratina ungulina* Triebel & Bartenstein - Plumhoff, p. 48, pl. 11, figs. 166 a-d.

1979 *Monoceratina ungulina* Triebel & Bartenstein - Exton, p. 57, pl. 11, fig. 7.

1983 *Monoceratina ungulina* Triebel & Bartenstein - Knitter, p. 220, pl. 36, fig. 4.

1987 *Monoceratina ungulina* Triebel & Bartenstein - Tröster, p. 440, pl. 5, fig. 20.

1999a *Monoceratina ungulina* Triebel & Bartenstein - Arias & Lord, p. 92, pl. 4, fig. 6.

Diagnosis: See Triebel & Bartenstein 1938, p. 506.
Material: see Tab. 1

Dimensions (mm). Length 0.30-0.57; height 0.13-0.32 and width 0.20-0.22.

Remarks. This form is similar to *Monoceratina stimulea* (Schwager, 1866) in general shape and size, but this latter species is less elongate and has a long alar extension.

Stratigraphic and geographic range. France: early and late Toarcian of the Paris Basin (Apostolescu et al. 1961; Magne et al. 1961); Germany: Hettangian to Aalenian (Triebel & Bartenstein 1938; Fischer 1962; Klingler 1962; Plumhoff 1963; Knitter 1983); Great Britain: Falciferum to Thouarsense zones of the South of England (Boomer 1992); Portugal: Falciferum to Variabilis zones of Zambujal (Exton 1979; Boomer et al. 1998); Switzerland: Levesquei Zone (Tröster 1987); Cordillera Ibérica: Serpentinus and Bifrons zones (Arias and Lord 1999a) and late Toarcian, Aalensis Zone, Mactra and Aalensis subzones of the Fuentelsaz section.

Family Cytheruridae Müller, 1894
Subfamily Cytheropterinae Hanai, 1957
Genus *Cytheropteron* Sars, 1866

Cytheropteron alafastigatum Fischer, 1962

Pl. 2, fig. 4

* 1962 *Cytheropteron (Cytheropteron) alafastigatum* n. sp. Fischer, p. 336, pl. 20, figs. 1-6.

1979 *Cytheropteron alafastigatum* Fischer - Exton, p. 57, pl. 11, fig. 5.

1981c *Cytheropterina alafastigata* (Fischer) - Herrig, pp. 1017-1018, pl. 1, fig. 1.

1983 *Cytheropterina alafastigata* (Fischer) - Knitter, pp. 221-222, pl. 37, fig. 1.

1987 *Cytheropterina alafastigata* (Fischer) - Tröster, pl. 5, fig. 16.

?1988 *Cytheropteron alafastigatum* Fischer - Bodergat & Donze, pl. 1, fig. 11.

Diagnosis: See Fischer, 1962, fig. 336-7.
Material: See Tab. 1

PLATE 2

Figs. 1-2 *Monoceratina stimulea* (Schwager, 1886): 1) Right valve, adult. Aalensis Zone, Aalensis Subzone. (FZ-63.2); 2) Left valve, adult. Aalensis Zone, Aalensis Subzone. (FZ-63.87).

Fig. 3 *Monoceratina ungulina* Triebel & Bartenstein, 1938: 3) Right valve, adult. Aalensis Zone, Mactra Subzone. (FZ-43.66).

Figs. 4 *Cytheropteron alafastigatum* Fischer, 1962: 4) Right valve, adult. Opalinum Zone, Comptum Subzone. (FZ-105.8).

Figs. 5-6 *Cytheropteron cribrum* (Fischer, 1962): 5) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-43.23); 6) Right valve, adult. Aalensis Zone, Mactra Subzone. (FZ-43.21).

Figs. 7-9 *Otocythere callosa* Triebel & Klingler, 1959: 7) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-43.11), 8) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-43.9); 9) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-43.8).

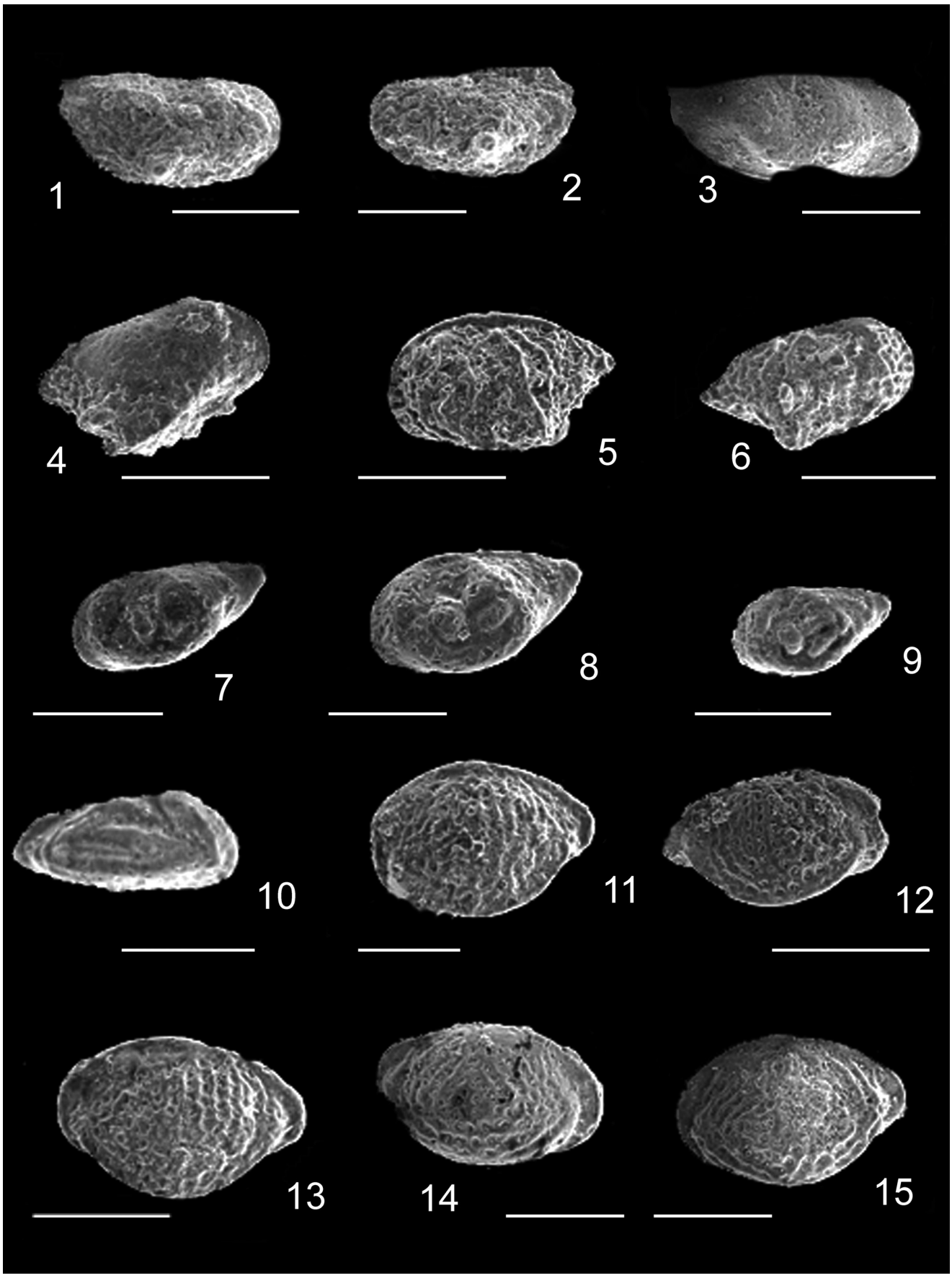
Fig. 10 *Ektyphocythere furcata* (Wienholz, 1967): 10) Right valve, adult. Aalensis Zone, Mactra Subzone. (FZ-49.45).

Figs. 11-12 *Kinkelinella costata* Knitter, 1983: 11) Left valve, adult. Aalensis Zone, Aalensis Subzone. (FZ-77.80); 12) Right valve, adult. Aalensis Zone, Aalensis Subzone. (FZ-77.83

Fig. 13 *Kinkelinella sermoisensis* (Apostolescu, 1959): 13) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-49.8).

Figs. 14-15 *Kinkelinella fischeri* Malz, 1966: 14) Right valve, adult. Opalinum Zone, Comptum Subzone. (FZ-123.6); 15) Left valve, adult. Opalinum Zone, Comptum Subzone. (FZ-123.8).

Scale bars 400 μm long.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Dimensions (mm). Length 0.40-0.55; height 0.33-0.28 and width 0.20-0.22.

Remarks. *Cytheropteron (Infracytheropteron)* sp. of Bate & Coleman (1975) could be referred to this species, since it is possible that their material represents juvenile instars. Another similar species is *Eocytheropterina jutlandica* (Michelsen, 1975), although it can be distinguished from *Cytheropteron alafastigatum* Fischer, 1962 by its oval carapace, lack of alar extensions and possession of a caudal extension. *Cytheropteron? cavatum* Michelsen, 1975 differs from the present material in lacking an alar extension and by its different ornamentation, which consists of pits over the entire lateral surface and fine longitudinal ribs.

Stratigraphic and geographic range. France: Toarcian, from the Bifrons Zone to Pseudoradiosa Zone of the Paris Basin (Bodergat & Donze 1988); southwest Ireland, Fastnet Basin: Toarcian and Aalenian (Ainsworth 1986); Southern Germany: Late Toarcian-Aalenian (Fischer 1962; Herrig 1981c; Knitter 1983). North Switzerland: late Toarcian-Aalenian (Tröster 1987); Cordillera Ibérica: late Toarcian, Aalensis Zone, Buckmani Subzone of the Fuentelsaz section.

Cytheropteron cribrum (Fischer, 1962)

Pl. 2, figs 5-6

1962 Ostracod Nr. 96 Klingler - Klingler, p. 112, pl. 7, pl. 14, fig. 58.

* 1962 *Cytheropteron (Cytheropteron) bispinosum cribrum* n. ssp. Fischer, p. 339, pl. 20, figs. 8 -11.

1963 *Cytheropteron (Cytheropteron) bispinosum cribrum* Fischer - Plumhoff, p. 39, pl. 8, figs. 117-119.

1967 *Cytheropteron cribra ziegleri* (Fischer) - Stoermer & Wienholz, pp. 555-556, pl. 5, figs. 37-39.

1981c *Cytheropteron cribra ziegleri* Stoermer & Wienholz - Herrig, p. 1018, pl. 5, figs. 1-3.

1983 *Cytheropterina cribra* (Fischer) - Knitter, pp. 221-222, pl. 37, fig. 2.

1986 *Cytheropterina bispinosum cribrum* Fischer - Ainsworth, pp. 301-302, pl. 4, fig. 6.

1987 *Cytheropterina cribra* (Fischer) - Tröster, pl. 1, fig. 17.

1988 *Cytheropterina bispinosum cribrum* Fischer - Bodergat & Donze, pl. 1, fig. 18.

Diagnosis: See Fischer 1962, p. 339.
Material: See Tab. 1

Dimensions (mm). Length 0.40-0.48; height 0.23-0.28 and width 0.20-0.22.

Remarks. The present material is similar to *Cytheropteron alafastigatum* Fischer, 1962, but this species did not have the well-defined reticulation. *Eocytheropterina jutlandica* (Michelsen, 1975) and *Cytheropteron? cavatum* Michelsen, 1975 can be distinguished from *Cytheropteron criba* (Fischer, 1962) by its more elongate-oval carapace and the lack of alar extensions. *Cytheropteron reticulatum* Michelsen, 1975 is also a similar form, but it can be distinguished by a different morphology of the alar extensions and its ornamentation consisting of numerous longitudinal and cross ribs.

Stratigraphic and geographic range. France: late Toarcian, from the Insigne to Aalense zones, of the Paris Basin (Bodergat & Donze 1988); southwest Ireland, Fastnet Basin: Toarcian and Aalenian (Ainsworth 1986); Northwest Germany: late Aalenian (Plumhoff 1963); Southern Germany: late Toarcian, Aalensis Zone, to early Aalenian (Fischer 1962; Herrig 1981c; Knitter 1983); Cordillera Ibérica: from late Toarcian, Pseudoradiosa Zone, to early Aalenian, Opalinum Zone, of the Fuentelsaz section.

Genus *Otocythere* Triebel & Klingler, 1959

Otocythere callosa Triebel & Klingler, 1959

Pl. 2, figs 7-9

1959 Ostracoda J - Apostolescu, p. 817, pl. IV, fig. 79.

* 1959 *Otocythere callosa* n. sp. Triebel & Klingler, pp. 349-352, pl. 10, figs. 37-43, pl. 11, figs. 44-48; pl. 12, figs. 50-55.

1962 *Otocythere callosa* Triebel & Klingler - Fischer: 340, pl. 20, figs. 12-15.

1962 *Otocythere callosa*. Triebel & Klingler - Klingler: 115, pl. 7; pl. 15, fig. 74.

1967 *Otocythere callosa* Triebel & Klingler - Stoermer & Wienholz, p. 557, pl. 5, figs. 41-44.

1981c *Otocythere callosa* Triebel & Klingler - Herrig, p. 1020, pl. 1, figs. 5-6.

1983 *Otocythere callosa* Triebel & Klingler - Knitter, pp. 223-224, pl. 36, fig. 1.

1987 *Otocythere callosa* Triebel & Klingler -Tröster, pl. 5, fig. 13.

1988 *Otocythere callosa* Triebel & Klingler - Bodergat & Donze, pl. 1, fig. 15.

1994 *Otocythere callosa* Triebel & Klingler - Ohmert &Rolf, pl. 34, fig. 11.

Diagnosis: See Triebel & Klingler 1959: 349-352.
Material: See Tab. 1

Dimensions (mm). Length 0.30-0.57; height 0.13-0.28 and width 0.20-0.22.

Remarks. This species has a very distinctive subtriangular carapace with a short caudal process and a wrinkled mid-valve area characterized by the presence of strong rounded grooves and tubercules.

Stratigraphic and geographic range. France: late Toarcian-early Aalenian of the Paris Basin (Apostolescu 1959; Bodergat & Donze 1988); South-west Ireland. Fastnet Basin: Toarcian and Aalenian (Ainsworth 1986); Northeastern Germany: late Toarcian, Aalensis Zone (Stoermer & Wienholz 1967); Southern Germany: from the late Toarcian to Aalenian (Triebel & Klingler 1959; Fischer 1962; Herrig 1981c; Knitter 1983); Northern Switzerland: from the late Toarcian to Aalenian (Tröster 1987); Cordillera Ibérica: from the late Toar-

cian, Pseudoradiosa Zone, to the early Aalenian, Opalinum Zone, of the Fuentelsaz section.

Subfamily Cytherurinae Müller, 1894

Genus *Eucytherura* Gründel, 1981

Eucytherura tricostata (Michelsen, 1975)

* 1975 *Acrocythere tricostata* n. sp. Michelsen, p. 158, pl. 9, figs. 131, 142 - pl. 11, figs. 157-158, text-fig. 26.

1975 *Lophodentina tricostata* (Michelsen) - Bate & Coleman, p. 1214, pl. 6, figs. 6-9, text-fig. 8.

1975 *Rutlandella transversiplicata* sp. nov. - Bate & Coleman, p. 34, pl. 13, figs. 7-10, 12, text-figs. 14a, b, 15, 16.

1979 *Rutlandella transversiplicata* Bate & Coleman - Exton, p. 58, pl. 14, fig. 6.

1981c *Acrocythere tricostata* Michelsen - Herrig, p. 1021, pl. 1, figs. 13-14.

1983 *Acrocythere michelseni* (Michelsen) - Finger, p. 110.

1983 *Rutlandella transversiplicata* Bate & Coleman - Knitter, p. 223, pl. 38, figs. 1-2.

1984 *Rutlandella transversiplicata* Bate & Coleman - Exton & Gradstein, p. 26, pl. 2, fig. 12.

1986 *Rutlandella transversiplicata* Bate & Coleman - Ainsworth, p. 308, pl. 5, fig. 15.

1986 *Acrocythere tricostata* Michelsen - Ohm, p. 106, pl. 22, figs. 9-10.

1987 *Acrocythere michelseni* Finger - Tröster, p. 447, pl. 5, fig. 10.

1989 *Acrocythere* cf. *Acrocythere*? *tricostata* Michelsen - Ainsworth, p. 129, pl. 1, figs. 25-29.

?1991 *Acrocythere*? *michelseni* Finger - Boomer, p. 209, pl. 2, fig. 6.

1994 *Acrocythere michelseni* Finger - Ohmert & Rolf, pl. 34, figs. 9-10.

Diagnosis: See Michelsen 1975, p. 158.
Material: See Tab. 1

Dimensions (mm). Length 0.29-0.31; height 0.13-0.17 and width 0.20.

Remarks. The authors agree with Herrig (1981c) in considering *Rutlandella transversiplicata* Bate & Coleman, 1975 as synonym of *Acrocythere tricostata* Michelsen, 1975 (=*Acrocythere michelseni* Finger, 1982). By its merodont hinge and its different ornamental pattern, the present species was placed in the genus *Eucytherura. Rutlandella mimica* Bate & Coleman, 1975 shows a similar lateral outline but differs by the lack of the lateral transversal rib. *Rutlandella striata* Knitter, 1983 resembles *Eucytherura tricostata* (Michelsen, 1975) but can be distinguished by the possession of the moderately developed inter-rib reticulation.

Stratigraphic and geographic range. Denmark: late Sinemurian to Pliensbachian (Michelsen 1975); southwest Ireland, Fastnet Basin: Sinemurian to Aalenian (Ainsworth 1986, 1989); Germany: Pliensbachian (Knitter 1983; Ohm 1986); late Pliensbachian to Aalenian (Herrig 1981c; Ohmert et al. 1996); Great Britain: lower Toarcian, Tenuicostatum to Bifrons zones (Bate & Coleman 1975); late Toarcian, Thouarsense and Levesquei zones (Boomer 1991); Portugal: Thouarsense and Levesquei zones (Exton 1979; Exton & Gradstein 1984); Cordillera Ibérica: from the late Toarcian, Pseudoradiosa Zone, to the early Aalenian, Opalinum Zone, of the Fuentelsaz section.

Family Protocytheridae Ljubimova, 1955

Subfamily Progonocytherinae Sylvester-Bradley, 1948

Genus *Ektyphocythere* Bate, 1963

Ektyphocythere furcata (Wienholz, 1967)

Pl. 2, fig. 10

?1961 *Procytheridea vitilis* n. sp. - Apostolescu, Magne & Malmoustier, p. 339-340, pl. I, fig. 1 A-D.

?1961 *Procytheridea vitilis* Apostolescu, Magne & Malmoustier - Magne, Seronie-Vivien and Malmoustier, pp. 548-550, pl. XI, fig. 5A-D.

1962 Ostracod Nr. 85 - Klingler, p. 107, pl. 7, pl. 14, fig. 48.

*1967 *Procytheridea vitilis furcata* n. ssp. Wienholz (in Stoermer & Wienholz), pp. 548-550, pl. 2, figs. 19-20.

1985 *Ektyphocythere vitiosa furcata* (Apostolescu) - Donze, pl. 25, figs. 9-11.

1983 *Kinkelinella (Ektyphocythere) furcata* (Wienholz) - Knitter, p. 226 - pl. 39, fig. 2.

1987 *Ektyphocythere furcata* (Wienholz) - Tröster, pl. 5, fig. 2.

1994 *Ektyphocythere furcata* (Wienholz) - Ohmert, pl. 30, fig. b.

?1988 *Ektyphocythere vitilis* Apostolescu, Magne & Malmoustier - Bodergat & Donze, pl. 1, fig. 16.

Diagnosis: See Wienholz 1967 (in Stoermer & Wienholz), p. 549.
Material: See Tab. 1

Dimensions (mm). Length 0.57-0.66; height 0.30-0.39 and width 0.16-0.20.

Remarks. This species is very close to *Ektyphocythere champeau* (Bizon, 1960) but it has a more subtriangular lateral outline and fewer primary ribs at the centre of the valve which show a more triangular arrangement.

Stratigraphic and geographic range. France: late Toarcian-early Aalenian, from the Thouarsense to Opalinum zones (Apostolescu et al. 1961; Magne et al. 1961; Bodergat & Donze 1988); northeastern Germany: Late Toarcian (Stoermer & Wienholz 1967; Ohmert 1994), late Toarcian-early Aalenian (Knitter 1983); Northern Switzerland: late Toarcian-early Aalenian (Tröster 1987); Cordillera Ibérica: late Toarcian, Aalensis Zone, Mactra Subzone of the Fuentelsaz section.

Genus *Kinkelinella* Martin, 1960

Kinkelinella costata Knitter, 1983

Pl. 2, figs 11-12

1959 Ostracoda I Apostolescu - Apostolescu, p. 817, pl. IV, figs. 67-8.

1961 Ostracoda I Apostolescu - Magne et al., pl. XIV, figs. 6 A-B.

1962 Ostracod Nr. 84. Klingler - Klingler, pp. 104-105, pl. 14, fig. 45.

*1983 *Kinkelinella (Kinkelinella) costata* n. sp. Knitter, p. 224, pl. 39, figs. 7-10.

1986 *Kinkelinella costata* Knitter - Ainsworth, p. 313, pl. 7, figs. 13-15, 17-20.

1987 *Kinkelinella (Kinkelinella) costata* Knitter - Tröster, pl. 4, figs. 14-15.

1994 *Kinkelinella costata* Knitter - Ohmert, pl. 30, fig. a.

Diagnosis: See Knitter 1983, p. 224-225.
Material: See Tab. 1

Dimensions (mm). Length 0.51-0.70; height 0.28-0.48 and width 0.11-0.20.

Remarks. *Kinkelinella costata* Knitter, 1983 is similar to *Kinkelinella sermoisensis* (Apostolescu, 1959) but *Kinkelinella costata* Knitter, 1983 can be distinguished by its less subtriangular outline and its strong vertical ribbing.

Stratigraphic and geographic range. France: from Toarcian, Bifrons Zone, to early Aalenian, Opalinum Zone, of the Paris Basin (Apostolescu 1959; Magne et al. 1961); southwest Ireland, Fastnet Basin: late Toarcian and early Aalenian (Ainsworth 1986); Southern Germany: late Toarcian to Aalenian (Klingler 1962; Knitter 1983; Ohmert 1994); Northern Switzerland: from the late Toarcian to Aalenian (Tröster 1987); Cordillera Ibérica: late Toarcian, Aalensis Zone, Aalensis Subzone of the Fuentelsaz section.

Kinkelinella fischeri Malz, 1966

Pl. 2, figs 14-15

1962 Ostracod Nr. 94 Klingler - Klingler, p. 110, pl. 14, fig. 53.

1963 *Procytheridea adunca* n. sp. Fischer, p. 296.

non 1963 *Procytheridea adunca* Fischer - Plumhoff, p. 32, pl. 4, figs. 64-66.

*1966 *Kinkelinella fischeri* nom. subst. Malz, pp. 389-391, pl. 48, figs. 4-14.

1983 *Kinkelinella (Kinkelinella) fischeri* Malz - Knitter, p. 225 - pl. 39, figs. 3-4.

1987 *Kinkelinella (Kinkelinella) fischeri* Malz - Tröster, pl. 4, figs. 16-17.

Diagnosis: See Malz 1966, p. 389-391.
Material: See Tab. 1

Dimensions (mm). Length 0.61-0.70; height 0.25-0.47 and width 0.10-0.20.

Remarks. Although this species resembles *Kinkelinella sermoisensis* (Apostolescu, 1959), it may be distinguished by its generally more strongly developed ventro-medial ridges in a subtriangular pattern model.

Stratigraphic and geographic range. Northwestern and southern Germany: late Toarcian, Aalensis Zone and early Aalenian, Opalinum Zone (Klingler 1962; Fischer 1963; Malz 1966; Knitter 1983); Northern Switzerland: from the late Toarcian to Aalenian (Tröster 1987); Cordillera Ibérica: late Toarcian, Aalensis Zone and early Aalenian, Opalinum Zone, of the Fuentelsaz section.

Kinkelinella sermoisensis (Apostolescu, 1959)

Pl. 2, fig. 13

*1959 *Procytheridea sermoisensis* n. sp. Apostolescu, p. 812, pl. 2, figs. 37-38.

1960 *Procytheridea sermoisensis* Apostolescu - Bizon, p. 210, pl. 1, fig. 7, pl. 3, fig. 19a.

1961 *Procytheridea sermoisensis* Apostolescu - Magne et al., pl. 4, fig. 3.

1962 Ostracod Nr. 81 Klingler, p. 108, pl. 14, fig. 50.

1974 *Kinkelinella sermoisensis* (Apostolescu) - Lord, pl. 90, figs. 6-9.

1975 *Kinkelinella sermoisensis* (Apostolescu) - Bate & Coleman, p. 16, pl. 4, fig. 1, pl. 11, fig. 9a, 10c.

1978 *Kinkelinella sermoisensis* (Apostolescu) - Lord, p. 202-203, pl. 3, figs. 7-8, tb. 2.

1979 *Kinkelinella sermoisensis* (Apostolescu) - Exton, p. 59, pl. 12, figs. 1-4.

1983 *Kinkelinella sermoisensis* (Apostolescu) - Knitter, p. 285, pl. 39, figs. 5-6.

1984 *Kinkelinella sermoisensis* (Apostolescu) - Exton & Gradstein, p. 27, pl. 3, fig. 78.

1985 *Kinkelinella (Kinkelinella) sermoisensis* (Apostolescu) - Riegraf, p. 79, pl. 3, figs. 7-10.

1986 *Kinkelinella sermoisensis* (Apostolescu) - Ainsworth, p. 314, pl. 7, figs. 9, 12, 16.

1987 *Kinkelinella (Kinkelinella) sermoisensis* (Apostolescu) - Tröster, p. 445, pl. 4, fig. 19.

1992 *Kinkelinella sermoisensis* (Apostolescu) - Arias & Comas-Rengifo, pp. 446-448, pl. 3, figs. 7-9.

1992 *Kinkelinella sermoisensis* (Apostolescu) - Arias et al., pl. 2, fig. 17.

1994 *Kinkelinella sermoisensis* (Apostolescu) - Ohmert & Rolf, pl. 34, fig. 14.

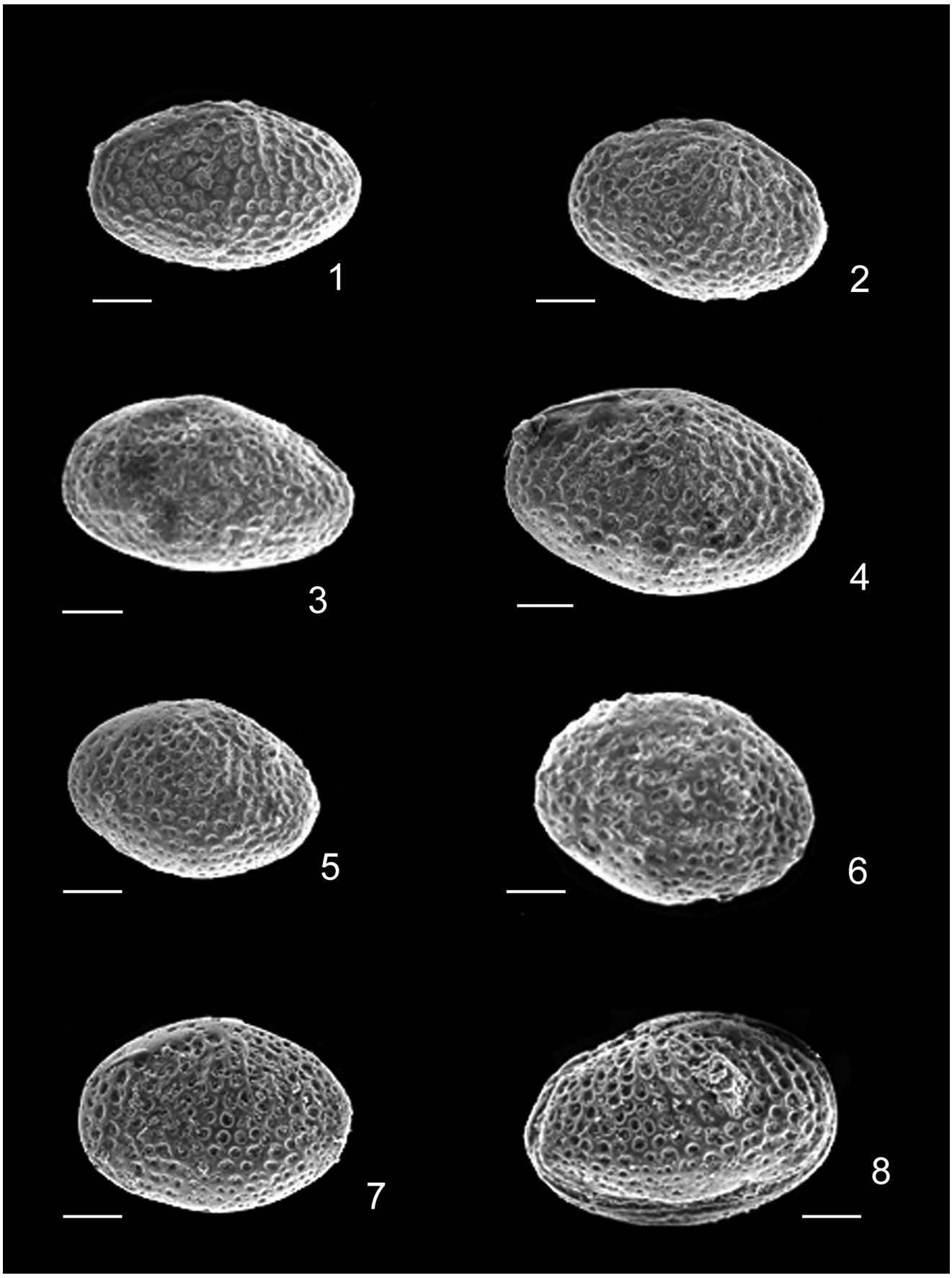
1999b *Kinkelinella sermoisensis* (Apostolescu) - Arias & Lord, p. 232, pl. 3, fig. 6.

PLATE 3

Figs. 1-3 *Praeschuleridea aspera* Knitter 1983: 1) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-47.66); 2) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-47.32); 3) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-47.44).

Fig. 4 *Praeschuleridea punctulata* (Plumhoff 1963): 4) Left valve, adult. Aalensis Zone, Mactra Subzone (FZ-47.99).

Figs. 5-8 *Praeschuleridea ventriosa* (Plumhoff 1963): 5) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.38); 6) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.50); 7) Left valve, adult. Aalensis Zone, Mactra Subzone. (FZ-41.54); 8) Carapace, Right view, adult. Aalensis Zone, Mactra Subzone. (FZ-47.47). Scale bars 100 μm long.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Diagnosis: See Apostolescu 1959: 810.
Material: see Tab. 1

Dimensions (mm). Length 0.41-0.70; height 0.20-0.42 and width 0.10-0.20.

Remarks. This species shows a great variation in its ornamental pattern, from coarsely reticulate to dominantly vertical ribbing (Bizon 1960; Lord 1974; Knitter 1983; Herrig 1985; Ainsworth 1986; Riegraf 1985). *Kinkelinella costata* Knitter, 1983 is similar, but can be distinguished by a different ornamentation with the possession of vertical ribs.

Stratigraphic and geographic range. Southwest Ireland, Fastnet Basin: Toarcian and Aalenian (Ainsworth 1986); France: Toarcian and Aalenian of the Paris Basin (Apostolescu 1959; Bizon 1960; Magne et al. 1961); Germany: Toarcian (Klingler 1962; Knitter 1983; Riegraf 1985; Tröster 1987); Grand Banks: Tenuicostatum to Bifrons zones (Exton & Gradstein 1984); Great Britain: Toarcian (Lord 1974, 1978; Bate & Coleman 1975; Boomer 1992); Portugal: Falciferum to Bifrons zones at Zambujal (Exton 1979; Boomer et al. 1998); Northern Switzerland: from the late Toarcian to Aalenian (Tröster 1987); Cordillera Ibérica: early Toarcian, Tenuicostatum to Bifrons zones (Arias 1991, 1995; Arias & Comas-Rengifo 1992; Arias & Lord 1999b; Arias et al. 1992) and late Toarcian, Aalensis Zone, from Pseudoradiosa to Aalensis subzones of the Fuentelsaz section.

Family Schulerideidae Mandelstam, 1959
Subfamilia Schulerideinae Mandelstam, 1959
Genus *Praeschuleridea* Bate, 1963

Praeschuleridea aspera Knitter, 1983

Pl. 3, figs 1-3

1962 Ostracod Nr. 82 Klingler - Klingler, pl. 14, fig. 51.
1963 *Procytheridea? ventriosa* n. sp. Fischer, pp. 298-299, pl. 2.
non 1963 *Procytheridea? ventriosa angulata* n. ssp. Plumhoff, pp. 36-37, pl. 6, figs. 99-100.
1966 *Praeschuleridea angulata* (Plumhoff) - Malz, pp. 397-398, pl. 49, figs. 24-25.
1981c *Dominocythere angulata (*Plumhoff) - Herrig, p. 1022, pl. 2, figs. 1-3.
*1983 *Praeschuleridea aspera* n. sp. Knitter, p. 226, pl. 40, figs. 1-2.
1983 *Praeschuleridea aspera* Knitter - Knitter & Ohmert, p. 278, pl. 4, fig. 7.
1983 *Praeschuleridea ventriosa* (Fischer) - Knitter & Ohmert, pl. 5, fig. 7.
? 1983 *Praeschuleridea gallemannica* Malz - Knitter, pp. 227-228 - pl. 40, figs. 5-6.
1986 *Praeschuleridea arguta arguta* sp. et subsp. nov. - Ainsworth, pp. 317-318, pl. 8, figs. 13-18 - pl. 9, figs. 1-4.
1987 *Praeschuleridea angulata (*Plumhoff) - Tröster, pl. 5, fig. 3.
1988 *Praeschuleridea* cf. *ventriosa* (Fischer) - Bodergat & Donze, pl. 1, fig. 19.
1994 *Praeschuleridea gallemannica* Malz - Ohmert & Rolf, pl. 5, fig. 13.

Diagnosis: See Knitter 1983, p. 396.
Material: See Tab. 1

Dimensions (mm). Length 0.65-0.72; height 0.33-0.51 and width 0.30-0.35.

Remarks. Its subtriangular outline and triangular ribbing, which converges to the centrodorsal area, serve to distinguish from other species of the genus *Praeschuleridea*, such as *Praeschuleridea ventriosa* (Plumhoff, 1963), *Praeschuleridea gallemannica* Malz, 1966 or *Praeschuleridea arguta* Ainsworth, 1986, whose lateral outlines are more subcircular, while the pitted reticulation is more well vertically oriented. *Praeschuleridea tenera* Knitter, 1983 and *Praeschuleridea punctulata* Plumhoff, 1963 both show a similar outline, but can be distinguished because no orientation can be observed in the arrangement of their shallow ornament of pits. *Praeschuleridea gallemannica* Malz, 1966 (=*Dominocythere ventriosa ventriosa* sensu Stoermer & Wienholz (1967)) and *Praeschuleridea ventriosa angulata* sensu Plumhoff (1963) but non *Praeschuleridea gallemannica* sensu Knitter (1983) are referred as *Praeschuleridea angulata* (Plumhoff, 1963). *Praeschuleridea gallemannica* sensu Knitter (1983) possess a different ornamental pattern (more strongly defined subvertical ribbing in the middle region of the valves) and a more subcircular lateral outline.

Stratigraphic and geographic range. France: late Toarcian, Pseudoradiosa and Aalensis zones of the Paris Basin (Bodergat & Donze 1988); southwest Ireland, Fastnet Basin: Toarcian and Aalenian (Ainsworth 1986); Northwest Germany: late Aalenian (Plumhoff 1963); Southwest Germany: late Toarcian, Aalensis Zone, and early Aalenian, Opalinum Zone, (Klingler 1962; Fischer 1963; Malz 1966; Herrig 1981c; Knitter 1983); Northern Switzerland: from the late Toarcian to Aalenian (Tröster 1987); Cordillera Ibérica, Spain: late Toarcian, Aalensis Zone, and Early Aalenian, Opalinum Zone of the Fuentelsaz section.

Praeschuleridea punctulata (Plumhoff, 1963)

Pl. 3, fig. 4

*1963 *Procytheridea? punctulata* n. sp. Plumhoff, pl. 5, figs. 83-87, pl. 6, fig. 88.
1981c *Dominocythere punctulata* (Plumhoff) - Herrig, p. 1023, pl. 2, fig. 4.
1983 *Praeschuleridea punctulata* (Plumhoff) - Knitter, p. 228; pl. 40, figs. 3-4.

Diagnosis: See Plumhoff 1963, fig. 33.
Material: See Tab. 1

Dimensions (mm). Length 0.60-0.75; height 0.55-0.44 and width 0.30-0.35.

Remarks. This species is very similar to other species of the genus *Praeschuleridea*, such as *Praeschuleridea arguta* Ainsworth, 1986, *Praeschuleridea aspera* Knitter, 1983, *Praeschuleridea gallemannica* Malz, 1966 and *Praeschuleridea ventriosa* Plumhoff, 1963. It can be distinguished from these species by the more weakly developed ornament of pits and subvertical ribs, and a less pointed posterior margin. *Praeschuleridea tenera* Knitter, 1983 shows a similar outline, but can be distinguished because no orientation can be observed in the arrangement of the smaller pits.

Stratigraphic and geographic range. Northwestern Germany: Late Aalenian (Plumhoff 1963); Southern Germany: late Toarcian, Levesquei Zone (Knitter 1983) and early Aalenian (Herrig 1981c); Cordillera Ibérica, Spain: late Toarcian, Aalensis Zone, Mactra and Aalensis subzones of the Fuentelsaz section.

Praeschuleridea ventriosa (Plumhoff, 1963)

Pl. 3, figs 5-8

1959 Ostracoda G Apostolescu - Apostolescu, p. 817, pl. IV, figs. 58-59.

1961 Ostracoda G Apostolescu - Magne et al., pl. XIV, fig. 5.

1962 Ostracod Nr 101 Klingler - Klingler, p. 78 and 115, pl. 11, fig. 3, pl. 14, fig. 57.

non 1963 *Procytheridea? ventriosa* n. sp. Fischer, p. 298-299, pl. 2, fig. 5.

* 1963 *Procytheridea? ventriosa ventriosa* n. sp. Plumhoff, p. 6, pl. 6, figs. 95-98.

1966 *Praeschuleridea ventriosa* (Plumhoff) - Malz, pp. 394-395, pl. 49, figs. 21-23.

? 1967 *Dominocythere ventriosa ventriosa* (Fischer) - Stoermer &Wienholz, p. 554-555, pl. 4, fig. 30.

non 1967 *Dominocythere ventriosa ventriosa* (Fischer) - Stoermer & Wienholz, pl. 4, figs. 31-36.

1981c *Dominocythere ventriosa* (Plumhoff) - Herrig, p. 102, pl. 2, fig. 5.

1983 *Praeschuleridea ventriosa* (Plumhoff) - Knitter, p. 22, pl. 40, fig. 78.

? 1983 *Praeschuleridea gallemannica* Malz - Knitter, pp. 227-228, pl. 40, fig. 5-6.

1983 *Praeschuleridea gallemannica* Malz - Knitter & Ohmert, pl. 5, fig. 6.

1987 *Praeschuleridea ventriosa* (Plumhoff) - Tröster, pl. 5, fig. 6.

1987 *Praeschuleridea gallemannica* Malz - Tröster, pl. 5, fig. 5.

1990 *Praeschuleridea* cf. *Praeschuleridea decorata* Bate - Ainsworth, p. 188, pl. 5, figs. 1, 2, 4, 5.

1994 *Praeschuleridea ventriosa* (Fischer) - Ohmert & Rolf, pl. 5, fig. 15.

1996 *Praeschuleridea angulata* (Plumhoff) - Arias in Goy et al., pl. 4, fig. 11.

1996 *Praeschuleridea ventriosa* (Plumhoff) - Arias in Goy et al., pl. 4, fig. 12.

Diagnosis: See Plumhoff 1963: 33.

Material: See Tab. 1

Dimensions (mm). Length 0.60-0.75; height 0.55-0.43 and width 0.30-0.35.

Remarks. This species which is very similar to other species of the genus *Praeschuleridea*, such as *Praeschuleridea arguta magna* Ainsworth, 1986, *Praeschuleridea aspera* Knitter, 1983, *Praeschuleridea gallemannica* Malz, 1966 and *Praeschuleridea ventriosa angulata* Plumhoff, 1963. It can be distinguished from these species by the more weakly defined subvertical ribbing, more ellipsoidal shape in lateral view, and a less pointed posterior margin. *Praeschuleridea gallemannica* sensu Malz (1966) (=*Procytheridea? ventriosa angulata* sensu Plumhoff (1963)) can be distinguished from our forms by its weaker reticulation along the peripheral area, the more rounded lateral outline and the more strongly defined longitudinal ribbing, which extends from the dorsal margin to central region. This species is readily distinguished from *Praeschuleridea angulata* sensu Malz (1966) by a less subtriangular lateral outline and their differing ornamental pattern (ribs above median line "V" upward, with the apex of the inverted "V" situated slightly behind mid-length). *Praeschuleridea tenera* Knitter, 1966 shows a similar outline, but can be distinguished because no orientation can be observed in the arrangement of the smaller pits.

Stratigraphic and geographic range. France: Toarcian, Aalensis Zone (Apostolescu 1959; Magne et al. 1961); Northwestern Germany: late Aalenian (Plumhoff 1963); northeastern Germany: late Toarcian and early Aalenian (Stoermer and Wienholz 1967); Southern Germany: late Toarcian and early Aalenian (Malz 1966; Herrig 1981c; Knitter 1983); Northern Switzerland: from the late Toarcian to Aalenian (Tröster 1987); Cordillera Ibérica, Spain: from the late Toarcian, Aalensis Zone, to Early Aalenian, Opalinum Zone of the Fuentelsaz section.

Palaeobiogeography

Plumhoff (1963) and Knitter (1983, 1984) in their studies on the late Toarcian-early Aalenian ostracods from northeastern and southwestern Germany, stated that no distinct ostracod faunal changes took place across the Toarcian/Aalenian boundary in the European Epicontinental Sea. Arias & Whatley (2004) revised the late Toarcian-early Aalenian ostracod faunas from the different European basins and they arrived at the same conclusion. No clear differences could be recognized between European ostracod assemblages, neither in stratigraphical ranges nor in faunal composition. In order to elucidate the causes of this resemblance among Aalenian ostracods, both ecological and historical factors must be taken into account, together with the phylogeny of the fossil group being studied. How-

ever, this is difficult for the Aalenian, because of our limited knowledge of the Aalenian marine environments.

The upper Toarcian and Aalenian sediments of the Turmiel Formation at the Fuentelsaz section have yielded ostracod assemblages, that to some extent, comprise both early Toarcian species previously described in the Iberian Range and the first appearances of several species never beforehand described in Spain (*Cytheropteron alafastigatum, Cytheropterina criba*, *Kinkelinella fischeri, Ektyphocythere furcata, Praeschuleridea gallemannica, P. ventriosa, Otocythere callosa,* and *Cytherella cadomensis).* These assemblages show many species also described in other late Toarcian-early Aalenian European ostracod assemblages.

Meanwhile the Cordillera Ibérica assemblages shared numerous species with the Paris Basin (60% species), more than with those described from Germany, Switzerland and Great Britain during the Early Toarcian; during the late Toarcian- early Aalenian transition, the Cordillera Ibérica assemblages shares a little more than 30% species to French assemblages. Of the forty species recovered from the late Toarcian-early Aalenian of the Paris Basin by Apostolescu (1959, 1961), Bizon, (1961), Champeau (1961) and Magne et al. (1961), only thirteen of the most ubiquitous species recovered have been found in the Fuentelsaz section. In contrast with the results described for the early Toarcian ostracod assemblages recorded from the Quercy area (similarity up 80%), during the late Toarcian-early Aalenian transition, Quercy assemblages do not show a close remarkable similarity to the Cordillera Ibérica assemblages. A possible explanation for the discrepancy between both results would be the reduced number of species that have been described in the Aalenian of the Quercy area.

On the other side, Spanish assemblages show a poor similarity (share less than 30%) to Canadian, Irish and Portuguese assemblages. As for the western and northern European Epicontinental Sea (the Fastnet Basin, Great Banks and Portugal), nine ostracod species are found to be common. Inner shelf Toarcian-Aalenian dark calcareous bituminous shales of the Stratton Formation in the Fastnet, Celtic and Cardigan Bay basins, produced less abundant assemblages, where large cytheroids dominate, with many new species of *Bairdia, Cardobairdia, Isobythocypris, Bairdiacypris, Liasina,* and *Procytherura* (Ainsworth 1986, 1990). These assemblages show a minor similarity with those described from the Cordillera Ibérica (they share less than 20% of the ostracod species).

Results obtained from the present study show the highest values of similarity to southwestern German and Swiss assemblages. The late Toarcian ostracod assemblages recorded from the marls, marly limestones and interbedded calcareous shales of the Upper Schwarzjuramergel Formation and for the dark marine shales of the Lower Opalinuston Formation (Plumhoff 1963; Knitter 1983, 1984; Knitter & Riegraf 1984, Riegraf 1985; Richter 1987, and Ohmert et al. 1996) are characterised by the occurrence of the genera *Praeschuleridea (P. angulata, P. bernierensis, P. ventriosa*) and *Kinkelinella* (*K. sermoisensis, K. costata*) and also by some cytherellids. These assemblages show a high similarity to the Cordillera Ibérica (up 40% species in common). Of seven species recorded from East Germany and forty-one species recorded from southern Germany, only twenty species are described in the Fuentelsaz section.

The ostracod record for the Toarcian-Aalenian transition described at the Fuentelsaz section yielded a diverse and abundant ostracod fauna. The most prevalent ostracod assemblages in the Aalensis Zone, late Toarcian are dominated by two species, which already characterized the early Toarcian ostracod assemblages: *Kinkelinella sermoisensis* (Apostolescu, 1959) and *Cytherella toarcensis* (Bizon, 1960). Both species disappear throughout the Aalensis Zone and do not trespass the Toarcian-Aalenian boundary. During the Toarcian-Aalenian transition three new species start to dominate the assemblages: *Praeschuleridea ventriosa* (Plumhoff, 1963), *Praeschuleridea aspera* Knitter, 1983 and *Cytherelloidea cadomensis* Bizon, 1960. They are going to overshadow the Aalenian assemblages. Assemblages of early Aalenian age with *Praeschuleridea ventriosa* (Plumhoff, 1963), *Praeschuleridea aspera* Knitter, 1983 and *Cytherelloidea cadomensis* Bizon, 1960 are very well known from all areas where Aalenian deposits crop out. *Praeschuleridea ventriosa* (Plumhoff, 1963) was found at several localities in southern Germany, Switzerland and France. Distribution of *Praeschuleridea aspera* Knitter, 1983 shows a similar pattern, as it is common in the middle part of the beginning of the Opalinum Zone of central Europe, but it may be that it was more widespread, since sampling of this level was very restricted (Knitter 1984).

Representatives of the bythoceratidae in the Fuentelsaz section is very limited, and in the Germany most of the described taxa [*Monoceratina ungulina* Triebel & Bartenstein, 1938, *Monoceratina scrobiculata* Triebel & Bartenstein, 1938, *Monoceratina stimulea* (Schwager, 1866)] are restricted to local occurrences. Another very characteristic Aalenian species is *Otocythere callosa* (Triebel & Klingler, 1959) that have been also described in Baden-Württemberg area and in the Paris Basin.

The most outstanding aspect is our study is that the genus *Aphelocythere* Triebel & Klingler (1959), which is an important constituent of the Toarcian -Aalenian boundary assemblages of France, Germany and

the Fastnet Basin (Depèche 1985; Plumhoff 1963; Knitter 1984; Ainsworth 1986; Ohmert et al. 1996; Bodergat 1997), neither *Aphelocythere undulta* Triebel & Klingler, 1959 nor *Aphelocythere kuhni* Triebel & Klingler, 1959 have been found at the Fuentelsaz section or in the British Isles. *Camptocythere* Triebel (1950) and *Aaleniella* Plumhoff (1963) are also two prevalent genera for the Toarcian-Aalenian boundary on the north of the European Epicontinental Sea that are absent in the Fuentelsaz section. It is possible that the deprived richness of the Fuentelsaz samples during the Opalinum Zone could be the cause of the absence of these typical Aalenian species.

Palaeobiogeographic analysis of the ostracod assemblages described at the Fuentelsaz section indicates significant similarities to those ostracod assemblages described in central European shallow marine areas. Late Toarcian and early Aalenian ostracod fauna exhibits only minor relations with the Tethyan area. The analysis points out that the closest similarities are with southern German platforms (Tab. 2). Because German assemblages are the best studied, this fact could have influenced the results of the present study. All species described in the Fuentelsaz section have been described in other areas of western and central Europe. The concordance of timing and composition between Spanish and central European assemblages give us details on a very homogeneous environmental conditions across the European Epicontinental Sea that covered most of the present European continent. During the Toarcian-Aalenian transition, biota of the Cordillera Ibérica basin was constantly communicated with that of the European Epicontinental Sea, whereas its links with the Panthalassa continue (via Hispanic Corridor), enhancing at the time of large transgressions. Since the late Toarcian-early Aalenian ostracod assemblages from central and northwestern Europe became essentially similar in their compositions, a very uniform environmental conditions must be prevalence in the central area of the European Epicontinental Sea. However, the scarcity of the Aalenian ostracod record in Europe made very difficult to be a better palaeobiogeographical analysis.

Conclusions

The detailed analysis of the ostracod faunas in the Fuentelsaz section, Iberian Range, has significantly improved our knowledge of the micropalaeontology of a geologic reference area, the stratotype of the Toarcian-Aalenian boundary stage in the Central Iberian Range region. More precisely, this new contribution pertains to a poorly known part of the studied interval, the late Toarcian-early Aalenian transition. It also made possible the correlation of a number of important species with the ammonite zonal scale. In addition to the forms already reported, a large number of species described in diverse regions of Western Europe have been identified in the Fuentelsaz section and their stratigraphic ranges have been established in a more accurate way.

Eight families, eleven genera and twenty species represent the total ostracod fauna. From the twenty species that are present during the latest Toarcian, only nine species range across the Toarcian/Aalenian boundary. The majority of the ostracod species belong to the Superfamily Cytheroidea, mainly to the genera *Praeschuleridea* and *Kinkelinella*. Although the species of the families Cytherellidae and Bairdiidae considered herein comprise only a small part of the overall studied ostracod fauna, they are important, since most have very restricted stratigraphical ranges and their record will contribute to future biostratigraphical and palaeobiogeographical studies.

The assessment of the distributions makes it possible to characterize with precision the Toarcian-Aalenian boundary by bringing to light that there are two groups with different compositions, which succeed each other in time and did not match with the ammonite subdivision. A first assemblage dominated by the genera *Kinkelinella, Ektyphocyther,* and *Cytherelloidea* in the upper Toarcian, Aalensis Zone, Mactra Subzone and a second assemblage dominated by different species of the genus *Praeschuleridea* throughout the rest of the section.

However, the evolution of the ostracod populations is perturbed by an episode of, to some extent, impoverishment situated at the base of the lower Aalensis Subzone (upper Toarcian, Aalensis Zone). The late Toarcian (Mactra - Aalensis subzones) ostracod event is the most important bioevent in the record of the Middle Jurassic Ostracoda in the Iberian Range at the species level, although it is less significant at the generic level. As a result, the study of the Toarcian-Aalenian Ostracoda in the Fuentelsaz section did not show a distinct event, but a progressing ostracod faunal change, as observed elsewhere (Plumhoff 1963; Knitter 1984).

Comparing with other paleontological groups analysed in the Fuentelsaz section, it is remarkable that this ostracod turnover is also coincident with a remarkable morphological innovation concerning the ammonite phyletic line *Leioceras-Pleydellia* and with a diversity drop off in the Late Toarcian Grammoceratinae ammonite subfamily with the disappearance of all species of the genus *Cotteswoldia*, remaining only the representatives of the phyletic line of the *Pleydellia-Leioceras* (Cresta et al. 2001). In addition, Late Toarcian foraminiferal assemblages show a gradual replacement from typical Early Jurassic species to characteristic Middle Jurassic taxa (Herrero & Canales 1997). Thus, these and other observed ostracod events have the potential to enhance stratigraphic resolution close to the Toarcian-Aalenian boundary. They provide additional

OSTRACOD SPECIES	PARIS BASIN	GREAT BRITAIN	FASTNET BASIN	DENMARK	NORTH GERMANY	SOUTH GERMANY	IBERIAN RANGE	PORTUGAL
Polycope discus			----------	----------	----------	----------	----------	----------
Polycope pelta	----------	----------	----------	----------	----------	----------	----------	----------
Cytherella toarcensis	----------	----------	----------		----------	----------	----------	----------
Cytherelloidea cadomensis	----------				----------	----------		
Cytherelloidea reticuloornata						----------		
Bairdiacypris dorisae	----------	----------				----------	----------	
Monoceratina scrobiculata					----------	----------		
Monoceratina stimulea		----------			----------	----------	----------	
Monoceratina ungulina	----------				----------	----------	----------	----------
Cytheropteron alafastigatum	----------				----------	----------	----------	----------
Cytheropteron cribum	----------		----------		----------	----------		
Otocythere callosa	----------				----------	----------		
Eucytherura tricostata		----------	----------	----------		----------		----------
Ektyphocythere furcata	----------				----------	----------		
Kinkelinella costata	----------		----------			----------		
Kinkelinella fischeri					----------	----------		
Kinkelinella sermoisensis	----------	----------	----------	----------	----------	----------	----------	----------
Praeschuleridea aspera	----------		----------		----------	----------		
Praeschuleridea punctulata					----------	----------		
Praeschuleridea ventriosa	----------		----------		----------	----------		

Tab. 2 - Late Toarcian-Early Aalenian palaeogeographical occurrence data for European benthic ostracod species incorporated in palaeobiogeographical analysis, indicating the zoogeographical affinities of the Fuentelsaz ostracod fauna during the Late Toarcian-Early Aalenian.

criteria to characterize this transition with reasonable accuracy.

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REFERENCES

Ainsworth N. (1986) - Toarcian and Aalenian Ostracoda from the Fastnet Basin, offshore Southwest Ireland. *Bull. Geol. Surv. Ireland,* 3: 277-336, Dublin.

Ainsworth N. (1989) - Remarks on the nomenclature of two ostracod species from the Pliensbachian and upper Toarcian-Aalenian of the Fastnet Basin, offshore Southwest Ireland. *Bull. Geol. Surv. Ireland,* 4: 165-166, Dublin.

Ainsworth N.R. (1990) - Uppermost Rhaetian to lower Bajocian Ostracoda from the Porcupine Slyne, Erris and Donegal Basins, offshore west Ireland. *Bull. Geol. Surv. Ireland,* 4: 169-200, Dublin.

Apostolescu V. (1959) - Ostracodes du Lias du bassin de Paris. *Rev. Inst. Fr. Pétrole,* 15: 795-817, Paris.

Apostolescu V. (1961) - Sud du Bassin, Région D'Argenton-sur-Creuse et de la Chatre (Départements du Cher et de lIndre). Ostracodes. In: Cousin N J., Espatilier, J. Sigal & Apostolescu V. (Eds) - Colloque sur le Lias français. *Mém. Bur. Recher. Géol. Min.*, 4: 445-449, Orléans.

Apostolescu V., Magne J. & Malmoustier G. (1961) - Quelques espèces nouvelles d'Ostracodes du Toarcien de Thouars (Deux-Sèvres). In: Cousin N J., Espatilier, J. Sigal & Apostolescu V. (Eds) - Colloque sur le Lias français. *Mém. Bur. Recher. Géol. Min*, 4: 399-415, Orlèans.

Arias C. (1991) - Las asociaciones de Ostrácodos del Domeriense superior y Toarciense inferior de la Cordillera Ibérica. *Coloq. Paleontol.,* 43: 79-99, Madrid.

Arias C. (1995) - Los ostrácodos del Toarciense inferior en la Cordillera Ibérica. Unpublished Ph.D. Thesis, Universidad Complutense de Madrid. 521 pp.

Arias C. (2007a) - Pliensbachian-Toarcian ostracod biogeography in NW Europe: evidence for water mass structure evolution. *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, 251: 398- 421, Amsterdam.

Arias C. (2007b) - Changes in ostracod provincialism during the Early Toarcian in the European Epicontinental Sea-Western Tethys area. *Rev. Esp. Micropaleontol., 38*: 245- 267, Madrid.

Arias C. & Comas-Rengifo M.J. (1992) - Ostrácodos del Domeriense superior y Toarciense inferior de la Cordillera Ibérica. *Rev. Esp. Micropaleontol.,* 24: 111-155, Madrid.

Arias C. & Lord A. (1999a) - Upper Pliensbachian and Lower Toarcian Ostracoda from the Cordillera Ibérica, North-East Spain. Part 1. *Rev. Esp. Micropaleontol.,* 31: 73-98, Madrid.

Arias C. & Lord A. (1999b) - Upper Pliensbachian and Lower Toarcian Ostracoda from the Cordillera Iberica, North-East Spain. Part 2. *Rev. Esp. Micropaleontol.,* 31: 219-242, Madrid.

Arias C., Comas-Rengifo M.J., Goy A. & Herrero C. (1992) - Variations dans les associations de brachiopodes, foraminifères et ostracodes du Toarcien basal dans le secteur central de la Cordillère Ibérique, un exemple dans La Rambla del Salto (Téruel, Espagne). *Cahiers Scientifiques de l'Université Catholique de Lyon,* 5: 5-25, Lyon.

Arias C. & Whatley C. (2004) - Distribution patterns of early Jurassic Ostracoda and possible communication routes through the European Epicontinental Sea, evidence of changes in ocean circulation patterns and its consequence to climate change. *Neues Jahrb. Geol. Paläontol. Abh.*, 232: 1-55, Stuttgart.

Bate R.H. & Coleman B.E. (1975) - Upper Lias Ostracoda from Rutland and Huntingdonshire. *Bull. Geol. Surv. Great Britain,* 55: 1-42, London

Bizon J.J. (1960) - Sur quelques ostracodes du Lias du Bassin parisien. *Rev. Micropaléontol.,* 2: 203-211, Paris.

Bizon J.J. (1961) - Basse-Normandie (régions d'Irigny et sur de Bayeux). In: Cousin N J., Espalier, J. Signal & Apostolescu V. (Eds) - Colloque sur le Lias français. *Mém. Bur. Recher. Géol. Min.*, 4: 431-438, Orléans.

Blake J.F. (1876) - Class Crustacea. In: Tate R. & Blake J.F. (Eds) - The Yorkshire Lias, 429-435 pp., London.

Bodergat A.M. (1997) - Ostracodes marins. Les ostracode marins du Jurassique Européen. Utilisation Stratigraphique. In: Cariou E., Hantzpergue P. (Eds) pour le Groupe Français d'études du Jurassique - Biostratigraphie du Jurassique ouest-européen et méditerranéen: zonations parallèles et distribution des invertébrés et microfossiles. *Bull. Centre rech. explor. prod. Elf Aquitaine*, Mémoire 17, 197-223 pp., Pau.

Bodergat A. M. & Donze P. (1988) - Biostratigraphical Scale in the Toarcian of the Paris Basin by means of ostracod associations. In: Hanai, T, Ikeya, N. & Ishizaki K. (Eds) - Evolutionary biology of Ostracoda, fundamentals and applications. Proceeding of the Ninth International Symposium on Ostracoda, Shizouoka, Japan. *Develop. Paleontol. Strat.,* 1: 1261-1267, Elsevier, Amsterdam.

Bodergat A.M., Donze P., Nicollin J.P. & Ruget C. (1985) - Répartition biostratigraphique des microfaunes toarciennes (Foraminifères et Ostracodes) en bordure du Bassin de Paris. *Cahiers de l'Institut Catholique, Lyon,* 14: 103-121, Lyon.

Boomer I. (1991) - Lower Jurassic ostracod biozonation of the Mochras Borehole. *J. Micropaleontol.,* 9: 205-218, London.

Boomer I. (1992) - Lower Jurassic ostracods from Ilminster, Somerset, England. *J. Micropaleontol.*, 11: 47-57, London.

Boomer I. (1994) - Ostracod Biostratigraphy of two borehole sections across the Toarcian/Aalenian (Lias / Dogger) boundary, southern Germany. *Newsl. Stratigr.,* 31: 143-150, Stuttgart.

Boomer I., Ainsworth N. & Exton J. (1998) - A re-examination of the Pliensbachian and Toarcian ostracod of Zambujal, west-central Portugal. *J. Micropaleontol.,* 17: 1-14, London.

Canales M.L. (2001) - Los Foraminíferos del Aaleniense (Jurásico Medio) en la Cuenca Vasco-Cantabrica (N de España). *Rev. Esp. Micropaleontol.,* 33: 253-438, Madrid.

Champeau, H. (1961) - Étude de la microfaune des niveaux marneux du Lias dans le sud-est du Bassin de Paris. In: N. Cousin, J. Espatilier, J. Sigal and V. Apostolescu, (Eds) - Colloque sur le Lias français. *Mém. Bur. Recher. Géol. Min.,* 4: 437-443, Orléans.

Cousin N. & Apostolescu V. (1961) - Ostracodes. In: Cousin N J., Espatilier, J. Sigal & Apostolescu V. (Eds) - Colloque sur le Lias français. *Mém. Bur. Recher. Géol. Min.,* 4: 423-431, Orléans.

Cresta S., Goy A., Ureta S., Arias, C., Barrón E., Bernard J., Canales M.L., García-Joral F., García-Romero E., Gialanella P.R., Gómez J.J., González J.A., Herrero C., Martínez G., Osete M.L., Perilli N. & Villalaín J.J. (2001) - The Global Boundary Stratotype Section and Point (GSSP) of the Toarcian-Aalenian Boundary (Lower-Middle Jurassic). *Episodes,* 24: 166-175, Beijing.

Depèche E. (1985) - Lias superieur, Doggcr and Malm. In: Oertli H. (Ed.) - Atlas des Ostracodes de France. *Bull. Centre rech. explor. prod. Elf Aquitaine,* Memoire 9: 119-145, Pau.

Donze P. (1967)- Les ostracodes du sondage de Laneuvellie-Devant-Nancy (Lotharingien de la region type). *Sciences de la Terre,* 12: 71-92, Paris.

Donze P. (1985) - Lias inferieur et moyen. In: Oertli H (Ed.) - Atlas des Ostracodes de France. *Bull. Centre rech. explor. prod. Elf Aquitaine Aquitaine* Memoire 9: 101-117, Pau.

Drexler E. (1958) - Foraminiferen und Ostracoden aus dem Lias von Siebeldingen Pfalz. *Geol. Jahrb.,* 75: 475-554, Stuttgart.

Exton J. (1979) - Pliensbachian and Toarcian microfaunas of Zambujal, Portugal. Systematic Paleontology. *Geol. Pap. Carleton University,* 79: 1-104, Carleton.

Exton J. & Gradstein F.M. (1984) - Early Jurassic stratigraphy and micropaleontology of the Grand Banks and Portugal. In: Westerman G.E.C. (Ed.) - Jurassic and Cretaceous biochronology and biogeography of North America. *Spec. Pap. Geol. Ass.,* 27: 13-28, Denver.

Field R.A. (1966) - Species of the family Cytherellidae (Ostracoda) from the Lower Lias of south Dorset, England. *Senckenbergiana Lethaea,* 47: 87-105, Frankfurt.

Finger L.L. (1983) - *Acrocythere michelseni*, a new name for *Acrocythere tricostata* Michelsen, 1975, Ostracoda. *Micropaleontology,* 29: 1-110, New York.

Fischer W. (1961a) - Neue Arten Ostracoden Gattung *Polycope* SARS (1865) aus dem Oberen Lias (Württemberg). *Neues Jahrb. Geol. Paläontol. Abh.,* 8: 497-501, Stuttgart.

Fischer W. (1961b) - Über die Lias/Dogger-Grenze in Süddeutschland. *Neues Jahrb. Geol. Paläontol. M.,* 8: 394-400, Stuttgart.

Fischer W. (1961c) - Über die Bildungsbedingungen der Posidonienschiefer in Süddeutschland. *Neues Jahrb. Geol. Paläontol. M.,* 8: 326-340, Stuttgart.

Fischer W. (1962) - Ostracoden der Gattungen *Monoceratina* ROTH, *Cytheropteron* G.O. SARS und andere im Lias Zeta Schwabens. *Neues Jahrb. Geol. Paläontol. Abh.,*114: 333-345, Stuttgart.

Fischer W. (1963) - Neue Arten Ostracoden-Gattung *Procytheridea* Peterson, 1954 aus dem Oberen Lias Scwabens. *Neues Jahrb. Geol. Paläontol. M.,* 11: 295-300, Stuttgart.

Gabaldón, V., del Olmo Zamora P. & Portero García J.M. (1983) - Hoja 464, Used. Mapa Geológico de España 1: 50.000, 74 pp. Instituto Geológico y Minero de España, Spain.

García-Frank A., Ureta S. & Mas R. (2008) - Aalenian pulses of tectonic activity in the Iberian Basin, Spain. *Sedimentary Geology,* 209: 15-35, Amsterdam.

García-Joral F. (1986) - Los Braquiópodos del Aaleniense de la Cordillera Ibérica. Unpublished PhD Thesis. Universidad Complutense de Madrid. 326 pp.

García-Joral F. & Goy A. (1995) - The associations of Brachiopods from the Toarcian-Aalenian transition in the Fuentelsaz Section (Iberian Range, Spain). *Geobios* M.S., 17: 223-228, Lyon.

García-Joral F., Goy A. & Ureta S. (1990) - Las sucesiones de braquiópodos en el tránsito Lías-Dogger en la Cordillera Ibérica. *Cuadernos de Geología Ibérica,* 14: 55-65, Madrid.

Gómez J.J., Comas-Rengifo M.J. & Goy A. (2003) - Las unidades litoestratigráficas del Jurásico Inferior de las Cordilleras Ibérica y Costeros Catalanas. *Rev. Soc. Geol. España*, 16: 227-238, Madrid.

Goy A. & Ureta M.S. (1987) - Leioceratinae (Ammonitina) del Aaleniense inferior de Fuentelsaz (Cordillera Ibérica, España). *Boll. Soc. Paleontol. It.*, 25: 213-236, Modena.

Goy A. & Ureta M.S. (1990) - El Aaleniense en la Cordillera Ibérica. *Les Cahiers de l'Université Catholique de Lyon. sér. Sciences,* 4: 73-87, Lyon.

Goy A. & Ureta M.S. (1991) -The lower boundary of the Aalenian in the Fuentelsaz section (Iberian Range, Spain). In: Morton N. (Ed.) - Conference on Aalenian

and Bajocian Stratigraphy, Isle of Skye, 33-47 pp., Birkbeck College, University of London.

Goy A., Ureta S., Arias C., Canales M.L., García-Joral F., Herrero C., Martínez G. & Perilli N. (1994) - The Fuentelsaz section (Iberian Range, Spain), a possible Stratotype for the base of the Aalenian Stage. *Miscellanea del Servizio Geologico Nazionale,* 5: 1-31, Roma.

Goy A., Ureta S., Arias C., Bernad J., Barrón E., Canales M.L., García-Joral F., Gialanella P.R., Gómez J.J., Herrero C., Martínez G., Osete M.L., Perilli N. & Villalaín J.J. (1996) - The Toarcian/Aalenian transition in Fuentelsaz section. In: Ureta S. (Ed.) - Fieldtrip Iberian Range Guide-Book. 1st Toarcian 4th Aalenian Working Groups Meeting, 51-77. Nuévalos (Spain) and Friburg (Germany).

Goy A., Ureta S., Arias C., Barrón E., Bernad J., Canales M.L., García-Joral F., Gialanella P.R., Gómez J.J., Herrero C., Martínez G., Osete M.L., Perilli N. & Villalaín J.J. (1999) - The Fuentelsaz section (Guadalajara, Iberian Range, Spain). A possible Global Geosite. In: Barettino D.,Vallejo M., Gallego E. (Eds) - Towards the Balanced Management and Conservation of the Geological Heritage in the New Millenium, 60-64. Madrid, Spain.

Gradstein F.M. & Ogg J.G. (2004) - Geologic time scale 2004 -Why, how, and where next!. *Lethaia,* 37: 175-181, Olso.

Henriques M.H., Linares A., Sandoval J. & Ureta S. (1996) - The Aalenian in the Iberia (Betic, Lusitanian and Iberian Basins). *GeoResearch Forum,* 1-2: 139-150, Stafa-Zürich.

Herrero C. & Canales M.L. (1997) - Diversidad en los foraminíferos del tránsito Toarciense/Aaleniense en la sección de Fuentelsaz (Cordillera Ibérica). *Rev. Esp. Paleontol.,* 12: 233-242, Madrid.

Herrig E. (1981a) - Die polycopiden Ostrakoden aus dem thüringischen Lias. *Z. Geol. Wissenchaften,* 9: 675-696, Berlin.

Herrig E. (1981b) - Ostrakoden aus dem Lias von Thüringen. Die Familien Bythoceridae, Gloriannellidae und Cytheruridae (I). *Z. Geol. Wissenchaften,* 9: 871-877, Berlin.

Herrig E. (1981c) - Ostrakoden aus dem Lias von Thüringen. Die Familie Cytheruridae (II) und die Gattungen *Acrocythere, Dominocythere* und *Aphelocythere. Z. Geol. Wissenchaften,* 9: 1017-1029, Berlin.

Herrig E. (1982a) - Ostrakoden aus dem Lias von Thüringen. Die Familien Progonocytheridae, Cytherettidae und Brachycytheridae. *Z. Geol. Wissenchaften,* 10: 1449-1461, Berlin.

Herrig E. (1982b) - Ostrakoden aus dem Lias von Thüringen. Die Familien Trachyleberididae, Paradoxostomatidae, Cytherellidae sowie Nachtrag zu den Paracypprididae. *Z. Geol. Wissenchaften,* 10: 231-243, Berlin.

Herrig E. (1985) - Zur Taxonomie und Evolution der Gattung *Kinkelinella* Martin, 1960 (Ostracoda) im Unteren Jura von Mittel- und Nordwesteuropa. *Z. Geol. Wissenchaften,* 13: 715-723, Berlin.

Klingler W. (1962) - Lias Deutschland. In: W. Simon and H. Bartenstein (Eds) - Arbeitskreis deutcher Mikropäleontologen (Hgrs), Leitfossilien der Mikropaläontologie: 73-122, Wien.

Klingler W. & Neuweiler F. (1959) - Leitende Ostracoden aus dem deutschen Lias. *Geol. Jahrb.*, A 76: 373-410, Stuttgart.

Knitter H. (1983) - Biostratigraphische Untersuchungen mit Ostracoden im Toarcien Süddeutschlands. *Facies,* 8: 213-262, Erlangen.

Knitter H. (1984) - Ostracod biostratigraphy of the Upper Toarcian in Southern Germany. In: O. Michelsen, and A. Zeiss, (Eds) - *International Symposium on Jurassic Stratigraphy,* 251-258. Erlangen.

Knitter H. & Ohmert W. (1983) - Das Toarcium a der Schwärz bei Badenweiler (Oberrheingebiet S. Freiburg). *Jahrb. Geol. Landesamt Baden-Württemberg,* 24: 233-281, Stuttgart.

Knitter H. & Riegraf W. (1984) - Biostratigraphie (Cephalopoden, Ostracoden) des Oberen Toarcium von Blumberg Achdorf, Wutachs und Weilheim/Teck (Baden-Württemberg). *Jahrb. Geol. Landesamt Baden-Württemberg,* 26: 57-97, Stuttgart.

Lord A. (1974) - Ostracods from the Domerian and Toarcian of England. *Palaeontology,* 17: 599-622, London.

Lord A. (1978) - The Jurassic. Part. 1 (Hettangian-Toarcian). In: Bate R & Robinson E. (Eds) - A Stratigraphic Index of British Ostracoda, 189-212. Seel House Press, London.

Magne J. & Malmoustier G. (1961) - Quelques espéces nouvelles d'Ostracodes du Toarcien de Thouars (Deux-Sevres). In: Cousin N J., Espatilier, J. Sigal & Apostolescu V. (Eds) - Colloque sur le Lias français. *Mém. Bur. Rech. Géol. Minièr.*, 4: 399-405, Orléans.

Magne J., Seronie-Vivien R.M. & Malmoustier G. (1961) - Le Toarcien de Thouars. In: Cousin N J., Espatilier, J. Sigal & Apostolescu V. (Eds) - Colloque sur le Lias français. *Mém. Bur. Rech. Géol. Minièr*, 4: 357-397, Orléans.

Malz H. (1961) - Erörterung der taxionalischen Fassung der Progonocytherinae (Ostracoda). *Senckenbergiana lethaea,* 42: 175-179, Frankfurt.

Malz H. (1966) - Zur Kenntnis Ostracoden-Arten der Gattungen *Kinkelinella* und *Praeschuleridea. Senckenbergiana lethaea,* 47: 385-404, Frankfurt.

Martínez G. (1992) - *Hammatoceratinae (Ammonitina) del Toarciense superior y Aaleniense en la Cordillera Ibérica*. Colección Tesis Doctorales 374/92, 331 pp. Universidad Complutense de Madrid.

Michelsen O. (1975) - Lower Jurassic biostratigraphy and ostracods of the Danish Embayment. *Danmarks Geologiske Undersøgelse,* 104: 1-289, Aarhus.

Ohm H. H. (1986) - Ostrakoden. In: R. Fischer R., Jager M., Konstantinopoulu A. Kristan-Tollmann E., Luppold F.W. & Ohm H.H. (Eds) - Paläontologie einer epikontinentalen Lias-Schichtfolge: Oberes Sinemurium bis Oberes Domerium von Empelde bei Hannover. *Facies*, 15: 53-176, Erlangen.

Ohmert W. (1994) - The Frechi horizon (Humphriesianum Zone, Lower Bajocian) from the Oberrhein (South West Germany). *Geobios* M. S., 17: 359-367, Lyon.

Ohmert W. (coord.) (1996) - Die Grenziehung Unter-Mitteljura (Toarcium/Aalenium) bei Wittnau und Fuentelsaz. Beispiele interdisziplinärer Geowissenschaftlicher Zusammenarbeit. *Jahrb. Geol. Landesamt Baden-Württemberg,* 8, 1-53, Stuttgart.

Ohmert W., Prauss M. & Weiss M. (1991) - The Toarcian-Aalenian boundary at Wittnau (Oberrrhein area, south west Germany) a possible boundary stratotype for the Aalenian. In: Morton N. (Ed.) - Conference on Aalenian and Bajocian Stratigraphy. Isle of Skye, 1-31. Birkbeck College, London.

Ohmert W. & Rolf C. (1994) - The Aalenian boundaries at Wittnau (Oberrhein area, south west Germany). *Servizio Geologico Nazionale Miscellanea,* 5: 33-61, Roma.

Perilli N. (1997) - Calcareous nannofossil of late Toarcian-early Aalenian transition at Fuentelsaz section (Rama Castellana, Spain). IV Congreso de Jurasico de España, Comunicaciones: 107 pp.

Plumhoff F. (1963) - Die Ostracoden des Oberaalenium und tiefen Unterbajocium (Jura) des Gifhorner Troges, Nordwestdeutschlands. *Abh. Sencken. Naturforsch. Gesell.,* 503: 1-100, Frankfurt.

Riegraf W. (1985) - Microfauna, Biostratigraphie und Fazies im Unteren Toarcian Südwestdeutschland und Vergleiche mit benachbarten Gebieten. *Tübinger Mikropalaontol. Mitt.,* 3: 1-232, Tübingen.

Sandoval J., Henriques M.H., Ureta S., Goy A. & Rivas P. (2001) - The Lias/Dogger boundary in Iberia: Betic and Iberian Cordilleras and Lusitanian basin. *Bull. Soc. Geol. France,* 172: 385-387, Paris.

Schwager C. (1866) - Foraminiferen. In: Oppel H. & Waagen W. (Eds.) - Über die zone Ammonites transversarius. *Geognostisch-paläontologische Beiträge,* 1: 508-665, Münich.

Sivhed U. (1980) - Lower Jurassic ostracods and stratigraphy of western Skåne, southern Sweden. *Sveriges Geologiska Undersokkning, C* 50: 1-85, Uppsala.

Stoermer N. & Wienholz E. (1967) - Mikrobiostratigraphie an der Lias/Dogger-Grenze in Bohrungen nördlich der Mitteldeutschen Hauptscholle. *Jahrbuch für Geologie,* 1: 533-591, Wien.

Triebel E. & Bartenstein H. (1938) - Die Ostracoden des deutschen Juras. *Monoceratina*-Arten aus dem Lias. *Senckenbergiana lethaea,* 20: 502-518, Frankfurt.

Triebel E. & Klingler W. (1959) - Neue Ostracoden-Gattungen aus dem deutschen Lias. *Geologie*, 76: 335-372, Berlin.

Tröster J. (1987) - Biostratigraphie des Obertoarcium und der Toarcium/Aalenium-Grenze der Bohrungen Weiach Beznau, Riuiken und Schafishheim (Nordschweiz). *Ecl. Geol. Helv.*, 80: 431-449, Basel.

Wischer C.A. (1938) - Mikrofaunen aus Jura und Kreide insbesondere Nordwestdeutschlands alpha bis epsilon. *Abh. Preuß. geol. Land.,* 193: 1-16, Stuttgart.