Upper Cretaceous Ostracoda of North Central Spain

R. A. REYMENT

Reyment, R. A. 1984 10 10. Upper Cretaceous Ostracoda of North Central Spain. *Bulletin of the Geological Institutions of the University of Uppsala,* N.S., Vol. 10, pp. 67–110. Uppsala ISSN 0302-2749.

Most of the ostracods described in this monograph come from the Turonian and Coniacian deposits of Segovia Province; additional material from localities in the provinces of Guadalajara and Soria is also treated. Forty three species are described, six of which are new. *Donmacythere* Gründel is described in detail and its two known species, *D. damottae* (Colin) and *D hafsuni,* analyzed. The Turonian is characterized by associations of *Pterygocythere, Mauritsina, Oertliella, Limburgina, Neocyprideis, Planileberis, Trachyleberidea, Dordoniella, Dolocytheridea, Asciocythere.* In some cases, ostracod associations have been dated with the help of Lower Turonian ammonites.

Particular attention is given to the question of polymorphism in the secondary ornament. Multivariate morphometrical methods are used to elucidate aspects of the variation displayed by some of the species. The environment in which the various ostracod associations lived was shallow-water marine. The appendix provides a summary in Spanish.

Richard A. Reyment, Paleontologiska Institutionen, Uppsala Universitet, Box 558, S-75122, Uppsala, Sweden, 15th March 1984.

Contents

Introduction

This monograph is concerned with the ostracods of the Turonian and Coniacian sequences of the Provinces of Segovia, Guadalajara, and Soria, here geographically designated as North-Central Spain. The field work yielding almost all of the species described was carried out in July in 1980 and 1981 and in November of 1983.

My primary interests have been palaeontological and biostratigraphical considerations have only been given a secondary role. A detailed stratigraphical study of Segovia has been made available by Alonso (1981) and Breman (1976) presented a stratigraphically oriented account of the eastern reaches of the area, to wit, parts of Guadalajara and Soria. I refer to both of these accounts for details of the Upper Cretaceous successions of North-Central Spain, as well as to relevant parts of the volume recently edited by García Quintana (1982) dealing with the Cretaceous of Spain.

The first qualified publication on Spanish marine Cretaceous ostracods is that of Grekoff and Deroo (1956), who described small collections from outcrop and borehole material in various parts of North-Central Spain. Unfortunately, this paper did not provide adequate descriptions of the species recorded and the illustrations are poor.

Later Swain (1978) figured several Upper Cretaceous species from areas in Northern Spain and, more recently, Colin *et al.* (1982) and Andreu (1983) have also described collections of Upper Cretaceous ostracods from Northern Spain. In passing, it may be noted that it is remarkable that there are so few species in common between Northern and North-Central Spain; a similar observation holds for the Cenomano-Turonian of Portugal (Babinot *et al.*, 1978), which may indicate (1) that many Cenomanian-Lower Turonian forms do not continue higher into the Turonian and, or, (2) that the distributions may be facies-controlled.

Most recently, Méndez and Swain (1983) have recorded a small ostracod association of Cenomanian age from the Asturias.

The associations described by Babinot (1980) from Provence seem to display more features in common with North-Central Spain. This could presumably be a natural outcome of the fact that Babinot's monograph represents the greatest compilation by far of Upper Cretaceous ostracods from the western Mediterranean realm with a concatenated weighting in favour of distributional evidence for southern France.

As has been noted on an earlier occasion (Reyment, 1984), cases of proven specific agreement with North Africa are rare indeed and even the general aspect of the faunas is not particularly close. *Protobuntonia* is entirely absent in the Iberian and French regions, nor do representatives of the *Veenia*-like elements of the Maghreb occur in Spain. The reason for this palaeobiogeographical enigma could lie with the relative positions taken up by Iberia and North Africa in the Middle Cretaceous.

In this connexion, biostratigraphers of the Cretaceous should not lose sight of the important fact that ostracod species may have very long ranges. This is clearly manifested in the Mediterranean region, for example, where some of the present-day elements of the ostracod fauna of the marine environment began their ranges in the Pliocene, some even in the Miocene. Thus the majority of the species occurring in the Pliocene of southern Andalusia are common at the present day. The ranges involved are usually much greater than those implied for any species in the present monograph.

Thus, of the 65 species recorded by Mr. J. Aranki of the Department of Historical Geology and Palaeontology (Uppsala), four range from the Oligocene to the present, 31 from the Miocene and 19 from the Pliocene. Thus, these species, all of which are currently living in the Mediterranean, can range from five to 25 million years, a sobering thought for some biostratigraphers.

I am well aware that the identification, or comparison, of some species treated in this monograph with forms considered to be typically Cenomanian may be viewed with mixed feelings by some (eg *Dolocytheridea crassa*). In this respect, I can only state that such determinations have only been made after mature consideration and extensive discussions with colleagues.

Acknowledgements

The work presented here was undertaken as part of my contribution to IGCP-Project 58 ”Mid-Cretaceous Events”; it was carried out under the aegis of the Spanish MCE regional group to whose leadership I express my sincerest thanks. The cost of the fieldwork was supported by grants of the Swedish Natural Science Research Council and the Nycander Fund for Scientific Research (Uppsala). I am grateful to Drs. J. P. Colin (Bordeaux) and J. P. Babinot (Marseille) for valuable advice and constructive criticism. The extensive SEM-photography was carried out by Eva Reyment to whose skill this monograph owes whatever merits it may possess. I owe a special debt of gratitude to my friend Dr. Marcos A. Lamolda (Bilbao) for constructive criticism and for revising the Spanish summary.

Origin of the Material

The sections sampled are listed below; the numbers in brackets refer to he designations utilized by Alonso (1981, p. 20 and fig. 5).

Castrojimeno (5) – Coniacian
Carabias-Bercimuel (10)
Moral de Hornuez (17)
Somolinos
Condemios de Arriba
Fuentetoba (Picofrentes)

The locations of the localities Somolinos, Condemios de Arriba and Fuentetoba (Picofrentes) are indicated in Fig. 1 of Breman (1976, p. 72) and Fig. 13. The relatively abundant material from these localities was deemed to be sufficient for an adequate representation of the taxonomical breadth of the associations. There are, however, many more localities within the area of interest (e.g. Navares, Linares, etc.) which, however, were not found to yield vital information.

The Segovian sections lie in the southern part of the ”Duero Basin” of North-Central Spain. The geological history of the Late Cretaceous of the area is dominated by the Cenomano-Turonian transgression, the Late Turonian regression, and the Coniacian transgression. These events are reflections of major tectono-eustatic phases in the history of the Cretaceous oceans and they may be recognized over the whole world (though local crustal disturbances may disturb the picture).

Breman (1976) recognized an episode of continental sedimentation around the Turonian-Coniacian transgression. This is in good agreement with the situation in other parts of the world. It should, however, be noted that extrapolations to northern Spain become increasingly difficult the further north one comes, owing to confounding of the global tectono-eustatic record with local crustal displacements.

Breman (1976) employed the name of Molinas Formation for the Somolinos – Soria Cenomano-Turonian beds. Alonso (1981, p. 89) referred to the Formación de Moral de Hornuez (mapping code C2a = limestones and marls of the Carabias member) for the Turonian beds in part and the Formación de Castrojimeno (mapping code C4a – limestones and marls of Castrojimeno). The descriptions of the sections are most clearly laid out on pp. 99, 111, 113, and 137 of Alonso's thesis. Some of the details have later been modified by Alonso in García Quintana (Ed., 1982, pp. 403–453).

The ostracod associations

Carabias (Carabias-Bercimuel road-section)

Section presented in detail by Alonso (1981, p. 258). The following ostracod species are described in this monograph (a somewhat more detailed account is given in the Spanish summary p. 107).

Mauritsina soriensis (Grekoff and Deroo)
Dordoniella turonensis Damotte
Cornicythereis ? *picofrentensis* (Grekoff and Deroo)
Veeniacythereis ? sp.
Dumontina ? sp.
Dolocytheridea crassa Damotte
Paracaudites ? sp. indet.
Parvacythereis ? sp. nov.
Spinoleberis petrocorica (Damotte)?
Neocyprideis iberiacus (Grekoff and Damotte)
Limburgina galvensis (Breman)
Cytherella aff. *postangulata* Babinot
Trachyleberidea alandalusensis sp. nov.
Oertliella guadalajarensis (Breman)

Neocythere (Physocythere) aff. *verbosa* (Damotte) was recorded in Reyment (1984) but was not encountered in the present collection.

Ten levels were sampled, spread over the range encompassed by beds 10 to 24 in the section illustrated in Fig. 15 of Alonso (1981). Judging from the admittedly sparse biostratigraphical evidence available, the age of this part of the sequence should be somewhere in the middle part of the Early Turonian.

Views of the section are presented in Fig. 1.

Moral de Hornuez

This section has been described in detail by Alonso (1981, p. 259 and fig. 17). Seven levels were sampled for the present study, encompassing beds 2 to 21 of Alonso (1981, Fig. 17). The following species are described in this monograph:

Mauritsina soriensis (Grekoff and Deroo)
Mauritsina speciosa Babinot?
Mauritsina radiocostata sp. nov.
"Cythereis" segoviensis sp. nov.
Planileberis aff. *praetexta* (Damotte)
Limburgina galvensis (Breman)
Trachyleberis alandalusensis sp. nov.
Veeniacythereis sp. juv.
"Veenia" moralensis sp. nov.
Dumontina ? almussatensis sp.nov.
Donmacythere hafsuni sp. nov.
Pterygocythere allinensis (Grekoff and Deroo)
Dolocytheridea crassa Damotte
Oertliella guadalajarensis (Breman)
Cytherelloidea aff. *denticulata* (Bosquet)
Parakrithe? sp.

Species recorded by Reyment (1984) and not found in the present collection are *Paracaudites colini* Babinot, *Nucleolina* sp. nov., and *Limburgina* aff. *damottae* Babinot.

Alonso (1981) reported fragments of ammonites from this section identified by Wiedmann as belonging to the genera *Wrightoceras, Pseudaspidoceras,* and *Jeanrogericeras*. These ammonites indicate an age fairly deep in the Lower Turonian and certainly somewhat older than the ostracod material from Carabias. Echinoids and pelecypods are relatively abundant.

Condemios de Arriba

The material described here comes from a marly bed in the escarpment above the hamlet of Condemios de Arriba. This part of the sequence contains species of *Fallotites* as well as abundant gastropods and pelecypods. The age of the ostracodiferous bed is therefore Early Turonian. The following species are described here:

Mauritsina soriensis (Grekoff and Deroo)
Mauritsina radiocostata sp. nov.
Bairdia cenomana Babinot
Oertliella guadalajarensis (Breman)
"Cythereis" segoviensis sp. nov.
Cytherella aff. *postangulata* Babinot
Limburgina ? sp.
Spinoleberis petrocorica (Damotte)?
Bythocypris sp.
Macrocypris siliqua (Jones and Hinde)?

Breman (1976) interpreted the environment in which the Condemios sequence was deposited as having been shallow marine, which is supported by the present study. The occurrence of naticid drillholes in molluscs and ostracods in part of the succession suggests a depth of around 30–40 m (Reyment, 1966).

Somolinos

The Somolinos succession, well exposed in the scarp rising steeply from the hamlet, is a well known ammonite locality with abundant representatives of vascoceratids and many other groups. The upper part of the sequence from which the present

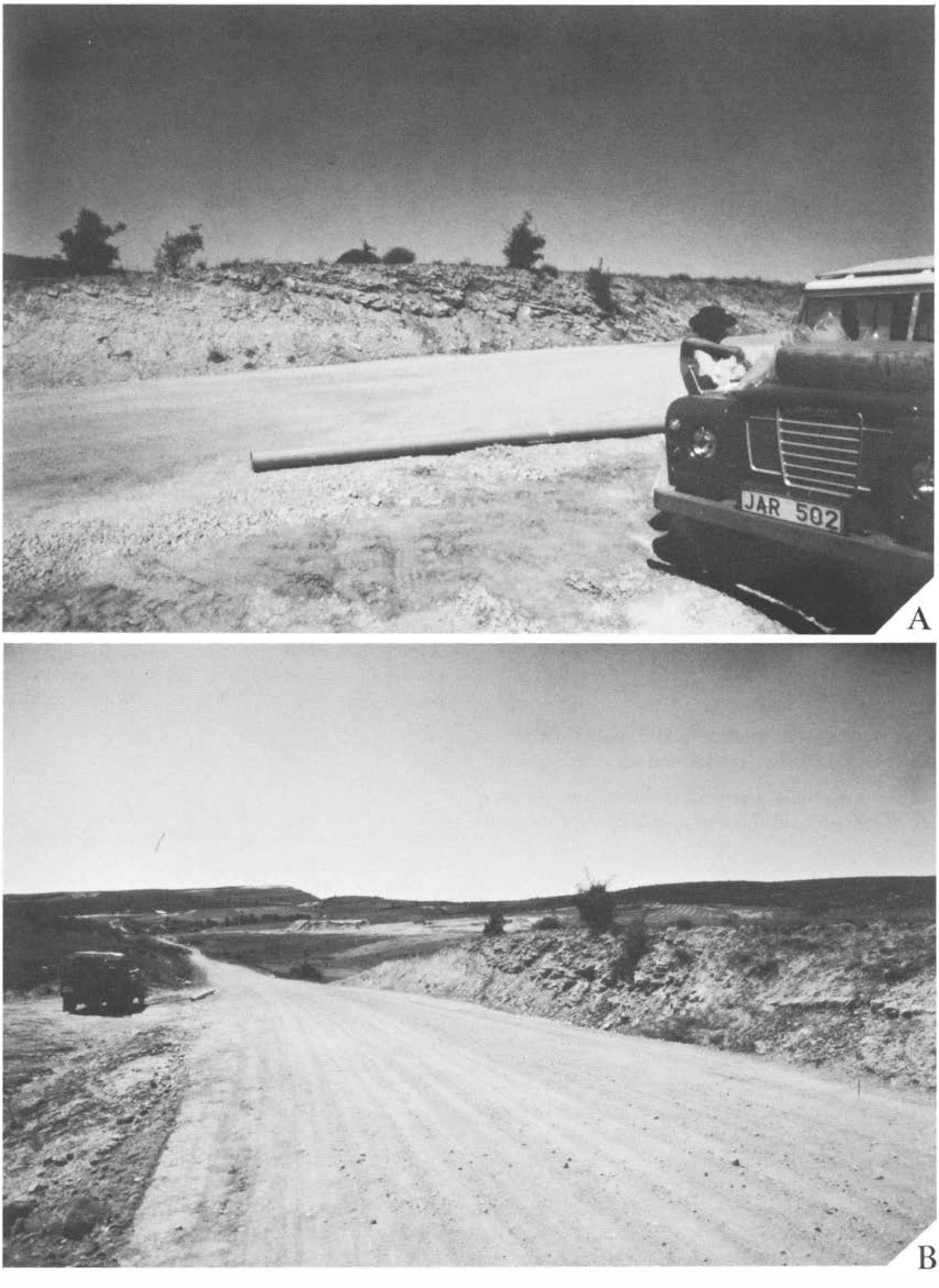


Fig. 1. A. The Carabias-Bercimuel section in the Lower Turonian. July, 1981. See also Fig. 13. B. The same section viewed in the direction of the hamlet of Carabias. The flexure in the sequence can be seen whereby the youngest beds exposed are repeated. The immediate background shows Lower Cretaceous sands of continental origin. July, 1981. See also Fig. 13.

collection was obtained is shown in Fig. 2A. The beds of interest are marls containing *Choffaticeras (Leoniceras)* spp. and are therefore well up in the Lower Turonian, as interpreted by Wiedmann (1960). Beds with *Fallotites* and *Gombeoceras*?, lower in the succession to the east of the hamlet, have also yielded ostracods but the material obtained so far is not well enough preserved to permit detailed description.

The following species are treated in this monograph:

Mauritsina soriensis (Grekoff and Deroo)
Mauritsina speciosa Babinot?
Mauritsina radiocostata sp. nov.
Mauritsina ? sp.
Spinoleberis petrocorica (Damotte)?
Dordoniella turonensis Damotte
Planileberis aff. *praetexta* (Damotte)
Trachyleberidea aff. *geinitzi* (Reuss)
Planileberis sp. indet.
Trachyleberidea alandalusensis sp. nov.
Cornicythereis ? *picofrentensis* (Grekoff and Deroo)
Donmacythere hafsuni sp. nov.
Spinoleberis sp.
Parvacythereis ? sp. nov.
"Dumontina" sp.
Dumontina sp. nov.?
Risaltina aquitanica Colin and Grekoff
Asciocythere polita Damotte
Pterygocythere allinensis (Grekoff and Deroo)
Oertliella guadalajarensis (Breman)

This constitutes a considerable increase in number of species over the names recorded by Reyment (1984).

Picofrentes

The locality Picofrentes is a hill near the village of Fuentetoba, some 7 km from the city of Soria (the locality is consistently named Fuentetoba by Breman, 1976).

The section at Picofrentes runs from the Cenomanian–Turonian passage through Turonian to later Cretaceous; the ammonite content and stratigraphy has been discussed by Wiedmann (1960). Fig 2B gives a view of the northern side of the hill.

Breman (1976, p. 79) refers the Cenomano–Lower Turonian part of the sequence to the "Abejar Formation" of marls and limestones (his section X); this formation is about 60 m in thickness and is overlain by some 200 m of sterile limestones. The two members of the formation are Late Cenomanian respectively Early Turonian in age. The upper member contains ammonites, including species of *Fallotites* and *Pseudaspidoceras* (some of the latter of which may attain 40 cm or more). Contrary to the opinion expressed by Breman (1976, p. 77), the ostracod and ammonite associations of Picofrentes and the "Atienza area" do not differ considerably. The lithostratigraphical designation Picofrentes Marls is introduced in Garcia Quintana (ed. 1982, p. 413) for part of the sequence at Picofrentes (see Appendix).

The following species from the lower part of the Picofrentes sequence are described in the present monograph:

Asciocythere sp.
Dolocytheridea crassa Damotte
Dordoniella turonensis Damotte
Pterygocythere allinensis (Grekoff and Deroo)
Pterygocythere pulvinata Damotte

These typically Turonian species were obtained from the marl level rich in vascoceratids and *Pseudaspidoceras* (the Picofrentes Marls).

Higher in the sequence, in presumed Coniacian deposits, and at the abrupt change in slope marking the sharp cliff of the top of Picofrentes, a 2 dm thick band of marl has yielded an abundant, though monotonous, association dominated by well preserved *Cytherella, Pontocyprella* and *Bythocypris*, an association which may represent deeper water conditions.

Castrojimeno

This section was described in detail by Alonso (1981, p. 255). The following ostracod species are treated in the present monograph:

Mauritsina radiocostata sp.nov.
Pontocyprella ? sp.
"Cythereis" nov. gen. et sp.
Mauritsina speciosa Babinot?
Pterygocythere sp.
Cytherella sp.
Xestoleberis sp.

Reyment (1984) recorded *Trachyleberidea geinitzi* Reuss? from this section.

Wiedmann (*in* Alonso, 1981) records fragments of *Hemitissotia* from the Castrojimeno sequence. Comparing with Wiedmann's (1960) interpretation of the ammonite biostratigraphy of the Upper Cretaceous in Spain, we observe that this would seem to point to a stratigraphical location fairly high in the Coniacian. There are no elements among the ostracods of specific significance for the Coniacian age attributed to the Castrojimeno beds.

Six levels were sampled in the Castrojimeno sec-

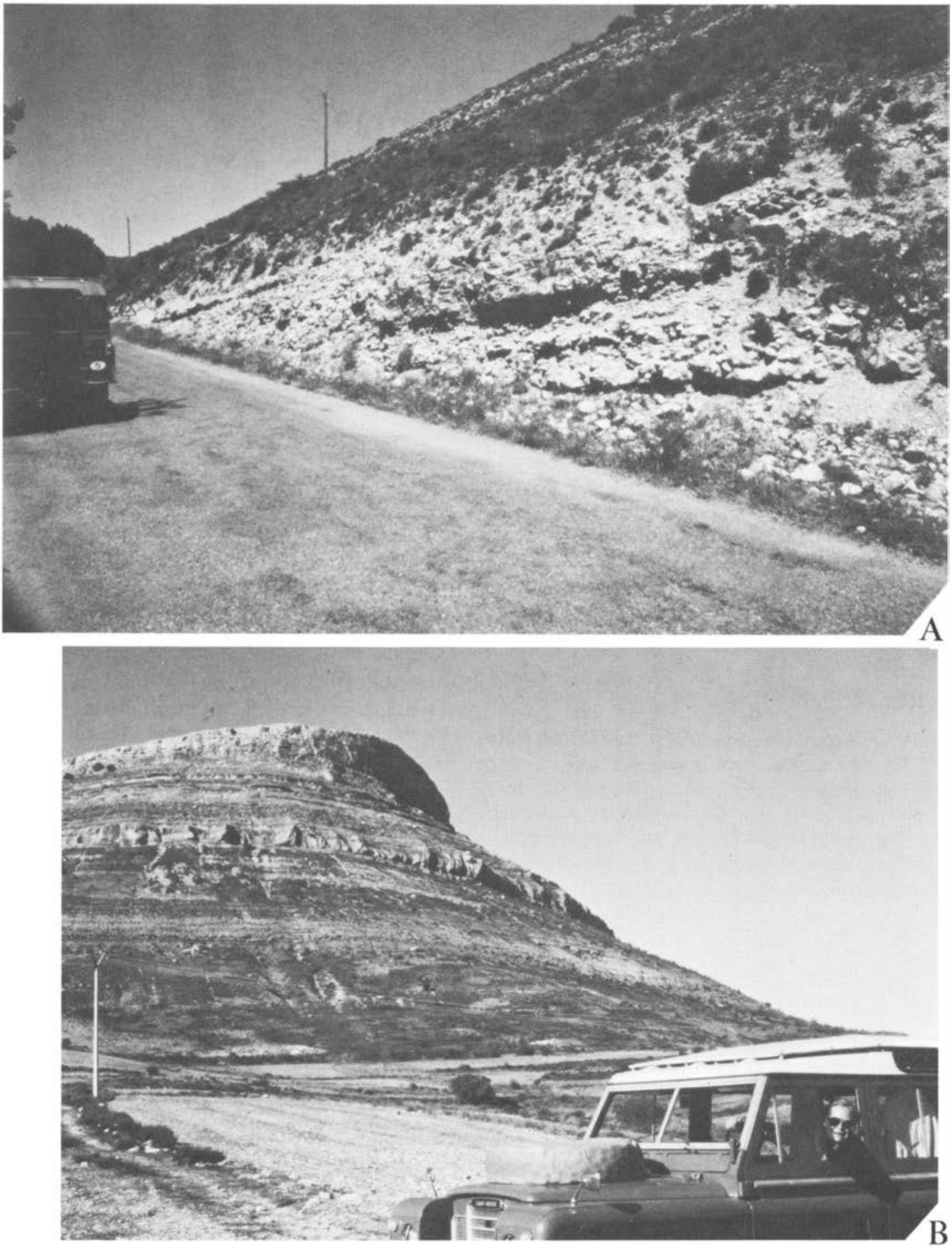


Fig. 2. A. The upper part of the Somolinos section showing limestones and marls from which the ostracods described in this monograph were obtained. July, 1981. Photo Eva Reyment. See also Fig. 13. B. The northern slope of Picofrentes, near Fuentetoba. The Cenomanian-Turonian transitional beds lie immediately above the sandy sediments of the Lower Cretaceous, exposed in a small sandpit visible in the middle part of the picture. The first ledge, located below the massive limestone bank, is the vascoceratid level. November, 1983. See also Fig. 13.

tion. Almost all ostracods were found in the youngest sample.

Methods

The usual methodology of micropalaeontology has been used. Washing of the samples has in some cases been aided by the sodium sulphate recrystallization procedure. The sieves were passed through a solution of methylene blue in order to mark eventual sources of contamination. The systematic descriptions have been built around the SEM- study of the material under consideration. Where necessary, and feasible, the samples of species available have been analyzed by pertinent methods of multivariate analysis (Reyment *et al.*, 1984). Care has been taken to keep a constant watch on the calibration of the SEM-reproductions. Stereophotography is a useful tool in micropalaeontology; where possible, stereophotographs of specimens have been figured. All figured material is kept in the type collection of the Paleontological Museum, Uppsala; the storage code is PMSp, under which the pertinent SEM stubnumbers are recorded.

Systematic Part

The systematic base used here is that of Hartmann (1975); this implies that many subfamilies, even families, known to palaeontologists are not used. Hartmann (1975) has demonstrated convincingly that the grounds upon which many of these have been based lack biological meaning and should, terefore, be avoided.

Family CYTHERELLIDAE Sars, 1866

Genus CYTHERELLA Jones, 1849

Cytherella sp.

Fig. 3A

Remarks: The genus *Cytherella* is amply represented in the material described in this monograph. Numerous species are doubtless represented in the collections but in only a few cases could a specific determination be attempted.

The material referred here consists of individuals of an ovoid species obtained from the Upper ? Coniacian part of the section at Castrojimeno. An interesting property of the present form is the occurrence of an impressed antero-marginal zone in the right valve.

The length of the figured individual is 0.67 mm.

Occurrence and Age: Coniacian at Castrojimeno; sample 26–5.

Material: More than 50 specimens.

General Note: As noted, *Cytherella* is extremely abundant at all localities studied in the present monograph. In most cases, however, it has not been possible to arrive at reliable determinations of the species (see below). *Cytherella* spp. are found throughout the sections at Moral de Hornuez and Carabias, part of the Picofrentes sequence (in great abundance in the Coniacian). The genus is less well represented in the Somolinos and Condemios sections.

Cytherella aff. *postangulata* Babinot

Fig. 3B

Remarks: Names applied to Cretaceous cytherellids abound in the literature and there cannot be much doubt that acceptable taxonomic standards are difficult to maintain in the face of such a featureless carapace, the variational norms and phenotypic expression of which still remain to be explored. The investigator of cytherellids may be required to opt for one of three choices: (1) to attempt to place his specimens under some available name, a task which can only attain a reasonable likelihood of success if the identificational process is based on biologically sound and biometrically oriented analyses (the haze surrounding the concept of *Cytherella ovata* attests eloquently to the difficulties involved). The practical convenience proffered by this first alternative is, however, largely offset by the biostratigraphical unquiet it may occasion.

(2) Erect a new name for the material concerned; this solution is safe from the point of view of the biostratigrapher but, for the systematist, it can only pave the way to nomenclatorial chaos.

(3) Give up and just refer the fossils to *Cytherella* sp.

I can see no easy way out of the cytherellid labyrinth. There is doubtless a great need for a monographic treatment of the cytherellids, encompassing Recent, Tertiary and Mesozoic species.

Such a monograph would have to be based on adequate quantitative procedures on representative material with an awareness of the occurrence of polymorphism in some species of *Cytherella* (cf. Reyment, 1963, 1965; Ducasse *et al.*, 1981).

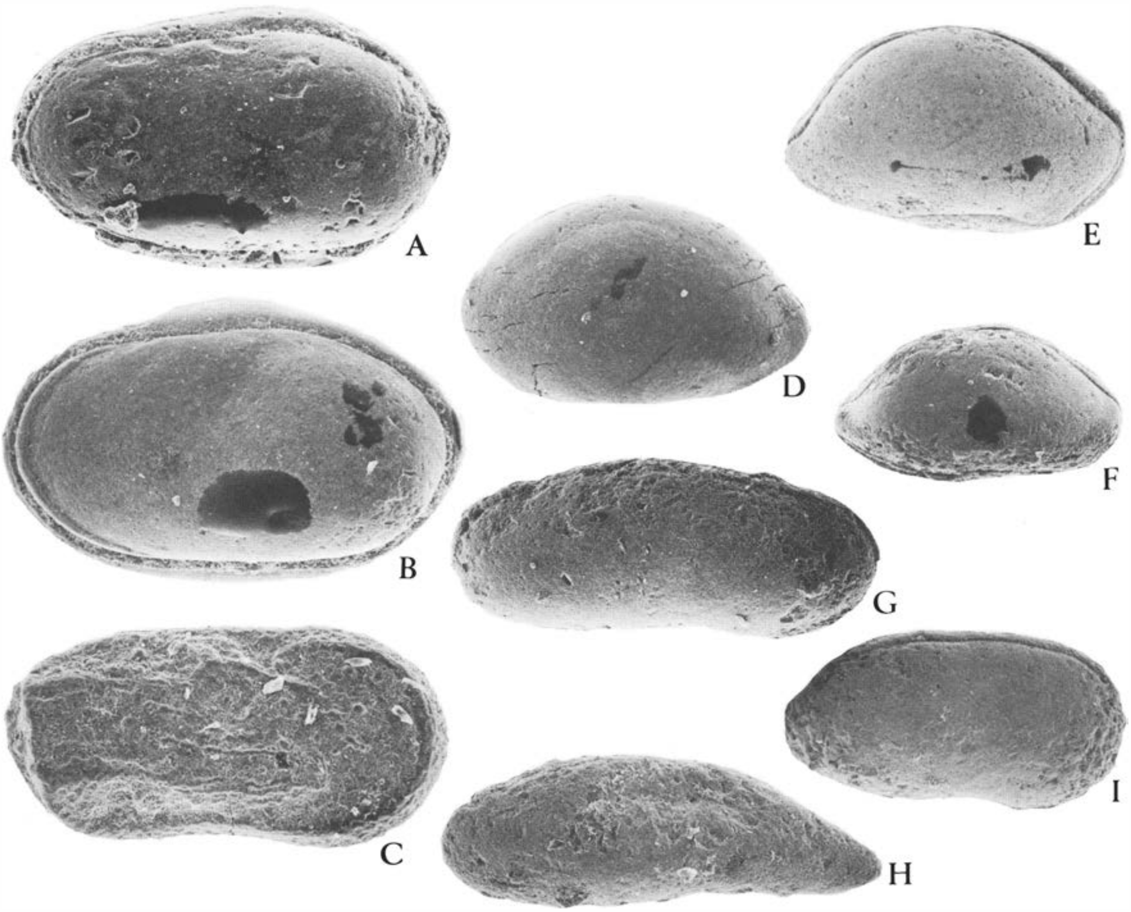


Fig. 3. A. *Cytherella* sp. Coniacian. Top of Castrojimeno road-section. Sample 265. PMSp217. × 70. B. *Cytherella postangulata* Babinot. Turonian. Condemios de Arriba. Sample 281. PMSp218. × 70. C. *Cytherelloidea* aff. *denticulata* (Bosquet). Turonian. Moral de Hornuez. Sample 276. PMSp219. × 90. D. *Bairdia cenomanica* Babinot. Turonian. Condemios de Arriba. Sample 281. PMSp220. × 50. E. Same species and provenance. PMSp221. × 60. F. Same species and provenance. PMSp222. × 50. G. *Bythocypris* sp. Turonian. Condemios de Arriba. Sample 281. PMSp223. × 70. H. *Macrocypris siliqua* (Jones and Hinde)? Turonian. Condemios de Arriba. Sample 281. PMSp225. × 70. I. *Pontocyprella ?* sp. Coniacian. Top of Castrojimeno section. Sample 265. PMSp224. × 50.

Cytherella postangulata Babinot seems to be a resonably well founded species in that the sharp postero-dorsal angle is a constant feature of specific validity. The material from Condemios de Arriba referred here has a well developed bend just above the mid-point of the posterior margin. However, the dorsal overlap seems stronger than appears to be indicated in the figures of Babinot (1980, pl. 2, figs. 6, 9, and 10). The anterior rim of the right valves is equally strongly developed in the French and Spanish material.

Dr. J. P. Babinot (personal communication, March, 1984) informs me that the differences in shape between his type material and the Spanish specimens are such as to indicate close affinity but not identity. For this reason I have desisted from proposing exact agreement in the two. However, shape polymorphism cannot be ruled out in the present connexion.

Some specimens from Carabias are less in agreement with the illustrations of Babinot with respect to the posterior angulation, which may not be distinctly expressed. In such specimens, it is not unusual for the antero-marginal rim to be no more than vaguely indicated.

The dimensions of the specimen figured (Fig. 3B) are: length = 0.72 mm, height = 0.48 mm.

Occurrence and Age: The type material of Babinot (1980) comes from the Cenomanian of Provence, with its main occurrences in the region to the north of Toulon. Our specimens derive from the Turonian of Carabias and Condemios de Arriba. Sample 281.

Genus Cytherelloidea Alexander, 1929

Cytherelloidea aff. *denticulata* (Bosquet)

Fig 3C

1980 *Cytherelloidea* aff. *denticulata* (Bosquet 1854), Babinot p. 62, pl. 2, figs. 14–15.

Remarks: Material referred here is very rare in the present collections. Despite a difference in the shape of the dorsal margin in relation to Babinot's (1980) illustrations, it seems to me that the Spanish specimens must be considered to be very close to the Santonian *Cytherelloidea* recorded by him from Provence. Lack of material precludes a more decisive approach to the specific identity of the present material.

The length of the figured specimen is 0.70 mm.

Occurrence and Age: The figured specimen comes from the Turonian of Moral de Hornuez at about half-way up the section (sample 29–6).

Family BAIRDIIDAE Sars, 1888

Genus BAIRDIA McCoy, 1844

Bairdia cenomanica Babinot

Fig. 3, D–F

1970 *Bairdia cenomanica* n. sp., Babinot, p. 97, pl. 1, figs. 7–8 (not fig. 6)
1973 *Bairdia cenomanica* Babinot, Colin, p. 104, pl. 7, fig. 9.
1978 *Bairdia* aff. *cenomanica* Babinot, Andreu, p. 99, pl. 4, figs. 4–6.
1980 *Bairdia cenomanica* Babinot, Babinot, p. 66, pl. 3, figs. 3–7.

Remarks: Some specimens from a single sample from the Condemios de Arriba section are referred to Babinot's species. Babinot (1980) did not record sexual dimorphism in his material; the present collection indicates that sexual dimorphism may be relatively strong (compare Fig. 3 E with Fig. 3 F). The age assigned to the species by Babinot (1970, 1980) is Cenomanian. Our specimens are Turonian in age, probably Early Turonian.

The rather characteristic outline of the left valve agrees with Babinot's figures, as does also the weak indentation which follows the dorsal margin of the left valve.

Colin *et al.* (1983, p. 197) recorded *Bairdia cuvillieri omnipraesens* Pokorny from the Middle Turonian of El Cabrio in northernmost Spain. Some of the *Bairdia* of the present collection resemble their figured specimens.

Occurrence and Age: Turonian. Condemios de Arriba. Sample 28–1.

Genus *Bythocypris* Brady, 1880

Bythocypris sp.

Fig. 3 G

Remarks: A few specimens of a markedly elongate species with equally rounded posterior and anterior margins are placed here. The material is neither sufficiently abundant nor well enough preserved to allow of a more definite identification. The convexity of the dorsal margin and concavity of the ventral seem to agree with the accepted morphological characteristics of the genus.

Occurrence and Age: Turonian. Condemios de Arriba, Sample 28–1.

Genus PONTOCYPRELLA Ljubimova, 1955

Pontocyprella ? sp.

Fig. 3 I

Remarks: A few specimens which seem to have external morphological properties corresponding to those of *Pontocyprella*, at least as indicated in the interpretation of Weaver (1982, p. 29), are tentatively referred here.
Occurrence and Age: Coniacian; Castrojimeno, sample 265.

Family MACROCYPRIDAE Müller, 1912

Genus MACROCYPRIS Brady, 1867

Macrocypris siliqua (Jones and Hinde)?

Fig. 3 H

Remarks: A single specimen with the general external properties of *Macrocypris siliqua*, as presented by Weaver (1982, p. 28), is referred here. The right valve is slightly larger than the left, with the main overlap occurring in the anterior half of the dorsal margin.

Against a definite assignation to *M. siliqua* speaks the fact that our specimen is very much

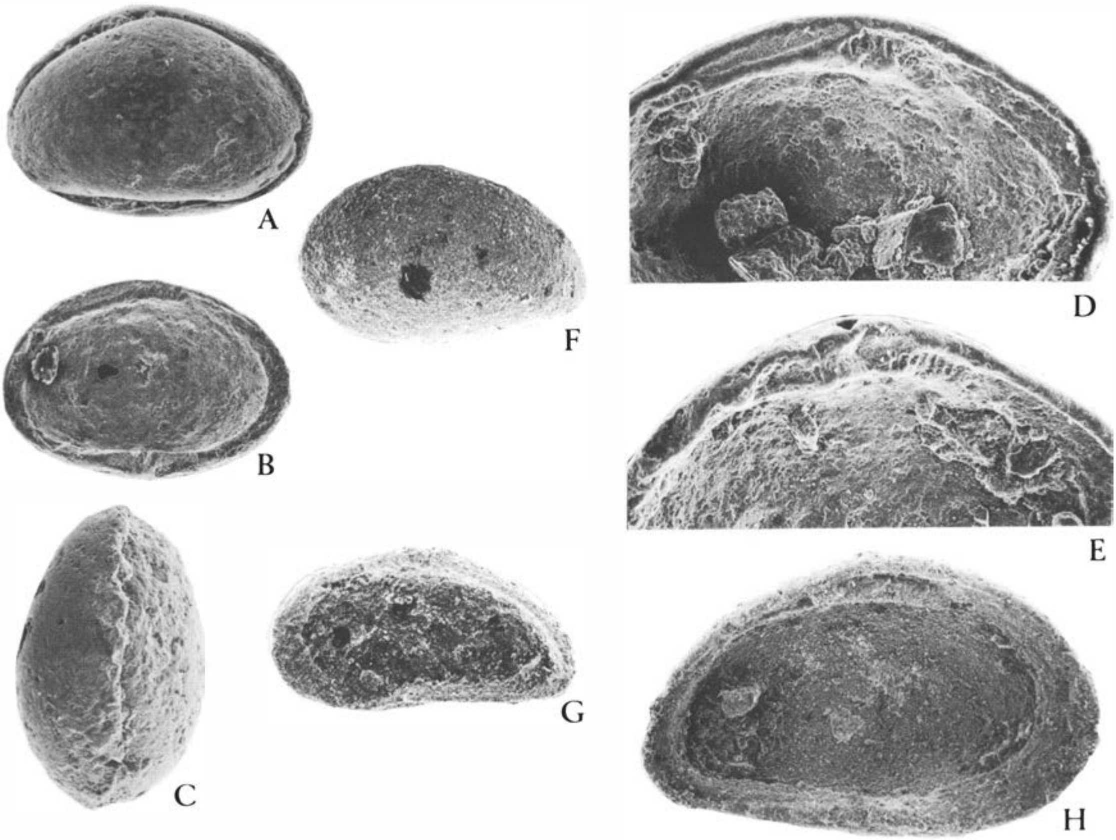


Fig. 4. Asciocythere polita (Damotte) Turonian. Somolinos, sample 289. A. Left side of a carapace. PMSp226. × 70. B. Interior view of a left valve. PMSp227. × 70. C. A carapace in dorsal aspect. PMSp228. × 70. D. Hinge of a left valve. PMSp229. × 120. E. Interior of a left valve. PMSp230. × 120. *Dolocytheridea crassa* Damotte Turonian. Carabias, sample 259. F. A left valve. PMSp231. × 50. G. Interior of a right valve. PMSp232. × 50. H. Interior of a left valve. PMSp233. × 75.

smaller than the norm exhibited by adults of the species, with a length of only 0.71 mm as opposed to an approximate value of 1.5 mm for the English material of Weaver (1982, p. 28). Our specimen could be an instar.

Babinot (1980, p. 236) has tentatively referred even smaller specimens to *M. siliqua*.

Occurrence and Age: Turonian. Condemios de Arriba. Sample 28–1.

Family CYTHERIDEIDAE Sars, 1925

Genus ASCIOCYTHERE Swain, 1952

Asciocythere polita Damotte

Fig. 4, A–E

Synonymy in Babinot (1980, p. 81).

Remarks: The specimens referred to *A. polita* were all encountered in the same sample. The shape is generally like that described by Damotte (1962, 1971) but with a tendency to more perfectly ovoid. Breman (1976, pl. 4, figs. 4a – b) identified this species in his collections but noted that his material displayed certain shape differences in relation to the French types and that his fossils were appreciably smaller (length: 0.40 – 0.45 mm and height: 0.25 – 0.30 mm). Our specimens are also somewhat smaller than the dimensions cited by Damotte, to wit, length ranging from 0.43 to 0.48 mm and height from 0.29 to 0.31 mm). The specimens referred by Babinot to *A. polita* (Babinot, 1980, p. 81, pl. 4, figs. 15–17) tend to be closer in shape to the Spanish ostracods.

The small, though noticeable, shape differences over the geographical sphere involved suggests that some kind of clinal differentiation could have been responsible for them. Also possible, and conceivably concatenated, is the intervention of ecophenotypic variation.

The details of the hinge accord satisfactorily with the original description (Fig. 4 D). The vestibule is not always preserved but can be observed in some specimens, Neale (1982, p. 184) has discussed the classification of *Asciocythere.*

Material: Fourteen specimens.

Occurrence and Age: Turonian. Somolinos section, sample 28–9.

Genus DOLOCYTHERIDEA Triebel, 1983

Dolocytheridea crassa Damotte

Fig. 4, F-H

1984 *Dolocytheridea crassa* Damotte. Reyment p. 198, pl. 3, figs. 13–16. Synonymy in Babinot (1980, p. 83).

Remarks: All of the material in the present collection referred to this species is poorly preserved. The specimens agree well with the original description and with subsequent interpretations by various authors.

D. crassa was reported by Breman (1976). Babinot (1980, p. 85) illustrated graphically sexual dimorphism in shape and size in the species.

Weaver (1982, p. 33) accepted Gründel's (1971) subgenus *Puracytheridea* for this species, as was also done by Babinot (1980). The individuals of Cenomanian age tentatively compared with *D. crassa* by Weaver (*op. cit.*) differ somewhat in habitus, as noted by that author, and should probably be referred to a new species.

Material: Several hundred specimens.

Occurrence and Age: Turonian. Moral de Hornuez, sample 26–6; throughout the entire sampled section at Carabias; Picofrentes, vascoceratid level, sample DA697–PFA11.

Genus NEOCYPRIDEIS Apostolescu, 1956

Neocyprideis iberiacus (Grekoff and Deroo)

Fig. 5, A–J

1956 ? *Cyprideis iberiacus* n. sp., Grekoff and Deroo, p. 219, pl. 47, figs. 29–31.

Remarks: This species is very abundant in the Carabias-Bercimuel section. *N. iberiacus* was originally described from the Cenomanian–Turonian passage beds of Burgo de Osma (Grekoff and Deroo, 1956). *Neocyprideis* is usually taken to have a brackish water ecology; the present species occurs, however, together with typical normal marine forms in many of the samples studied and it would therefore seem likely that at least *N. iberiacus* was euryhaline.

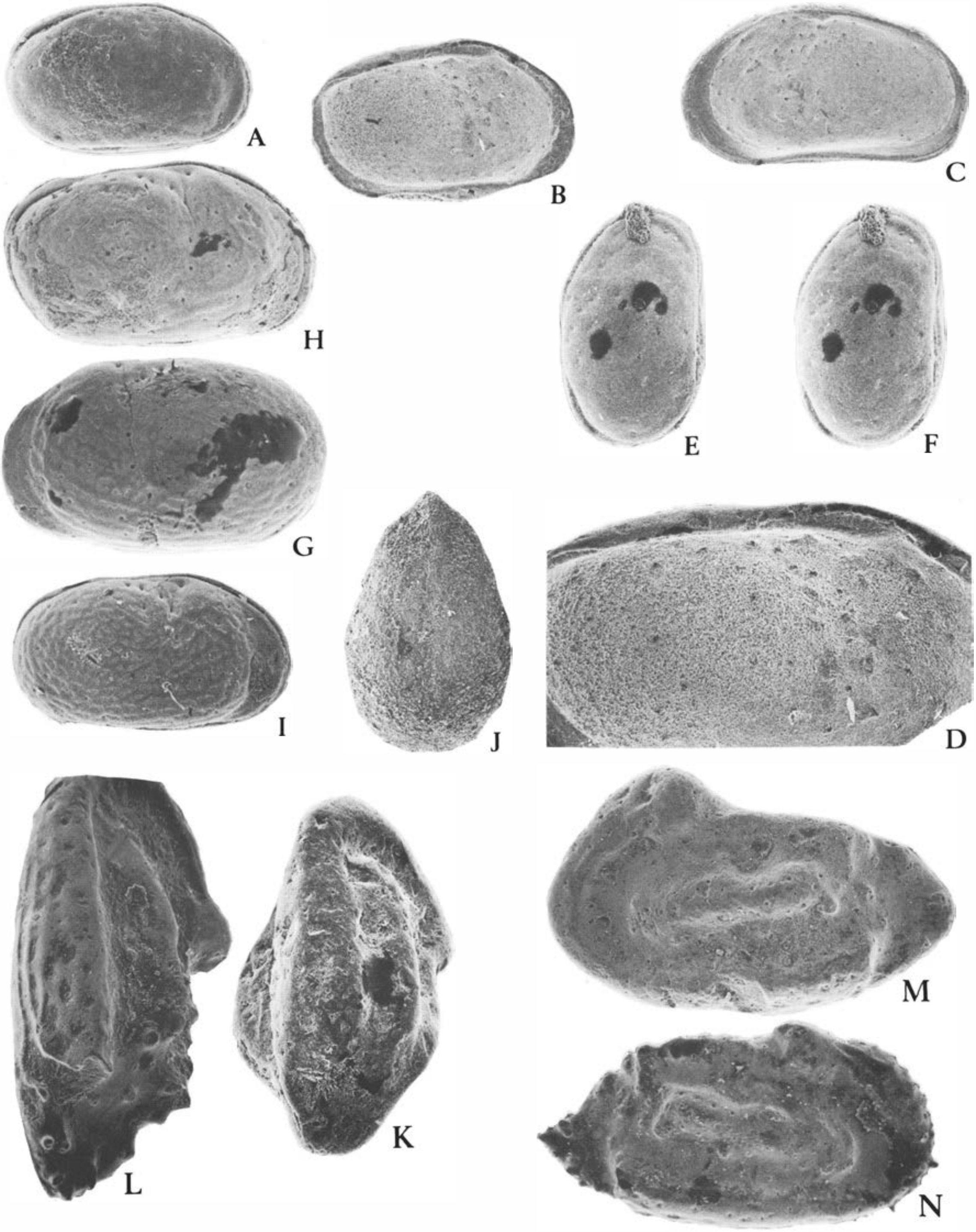
It is apparent from the material studied here that there is appreciable variation in the outline of the species. This does not seem to be connected with genetic polymorphism in the usual sense of the concept, but to be more an expression of ecophenotypic variation, presumably bound to the salinity of the environment; such variation is not unusual in euryhaline ostracods. There is, besides, variation in the degree of inflation of the posterior portion of the carapace – this variability is seemingly an expression of sexual dimorphic differences (cf. van Morkhoven, 1963).

The surface of some individuals of *N. iberiacus* is lightly reticulated. The manner of occurrence of smooth and ornamented individuals may point towards a polymorphic condition, possibly under ecological control. The ratio is 26% of ornamented shells to 74% of smooth shells. Both variants occur in the same sample.

The hinge is the left valve consists of an elongated and notched alveole, a median bar and an elongated, notched posterior alveole. The median bar is faintly serrated.

Neocyprideis vandenboldi Gerry and Rosenfeld from Israel is somewhat similar in general characteristics but seems to possess less strongly developed subsidiary hinge-elements, the anterior is

Fig. 5. Neocyprideis iberiacus (Grekoff and Deroo). All material from the Carabias section (Turonian). A. Right side of a carapace. Sample 252. PMSp234. × 50. B. Internal view of a left valve. Sample CAR3 (= level of sample 252, sampled July, 1980). PMSp235. × 50. C. Internal view of right valve. Same provenance as for specimen in Fig. 5B. PMSp236. × 50. D. Enlarged detail of specimen shown in Fig. 5B. × 90. E-F. Stereophotograph of right side of a carapace. Sample 251. PMSp236. × 50. G. Left side of reticulated morph. Sample 254. PMSp237. × 65. H. Right valve of a reticulated morph. Sample 254. PMSp238. × 60. I. Right side of a reticulated carapace. Sample 254. PMSp239. × 55. J. Dorsal view of a carapace. Sample 255. PMSp240. × 50. K. *Donmacythere hafsuni* sp. nov. Angled view of the ventral surface of the left side of a carapace. Moral de Hornuez. PMSp381. × 90. L. *Donmacythere damottae* (Colin). Angled view of the ventral surface of the left side of a carapace. Collection Colin. PMPro10. × 90. M. Same species and provenance. Left side of a carapace angled to show the coarse pitting of the ventral surface. PMPro9. Collection Colin (France). × 90. N. Same species and provenance. Right valve showing the pointed and denticulated posterior and the pores located on the median rib. PMPro8. Collection Colin (France). × 90.


A
B
C
H
E
F
G
I
J
D
L
K
M
N

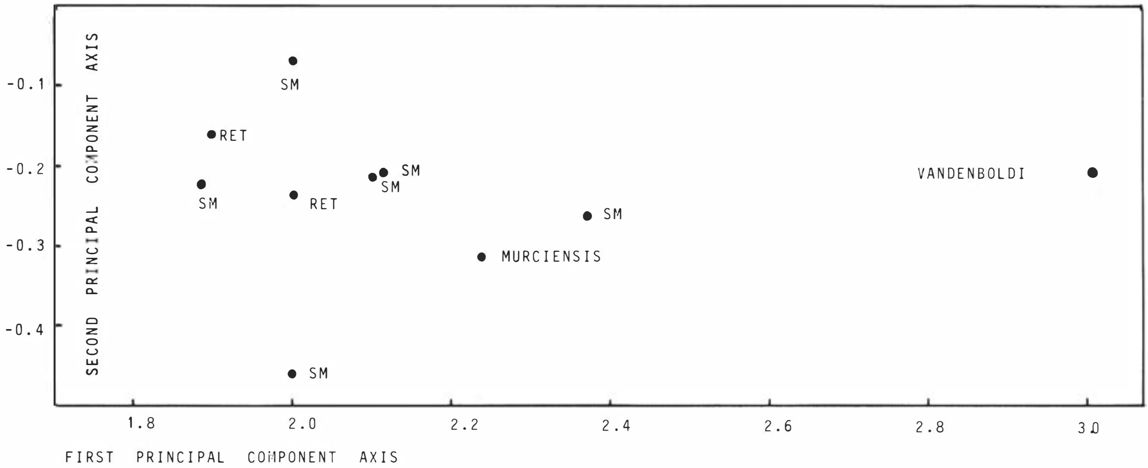


Fig. 6. Plot of the first two axes for the principal component analysis of species of *Neocyprideis.* The plot shows the locations of the two morphs of *N. iberiacus* (smooth and reticulated) together with two species included for comparative purposes, *N. vandenboldi* and *N. murciensis.* The abbreviation RET denotes reticulated lateral ornament; SM denotes smooth lateral surfaces.

less broadly rounded, and the posterior is more angular.

Shape analysis: The euryhaline status of the species makes the possibility of significant shape variation a reality. With the end in view of establishing the extent of such variation, a set of standard multivariate analyses was made on a representative cross setion of the material. The results of the graphical aspects of a principal components analysis are shown in Fig. 6; here, the variables consist of intersecting measures, aimed at capturing shape variation (Bookstein, 1978). The variables were reduced to unit length in order to standardize comparisons – to compensate for the imposed simplex space involved here, the log-ratio principal components method of Aitchison (1983) was used. The variables are (1) = length of carapace, (2) = height of carapace at the anterodorsal angle, (3) = diagonal length of carapace from the anterodorsal angle to the diagonally opposite corner, (4) = the posterior carapace height, (5) = reversed diagonal length, (6) = width of anterior margin, (7) = posterior length of carapace.

The analyzed specimens are 8 individuals (males and females) of *N. iberiacus*, one of *N. murciensis* (Damotte and Fourcade) and one of *N. vandenboldi* (Gerry and Rosenfeld) – values for latter two extracted from the literature.

The shape analysis gives the interesting result that there is a fairly clear tendency towards differentiation on the basis of this character. The smooth morphs locate together (presumably females) and the reticulated individuals lie near each other in the left central portion of the figure. *N. vandenboldi* is quite clearly separate from the main group, whereas the Neogene *N. murciensis* is in shape like some individuals of *N. iberiacus.*

The present analysis seems to suggest that we are dealing with a genuine case of ornamental polymorphism, manifested in both ornamental features as well as in minor differences in shape.

The ornament of some cytherideid ostracods can be remarkably susceptible to ecological influences. Carbonel and Pujas (1982, p. 80) describe smooth, diversely punctate and reticulate morphs of *Cyprideis torosa* in a lagoonal environment; in this special case, it seems possible to relate the surface ornament to the ratio between Mg and Ca of the lagoonal water (see also Keen (1982, p. 385) and Vesper (1972)).

Material: More than 100 specimens, most of which are poorly preserved.

Occurrence and Age: The species, developed as both morphs, occurs throughout the entire sampled sequence of the Carabias–Bercimuel road-section (Fig. 1). The most important samples are 25–1 and 25–10. Turonian.

Genus DORDONIELLA Apostolescu, 1955

Dordoniella turonensis Damotte

Fig. 7, A–C

Synonymy in Babinot (1980, p. 98).

Remarks: Although *Dordoniella* is not uncommon in the Carabias and Somolinos sections, most specimens are poorly preserved and cannot be identified with certainty. The specimens figured here seem to be referrable to *D. turonensis* (Figs. 7 B and 7 C) and *D.* aff. *turonensis* (Fig. 7 A).

The material placed by Babinot (1980, p. 98) in *D. turonensis* seems to be more sharply angled posteriorly than is usual for the species. It agrees better with Breman's (1976, pl. 6, fig. 12 a) interpretation. In Damotte's (1962) original description, Lower Turonian representatives of the species were said to show a great difference in shape between left and right valves. The figured left valves (Damotte, 1962) tend to have a mid-posterior sharpening which is lacking in most specimens seen here.

Some of the specimens from Carabias tend to be appreciably more ovoid than the norm for the species and it is not without doubt that I refer them to *D. turonensis*.

Material: More than 50 specimens, most of which are poorly preserved.

Occurrence and Age: Turonian. Carabias, samples 259, 2510, Somolinos, samples 287, 2810, 2811. Picofrentes, sample DA965–PFA9.

Genus RISALTINA Colin and Grekoff, 1973

Risaltina aquitanica Colin and Grekoff

Fig. 7 D

Synonymy in Reyment (1984, p. 202).

Remarks: This species has been recently reviewed by the writer (Reyment, 1984, p. 202) to which the reader is referred for details concerning synonymy and information on the geographical distribution. *R. aquitanica* is very rare in the material available for study. Neal (1982, p. 184) has recently discussed the classification of *Risaltina*.

Material: One right valve. (Further material previously described—see above).

Occurrence and Age: Turonian. Somolinos, sample 2811.

Genus PARAKRITHE van den Bold, 1958

Parakrithe ? sp.

Fig. 7, E–F

Remarks: A few specimens of what appear to be males and females of a species with the external morphology of *Parakrithe* are referred here. Dr. J. P. Colin (personal communication, March, 1984) has pointed out the similarity of the present form to a species of *Parakrithe* which is widely distributed in the Turonian of Aquitaine and Provence (cf. Colin, 1973, pl. 5, fig. 8).

Occurrence and Age: Turonian. Moral de Hornuez, sample 276.

Family CYTHERIDAE Baird, 1850

Subfamily Trachyleberidinae Bradley, 1948

Remarks: The status of *Pterygocythereis* and *Pterygocythere* has been debated by many who have been concerned with Cretaceous species of the group. Van Morkhoven (1963, p. 218) thought that the minor hinge differences between the two, together with the presence of an accommodation groove in the latter, warranted separation at the subgeneric level. Weaver (1982) adhered to this solution, whereas Babinot (1980, p. 111) opted for the full generic differentiation of the two categories.

I have followed Babinot's course of action in the following and referred all of my pterygocythereidids to *Pterygocythere.* Keen (1982, p. 387) has emphasized the artificial state of the taxonomy of the group.

Genus PTERYGOCYTHERE Hill, 1954

Pterygocythere aff. *robusta* (Jones and Hinde)

Pl. 1, Figs. 1–2

Remarks: The specimens referred here are similar to *P. robusta* in many essential details and they also are like the material tentatively allocated to *P. robusta* by Weaver (1982, p. 60, pl. 10, figs. 6–8). The anterior margin bears a few coarse spines which emanate from a thin marginal ridge. This ridge continues along the edge of the prominent, sharp ala and dorsally to the dorsal margin of the shell. The ovoid and fairly prominent eye-tubercle is joined by a strut to the ridge. The wings are strutted and bear a spine at mid-posterior length. The location of the eye-tubercle differs from that noted by Weaver (*op. cit.*) for his specimens. He also recorded a short dorsal rib in the left valve, a feature which is lacking in our material.

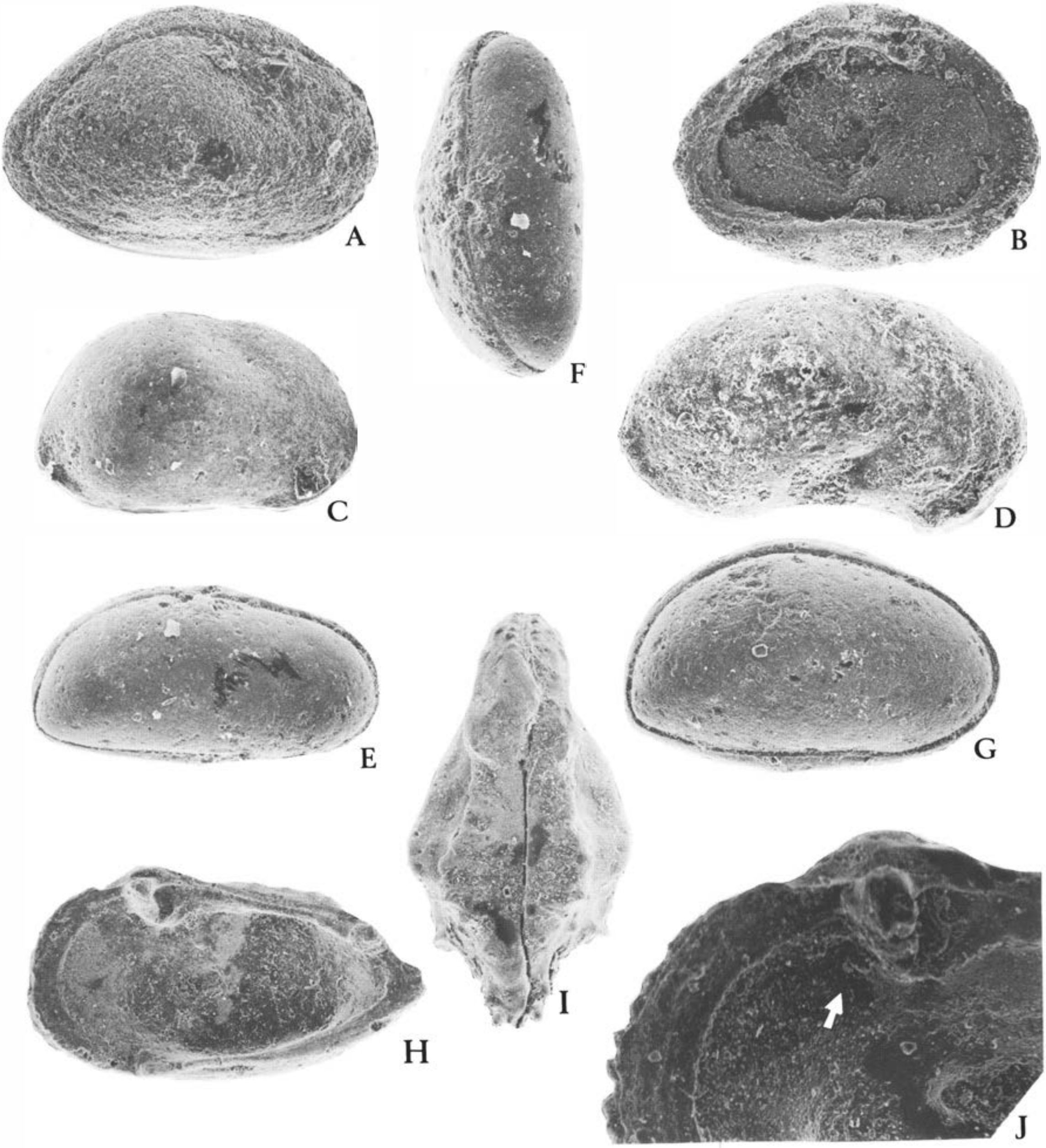


Fig. 7. A. *Dordoniella* aff. *turonensis* Damotte. Right side of a carapace. Turonian. Carabias, sample 2510. PMSp241. B. *Dordoniella turonensis* Damotte. Inside of a left valve. PMSp242. C. Same species. A right valve. Turonian. Somolinos, sample 2811. PMSp243. D. *Risaltina aquitanica* Colin and Grekoff. Turonian. Somolinos, sample 2811. PMSp244. E. *Parakrithe*? sp. Right side of a carapace. Turonian. Moral de Hornuez, sample 276. PMSp245. F. Same specimen; angled dorsal view. G. Same species and provenance. PMSp246. H. *Donmacythere damottae* (Colin). Internal view of a right valve showing the hinge and the anterior and posterior marginal developments. Turonian. Collection Colin (France). PMPro8. × 90. I. Same species and provenance. Dorsal aspect of a carapace showing the "eye-tubercles". PMPro7. × 90. J. Same species and provenance. Anterior hinge element of a right showing the indentation below the anterior tooth (arrow). PMPro6. × 190.

Material: Three specimens.

Occurrence and Age: Turonian. Moral de Hornuez, sample MH4 (= samples 276 and 277).

Pterygocythere allinensis (Grekoff and Deroo)

Plate 1, Figs. 3–6

1956 *Alatcythere allinensis* n. sp., Grekoff and Deroo, p. 221 (229), figs. 34, 35.

1978 *Pterygocythere allinensis* Grekoff and Deroo, Swain, p. 255, pl. 2, figs. 3–5.

?1982 *Pterygocythere* cf. *pulvinata* Damotte, Colin, Lamolda, Rodríguez, pl. 4, figs. 7, 1–2.

1984 *Pterygocythereis allinensis* (Grekoff and Deroo), Reyment, p. 203, pl. 2, figs. 17–18: pl. 3, figs. 7–9.

Remarks: This species was recently recorded from the section at Moral de Hornuez by the writer (Reyment, 1984, p. 203). The present records increase our knowledge of the geographical distribution of the species. Material was also obtained from the *Fallotites–Pseudaspidoceras* level at Picofrentes.

I have now placed *P. allinensis* in *Pterygocythere* on the basis of the accommodation groove as well as the other features enumerated by Babinot (1980). The wing may be furnished with short struts and there are 3–4 posterior spines. Swain (1978, pl. 2, 3–5) figured the species and drew attention to the robustly rimmed wing.

Babinot (1973) tentatively referred material from Cassis–La–Bédoule (Var, France) to the "group" of *P. allinensis*.

Measurements:
length = 0.83–0.91 mm; height = 0.44–0.54 mm; breadth = 0.51–0.54 mm.

Material: 30 specimens.

Occurrence and Age: Moral de Hornuez (several sampling levels), Somolinos, sample 286, Condemios de Arriba, sample 281, Picofrentes, sample DA967-PFA11.

Pterygocythere spp.

Plate 1, Figs. 7–9.

Remarks: The material contains isolated specimens of *Pterygocythere* which are too rare to permit a certain identification. The more interesting of these are shown on Pl. 1, together with details of age and provenance. Plate 1 Fig. 7 shows a pair of hinges for a species from the Cenomanian-Turonian of Soria.

Pterygocythere sp. A is available in three specimens. It is characterized by a strongly arcuate dorsal margin which flattens off anteriorly. The posterior process is serrated by 5 to 6 tubercles.

Pterygocythere sp. B differs from *P.* sp. A in general outline. It has an irregularly rounded and flattened anterior margin. The anterior zone of the carapace is impressed.

Occurrence and Age: Coniacian. Castrojimeno. Sample 265, Turonian. Soria (sample 13SO of A. Alonso Millan).

Pterygocythere pulvinata Damotte

Plate 1, Figs. 10–13

1962 *Pterygocythere pulvinata* n. sp., Damotte, p. 200, pl. 1, figs. 4,a-e; pl. 3, figs, 8,a-b.

1974 *Pterygocythere raabi* n. sp., Rosenfeld & Raab, pl. 2, figs. 1-2; pl. 4, figs 3, 4, ?5.

1980 *Pterygocythere* gr. *pulvinata* Damotte 1962, Babinot, p. 115, pl. 14, fig. 3.

Remarks: The spined pterygocytheres of the western Mediterranean Mid-Cretaceous pose several difficult taxonomic problems owing to the wide range of variation displayed by the group. *P. pulvinata* seems to be a very variable species unclearly bounded against other, presumably related, even conspecific, forms. This is amply reflected in the difficulty experienced by recent authors in providing an unequivocal identification of what is becoming known as "*Pterygocythere* gr. *pulvinata*". Let us look at the salient properties of the morphologically similar ostracods of the Mid-Cretaceous.

In the foregoing pages, a few specimens from the Turonian of Moral de Hornuez were assigned to *P.* aff. *robusta. P. robusta* is a Cenomanian species which was found to show exceptional variability by Kaye (1964, p. 51), particularly with respect to the size of the alae, the number of marginal denticulations and the strength of arching of the dorsal margin. It was specifically stated in Kaye's revision that there is no accommodation groove in the left valve – thus disqualifying *P. robusta,* formally, for admission into *Pterygocythere,* but leaving *Pterygocythereis* available (cf., Babinot, 1980, p. 111). Compared with the Spanish fossils, the English *P. robusta* must be accepted as being specifically distinct, although there are clear morphological similarities, not the least in the relationship between marginal rim and alar rim.

Rosenfeld *in* Rosenfeld and Raab (1974, p. 9) erected *P. raabi,* a species with characteristics strongly reminiscent of *P. pulvinata;* inasmuch as no differential diagnosis was supplied, it is not possible to recognize the taxonomical grounds upon which the new species was founded. The description supplied accords closely with our Pl. 1, Figs. 10–13 which either makes these specimens candidates for admission into *P. raabi*, or *P. raabi* a synonym of *P. pulvinata*. *Inter alia,* the ventral configuration of the Spanish and Israeli forms, as well as the posterior configuration of the wings, are identifical.

Pterygocythere allinensis (Grekoff and Deroo) is another closely related form, Spanish specimens of which are described in this monograph. Considering only extremes, a case can be made for holding *P. pulvinata* distinct from *P. allinensis*. However, *allinensis* is also highly variable and no two specimens are exactly alike. Among the variable elements observed in the present collection, the presence of incipient spinosities along the posterior edge of the wings may be noted (see Pl. 1, Fig. 3). The presence of spines on the alae is one of the specific properties of *P. pulvinata* (Damotte, 1962, p. 200), but also other species of the "group".

As regards conspecificity of the Picofrentes specimens with *P. pulvinata,* we note that the lateral outlines are identical, the same number of anteromarginal spines (3-4) occurs, and the wings are similarly developed. Breman (1976, p. 116) noted a greater number of spines for his "*P.* aff. *pulvinata*" as well as the presence of three spines on the wings instead of two. His material was obtained from the "Molina Formation", a lateral equivalent of the beds at Picofrentes yielding our specimens. The specimens figured by Babinot (1980) are probably genuine representatives of the species, at least the one shown in his pl. 14, fig. 3.

In summary, it seems to be desirable that the connexion between *P. allinensis* and *P. pulvinata* be studied in depth, based on large collections from geographically separated sites.

The dimensions of specimens interpreted as females are around 0.95 mm in length and 0.60 mm in height. A male specimen has the dimensions length = 1.15 mm and height = 0.60 mm. More than 25 specimens were studied.

Occurrence and Age: Early Turonian. Picofrentes, sample DA965-PFA9.

"Cythereis" gen. nov.

Remarks: The Segovian Upper Cretaceous has yielded rare specimens of what is almost certainly a new genus which is here very provisionally referred to *"Cythereis"* for want of a better solution. The two species occurring in our material, one of which is recognized formally as *"Cythereis" segoviensis* sp. nov., have some external features in common with *Opimocythere* Hazel. Moreover, some species of *Brachycythere* bear a superficial resemblance to the Spanish forms. In some respects, *Trachyleberidea* exhibits analogous features, particularly with respect to general shape and the posterior and ventrolateral configuration of the carpace. Although the material at hand is scarce, it is well preserved and has therefore been illustrated in detail. The properties of *"Cythereis"* are summarized in Table 1.
Age: Turonian and Coniacian.

"Cythereis" segoviensis sp. nov.

Plate 2, Figs. 1–10

Holotype: The specimen PMSp257 figured in Plate 2, Figs. 1–3 from Moral de Hornuez.

Derivatio Nominis: From the Province of Segovia.

Diagnosis: A species of *"Cythereis"* showing strong ornamental polymorphism of marked, respectively, weak-walled reticulations, presence or absence of posterior spines and a bulbous eye-tubercle.

Description: This remarkable form occurs in just five specimens, three from Moral de Hornuez, and two from Condemios de Arriba.

The shape of the carapace is roughly trianguloid, and reminiscent of *Trachyleberidea* and some *Brachycythere*. There is a broad anterior marginal zone, devoid of ornament, apart from a thin, persistent anterior rim.

The feebly reticulated morph (Plate 2, figs. 1–7). The lateral surface of the valves is ornamented with a pattern of anastomizing riblets, which join up to form a subreticulate pattern (Plate 2, Fig. 1; the holotype). The anastomizing grid is superimposed on an analogous, second-order system (Plate 2, Fig. 3). The ornament stabilizes on the ventral surface where two to three rows of ladder-like reticulations occur. The dorsal surface is likewise ornamented (Plate 2, Figs. 2 and 7).

The strongly reticulated morph. (Plate 2, Figs. 8–10). This morph is more stoutly walled than the other morph and tends to be slightly more rectangular in outline and there are posteroventral denticules. In all other respects it conforms with the alternative morph, even to the presence of a thin anterior rim.

Mutual features. There is a hollow, spine-like ventral process (Plate 2, Figs. 4, 6, 7, 10). The regularly rounded anterior margin bears a row of button-like tubercles (Plate 2, Figs. 7, 9).

The eye-tubercle is well developed and bulbous. There is an ocular tube which enters beneath the anterior hinge element (Plate 2, Figs. 4 and 6). The hinge is heterodont, with a coarsely notched median bar (Plate 2, Fig. 5). There is a secondary tooth anterior to the "roofed" terminal socket (Plate 2, Fig. 5) in the left valve which, in its turn, is fronted by an elongate, shallow groove. The zone of concrescence is broad.

Lateral ribs as such do not occur. However, the carapace widens posteriorly, particularly in the ventral sector, due to the ventrolateral spine. The postero-marginal area is compressed, almost axe-like. Internally, the site of the adductor muscle tubercle forms a broad pit (Plate 2, Figs. 4 and 6), which is visible as a low mound on the outer surface.

Remarks: The present species seems to differ from other morphologically similar forms in having a deep internal niche marking the site of the ventrolateral protruberance. There are morphological similarities with some species of *Brachycythere* and *Opimocythere*. Inasmuch as *"Cythereis" segoviensis* lacks an accommodation groove (which species of the afore-mentioned genera possess), a location in the vicinity of *Buntonia* could perhaps be contemplated.

The dorsal and ventral surfaces of both valves of the new species are flattened and provided with a characteristic pattern of reticulations; this constitutes a clear difference from species of the three genera mentioned. In addition, we note that *Opimocythere* possesses a well developed ventral rib.

Bosquetina bears a certain resemblance to the material from Segovia but lacks eye tubercles and a distinctive surface ornamentation. Colin, *in* Alonso (1981), referred undescribed specimens from Moral de Hornuez to *Opimocythere.*

Material Studied: Five carapaces and valves.

Occurrence and Age: Turonian. Moral de Hornuez, sample 276; Condemios de Arriba, sample 281.

"Cythereis" sp.

Plate 3, Figs. 1–4

1984 *Trachyleberidea* sp. nov., Reyment, p. 213, pl. 2, fig. 8.

Remarks: This specimen was recently referred by me to *Trachyleberidea.* It differs from representatives of that genus, however, in having a broad anterior field, as in the case of the other species just considered, as well as in other morphological characteristics. The specimen figured here has a thin anterior rim which can be seen to unite with one of the ridges of the ventrolateral reticulations. This does not occur in the other form referred to *"Cythereis"* gen. nov.

Occurrence and Age: Coniacian. Castrojimeno, sample CAS3 (equivalent of sample 265).

Table 1. Comparison of species of *"Cythereis"* nov. gen.

	"Cythereis" segoviensis sp. nov.		*"Cythereis"* sp.
	Moral de Hornuez morph 1	Condemios de Arriba morph 2	Castrojimeno
Outline	trianguloid	trianguloid-rectangular	trianguloid
Anterior margin	regularly rounded, feeble denticulations, anterior rim, broad, smooth anterior field	regularly rounded, feeble denticulations, broad smooth anterior field, anterior rim	regularly rounded, feeble denticulations, smooth anterior field anterior rim
Posterior margin	sharply rounded to bluntly pointed; feebly studded	bluntly pointed, prominent denticules	bluntly pointed
Eye-tubercle	prominent	prominent	prominent
Ribbing	indistinct; ventrolateral bulge	ventrolateral bulge	ventrolateral bulge
Muscle tubercle	flat, indistinct	flat indistinct	rather prominent, flat, patterned
Ornament	network of irregular reticulations with reticular background ladderlike ventral and dorsal reticulations	network of irregular reticulations with reticular background ladderlike ventral and dorsal reticulations	network of irregular reticulations ladderlike ventral and dorsal reticulations
Dorsal aspect	wedge-shaped	wedge-shaped	wedge-shaped
Hinge	heterodont	not seen	not seen

Genus PLANILEBERIS Deroo, 1966.

Planileberis aff. *praetexta* (Damotte)

Plate 3, Figs. 5–9

Remarks: – Some 15 specimens are referred here. The general appearance of the material is quite like *Planileberis praetexta* (Damotte), but the dorsal and ventral margins of that species seem to be more nearly parallel. Moreover, the specimens from Segovia lack the typical lateral ornament described and figured by Damotte (1962, pl. 3, fig. 15b).

A later figure published by Damotte (1975, pl. 2, fig. 2b) shows certain features which are not apparent in the earlier publication. Thus, the mid-posterior point seems to be lower and the postero-dorsal angle more nearly rectangular than shown for the originally described specimens. Moreover, the morphology of the dorsal rib can be seen to be different in the Spanish specimens under consideration.

Babinot (1980, p. 154), in his discussion of this species, speculated about its location under the genus *Trachyleberidea* and there is clearly some uncertainty attaching to the best taxonomic assignation of *praetexta.* Essentially the same conclusions were presented by Babinot and Colin (1979).

The specimen interpreted by Colin *et al.* (1982, pl. 2, fig. 10) as *Trachyleberidea geinitzi* (Reuss) is reminiscent of the form recorded here.

Occurrence and Age: Turonian. Somolinos, sample 286; Moral de Hornuez, sample 271.

Planileberis sp.

Plate 4, Figs. 1–5

Remarks: There is not enough material available of this species to permit a more certain determination than that now attempted. The dorsal aspect is typical of the genus (Pl.4, Fig.2) – the carapace is straight-sided, with the site of maximum inflation lying at the point at which the compressed posterior can be said to begin. The posterior is very compressed. The anterior margin is rimmed, as in Deroo's (1966) original description of the genus; this rim is strongly developed and continues directly into the club-shaped ventral rib.

The lateral ornamental field consists of large, irregular reticulations encompassing a minor pattern of reticulations. "Conuli" occur at the intersections of some of the reticular walls.

There is an eye-tubercle as well as ventral' median and dorsal ribs. In ventral aspect, the form of the carapace is reminiscent of *Planileberis* ? sp. from Iran, recorded by Grosdidier (1973), but the lateral morphology is different. The specimen figured as Pl.4, Fig. 1 has the following basic dimensions: length = 0.69 mm; height = 0.37 mm.

Occurrence and Age: Somolinos, sample 286. The age is Turonian.

Genus TRACHYLEBERIDEA Bowen, 1953

Trachyleberidea alandalusensis sp. nov.

Plate 4, Figs. 6–10; Plate 5, Figs. 1–8

? 1976 *Rehacythereis praetexta arta* (Damotte), Breman, p. 113, pl. 18, a–b.

Holotype: The specimen PMSp 268 figured in Plate 4, Fig. 6. from Moral de Hornuez.

Derivatio Nominis: From *al-Andalus,* the name of all of Moslem Spain, the northern march of which encompassed Segovia.

Diagnosis: A species of *Trachyleberidea* with the following characteristics. Dorsal and ventral ribs terminating in tuberculoid swellings; strong eye-tubercle; anterior margin coarsely denticulated.

Description: The shape is typical of the genus, although there is considerable variation in the development of the posterior process with respect to its length and the location of the mid-point. There is a strong eye-tubercle with is joined to the anterior rim. The anterior rim may bear coarse studs on both valves. The ventral and dorsal ribs expand posteriorly to terminate in a tubercle-like swelling (Plate 5, Figs. 6, 7).

The surface of the carapace is ornamented with irregular reticulations of variable prominence. The posterior is strongly compressed.

The left hinge consists of a socket, a prominent postjacent tooth, a bar and an elongated posterior socket.

Sexual dimorphism seems to be pronounced with males being longer and having a relatively higher posterior mid-point.

Measurements: The length of the carapace ranges from 0.60 to 0.74 mm; the height ranges from 0.31 to 0.36 mm.

Remarks: The form referred by Breman (1976, p. 113) to Damotte's species *Trachyleberidea arta* (Damotte, 1971, p. 9), and which seems to belong to *T. alandalusensis,* is different from the French form in that the dorsal margin is more rectilinear, the posterior process differs in morphology and the ribbing is clavate. *T. acutiloba* (Marsson), as interpreted by Babinot (1976), displays a similar posterior development, but the cardinal area is very rounded (cf. Babinot, 1980, pl. 27, fig. 9 – a specimen from the Maastrichtian of Rügen). (See also Babinot and Colin (1979, figs. 3 and 5).)

T. geinitzi (Reuss), as interpreted by Babinot (1980, pl. 27, figs. 3–14), is similar in general shape, but the posterior region is different, the lateral ornament less distinct, and the cardinal angle is broader than in the present species. In order to facilitate comparison, a specimen of *T. geinitzi* kindly supplied by Dr. Babinot is shown in Plate 5, Fig. 9.

Trachyleberidea arta, as figured by Babinot (1980), is similar with respect to the development of the posterior parts of the dorsal and ventral ribs, but the general shape is dumpier, the posterior process is appreciably shorter and the anterior is less regularly rounded. A specimen kindly supplied by Dr. Babinot is shown in Plate 5, Fig. 10.

Material Studied: More than 20 carapaces and valves.

Occurrence and Age. The Turonian of Segovia and Guadalajara Provinces. The described material comes from the localities Carabias (253), Moral de Hornuez (266), Carabias (Car 3), Somolinos (289).

Genus SPINOLEBERIS Deroo, 1966

Spinoleberis petrocorica (Damotte)?

Plate 5, Figs. 11–12; Plate 6, FIgs. 1–5, 6(?)

(See Babinot (1980, p. 151) for relevant details concerning the synonymy of the species *Spinoleberis petrocorica.*)

1984 *Cythereis? damottae* Swain, Reyment, p. 206, pl. 1, figs. 19, 20.

Remarks: The specimens referred here are somewhat irregularly reticulated. This ornamental feature is polymorphic with the one morph displaying more regular reticulations. There are anterior and posterior rims, the latter being provided with a few coarse denticules. There is a prominent adductor tubercle in most specimens (it may be smaller and more pointed in a minority of cases); this type of variation was also observed to occur in comparative material from Provence supplied by Dr. Babinot. The eye tubercle is fairly strong; it is joined to the anterior rim and posteriorly located to a deep incision in the margin. There are ventral and dorsal ribs.

In order to facilitate comparison, two specimens of *S. petrocorica* from the collections of Dr. Babinot (Provence) are figured here (Plate 5, Fig. 12 and Plate 6 Fig. 2 – stereomicrograph). They are of Cenomanian age and show a few differences in relation to the Spanish Turonian material. The average size for Spanish specimens is less than the French material, but the range of variation encompasses it. Spanish female individuals vary in length from 0.52 to 0.54 mm and in height from 0.29 to 0.31 mm. A male specimen attains 0.70 mm in length. The dimensions of a female of the species from Provence are length = 0.58 mm and height = 0.37 mm. The figures cited by Damotte for females are 0.63 to 0.65 mm for length (Damotte, 1971, p. 8).

According to the criteria recognized by Weaver (1982, p. 63), the specimens considered here qualify for admission into *Cythereis* s. str. However, study of the practical distinction made by him on his plate 11 between *Rehacythereis* Gründel and *Cythereis,* makes one less sure of how these criteria are supposed to be applied. The recommendations made by Babinot (1980), based on the opinion of Damotte (1975), are adhered to here. Dr. J. P. Colin (personal communication) has suggested that some of our specimens may be closer to *S. ectypus* Babinot.

Some of the specimens show what could be a further polymorphic condition, or the outcome of good preservation, to wit, the occurrence of a secondary level ornament filling the reticulations, which is not unlike what is found in some species of *Mauritsina.* One of the specimens in the Babinot collection was found to have this kind of development on restricted parts of the lateral surface.

Material: 15 specimens.

Occurrence and Age: Turonian. Somolinos, sample 287; Carabias, samples 256 and 257; Moral de Horneuz, sample 276; Condemios de Arriba, sample 281; Picrofrentes (Soria), unnumbered (basal part of Turonian sequence).

Spinoleberis sp.

Plate 6, Figs. 7–9

Remarks: This rare form has subparallel ventral and dorsal margins, rimmed anterior and posterior margins, a largely smooth posterior field and a lateral ornament consisting of irregular reticulations, some of which contain secondary reticulations (cf. Fitz-Gerald, 1983). There is a prominent adductor muscle tubercle developed in the form of a knob. The dorsal and ventral ribs each terminate in a knob-like process. The dorsal ribs flare posteriorly, thus making the dorsal surface trianguloid. The dorsum bears coarse, elongated reticulations.

The eye tubercles are prominent in both valves.

The specimen referred here bears a resemblance to *Spinoleberis petrocorica* (Damotte). Comparison with material kindly donated by Dr. Babinot indicates that there are significant differences, such as the stronger adductor tubercle of the Spanish form, the weaker hinge-ear, the broader zone of anterior reticulation and the narrower and less markedly ornamented ventral surface. Both forms are relatively small, the measurement for length being 0.58 mm for a female individual from Provence and 0.54 mm for the present specimen (cf. Pl. 6, Fig. 9).

There is also a certain degree of similarity with *Limburgina* ? *sarlatensis* Colin (Colin, 1974, pl. 3, figs. 6–9), but the reticulation patterns are different in the two forms and the posterior areas of the carapaces have different outlines.

Gründel (1973) placed *S. petrocorica* in his *Rehacythereis,* in action which has been critically appraised by Damotte (1975, p. 205).

Occurrence and Age: Turonian. Somolinos, sample 287.

Genus PARVACYTHEREIS Gründel, 1973

Parvacythereis ? sp. nov.

Plate 7, Figs. 1, 2

Remarks: The Lower Turonian of Somolinos and Carabias has yielded a few specimens of a small form here provisionally referred to Gründel's (1973) inadequately defined generic category which, despite valient efforts by Damotte (1975), still remains something of an enigma.

The dorsal and ventral margins of presumed females are sub-parallel; the posterior half of the ventral surface bears a reticulated platform in both valves, which are approximately equal in size, although the left valve overhangs the right one in the anterodorsal area. The muscle tubercle is prominent.

The is a broad, smooth concave zone behind the sharp, thin anterior ridge. The eye-tubercle is moderately prominent and provided with a short ventral extension. The dorsal rib stops just short of the eye-tubercle. The ventral rib is an extension of the anterior ridge; both the dorsal and ventral ribs terminate posteriorly in a knob-like process. In dorsal aspect, the carapace is wedge-shaped.

There is a certain superficial resemblance to the specimen called *Parvacythereis* ? sp. by Breman (1976, pl. 10, fig. 20). However, our form possesses a strong adductor muscle tubercle. One of the specimens referred by Swain (1978, pl. 3, fig. 9) to his *Cythereis* ? *damottae* is somewhat similar to the present species. The same author has also figured a *Parvacythereis* ? sp. (Swain, 1978, pl. 3, fig. 4), but the comparison of his sterophotographs with our specimen indicates several fundamental differences to exist – the sub-central tubercle is different and the anterior zone of our material is more axe-shaped.

There is also a clear resemblance to some figures of *Spinoleberis petrocorica* (Damotte) with respect to outline, lateral ornament and carapace dimensions. The dimensions of the carapace of the figured specimen (Pl. 7, Fig. 1) are length = 0.59 mm; height = 0.33 mm; breadth = 0.31 mm.

Occurrence and Age: Turonian. Somolinos (sample 285) and Carabias (259).

Genus VEENIA Butler and Jones, 1957

"Veenia" moralensis sp. nov.

Plate 7, Figs. 3–9

Holotype: – The specimen PMSp 290 figured in Plate 7, Fig. 3, a carapace.

Locus Typicus: The Lower Turonian section at Moral de Hornuez, Province of Segovia.

Derivato Nominis: From the village of Moral de Hornuez.

Material: 14 carapaces and valves.

Diagnosis: A species of *"Veenia"* with a studded and irregular antero-marginal ridge, a subrectangular outline, spaced ventral riblets and three stout (in the right valve) short ribs (weaker on left valves).

Description: The outline of the carapace may appear subrectangular owing to the jutting rib-profile (Plate 7, Fig. 3); internally, the shape of the outline is triangular with converging dorsal and ventral margins. There is a moderately strong hinge-ear in the left valve (Plate 7, Fig. 9). The posterior margin is obliquely pointed and provided with one or more tubercles. The anterior margin is unevenly rounded; it bears an irregularly thickened rim which may be studded with four to five tubercles.

The left valve overlaps the right along the central part of the ventral margin, along the postero-dorsal margin and at the eye-tubercle. The cardinal areas are marked by thickenings of the anterior rim.

The eye-tubercles are prominent; the ocular tubes are coarse and exit obliquely anterior of the anterior hinge elements.

There are three lateral ribs on the posterior half of the shell, stronger in the right valve than in the left, thus leading to a pronounced asymmetry. The ribs are pinched and vary in strength from specimen to specimen (Plate 7, Figs. 3, 4). There are five to six ventral ribs, the outer of which terminate in tubercles. Posterior of the median rib there is a pointed tubercle.

The inner margin and line of concrescence coincide. The right hinge (Plate 7, Fig. 7) comprises an anterior, notched tooth, a postjacent, breached socket, a median, weakly notched groove, and an elongated posterior tooth. The left hinge is complementary (Plate 7, Fig. 9).

Generic Assignation: In many respects, this species qualifies for admission into *Veenia* and Babinot (1980) has placed morphologically similar material tentatively in the genus (*"Veenia"* aff. *ballonensis* Damotte & Grosdidier). The posterior development is, however, not sharply pointed as in typical *Veenia,* which possess, besides, a strongly developed, partly moated adductor muscle tubercle, a very prominent hinge-ear in the left valve, and are holamphidont.

Mandocythere has several features in common. It is said to have a modified heterodont dentition, a strong antero-marginal ridge and, as far as can be judged from available information, a specific ornamental pattern on the ventral surface. Apart from the lack of an "exterior tooth" in the hinge, a property ascribed taxonomic prominence by Weaver (1982), the presence of eye-tubercles would seem to preclude assignation of the present form to *Mandocythere.* Weaver (1982) makes no mention of the presence of eye-tubercles in his material, but his figured specimens show tubercular developments suspiciously like those occurring in the present species. Damotte (1968) stated specifically that *Mandocythere* lacks eye-tubercles.

Remarks: Cythereis fournetensis Damotte (Damotte, 1971, pl. 2, fig. 8d) displays similarly developed ribs but differs in other respects, including the outline of the carapace, partly owing to the differing configuration of the posterior. Perhaps *Veenia tenera* (Damotte) (Damotte, 1968, pl. 3, fig. 18) is more similar in this respect.

Cornicythereis larvivaurensis (Damotte & Grosdidier), as interpreted by Weaver (1982, pl. 10, fig. 18), has a similar habitus, but the shell is more pronouncedly triangular, the ventral margin is different, and the ribs are sharper. Closer still in general appearance is the Lower Cenomanian *Mandocythere ornata* Weaver (Weaver, 1982, pl. 10, figs. 1–2). This species has, however, finer ribs and a background net of punctae. The posterior is also somewhat shorter (Weaver, 1982, p. 52, pl. 10, fig. 2).

Mandocythere inferangulata Donze is, in Weaver's (1982, pl. 9, fig. 8) interpretation, somewhat similar. The antero-dorsal angle is alike with respect to the tuberculation, but the posterior region is less elevated and the ribs less strong.

Occurrence and Age: Turonian. Moral de Hornuez, sample 277; sample MO17 (locality of Alonso (1981), equivalent to sample 271).

Genus DONMACYTHERE Gründel, 1976

Type species: Hazelina ? damottae Colin.

Description: A genus of triangularly shaped, heavily calcified cytherids with a holamphidont hinge and a characteristic pattern of muscle scars; the right valve is entirely enclosed by the left, with overlap or overhang all around the circumference. Functional eye-tubercles and eye-tubes seem to be lacking, although there is a tubercle at the site normally occupied by the eye-tubercle. There is a narrow vestibule. There are three, short, fold-like ribs; the median rib is truncated by a broad anterior furrow. The anterior rim is bulgy and joined to the ventral rib. The lateral surface is smooth or vaguely patterned; coarse and sparsely located pores may occur on the ribs and ventral surface. The ventral surface may bear spaced, irregular, sub-quadrate pits. The ornament displaces polymorphism. Sexual dimorphism is strong.

Age: Cenomanian to Early Turonian.

Discussion: Donmacythere was erected as a subgenus of *Mandocythere* (Gründel, 1976, p. 1297). The general shape of *Donmacythere* is rather like some *Veenia* (particularly the right valve as in the type species, *D. damottae*), but the lateral ornament differs with respect to the ribbing. *Veenia* has genuine eye-tubercles and a well defined adductor muscle tubercle and there is no vestibule.

Veeniacythereis Gründel is similar in shape and general habitus. The main differences lie with the more definitely expressed lateral ribbing, the hemiamphidont hinge, and the presence of eye-tubercles. Less significant may be the presence of anterior and posterior studding of the marginal ridges.

Hazelina Moos is usually considered to be subrectangular in outline; it has rather sharp to bulgy lateral ribs, and there are small eye-tubercles (in the original description, the term eye-lens was employed). In the type species, the valves are almost equal in size. Babinot (1980, p. 135) records a *Hazelina* with a well developed eye-tubercle.

The enigmatic genus *Farkacythere* Gründel possesses bulgy lateral ribs (as far as can be concluded from the original description), a strong eye-tubercle, and notched and crenulated hinge elements. *Costaveenia* Gründel seems to have a characteristic rib pattern and outline, a marked anterior ridge, a broad inner lamella and there are eye-tubercles

(Damotte, 1968). The median rib is anteriorly deflected downwards. *Curfsina* has eye-tubercles and strong posteroventral spines.

Mandocythere, considered to be ancestral to *Donmacythere,* is subrectangular in lateral aspect; it lacks eye-tubercles and the hinge-elements are notched (see Gründel, 1976, p. 1297). Some species referred to *Mandocythere* by Damotte (1968) are similar in shape to *Donmacythere,* but have a paraamphidont hinge.

Topotypes of *Donmacythere damottae,* kindly supplied by Dr. J.-P. Colin, are illustrated here (Fig. 5, L-N; Fig. 7, H–J).

Donmacythere hafsuni sp. nov.

Plate 7, Fig. 10; Plate 8, Figs. 1–6; Plate 9, Figs. 1–4; Fig. 5K.

1984 *Veeniacythereis* ? sp. nov., Reyment, p. 207, pl. 2, figs. 4–7.

Holotype: The specimen PMSp 298, a carapace, figured in Plate 8, Fig. 1, a female.

Locus Typicus: Moral de Hornuez.

Derivatio Nominis: For Umar ibn Hâfsun, Unitarian Christian leader of 10th century Moslem Spain.

Material Studied: More than 30 carapaces and valves.

Diagnosis: A species of *Donmacythere* with the following characteristics: Carpace strongly inflated at posterior third; variable ventral and dorsal bulging ribs; posteriorly and anteriorly abruptly truncated median rib; arched median element in left hinge, which is holamphidont.

Description: The left and right valves are markedly different in size, with the left valve overlapping or overhanging the right valve along its entire margin. The left and right valves differ markedly in shape. The left valve has a prominent hinge-ear, whereas there is no hinge-ear in the right valve.

The left anterior margin is smoothly rounded, though more sharply curved in its ventral half, which influences the degree of overlap along the anterior margin. The posterior is compressed and bluntly pointed. The anterior zone is lightly compressed. The right valve is ovoid in outline, with a blunt, short posterior process.

There are ventral and dorsal bulgy ribs in the left valve and a median rib. The right valve lacks a well defined dorsal rib; it has a median rib and a broad ventral bulge. The short, thick median rib is obliquely oriented; it may be medially expanded and could then be outlining the location of the adductor muscle field.

There is a broad, shallow anterior depression, which is recognizable inside the shell and which separates the median rib from the anterior zone. There is a bulgy anterior rim. There are no marginal denticulations. The anterior rim continues into the ventral rib.

The dorsal margin of the left valve is almost straight, whereas that of right valves is convex. The ventral margins of both valves are strongly convex.

There are four vertically aligned adductorial muscle scars, fronted by a coalesced pair of scars which form a "V", the posterior arm of which is the longer (Plate 8, Figs. 2, 3). There is an elongated mandibular scar.

There is a narrow vestibule. The hinge is holamphidont, with the peculiarity that the central element is slightly arched.

Dimensions: The length ranges (in females) from 0.63 mm to 0.70 mm. The height ranges from 0.43 mm to 0.48 mm.

Remarks: Compared with *Donmacythere damottae* (Colin), there is a distinct anterior ridge in that species in the left valve (Fig. 5M). Colin (1974) referred to the occurrence of eye-tubercles in his material; although there are bulges at the site normally occupied by the eye-tubercle (Figs. 5 L and M; Fig. 7I), and the bulge is united to the anterior ridge (Fig. 5M), I could not prove the existence of an ocular tube in any of the specimens supplied by Dr. Colin (see Fig. 7J). I have interpreted a hole below the hinge socket in *D. hafsuni* as an eye-socket (Reyment, 1984; Plate 8, Fig. 2). However, only one of several well preserved valves displays such a hole and it could derive from some burrowing micro-organism. On the evidence available at present, it would seem that the antero-dorsal swellings of *Donmacythere* are not ocular tubercles (see also Hartmann, 1975). It is worth noting, moreover, that even if these swellings were eye-tubercles, they can hardly have been functional as the shell substance in them is exceptionally thick.

Occurrence and Age: Turonian. Moral de Hornuez, locality MO17 (Alonso, 1981) and Condemios de Arriba, sample 283.

Genus VEENIACYTHEREIS Gründel, 1973

Veeniacythereis ? cf. *xixunensis* (Méndez and Swain)

Plate 9, Fig. 5

?1976 *Cornicythereis mdaourensis* (Bassoullet & Damotte), Breman, p. 113, pl. 4, figs. 19, a–b.

?1984 *Veeniacythereis* ? *begudensis* (Babinot), Reyment, p. 207 pl. 1, figs. 8–12.

Remarks: The shape is characteristic of *Veeniacythereis* and the lateral ribbing strongly developed Plate 9, Fig. 5. The median and ventral ribs coalesce anteriorly and the ventral rib is joined to the studded anterior marginal ridge. This ridge is, in turn, connected to the eye-tubercle. The dorsal rib coalesces with the eye-tubercle also. The surface is ornamented with irregular reticulations.

Recently (Reyment, 1984), I suggested that the fossils referred here could possibly belong to *Veeniacythereis* ? *begudensis* (Babinot). Comparison with material kindly sent by Dr. Babinot shows this suggestion to have been in error. Another similar species, *Donmacythere damottae* (Colin), has also been compared with the present form (Reyment, 1984). The recently described *Veenia xixunensis* (Méndez and Swain, 1983, p. 479) may be identical with the form recorded here (see particularly pl. 5, fig. 4 of that paper). The species is better located with *Veeniacythereis* than *Veenia,* as can be seen from the ribbing and posterior configuration.

Occurrence and Age: Turonian. Carabias, sample 252. *Veeniacythereis* ? *xixunensis* was originally described from the Cenomanian of Asturias, Spain.

Veeniacythereis sp. juv.

Plate 9, Fig. 6

Remarks: This specimen of an immature individual has the morphological properties usually associated with *Veeniacythereis.* There are three ribs, including a mediolateral one on which there is a tubercle, possibly indicating the site of the adductorial musculature. The anterior ridge is not developed in the manner said to be typical of the genus. The broad, anterior field is also out of keeping with the properties of the type species, *V. imparia* (Gründel).

Kaye (1963) recorded a species *blanda,* which he referred to *Veeniacythereis.* This form has some features in common with the present specimen.

Occurrence and Age: Turonian. Moral de Hornuez, sample 276.

Genus CORNICYTHEREIS Gründel, 1973

Cornicythereis ? *picofrentensis* (Grekoff & Deroo)

Plate 9, Figs. 7–10; Plate 10, Figs. 1, 2

1956 *Cythereis picofrentensis,* Grekoff and Deroo, p. 230, pl. 47, figs. 36–37.

Description: The shape of the valves is trianguloid with a fairly prominent hinge-ear. Right valves are roughly ovoid. The anterior margin bears a broad rim and the posterior is bluntly to moderately sharply pointed. The left valve is larger than the right and overlaps it along the antero-dorsal and antero-ventral sections of the margin and overhangs the other stretches of the margin. The anterior margin bears stubby denticules.

The median rib encompasses a feebly delineated adductor tubercle. The ventral rib joins the anterior rim and there is a long dorsal rib. There is a deep furrow behind the anterior rim, which truncates the median rib; the furrow may contain reticulations.

There is strong sexual dimorphism, with males being relatively longer and lower than females (Plate 9, Fig. 10). A poorly preserved left hinge is shown in Plate 9, Fig. 8.

Remarks: There are certain features in common with Breman's (1976) *Cornicythereis mdaourensis,* and his specimens might possibly belong to the present species. There are characteristics reminiscent of the genus *Donmacythere* and there seems to be reason to suspect that *C.* ? *picofrentensis* lacks eye tubercles. The material, although abundant, could not provide information concerning this feature, owing to the lack of well preserved single valves.

Although the original figures of *C.* ? *picofrentensis* are poor (Grekoff and Deroo, 1956, pl. 47, figs. 36–37), they are sufficiently distinctive for identifying the present material. There is a slight resemblance to *Cornicythereis carrensis* (Keen and Siddiqui), as interpreted by Méndez and Swain (1938, pl. 3). Another genus that might be considered for the present species is *Curfsina* Deroo. There is also a distinct resemblance to *Donmacythere damottae.*

Material Studied: More than 100 carapaces and valves.

Occurrence and Age: Turonian. Carabias, samples 259, 2510; Somolinos, sample 285.

Genus DUMONTINA Deroo, 1966

Dumontina ? *almussatensis* sp. nov.

Plate 10, Figs. 3–5; Plate 11, Fig. 1

Holotype: The specimen PMSp 315 figured in Plate 10, Fig. 3.

Derivatio Nominis: From *al Mussât,* the toponomical designation used in Moslem Spain for the central plateau of the Iberian Peninsula (today's term is *la Meseta*).

Material Available: Nine carapaces and valves.

Locus Typicus: The Lower Turonian of Moral de Hornuez; sampling level 276.

Diagnosis: A species of *Dumontina* ? with the following characteristics: Dorsal rib posteriorly sharply offset, median rib deflected to join the anterior rim; ventral rib sub-alate; posteroventral tubercle present.

Description: The shape is, in general, conformable with Deroo's original concept (Deroo, 1966, p. 144, pl. 21), there being a well rounded anterior and sharply pointed posterior. The dorsal margin is convexly arched, the ventral margin concave. There is an antero-marginal rim which unites with the short ventral rib. The left and right valves are almost equal in size.

The three ribs are of unequal length and morphology. The dorsal rib is weak; posteriorly, it deflects sharply and obtusely downward from a thickening to form a scarplet, which delineates the compressed posterior process.

The median rib is likewise thin and begins a short distance anterior of the scarplet; it is arched and at about the level of the antero-dorsal transition it is sharply deflected downwards to join the antero-marginal rim. The ventral rib is sub-alate; it widens posteriorly to form a tuberculoid process. The ventral rib-surface is ornamented with rows of rectangular reticulations. The postero-ventral part of the margin bears an elongated thickening, which closely resembles a like structure in the form here referred to as "*Dumontina*" sp.

The lateral ornament consists of regular, pentagonal reticulations. The thickened anterior valve-margins bear small denticules.

There is no eye-tubercle. Deroo (1966, p. 144) specifically refers to an eye-tubercle in *Dumontina* and Babinot (1980), for example, refers to such in his specimens. There is no adductor tubercle.

Remarks: D ? almussatensis is characterized by the "swung" shape of the carapace and the offset relationship between the median and ventral ribs, as opposed to the location of the dorsal rib. It shows some features in common with the form here recorded as "*Dumontina*" sp. from the Somolinos section. This agreement lies chiefly with the posteroventral tuberculation, the offset development of the lateral ribs, and the aspect of the reticulate ornamental pattern.

There is some morphological similarity with *Trachyleberidea,* but *almussatensis* differs from true representatives of that genus in lacking an eye-tubercle, the ribbing, and the postero-ventral tuberculation.

Some forms referred to *Imhotepia* Gründel bear a slight ornamental resemblance to the present species. There are superficial similarities with "*Cythereis arta* Damotte", but comparison of specimens of that species with our material shows that the two are quite different as regards ornament and development of the marginal zones.

Trachyleberidea sobrenensis (Colin, Lamolda and Rodríguez) is somewhat comparable in lateral aspect, and the dorsal and ventral margins are strongly concave; however, that species from the Upper Cenomanian of northern Spain is far more compressed (cf. Colin *et al.,* 1982, pl. 2, fig. 9).

Occurrence and Age: So far, known only from one level in the Lower Turonian Moral de Hornuez section (sample 276).

"*Dumontina*" sp.

Plate 10, Figs. 6–10

Remarks: This remarkable form possesses the morphological properties of several, presumably related, genera, but differs from all known to me in one or more essential details. The present location with "*Dumontina*" is one of mere convenience.

The anterior and posterior development of the carapace resemble in general those of *Trachyleberidea* – thus, there is a regularly rounded anterior margin and a rather bluntly pointed posterior.

The carapace is exceptionally elongated and the dorsal and ventral margins strongly concave. There are three curved, anteriorly downward-directed and rather prominent ribs.

The dorsal rib begins at a small, glassy eye-tubercle and ends in a swelling at the postero-dorsal angle. The median rib begins at the small adductor muscle tubercle and terminates at a swelling. The median and dorsal swellings are united via a bulge. The ventral rib, which is shorter than the other two and which forms a continuation of the anterior rim, is sub-alate. Its ventral surface is ornamented with five ladderlike reticulations (Plate 10, Fig. 7). This rib is terminated by a peculiar, dumbell-like tubercle.

The postero-ventral margin bears indistinctly bounded swellings. The surface is ornamented with a regular pattern of pentagonal reticulations. Two specimens were available for study.

Occurrence and Age: Turonian. Somolinos, samples 285 and 286.

Dumontina ? sp.

Plate 10, Fig. 11

Remarks: A slightly crushed specimen is located here. The lateral costational pattern and the development of the posterior are like *Dumontina,* although the antero-dorsal angle seems to be less typical. The anterior is provided with a stout rim, bordered posteriorly by an "A-row" set of reticulations (cf. Liebau, 1971).

The dorsal margin is weakly convex and the ventral margin slightly concave. The posterior is bluntly pointed and there is ventral as well as posterior overlap, although the valves are almost of equal size. There are three sharp, strong ribs. The background ornament consists of reticulations.

The form referred here is something like *Paracaudites colini* Babinot, but the dorsal margin appears to be straighter. There are also some features in common with *Cornicythereis mdaourensis* (Bassoullet and Damotte) (Bassoullet and Damotte, 1969, pl. 1, fig. 5d) in that the ribbing is similar.

Cornicythereis ? *picofrentensis* (Grekoff and Deroo) is also slightly similar.

Occurrence and Age: Turonian. Carabias, sample 257.

Dumontina sp. nov. ?

Plate 11, Figs. 2–5

Remarks: A few specimens of what seems to be a new species of *Dumontina* are referred here. The carapace has roughly equal valves, a broad, evenly rounded anterior, and a truncated posterior. The dorsal and ventral margins converge rather strongly. The main area of overlap of the valves lies along the postero-dorsal margin.

There are three ribs. The dorsal rib is short and most prominent in the posterior half of the shell. The median and ventral ribs are parallel and occur at an angle to the median line of the shell; the ventral rib is club-shaped, with a posterior knob (Plate 11, Fig. 5). The posterior and anterior margins are rimmed.

The surface is ornamented with a regular network of reticulations; in the posterior and anterior zones, this reticulation coarsens markedly.

There is a slight resemblance to *Dumontina cenomana* Damotte (Damotte, 1971). Another species showing slight similarity is *Paracaudites (Dumontina) grekoffi* Babinot (Babinot, 1980, pl. 25, fig. 2). The antero-dorsal morphology of *P. (D.) punctura-toides* Babinot is similar to that of the form considered here.

The most similar form encountered by me is *Dumontina* ? *macerior* (van Veen) (Deroo. 1966, p. 146, pl. 21, figs, 631–633) from the Upper Maastrichtian. The shapes seem to be very close and the general aspect of the ribbing agrees.

Occurrence and Age: Turonian. Somolinos, sample 285.

Genus PARACAUDITES Deltel, 1962

Paracaudites ? sp. indet.

Plate 11, Fig. 6

Remarks: A single, poorly preserved specimen is referred here. It consists of an almost equi-valved carapace. The material is insufficient for anything like a certain identification; however, *Paracaudites (Dumontina) grekoffi* Babinot from the Middle Cenomanian of Pas d'Ouillier is somewhat similar in shape.

Occurrence and Age: Turonian. Carabias 254.

Genus LIMBURGINA Deroo, 1966

Limburgina galvensis (Breman)

Plate 11, Figs. 7–11; Plate 12, Figs. 1–4

1976 *Rehacythereis galvensis* n. sp., Breman, p. 111, Figs. 16, a–c

Description: The outline of the carapace is sub-quadrate in lateral aspect. The cardinal angle in left valves is fairly strongly developed. The anterior is evenly rounded; the posterior margin has an almost straight dorsal section and a sharply rounded ventral part. The mid-point of the posterior lies at about one third the height of left valves. The surface of the robust shell is coarsely reticulated (see below).

There is a strong and sharp ventral rib, posteriorly elevated, and a broad and low median rib in some specimens. The dorsal rib is sharp but of low relief. Right valves lack a well developed hinge-ear. There is a broad, flat eye-tubercle.

Most specimens are entire carapaces. In the few single valves available, the hinge can be seen to be holamphidont (Plate 12, Fig. 4). The adductor muscle tubercle is flat and irregular in outline.

Sexual dimorphism is strong with males being relatively longer than females. There is also a difference in shape in that the mid-posterior point in females is slightly higher.

Ornamental polymorphism. This species presents an ornamental dimorphism which is rather common in reticulate ostracods of the *Limburgina-Oertliella* group (cf. Reyment, 1984). The "basic" ornamental pattern consists of reticulations (Plate 11, Fig. 10). The complementary morph displays smooth centro-lateral fields (Plate 11, Fig. 11; Plate 12, Fig. 1). In the present collection, about 60 % of the specimens show an entire field of lateral reticulations and 40 % have smooth area(s) superimposed on the reticulations.

Remarks: Babinot (1980, p. 190) has given a penetrating analysis of the confused situation existing for *Oertliella, Limburgina* and *Horrificella* and come up with a rather Solomonic compromise. He suggests that the name *Limburgina* should be reserved for quadrangular carapaces, stoutly constructed, and with reticular ornament; spines may occur, but this is not a primary property of the genus. There is a strong muscle tubercle, more or less reticulated, but sometimes smooth. The strong dorsal rib is joined to the anteriorly subjacent mesh.

Material: More than 40 carapaces and valves.

Occurrence and Age: Turonian. Carabias section: levels 251, 2510 and locality 14CB of Alonso (1980), which approximates to our 253. Moral de Hornuez, level 276.

Limburgina ? sp.

Plate 12, Figs. 4–6

Remarks: A single, well preserved specimen displays many of the characteristics of *Limburgina* but differs from most species located with that genus in the very irregular nature of the lateral reticulations. There is a very prominent adductor muscle tubercle. In some features the present form is like *Oertliella,* particularly with respect to the posterior.

Occurrence and Age: Condemios de Arriba, sample 281. Turonian.

Genus OERTLIELLA Pokorny, 1964

Oertliella guadalajarensis (Breman)

Plate 12, Figs. 8–12; Plate 13, Figs. 1–9

1976 *Rehacythereis guadalajarensis* sp. nov., Breman, p. 112, pl. 9, figs. 17, a–c.
?1982 *Limburgina* sp. 2 Andreu, Colin *et al.*, p. 206, pl. 5, figs. 8–9.
1984 *"Rehacythereis" guadalajarensis* Breman, Reyment p. 211 pl. 3, figs. 3–4.

Remarks: This species was said by Breman (1976, p. 112) to be typified by the pattern of anterior and posterior reticulations, the pronounced eye-tubercles (which, however, vary somewhat in strength from individual to individual) and the asserted weakly developed hinge-ear. This latter feature is not invariable and occasional specimens may show a strongly developed hinge-ear (Plate 13, Fig. 7). Another morphological feature subject to considerable variation is the length of the posterior process. The lateral ornament is also variable and may occur either as regular reticulations, as in Plate 13, Fig. 6, or broken reticulations, as in Plate 13, Fig. 7. These variations indicate the occurrence of polymorphism in the lateral ornament.

The dorsal rib may be interrupted by protruberances. The ventral rib is slightly convex-downwards; it expands strongly in a posterior direction. The median rib referred to in Breman's (1976, p. 113) description is not visible on the present specimens, nor can I make it out on his figure. The postero-dorsal and postero-ventral rib-terminations are united by a long, broadly rounded ridge. There is a thin rim along the posterior and anterior margins.

According to the strength of the dorsal costation, the species displays a concave dorsal outline, or a straight dorsal outline (Plate 13, Figs. 5–8).

In ventral aspect, the species displays a strongly triangular shape (arrowhead), with a row of outer, deep, quasi-loculate reticulations and inner, shallower pits (Plate 13, Fig. 4).

The adductor tubercle is smooth and superimposed on the basic reticulate ornamental pattern.

Biometric Analysis: A principal coordinate analysis of 16 carapaces was made, using the log-ratio transformation for closed variables (Aitchison, 1983) with the end in view of exposing eventual groupings in the data. The variables measured were (1) length of carapace; (2) height of carapace; (3) diagonal length from eye-tubercle to postero-ventral knob; (4) posterior height along the posterior vertical ridge; (5) distance from the anterior margin to the adductor tubercle; (6) width of the anterior ridge zone; (7) length of the posterior process. These are a combination of size and shape variables in the sense of Bookstein (1978). No clear groupings exist additional to the natural subdivision into males and females; there is pronounced sexual dimorphism in the species with females outnumbering males.

Basic statistical data are summarized in Table 2.

Table 2. Basic statistics for *Oertliella guadalajarensis*

Variable	1	2	3	4	5	6	7
Means	0.74	0.40	0.63	0.33	0.31	0.12	0.12
Standard deviations	0.009	0.005	0.006	0.006	0.004	0.004	0.002

Generic Assignation: Breman (1976) referred his species to the poorly defined category *Rehacythereis* Gründel, without elaborating on the grounds underlying this assignation. For reasons summarized below, *Oertliella* seems to be a more logical location for the species.

The location of the ventral rib in *O. guadalajarensis* agrees with Pokorny's (1964) drawings of the type species of his genus. *O. pulchra* Babinot (1980) shows the same characteristics.

Babinot (1980, pp. 181–183) discussed in some detail the confusion surrounding the group of *Oertliella-Horrificella-Limburgina.* Not the least of the problems connected with the confused taxonomical state of the group is of historical origin in that genera have been proposed by a number of people, independently of each other, for very closely related taxa.

Using Liebau's (1975) redefinition of *Limburgina* as a starting point, Babinot (1980, p. 181) reserves the spinier carapaces for species of *Oertliella* and the more robust less spiny carapaces for *Limburgina.* This is doubtless an arbitrary solution and it may prove to be difficult to maintain it in the light of the influence of ecophenotypic variability.

Occurrence and Age: Turonian. The type material of Breman (1976) derives from Condemios de Abajo (Molina Formation; Lower Turonian). In passing, we note that he believes that all but a few of the several hundred specimens seen by him are juveniles. Somolinos, sample 286, Condemios de Arriba, sample 281, Moral de Hornuez, sample 276, Soria (Alonso locality 13SO), Carabias samples 254, 259.

Material: More than 40 specimens.

Genus MAURITSINA Deroo, 1966

Mauritsina soriensis (Grekoff and Deroo)

Plate 13, Figs. 11–15; Plate 14, Figs. 1–7; Fig. 8, A-H; Fig. 9

1956 *Cythereis soriensis* n. sp., Grekoff and Deroo, p. 223 (231), pl. 47, figs. 38–39.

Remarks: This is a poorly known species. As far as I can decide from the inadequate figures and sketchy description given by Grekoff and Deroo (1956), the material referred here seems to qualify for admission into *Mauritsina soriensis* and it derives, presumably, from the same formation. In addition, some individuals which seem to fall within the range of variation of *M. soriensis* also display features in common with *M. speciosa* Babinot. As far as I can judge, the principal morphological differences between that species and *M. soriensis* seem to lie with the reticular pattern (although polymorphism makes this character difficult to assess), the somewhat less prominent hinge-ear in left valves, and the longer posterior area in relation to the termination of the centro-lateral ornament. The statistical properties of the *Mauritsina* species considered here are taken up on p. 101.

The reticular pattern tends to be less regular than is the case in *Mauritsina radiocostata* n. sp., being composed of rather undulating walls encompassing two classes of microreticulations. The microreticulations display polymorphism, the two types being (a) reticular ridges rather thin and unevenly sloped and with very fine, indistinct micro-reticulation (Fig. 8 A, C and E); (b) the second category is composed of thick reticular walls encompassing coarser microreticulations (Fig. 8, B, D, F, G and H). The morphs occur in the same associations and are found at Somolinos, Carabias and Condemios de Arriba. The general aspect of the latter category of ornament is that of "shagreen texture" (Plate 13, Fig. 13 and Plate 14, Fig. 7).

The denticulations along the posterior margin are coarse and few in number. The muscle tubercle is prominent and flat; it is marked by a depression on the internal surface of the valves.

The hinge is amphidont (Plate 13, Figs. 14, 15; Plate 20, Figs. 5, 6). The anterior pore canals are illustrated in Fig. 9. The lateral ribbing consists of ventral and dorsal ribs, with the former flaring strongly backwards. The median field may attain a rib-like appearance owing to elongation of the adductor tubercle and coalescence with an elongated reticular structure of the background ornament (Plate 14, Fig. 7).

The eye-tubercles are prominent.

The polymorphism in the second-order ornamental features of this species (the two categories of micro-reticulations) seems to be a different mechanism for second order ornament than the excavational hypothesis propounded by Fitz-Gerald (1983).

Occurrence and Age: The Lower Turonian sequences at Condemios de Arriba (281), Somolinos (286, 287, 289, 2811), Moral de Hornuez (276) and Carabias (254, 255, 2510) and Soria (locality 13SO of Alonso, 1981).

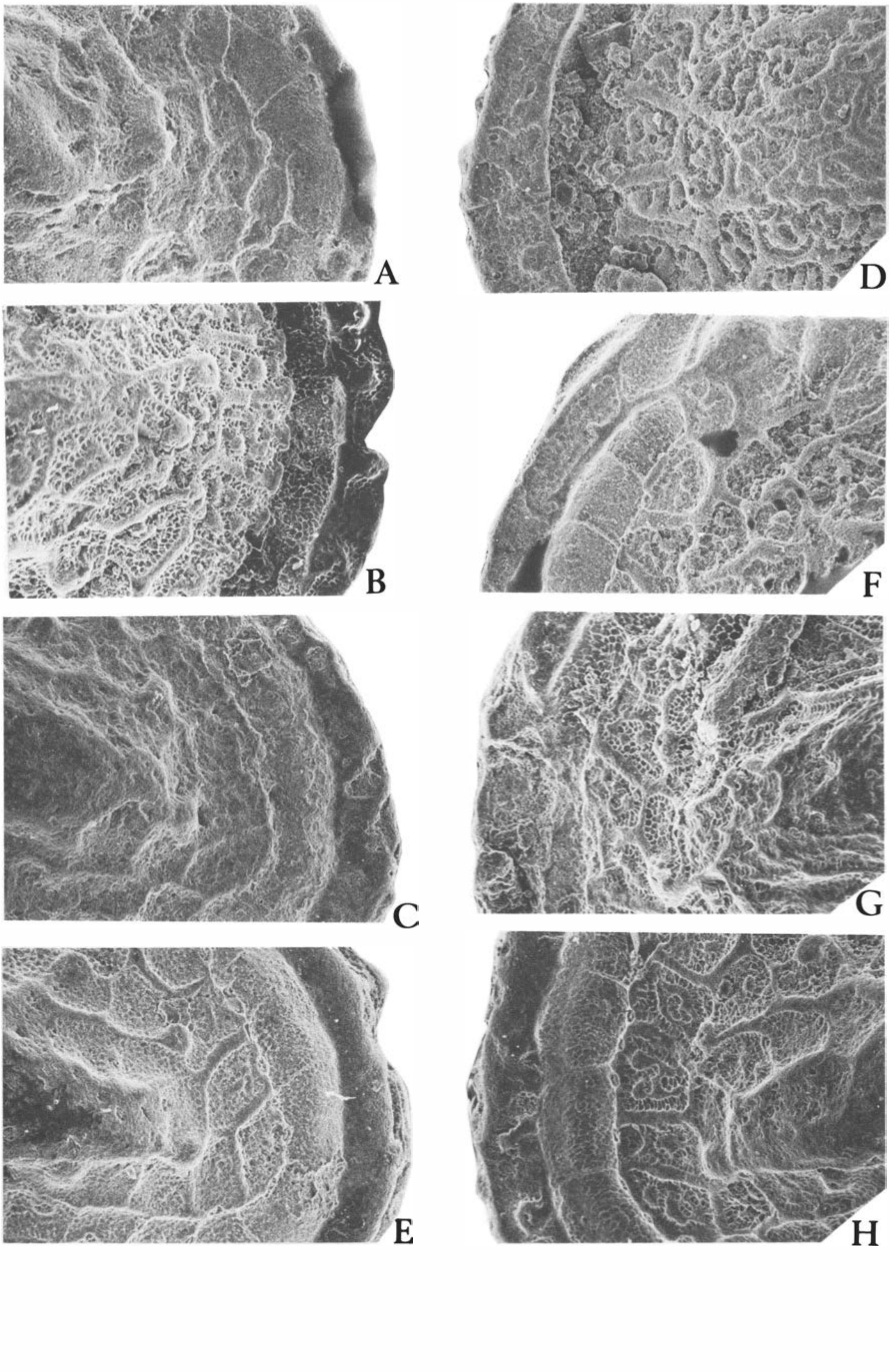
Material: More than 100 specimens.

Mauritsina speciosa Babinot?

Plate 14, Figs. 9–15; Plate 15, Figs. 1–3

?1980 *Mauritsina speciosa* nov. sp., Babinot, p. 175, pl. 32, figs. 1–6.

Remarks: The material here referred to *M. speciosa*


A
D
B
F
C
G
E
H

seems to agree reasonably well with Babinot's original description and with specimens kindly supplied by Dr. Babinot (Plate 14, Fig. 8).

There are ventral and dorsal ribs, the ventral of which expands into a tubercular protruberance. The dorsal rib swings back on itself and terminates at a characteristically ornamented "plate". There are conuli sparsely located over the reticulations. The eye-tubercle is joined to the anterior rim, which is crimped. There is a flat adductor muscle tubercle. The posterior bears a few coarse spines. The secondary background ornament (Plate 15, Fig. 2) corresponds to the more coarsely ornamented morph of some specimens attributed here to *M. soriensis* (cf. Fig. 8H).

Occurrence and Age: Turonian: Moral de Hornuez (sample 276); Somolinos, (sample 289, 2811); Coniacian; Castrojimeno (sample 265, 266). Babinot (1980, p. 179) described the species typically from the Coniacian of Provence but also noted it to occur in the Turonian.

Material: More than 30 specimens.

Mauritsina radiocostata sp. nov.

Plate 15, Figs. 4–12; Fig. 10, A–G

Holotype: The specimen figured in Plate 15, Fig. 4 a right valve, No. PMSp373.

Derivatio Nominis: In reference to the radial pattern displayed by the lateral ribs and folds.

Locus Typicus: The Lower Turonian sequence at Moral de Hornuez, sampling level 277.

Material Studied: More than 20 carapaces and valves.

Diagnosis: A species of *Mauritsina* with the following characteristics: Shape typical of the genus but with sharply shifting radius of curvature for the anterior margin; lateral pattern of ribs or folds radial, outgoing from the adductor muscle tubercle; posterior process very compressed; deep furrow behind anterior rim; secondary reticulations a combination of finer and coarser elements.

Description: The anterior margin is not evenly rounded, there being a gradual and continuous change in the radius of curvature. The posterior process is short for the genus. The anterior and posterior margins are rimmed; the anterior rim borders a deep moat in most individuals. There are a few short and coarse denticules along the lower part of the posterior margin and faint studs may line the anterior margin (Plate 15, Fig. 8). The interior surface of the anterior margin is crimped.

Fig. 9. Mauritsina soriensis (Grekoff and Deroo). The anterior pore canals. Turonian. Somolinos, sample 286. × 260. PMSp368.

The valves are unequal. There are ventral and dorsal fold-like ribs, embedded in a radially arranged pattern, which originates at the prominent and irregular adductor muscle tubercle. The intercostal areas have steep sides. The ventral rib terminates in a "pinched-out" extension (Plate 15, Figs. 11, 12; Fig. 10B).

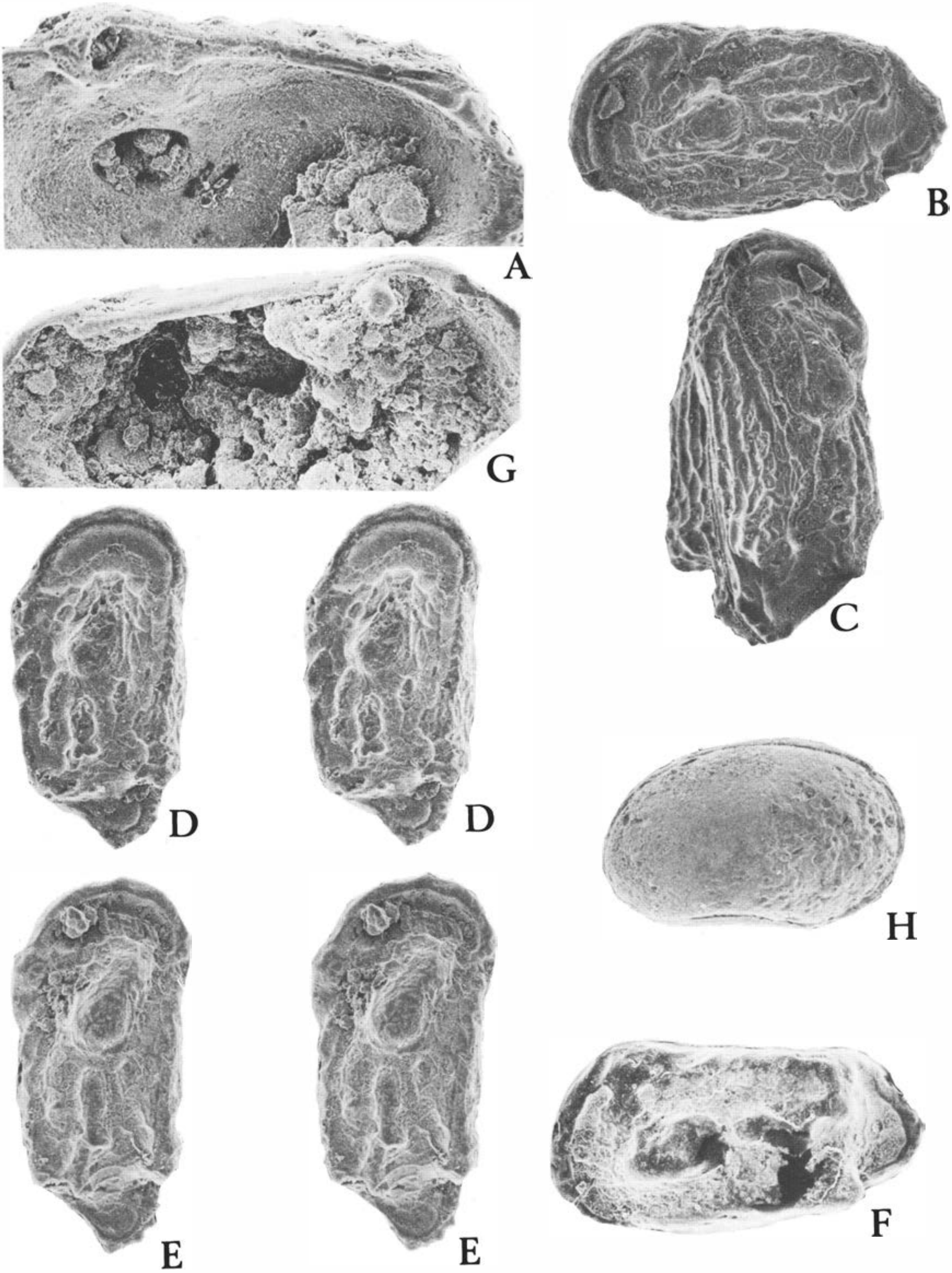
The surface is ornamented with reticulations arranged in a haphazard manner, except for the ventral surface. The secondary ornament consists of coarser "pits" embedded in a finer-grained matrix. Some first-order reticular walls bear notches.

The hinge is amphidont (Plate 15, Fig. 8, Fig. 10A) with a low, strongly elongated posterior right element and an anterior tooth bearing two coarse notches. The central muscle field is unknown.

In dorsal apect, the carapace is roughly rectangular in shape and rather coarsely reticulated on the dorsal surface. Sexual dimorphism is pronounced, with males being significantly longer than females.

Remarks: The new species seems to be most closely related to *Mauritsina hieroglyphica* with respect to gross morphology. The form figured as *M.* cf.

Fig. 8. Mauritsina soriensis (Grekoff and Deroo). Pattern of variation in the lateral ornament, particularly the secondary ornament. All material is Turonian in age and all specimens are magnified 250 times. A. Somolinos, sample 286. PMSp351. Same specimen as in Plate 14, Fig. 1. B. Somolinos, sample 289. PMSp363. C. Somolinos, sample 286. PMSp353. Same specimen as in Plate 14, Fig. 3. D. Condemios de Arriba, sample 281. PMSp364. E. Carabias, sample 254. PMSp365. F. Condemios de Arriba, sample 281. PMSp369. G. Carabias, sample 256. PMSp366. H. Somolinos, sample 286. PMSp368.


A
B
G
C
D
D
H
E
E
F

hieroglyphica by Babinot (1980) plots rather close to the new form in the principal coordinate analysis (see p. 102), which bears testimony to the general similarity in shell properties selected for quantitative analysis. The anterior margin of *M. hieroglyphica* is more evenly rounded than is the case in *M. radiocostata;* moreover, the posterior process of the new species appears to be essentially smaller and more sharply offset from the main part of the carapace.

Another species showing a certain degree of morphological similarity is *Mauritsina cuvillieri* (Damotte). Apart from rather marked differences in the lateral ornament, the cardinal areas are different as are also the anterior and posterior parts of the shell. The present species is of Early Turonian to Coniacian age. *M. cuvillieri* is Turonian and *M. hieroglyphica* is Santonian.

Mauritsina speciosa Babinot is similar in some respects; the ventral rib can be similarly developed (pinched-up appearance) and the orientation of the adductor muscle tubercle may coincide (anteroventrally sloped). However, the adductorial tubercle seems to be consistently higher on the valve, the area behind the anterior rim is not moat-like, and the ribs seemed to be joined at their posterior terminations, at least in some specimens. Moreover, the secondary ornament is fundamentally different (Plate 15, Figs. 2, 9). This brings us to the troublesome question of the delineation of species of *Mauritsina.* Polymorphism in the secondary ornament of *M. soriensis* has been demonstrated. Is the present species no more than a polymorph of one of the *Mauritsina* occurring in the material studied or is it a genuine separate specific entity? For the time being, I have chosen to accept the latter alternative, but in full awareness of the possibility that new collections could prove it wrong. In favour of the present solution is the unusual secondary ornamental type (which could, however, be due to resorption – Fitz-Gerald, 1983), the deep post-rim furrow of the anterior zone and the tendency for the ribbing to form a radiating pattern.

Occurrence and Age: Turonian. Condemios de Arriba (281); Moral de Hornuez (277, 273, 271); Somolinos (289): Coniacian. Castrojimeno (265).

Mauritsina ? sp.

Fig. 10, F–G

Remarks: A few specimens from the Somolinos section are doubtfully referred to *Mauritsina.* They have the general shape and gross ornamental properties of species of the genus, but lack the characteristic primary and secondary background ornamental features. They also show certain affinities with *Limburgina,* but lack the massively calcified shell of species of that genus.

The lateral ornament consists of irregular reticulations; there are dorsal and ventral ribs, a rimmed anterior margin and a rimmed posterior margin. A contributing reason for considering *Mauritsina* lies with the course followed by the dorsal rib, which doubles back on itself, as it were. There is a large, irregularly shaped adductorial tubercle and a post-adductorial ornamental figure, separated from the dorsal rib.

The hinge (Fig. 10G) seems to agree with that illustrated for the type species of the genus. There is a feebly developed secondary ornamental structure, but it seems to differ from that developed by *Mauritsina* s. str.

Occurrence and Age: Lower Turonian. Somolinos (2811).

Analysis of variation in Mauritsina

Mauritsina is a "difficult" genus to assess at the species level. Although one might be reasonably sure of the gross properties of most of the species currently assigned to the genus, individual variability may be of such an order that characteristics considered to be of taxonomic significance in a particular case may occur within a single natural association. The occurrence of polymorphism at the level of the secondary ornament also raises a further spate of questions, to wit: (1) How typical is the polymorphism in secondary ornament for a particular species? (2) To what extent are first-order ornamental characters subject to polymorphism? (– one suspects that this could be an important factor, although direct evidence for it is lacking). (3) Is the polymorphic condition partly or entirely controlled by environmental stimuli? (4) Is the ornamental

Fig. 10. A. *Mauritsina radiocostata* sp. nov. Internal view of a right valve showing the hinge and the adductorial furrow. Turonian. Moral de Hornuez, sample 277. × 110. PMSp381. B. Same species; a left valve. Turonian. Moral de Hornuez, sample 276. × 65. PMSp382. C. Same individual, angled to display the ventral ornament. × 70. D. Same species. Stereophotographs of a right valve; note the deep furrow behind the anterior rim. Coniacian. Castrojimeno, sample 265. × 60. PMSp383. E. Same species. Stereophotographs of a right valve. Turonian. Somolinos, sample 289. × 70. PMSp384. F. *Mauritsina?* sp. A left valve. Turonian. Somolinos, sample 2811. × 70. PMSp385. G. Same species and provenance. A left hinge. × 110. PMSp386. H. *Xestoleberis* sp. Right side of a carapace. Coniacian. Castrojimeno, sample 265. × 70. PMSp387.

Table 3. Some ornamental features of taxonomic significance for Spanish *Mauritsina*

Species	anterior rim	ventral rib	dorsal rib	anterior furrow	secondary ornament	lateral conuli	margins	intercalated ribs	subocular riblet	adductor tubercle
soriensis (this study)	vague ornament	not joined to AR	joined to forked median rib	shallow	polymorphic	flat, broad, finely pored	DM and VM convex	usually not developed	absent in LV crescent-shaped in RV joined to AR	smooth
speciosa? (this study)	crimped	not clearly joined to AR	joined to median rib	deep and narrow	vesicular	large: round porous base	variable	variable dorsolateral	straight; joined to AR	partly ornamented
speciosa (Babinot)	crimped	joined by rim to AR	joined to median rib	deep and broad	polymorphic? pitted	large, smooth base	VM and DM concave	present according to Babinot: not present on topotypes	joined to AR	ornamented
radiocostata	almost smooth	In RV joined to AM by stricture	incomplete join to median rib	deep in RV: shallow in LV	polymorphic - coarse vs very fine pitting	broad, low, base smooth	DM and VM convex	ventrolateral and dorsolateral in radial arrangement	straight; joined to AR	hint of reticulation but surface smooth

AR = anterior rim; LV = left valve; RV = right valve; DM = dorsal margin; VM = ventral margin

variation in question a genuine polymorphic state, or is it the outcome of resorption of the carapace during moulting?

Babinot (1980, p. 178) has attempted to synthesize putative evolutionary and stratigraphical relationships in *Mauritsina.* He recognizes two lineages, namely, that of *M. macrophthalmoides* and that of *M. hieroglyphica*. Possibly, there are two branches of *Mauritsina,* although the morphological evidence for such a conclusion does not, at the present at least, seem to be conclusive.

Before proceeding to a formal analysis of variation in the Spanish material considered in this monograph, it is necessary to carry out a comparison between the species involved with respect to morphological properties. Some morphological properties of significance for assessing differences at the specific level are listed in Table 3.

Firstly, let us consider briefly the properties of the type species, as presented by Deroo (1966). Features considered by him to be of importance are: the lateral ribs, said to be long in the type species, *Mauritsina hieroglyphica* (Bosquet), and to consist of dorsal and ventral ribs and a posteromedian rib. There is a deep adductor pit, an amphidont hinge, and about 25 anterior marginal pore-canals. The figure of the type species shows the right anterior tooth to be coarsely notched (Deroo, 1966, Plate 4, fig. 37). The adductor muscle tubercle is shown to be very large, and to cover a considerable part of the lateral surface (*op. cit.,* pl. 16, figs. 392–297). There is a deep and narrow moat behind the prominent anterior rim and two short intercalated ribs in both valves – this feature is not well developed in the specimen figured by Colin (1973, pl. 4, fig. 3). The description of the secondary ornament given by Deroo (1962) is not very informative – this was in connexion with the erection of the genus. In this connexion, we point out the close agreement in the right hinge of *M. hieroglyphica,* as seen by Deroo (1962, pl. 2, fig. 20), and our Fig. 10A *(M. radiocostata).*

Babinot (1980, p. 171) has been concerned with assessing relationships between his lineages; this analysis serves to show the difficulty experienced by all who have been concerned with *Mauritsina* in establishing really diagnostic features for taxonomical purposes. He stresses the systematic significance of the ventrolateral riblet and its degree of separation from the ventral rib and be believes he has observed a general tendency towards a reduction in size through time.

Three species of special significance for the present study are *M. soriensis, M. speciosa* and the new species, *M. radiocostata.* The morphological properties of significance here are summarized in Table 3.

Mauritsina soriensis (Grekoff and Deroo). This species was originally described as coming from the

Table 4. Basic statistics for Spanish *Mauritsina*.

Species	Means and standard deviations var1	var2	var3	var4	var5	var6	var7
soriensis	0.80	0.45	0.55	0.34	0.32	0.10	0.16
(N=7)	(0.067)	(0.024)	(0.062)	(0.023)	(0.041)	(0.018)	(0.021)
speciosa?	0.83	0.44	0.59	0.34	0.33	0.08	0.13
(N=12)	(0.063)	(0.023)	(0.056)	(0.022)	(0.023)	(0.022)	(0.027)
radiocostata	0.89	0.46	0.64	0.37	0.35	0.04	0.14
(N=3)	(0.060)	(0.040)	(0.009)	(0.022)	(0.028)	(0.003)	(0.017)

"Lower Cenomanian" of Soria. On the evidence available today, the marine succession of interest begins in latest Cenomanian and reached its culmination during the early half of the Turonian. The borehole sample studied by Grekoff and Deroo (1956) must, therefore, lie within that interval and not earlier (a fact also realized by Babinot, 1980, p. 177). The figures are poor and it is by no means certain that the specimens here referred to *M. soriensis* really belong to that species. The description refers to small tubercles posterior to the adductor tubercle – this could be the irregularly formed mediolateral rib of our material. The figures show a very expanded adductorial tubercle, more so than in any of the specimens of the present collection. The anterior rim seems exceptionally thick, a rather unusual condition in *Mauritsina*. Babinot (1980, pl. 31, fig. 8) refers material similar to the specimens of the present study to *M. soriensis* (compare his pl. 31, fig. 9 with Plate 14, Fig. 1). He notes intercalated ribs to be absent in his specimens but also mentions material from Provence with an "embryonal" dorsolateral riblet.

Mauritsina speciosa Babinot. This species may attain a rather large size, up to 1.20 mm (none of our specimens attain quite this size, although they lie well within the range of size variation of *M. speciosa*). The postero-dorsal margin is concave. The dorsal rib turns back on itself to form a "knee". The ventral rib thickens posteriorly and is said to possess a ridge-like development which joins to the anterior rim. The secondary ornament is, as far as can be judged, composed of pits (cf. Babinot (1980, pl. 32, fig. 2 and Plate 14, Fig. 9 of this monograph).

These are then the main morphological features of the species *M. soriensis* and *M. speciosa* as gleaned from the original descriptions and figures; in actual practice, the differences outlined are much more diffuse and difficult to maintain as useful taxonomical criteria.

The conclusions suggested by Table 3 are that the forms referred to *speciosa* in the present monograph differ in several minor details from Babinot's specimens: size seems to be a different factor (but this is a labile character). An important difference may lie with the moat bordering the anterior rim. This is deep and narrow in the Spanish material, but rather broad in the Provençal specimens seen. The moat is in the Spanish specimens striated, the striae being continuations of the crimping of the anterior rim. A further difference, of which the significance cannot yet be assessed, is the nature of the secondary ornament of the reticulations. There is therefore some doubt concerning the conspecificity of our material and that of Babinot (1980), but whether the differences annotated in Table 3 are sufficient to warrant separation remains to be proved.

There is also some doubt concerning the specimens here referred to *M. soriensis* (Grekoff and Deroo). These are more difficult to spell out owing to the uncertainty attaching to the original description. None of the material studied from the Picofrentes section near Soria can be referred to *soriensis*.

Morphometric analysis of the species. In addition to pertinent univariate statistics (Table 4), the morphometric study has been made at the multivariate level. The methods of principal components, principal coordinates and canonical variates were used for analyzing size and shape relationships occurring in the taxa of *Mauritsina* considered in the present connexion. The variables chosen for study are of the Thompson-Bookstein class; i.e., intersecting variables selected for their inherent shape- interest (cf. Bookstein, 1978). These variables are (1) the length of the carapace; (2) the maximum height of the carapace measured at the hinge-ear; (3) the distance from the eye-tubercle to the postero-ventral termination of the ventral rib; (4) the height of the carapace measured along the terminations of the dorsal and ventral ribs; (5) the distance from the centre of the anterior margin to the middle of the

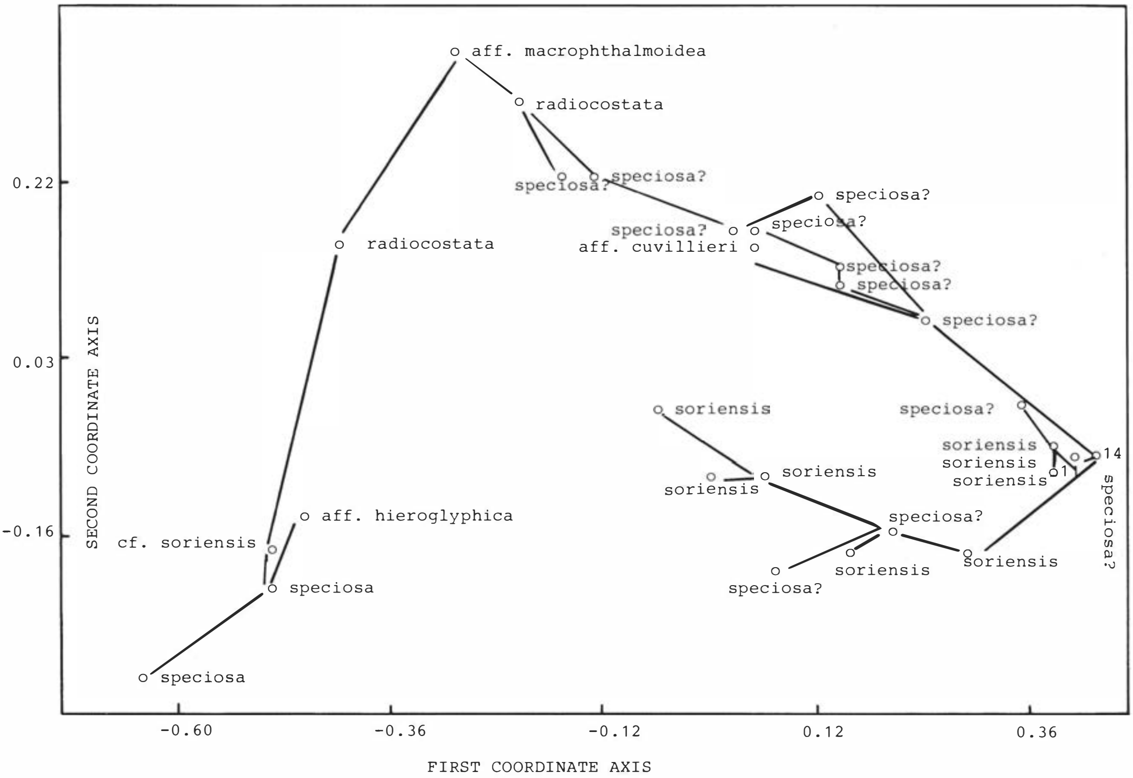


Fig. 11. Coordinate analysis of Spanish *Mauritsina speciosa?*, *M. soriensis* and *M. radiocostata* in relation to other species of the genus *Mauritsina.* The data for *M.* aff. *hieroglyphica, M.* aff. *cuvillieri, M.* cf. *soriensis* and *M.* aff. *macrophthalmoidea* were gleaned from Babinot (1980). Two topotypes of *M. speciosa* were donated by Dr. Babinot. The lines joining the points are the Prim minimum spanning tree.

adductor muscle tubercle; (6) the width of the anterior moat; (7) the length of the posterior process.

The biological significance of the multivariate statistical methods employed is discussed at length in Reyment *et al.* (1984).

The coordinate analysis (Fig. 11) for the seven variables shows that there are distinct clusters in the observations. A noteworthy result of the analysis is that the three Provençal specimens of *M. speciosa* (topotypes supplied by Dr. Babinot) differ widely from all the Spanish material. The Spanish specimens referred to *speciosa?* and *soriensis* seem to possess the same mode of multivariate variation, which suggests them to be closely related. Stabilizing size variation by taking logarithms did little to change the pattern displayed by the raw data. The inclusion of the minimum spanning tree in Fig. 11 provides further useful information. A minimum spanning tree (cf. Gordon, 1981) joins points nearest each other in *N*-space (here *N*=7); thus, two points that may seem to be adjacent to each other in the projection of points onto the plane of the first and second principal coordinate axes may actually lie far apart. Fig. 11 supplies several examples of such nearness relationships. The plot indicates that the specimens of *M. soriensis* and *M. speciosa?* are morphometrically closely interlaced and behave more like morphs of the same species than distinct entities; there seems to be a certain degree of overlap in other directions as well, and both can be similarly bedighted. The individuals referred to *M. radiocostata* are fairly differently located in the plot but are evidently morphologically linked to *M. speciosa?*

A principal coordinate analysis including measurements on specimens determined by Babinot (1980) yielded interesting results. The logarithmically transformed observations were used to produce the plot in the plane of the first and second axes. (The results for raw data are virtually identical). Here, the specimens from Provence of *M.* cf. *soriensis* and *M. speciosa* are analogously connected to *M. soriensis.*, respectively, *M. speciosa.*

The principal coordinate analysis was repeated with the variables standardized to unit length in order to minimize the effects of size-variation and to more clearly expose variation in shape. The analysis of the raw data indicates that some Spanish *M. speciosa?* and Provençal *M. speciosa* have identical modes of shape variation, together with *M. radiocostata*. Most of the specimens of *M. soriensis* and *M. speciosa?* form interlocking clusters distinct from the afore-mentioned grouping.

A principal component analysis of all Spanish specimens does not disclose noticeable differences among them, which tends to underline the variational homogeneity in Spanish *Mauritsina*.

About 88 % of the variation is contained in the first two principal components; the first component is dominated by covariation in characters 1 to 5, thus:

$$y_1 = 0.64x_1 + 0.34x_2 + 0.54x_3 + 0.32x_4 + 0.27x_5 \quad (80.57\%).$$

The second principal component represents covariation in variables 1, 2, 3 and 6:

$$y_2 = 0.51x_1 + 0.22x_2 - 0.79x_3 + 0.22x_6 \quad (7.51\ \%).$$

These relationships suggest that variable 7 (length of posterior process) is not important in shape variation. In fact, it is only prominent in principal components 4 (3.09 %) and 5 (1.82 %). (As is shown further on, it is important in discriminating between groups, because of its relative stability.)

The first principal component represents, as often is the case, differential size variability, with all of the obvious size characters involved. Presumably, the second principal component accounts for sexual dimorphic shape differences (males are longer and lower than females).

Basic statistics for each of the taxonomic characters recognized are displayed in Table 4.

Q-Q probability plots for each of the larger samples do not indicate atypical values to occur at the multivariate level, with the exception of one specimen of *M. speciosa.*

The one-way analysis of variance for the three (subjective) categories in the Spanish material shows that samples differ significantly for only one character, namely, the width of the anterior "moat" ($P = 0.001$).

There are interesting covariance relationships, as exposed by a study of the correlation coefficients. In *M. soriensis,* length is significantly correlated with all variables, as is also anterior height (var. 2). The diagonal length (var. 3) is not significantly correlated with posterior height (var. 4) and the position of the adductor tubercle (var. 5). Character 4 is significantly correlated with the adductor location. Characters 6 and 7 are significantly correlated.

Table 5. Correlations in Spanish *Mauritsina.*

Correlation	>0.9	>0.8	>0.7	>0.6
Species				
soriensis	r_{12} r_{27}	r_{17}	r_{25} r_{67} r_{36}	r_{13} r_{16} r_{15} r_{24} r_{26} r_{45}
speciosa?			r_{34} r_{36}(-) r_{45}	r_{24} r_{35}

The afore-given correlations are in marked contrast with those occurring in the material of *M. speciosa?* Length is *not* significantly correlated with any of the characters; moreover, there is a significant negative correlation (to wit r_{36}). Anterior height (var. 2) is only correlated significantly with posterior height (var. 4). Diagonal length (var. 3) is significantly correlated with posterior height (var. 4) adductor location (var. 5) and negatively with moat-width (var. 6). Character 4 is significantly correlated with the location of the adductor tubercle (var. 5).

The main features of the foregoing analysis are presented in Table 5; it will be seen that the level of morphological integration (*sensu* Olson and Miller, 1958) in *M. soriensis.* is appreciably higher than in *M. speciosa?*

The morphological validity and relevance of the taxonomic subdivisions proposed here can be tested by means of the method of canonical variates. Fig. 12 shows the plot of the individual specimens in the plane of the two canonical variate axes specified by the equations:

$$z_1 = 0.28x_1 - 0.56x_2 - 0.62x_6 - 0.46x_7$$

and

$$z_2 = -0.18x_3 + 0.66x_4 - 0.40x_6 + 0.59x_7.$$

These equations are, in effect, discriminant functions. The first of them indicates that most separation is being brought about by the anterior height (var. 2), moat-width (var. 6) and length of the posterior process (var. 7). The second discriminator is largely a function of posterior height (var. 4), moat-width, and length of the posterior process.

The plot of the points shows the three specimens of *M. radiocostata* to group together. The speci-

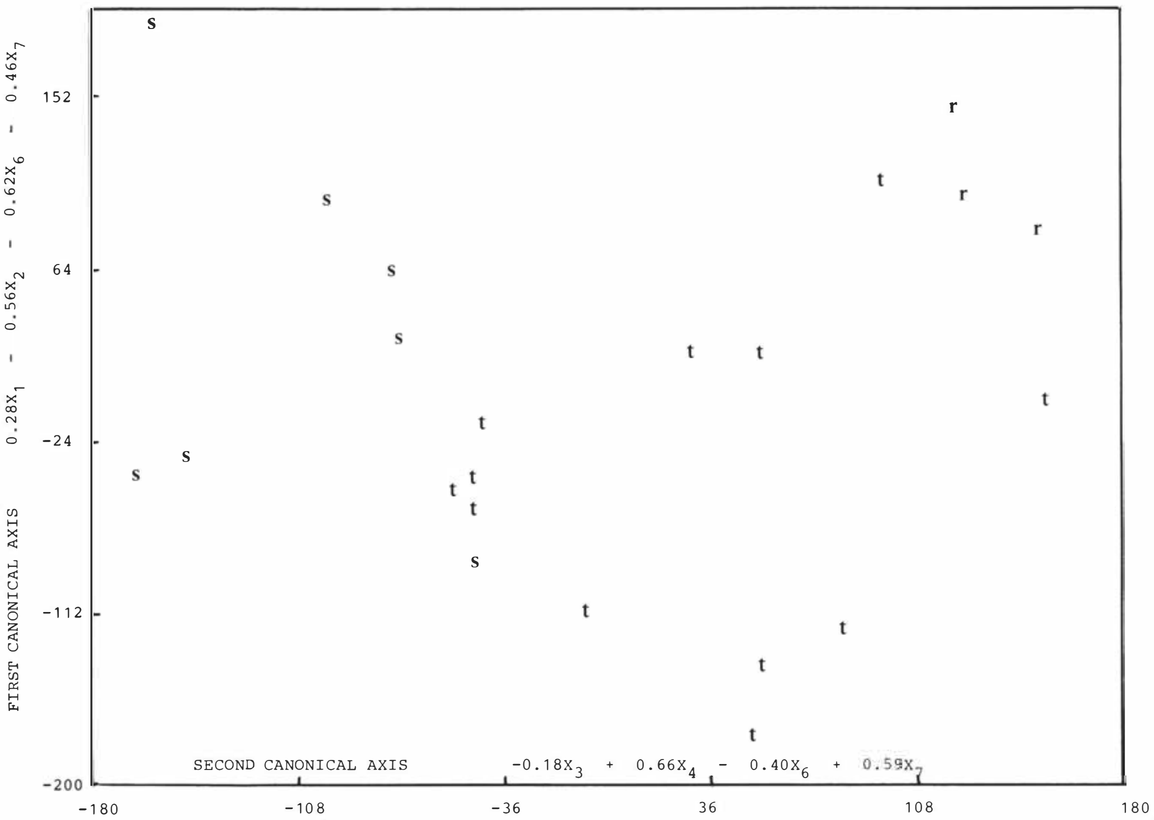


Fig. 12. Plot of the points for the three samples of Spanish *Mauritsina* in the plane of the first and second canonical variate axes. The symbols signify *Mauritsina soriensis* (s), *M. speciosa?* (t) and *M. radiocostata* (r). There is a slight degree of overlap between *soriensis* and *speciosa?* The points for *radiocostata* are separated from *speciosa?* although it seems that some *speciosa?* are morphologically similar to *radiocostata.* These observations support the indications yielded by the principal coordinate analysis and the visual inspection of the ornamental variation displayed by the two forms.

mens of *M. speciosa?* fall into several clusters, thus belying the picture of homogeneity intimated by previous analyses. The specimens of *M. soriensis.* lie apart from the rest of the material, with the exception of one specimen, which plots with one of the clusters of *M. speciosa?* Also, in the case of *M. soriensis.,* the canonical variate plot suggests the likelihood of heterogeneity in the material. It has not been possible to relate the hints of morphological heterogeneity to polymorphism.

A further test of the reliability of the subjectively made taxonomical subdivision into *M. soriensis* and *M. speciosa?* can be made by means of a linear discriminant function between the two samples composed of these species as recognized here.

The method is to construct a linear discriminant function between the samples and then to see how well the individual specimens are allocated to their sample of origin by this function. In the present case, all specimens of *M. speciosa?* are correctly allocated to the original sample. For *M. soriensis.,* one specimen of seven is wrongly allocated.

The analysis was repeated using a quadratic discriminant function. In that case, all specimens of both samples were found to be correctly allocated to the sample of origin by this function.

This method of using closed sets for testing the efficiency of a discriminant function is, of course, not perfect and can no more than give a reasonably useful indication of the probability of mis-allocation. It does, however, show that the two forms recognized here are really quite unlike at the multivariate morphometric level. Further evidence of this is supplied by the fact that the generalized statistical distance computed between the two samples is statistically significant.

In summary, the morphometric analysis of *Mauritsina* brings out the following more important points:

(1) It is not possible to achieve a water-tight subdivision of the material studied into neat taxonomic compartments. Presumably, some specimens of *M. speciosa,* for example, lie close to the originally described association from Provence, but others are apparently related, though not clearly conspecific. The high level of variability shown in ornament and outline may reflect sensitiveness to environmental influences.

(2) Although *M. speciosa?* and some *M. speciosa* (Provence) can be accepted as coming from the same multivariate normal population, the sample of *M. speciosa?* may show evidence of heterogeneity. It could not be resolved whether this condition could be the outcome of polymorphism.

(3) With respect to the covariance structure of the Spanish forms, there are marked differences between *soriensis* and *speciosa?* in the level of integration between many characters.

Family XESTOLEBERIDIDAE Sars, 1928

Genus XESTOLEBERIS Sars, 1866

Xestoleberis sp.

Fig. 10J

Remarks: A single carapace from the Castrojimeno section is referred here. The shape of the shell is typical of the genus *Xestoleberis,* with a strongly arched dorsal margin and a slightly concave ventral margin. The left valve overlaps the right around the entire margin of the right valve.

The dimensions are: length = 0.67 mm; height = 0.35 mm. These figures indicate that the present form is not among the smaller representatives of the genus.

Occurrence and Age: Coniacian. Castrojimeno, sample 265.

Polymorphism in ostracods

Several of the species described in this monograph display ornamental polymorphism. The main features of this condition for the species in question are recapitulated below:

Neocyprideis iberiacus displays polymorphic differences in shape and more pronounced differences in details of the surface ornament (smooth morphs versus highly reticulated individuals). Inasmuch as this condition occurs at several of the levels, it is more likely than not that the morphs are really synchronous and do not indicate post-mortem mixing. The associations in which the morphs of *N. iberiacus* occur seem to denote stable marine conditions and are not likely to be analogous to the situation described by Carbonel and Pujas (1982) for *Cyprideis* inhabiting a labile lagoonal environment. The ratios of smooth to ornamented shells is 26:74 (note, that there is *no* punctate morph in *N. iberiacus*).

Spinoleberis petrocorica? This species has two ornamental morphs, to wit, regularly ornamented shells contra irregularly reticulated shells. A second type of polymorphism may also occur, namely, at the level of the secondary ornament.

Limburgina galvensis. This species displays two morphs, regularly reticulated, and individuals showing smooth fields, such as may be typical of the *Limburgina*/*Oertliella*-group. The relative proportions in the samples studied are 60 % fully reticulated as opposed to 40 % smooth-field individuals.

Oertliella guadalajarensis. Polymorphism is manifested in the strength of the hinge-ear (shape-polymorphism) and the length of the posterior process (likewise shape-polymorphism). There is no evidence for ornamental polymorphism in the material studied.

Mauritsina soriensis? Polymorphism is manifested in the secondary ornament in the following manner: (a) individuals with thin reticular walls, unevenly sloped, and with fine and indistinct microreticulations; (b) thick reticular walls encompassing coarser microreticulations. These variants are geographically valid in that they occur in the same associations at different localities.

All of the polymorphisms identified in the Spanish collections occur in the same context; i.e. they are not geographically distinct. This fact in itself suggests a genetic origin to underly them, thus indicating them to be analogous to the polymorphism in Paleogene ostracods described by me in earlier work (Reyment, 1963, 1966) and for a Recent species (Reyment and Van Valen, 1969).

Ducasse (1981) has identified a remarkable suite of shape-morphs in Paleogene species of *Cytherella* from Aquitaine. Ducasse and Cirac (1981) reported polymorphism in two species of Miocene *Mutilus* from northwestern Morocco – in this case, the polymorphism is in the development of the lateral ornament (five morphs are identified for one species and four for another). Ducasse and Cirac believe that the variants are correlated with environmental effects on selection. Ducasse and Coustillas (1981) observed closely similar polymorphism to occur in species of *Pokornyella*.

Keen (1982) summarized work done by himself and others on polymorphism in ostracods and could relate his own work to the Oligocene transgressional event. In this respect, his conclusions agree with my own (Reyment, 1982).

Hartmann (1982) reported on ornamental variations between populations of three littoral ostracod species from Australia. He believes that in some cases, and some cases only, the polymorphism is the outcome of the interplay of environment (particularly temperature) with the genetical consititution of the organisms. These interact to influence the degree of calcification of the shell. It should be kept in mind, however, that warmer temperatures do not necessarily lead to heavier calcification of the crustacean shell, as has been observed in areas of waste-water release from nuclear power-plants off the west coast of Sweden – barnacles and bivalves produce thin, brittle shells in connexion with accelerated growth and attainment of maturity. Hartmann noted that the soft parts (e.g. copulatory organs) are significantly less variable than the shell of the polymorphic individuals.

The polymorphic condition seen by Hartmann (1982) for *Mutilus* and *Hiltermannicythere* are of such a nature that it makes it fully possible, and feasible, that the three species of *Mauritsina* recognized in this monograph actually belong to the same species.

Hartmann's data for *Xestoleberis* indicate an analogous polymorphic condition to that recorded here for *Neocyprideis iberiacus,* in that the two ornamental morphs occur in the same associations.

If any general conclusion can be drawn from the information currently available on polymorphism in the ostracod shell, it would be that observed variations can be of two main kinds, which are not mutually exclusive. Firstly, there is an evolutionarily significant type in which two, or initially more, morphs compete in relation to sustained environmental conditions – this is Clark's model of environmentally cued polymorphism (cf. Reyment (1982) for a palaeobiological discussion). The second kind would seem to be more clearly ecophenotypic in origin in which ornamental features appear and disappear or are replaced in response to the reaction of the calcification mechanisms of the organism to environmental fluctuations, including ionic ratios. The palaeontological implications of such variations have been summarized by Reyment (1983) for several groups of microfossils.

References

Aitchison, J. 1983. Principal component analysis of compositional data. *Biometrika. 70,* 57–65.

Alonso Millan, A. 1981. El Cretácico de la Provincia de Segovia (borde norte del sistema central). Seminarios de Estratigrafía; monografía 7, 271 pp. Madrid.

Andreu, B. 1983. Nouvelles espèces d'Ostracodes de l'Albien et du Cénomanien sud-Pyréneen (Sierra d'Aulet, Espagne). *Bull. Centres Rech. Explor-Prod. Elf-Aquitaine. 7,* 1–43.

Babinot, J. F. 1973. Ostracodes turoniens de la région de Cassis-La Bédoule (Bouches-du-Rhône, Var): associations et affinités paléogéographiques. *Géobios.* 6, 27–48.

Babinot, J. F. 1980. Les Ostracodes du Crétacé Supérieur de Provence. These: Université de Provence (Travaux du Laboratoire de Géologie Historique et de Paléontologie). *10,* 634 pp. (3 vols).

Babinot, J. F. and Colin, J. P. 1979. Taxonomic and paleoecologic comments on the genus *Trachyleberidea* Bowen, 1953. *Crpcko Geol. Drushtvo.* Seventh International Symposium on Ostracods, Beograd (1979). 55–58.

Babinot, J. F., Berthou, P. Y., Colin, J. P., Lauverjat, J. 1978. Les Ostracodes du Cénomanien du Bassin Occidental Portugais: biostratigraphie et affinités paléobiogéographques. *Cahiers de Micropaléontologie:* 3–1978, 11–23.

Bassoullet, J. P. and Damotte, R. 1969. Quelques Ostracodes nouveaux du Cénomano-Turonien de l'Atlas Saharien Occidentale (Algérie). *Revue de Micropaléontologie. 12,* 130–144.

Bookstein, F. L. 1978. The measurement of biological shape and shape change. *Lecture Notes in Biomathematics. 24,* 1–191. Springer Verlag, N. Y.

Breman, E. 1976. Paleoecology and systematics of Cenomanian and Turonian ostracods from Guadalajara and Soria (Central Spain). *Revista Española de Micropaleontología. 8,* 71–122.

Carbonel, P. and Pujos, M. 1982. Les variations architecturales des microfaunes du lac de Tunis: relations avec l'environnement. *Oceanologica Acta.* 5, 79–85.

Colin, J. P. 1973. Nouvelle contribution à l'étude des Ostracodes du Crétacé Supérieur de Dordogne (S. O. France). *Palaeontographica* Abt. A. *145,* 1–38.

Colin, J. P., Lamolda, M. A., Rodríguez Lazaro, J. M. 1982. Los ostrácodos del Cenomaniense Superior y Turoniense de la Cuenca Vasco-Cantábrica. *Revista Española de Micropaleontología. 14,* 187–220.

Damotte, R. 1962. Quelques Ostracodes du Turonien Inférieur de la Touraine. *Revue de Micropaléontologie. 3,* 191–204.

Damotte, R. 1968. *Protocythere* Triebel 1938, *Mandocythere* Gruendel 1964 et *Costacythere* Gruendel (1966) (Ostracodes) dans le Crétacé du Bassin de Paris. *Bull. Soc. Géol. France.* Ser. *7, 10,* 384–392.

Damotte, R. 1971. Les Ostracodes marins dans le Crétacé du Bassin de Paris. *Mém. Soc. Géol. France. N. S. 113,* 1–150.

Damotte, R. 1977. Sur les genres crétacés: *Rehacythereis, Veeniacythereis, Cornicythereis, Parvacythereis* et *Chapmanicythereis* (Trachyleberididae, Ostracoda) créés par J. Gruendel en 1973. *Revue de Micropaléontologie. 19,* 200–210.

Deroo, G. 1962. Mauritsinae, nouvelle sous-famille de la Cytheridae (Ostracodes) dans le Crétacé Supérieur de la région de Maastricht, Pays Bas. *Révue de Micropaléontologie. 4,* 203–210.

Deroo, G. 1966. Cytheracea (Ostracodes) du Maastrichtien de Maastricht (Pays-Bas) et des régions voisines: résultats stratigraphiques et paléontologiques de leur étude. *Mededelingen van de Geologische Stichting. C2,* 197 pp.

Ducasse, O. 1981. Etude populationniste du genre *Cytherella* (Ostracodes) dans les facies du Paléogène aquitain. Intérêt dans la reconstitution des paléoenvironnements. *Bull. Inst. Géol. Bassin d'Aquitaine.* 30, 161–186. Bordeaux.

Ducasse, O. and Cirac, P. 1981. La faune de *Mutilus* (Ostracodes: Hemicytheridae) de la région des Zemmours (Maroc nord-occidental) à la fin du Miocène et au Pliocène. *Géologie Méditerranéenne. 8,* 87–100.

Ducasse, O. and Coustillas, F. 1981. Les Ostracodes du genre *Pokornyella* dans le Paléogène aquitain. Partie 1. Etude systematique par analyse structurale des espèces en populations. *Bull. Instn Géol. Bassin d'Aquitaine. 29,* 5–30. Bordeaux.

Fitz-Gerald, B. 1983. Observations on surface ornament in fossil ostracods. *J. Micropaleont. 1,* 111–117.

García-Quintana, A. 1982. (Ed.). *El Cretácico de España.* Universidad Complutense de Madrid.

Gordon, A. 1981. *Classification.* Chapman and Hall, London.

Grekoff, N. and Deroo, G. 1956. Algunos ostrácodos del Cretácico medio del Norte de España. *Estudios Geológicos. 31–32,* 215–235.

Grosdidier, E. 1973. Associations d'Ostracodes du Crétacé d'Iran. *Rev. Inst. français du Pétrole. 28,* 131–168.

Gründel, J. 1976. Neue taxonomische Einheiten der Cytherocopina Gründel, 1967 (Ostracoda). *Z. geol. Wissensch.* 4, 1295–1304.

Hartmann, G. 1975. Ostracoda *in* H. G. Bronn: *Klassen und Ordnungen des Tierreichs.* Fünfter Band: Arthropoda, I. Abteilung: Crustacea. 2 Buch, IV. Teil. VEB Gustav Fischer Verlag Jena.

Hartmann, G. 1982. Variation in surface ornament of the valves of three ostracod species from Australia. *In Fossil and Recent Ostracoda* (Eds. R. H. Bate, E. Robinson, and L.M. Sheppard). British Micropalaeontological Society Series. Ellis Horwood. Chichester, 265–380.

Hazel, J. E. 1968. Ostracodes from the Brightseat Formation (Danian) of Maryland. *J. Paleont. 42,* 100–142.

Kaye, P. 1964. Revision of British marine Cretaceous Ostracoda with notes on additional forms. *Bull. Brit. Museum (Nat. Hist.).* Geology. *10,* 35–79.

Keen, M. C. 1982. Intraspecific variation in Tertiary ostracods. *In Fossil and Recent Ostracoda* (Eds. R. H. Bate, E. Robinson, and L. M. Sheppard). British Micropalaeontological Society Series. Ellis Horwood. Chichester, 381–405.

Liebau, A. 1971. *Homologe Skulpturmuster bei Trachyleberididen und verwandten Ostrakoden.* Dissertation. Universität Berlin.

Liebau, A. 1975. The left-right variation of the ostracode ornament. *Bull. Amer. Paleont. 65,* 77–86.

Méndez, C. A. and Swain, F. M. 1983. Ostrácodos cenomanenses de dos secciones en los alrededores de Oviedo, Asturias. *Revista Española de Micropaleontología.* 15, 467–496.

Moos, B. 1966. Die Ostracoden-Fauna des Unteroligozäns von Bünde (Bl. Herford-West, 3817) und einige verwandte Arten aus verschiedenen Tertiärstufen (Ostr., Crust.). II. *Trachyleberidea* Bowen 1953, *Hazelina* n. gen. *Geol. Jb. 84,* 281–298.

Morkhoven, F. P. C. M. Van. 1963. *Post-Palaeozoic Ostracoda: Their Morphology, Taxonomy and Economic Use.* 2, 1–478. Elsevier, Amsterdam.

Neale, J. W. 1982. Aspects of the Subfamily Schulerideinae. *In* "Fossil and Recent Ostracods" (Eds. R. H. Bate, E. Robinson, L. M. Sheppard). *British Micropalaeontologial Series.* 178–192. Ellis Horwood Ltd.

Olson, E. C, and Miller, R. L. 1958. *Morphological Integration.* University of Chicago Press.

Pokorny, V. 1964. *Oertliella* and *Spinicythereis,* new ostracod genera from the Upper Cretaceous. *Zvlastni Ofisk Vestn. Ustred. Ustav. Geol. 39,* 283–284.

Reyment, R. A. 1963–1966. Studies in Nigerian Upper Cretaceous and Lower Tertiary Ostracoda. Part 2 (1963). *Stockholm Contrib. Geol. 10,* 1–286. Part 3 (1966). *ibid. 14,* 1–151.

Reyment, R. A. 1966a. Preliminary observations on gastropod predation in the western Niger Delta. *Palaeogeogr. Palaeocl., Palaeoecol. 2,* 81–102.

Reyment, R. A. 1982. Analysis of trans-specific evolution in Cretaceous ostracods. *Paleobiology. 8,* 193–306.

Reyment, R. A. 1983. Phenotypic evolution in microfossils. *Evolutionary Biology. 16,* 109–254.

Reyment, R. A. 1984. Preliminary account of Middle Cretaceous ostracods from Segovia and Guadalajara Provinces (Spain). *Cuad. Geol. Ibérica.* 8, 195–218.

Reyment, R. A. and Van Valen, L. 1969. *Buntonia olokundudui* sp. nov. (Ostracoda, Crustacea): A study of meristic variation in Paleocene and Recent ostracods. *Bull. Geol. Instn Univ. Uppsala. N.S. 1,* 83–94.

Reyment, R. A., Blackith, R. E., Campbell, N. A. 1984. *Multivariate Morphometrics.* Second Edition. Academic Press, London.

Swain, F. M. 1978. Some Middle Cretaceous Ostracoda from Northern Spain and their interregional relationships. *Revista Española de Micropaleontología. 10,* 245–265.

Vesper, B. 1972. Zur Morphologie und Ökologie von *Cyprideis torosa* (Jones 1850) (Crustacea, Ostracoda, Cytheridae) unter besonderer Berücksichtigung seiner Biometrie. *Mitt. zool. Mus. Hamburg. 68,* 79–94.

Weaver, P. P. E. 1982. Ostracoda from the British Lower Chalk and plenus marls. *Palaeontographical Society,* Monogr. *135,* 1–127.

Wiedmann, J. 1960. Le Crétacé Supérieur de l'Espagne et du Portugal et ses céphalopodes. *Congr. Soc. Savantes* (Dijon). *84,* 709–764.

Appendix

Resumen: Los Ostrácodos del Cretácico Medio de Segovia, Guadalajara y Soria

Se han estudiado algunas asociaciones de Ostrácodos procedentes del Turoniense-Coniaciense de las Provincias de Segovía, Guadalajara y Soria. Se han determinado 43 especies, de las cuales cinco son nuevas. Las especies presentes son propias de aguas poco profundas. La macrofauna indicaría una zona costera.

Las asociaciones del Turoniense exhiben relaciones con las de la parte meridional de Francia (Provenza), pero no tienen muchas formas en común con la cuenca Vasco-Cantábrica, ni con Portugal, ni con el Norte de Africa. No obstante, las especies siguientes tienen una gran distribución en Europa Occidental: *Dolocytheridea crassa, Dordoniella turonensis, Asciocythere polita, Risaltina aquitanica, Bairdia cenomanica* y *Pterygocythere pulvinata.*

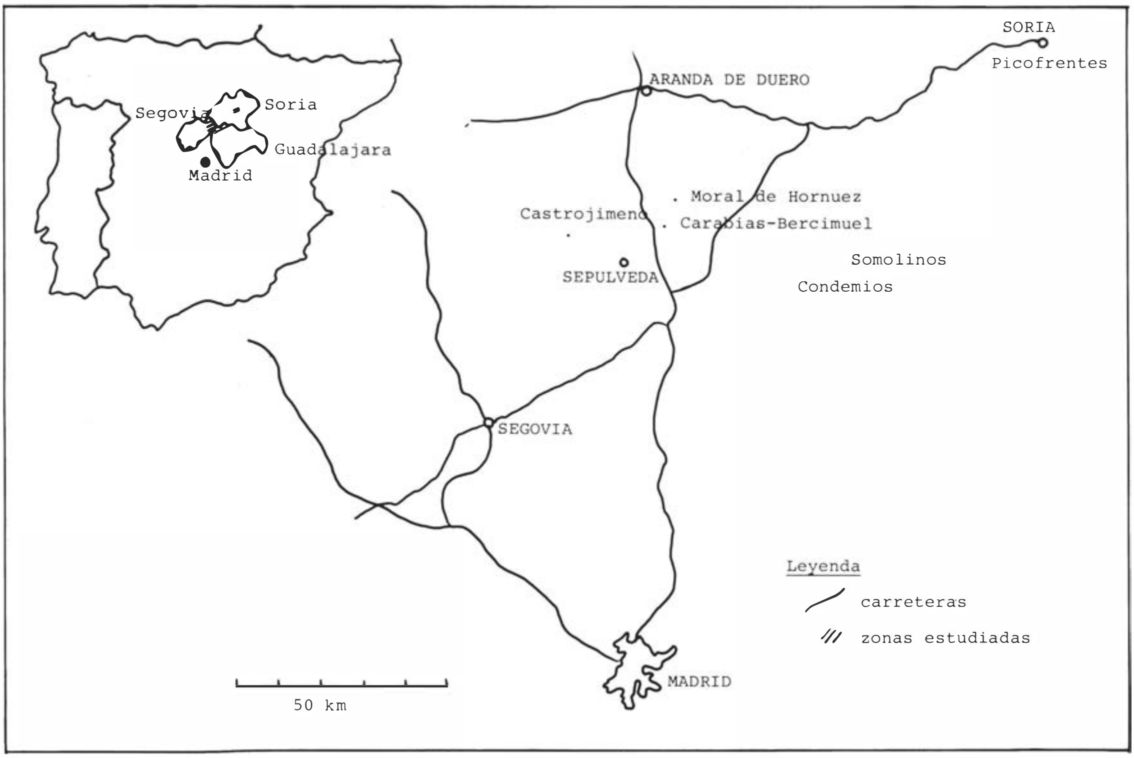


Fig. 13. Sketch-map showing the locations of the sections in the provinces of Segovia, Guadalajara and Soria.
Situación geográfica de los cortes muestreados.

Las asociaciones permiten caracterizar la edad Turoniense inferior en los cortes de Carabias, Moral de Hornuez, Picofrentes, Somolinos y Condemios de Arriba, y la edad Coniaciense en una parte de la sección de Castrojimeno. La asociación de Ostrácodos del Turoniense está principalmente caracterizada por especies de *Trachyleberidea, Limburgina, Oertliella, Planileberis, Mauritsina, Dordoniella, Dolocytheridea, Neocyprideis* y *Pterygocythereis.*

Notamos además que el fuerte control ecológico es, en gran parte, el responsable de las distribuciones verticales de las distintas especies, mientras que las distribuciones laterales de las especies son muy estables (igualdad de las faunas de Carabias, Moral de Hornuez y Somolinos). En los casos de las columnas de Carabias y Moral de Hornuez, cada una de las distribuciones verticales es también estable.

Bioestratigrafía: El Cretácico Medio de la meseta nordcastellana está compuesto por dos grupos principales – un grupo inferior, que define un ciclo de transgresión y regresión en el Cenomaniense-Turoniense (un fenómeno tectonoeustático conocido en todo el mundo), y un grupo superior de transgresión-regresión en el Turoniense terminal – Coniaciense/Santoniense (igualmente un acontecimeniento tectonoeustático de ámbito mundial).

El Grupo Español de Trabajo del Proyecto 58 del PICG ha introducido un sistema de codificación para caracterizar las 37 formaciones (C1 – C37) reconocidas en la meseta nordcastellana (García Quintana Ed., 1982, pág. 403). Además se ha realizado una división regional en cuatro áreas para simplificar la descripción de la estratigrafía de la meseta.

En esta monografía, he estudiado las asociaciones de los Ostrácodos de dos de las cuatro áreas propuestas para la Cordillera Ibérica (García Quintana Ed., 1982, pág. 391); es decir, el área 2 (Cordillera Ibérica norte) y 4 (Borde norte del Sistema Central) (cf. Alonso, 1981).

En el área 2, se han estudiado los afloramientos de los alrededores de Atienza (Somolinos, Condemios de Arriba) (cf. Breman, 1976) y Soria (Picofrentes, Fuentetoba). En el área 4, hemos investigado, sobre todo, los cortes de Moral de Hornuez, Carabias-Bercimuel y Castrojimeno (veáse Fig. 13).

En la siguiente descripción se utiliza la terminología litoestratigráfica elaborada en García Quintana Ed. (1982).

Margas de Picofrentes (región 2; C7)

La parte importante, en nuestro contexto, está constituida por unos 55 m de margas grises, arcillas calcáreas y calizas arcillosas y nodulosas. Hay bioturbación y las partes margosas son fosilíferas, sobre todo abundantes ammonites de los géneros *Fallotites, Choffaticeras,* y *Pseudaspidoceras* (de hasta 40 cm de diámetro) y Ostrácodos (veáse más abajo). Hacia el Sur, la formación vuelve a encontrarse en la región de Somolinos, donde las facies son más margosas y los microfósiles mucho más abundantes. Las Margas de Picofrentes se corresponden con la parte inferior del miembro C_{2a} de la "Formación de Moral de Hornuez" de Alonso (1981); es decir, los cortes de Carabías-Bercimuel y Moral de Hornuez.

Los Ostrácodos encontrados, hasta ahora, en esta formación pertenecen a las especies _Dolocytheridea crassa, Pterygocythere allinensis, P. pulvinata, Cytherella_ spp., _Bythocypris_ sp. y _Bairdia_ sp.

Formación de Castro de Fuentidueña: Según Alonso Millan (1981, pág. 100), el Miembre de Carabias pertenece a la Formación de Moral de Hornuez. Dice además, que dicho Miembro pasa lateral y transicionalmente a la Formación de Fuentidueña (unidad C15 de la región 4 en García Quintana Ed. (1982) y unidad C_{2b} en Alonso (1981)). Este cambio en la jerarquía estratigráfica podría, posteriormente, inducir a la sustitución de la unidad "Formación de Moral de Hornuez" por la de "Formación de Castro de Fuentiduena"; resultado que va en contra de la prioridad de la nomenclatura estratigráfica y sería una fuente de confusión.

La columna de Carabias-Bercimuel: El material descrito fue hallado en la parte superior del corte, en una alternancia de calizas y margas. En lo que concierne al contenido faunístico se presentan sólo los Ostrácodos de interés (veáse Alonso, 1981, fig. 15 y Fig. 1A, 1B).

La fauna indica que tenemos una asociación de edad Turoniense, tal vez la parte superior del Turoniense Inferior. Los Ostrácodos son bastantes abundantes en varios niveles del corte; estando presentes en todos los niveles estudiados. La distribución vertical de las especies identificadas es como sigue:

N.B. En los párrafos siguientes, los símbolos *, ** y *** tienen la significación: * < 5 individuos; ** 6 − 20 individuos; *** > 21 individuos en 20 gm de la muestra levigada, en seco.

(1) (Techo). _Dolocytheridea crassa_**, _Limburgina galvensis_**, _Cytherella_ sp.***, _Cytherella_ aff. _postangulata_* _Neocyprideis iberiacus_** (Numerosas perforaciones de gasterópodos – Naticidae.)

(2) _Dolocytheridea crassa_**, _Veeniacythereis_ sp.*, _Cytherella_ spp.***, _Trachyleberidea_ sp.*, _Neocyprideis iberiacus_**

(3) _Dolocytheridea crassa_***, _Trachyleberidea alandalusensis_*, _Limburgina galvensis_**, _Cytherella_ spp.***, _Neocyprideis iberiacus_***

(4) _Dolocytheridea crassa_**, _Paracaudites?_ sp. indet.*, _Oertliella guadalajarensis_**, _Mauritsina soriensis_**, _Cytherella_ spp.*, _Bairdia_ sp.*, _"Ovocytheridea"_ sp.*, _Neocyprideis iberiacus_**

(5) _Dolocytheridea crassa_***, _Neocyprideis iberiacus_*, _Mauritsina soriensis_*, _Cytherella_ sp.*

(6) _Dolocytheridea crassa_***, _Neocyprideis iberiacus_*, _Spinoleberis petrocorica?_**, _Cytherella_ spp.**

(7) _Dolocytheridea crassa_*, _Neocyprideis iberiacus_*, _Spinoleberis petrocorica?_*, _Dumontina?_ sp.*, _Cytherella_ spp.***
(8) _Dolocytheridea crassa_*, _Neocyprideis iberiacus_*, _Cytherella_ sp.*, _Bythocypris_ sp.*

(9) _Dolocytheridea crassa_***, _Neocyprideis iberiacus_**, _Dordoniella turonensis_**, _Parvacythereis?_ sp.*, _Cornicythereis? picofrentensis_**, _Oertliella guadalajarensis_**, _Cytherella_ sp.**

(10) (Base). _Dolocytheridea crassa_***, _Neocyprideis iberiacus_**, _Dordoniella turonensis_**, _Cornicythereis ? picofrentensis_***, _Limburgina galvensis_**, _Mauritsina soriensis_*, _Cytherella_ sp.**, _Bairdia_ sp.*, _Neocythere_ sp.*

La columna de Moral de Hornuez: La parte estudiada consiste en una alternancia de margas, calcarenitas y calizas (Alonso Millan, 1981, fig. 17). La asociación de Ammonites mencionada en Alonso (1981) indica el techo del Turonense Inferior. La sucesión es muy rica en microfauna, sobre todo, el tramo 6.

(1) (Techo) _Planileberis_ aff. _praetexta_*, _"Veenia" moralensis_*, _Donmacythere hafsuni_**, _Mauritsina radiocostata_*, _Oertliella guadalajarensis_**, _Bythocythere_ sp.*, _Cytherella_ sp.*

(2) _Cytherella_ spp.**, _Parakrithe?_ sp.*

(3) _Cytherella_ sp.*, _Trachyleberidea alandalusensis_**, _Mauritsina radiocostata_*

(4) esteril

(5) _Cytherella_ spp.***, _Mauritsina soriensis_**

(6) _Cytherelloidea_ aff. _denticulata_*, _Dolocytheridea crassa_**, _Dordoniella turonensis_**, _Cytherella_ spp.***, _Parakrithe_ sp.* _"Cythereis" segoviensis_*, _Trachyleberidea alandalusensis_**, _Spinoleberis petrocorica?_*, _Veeniacythereis_ sp. juv.*, _Dumontina?_ sp.*, _Dumontina? almussatensis_**, _Limburgina galvensis_**, _Oertliella guadalajarensis_**, _Mauritsina soriensis_***, _Mauritsina radiocostata_**, _Mauritsina speciosa?_**, _Pterygocythereis_ sp.**.

(7) _Pterygocythere_ aff. _robusta_*, _"Veenia" moralensis_**, _Mauritsina radiocostata_*
(Base)

Condemios de Arriba: La edad de la localidad 281 es Turoniense Inferior (parte superior). Esta determinación se base en la presencia del género _Fallotites_ y otros Ammonites. Hay numerosas perforaciones de gasterópodos natícidos, sobre los Ostrácodos.

Base: _Cytherella_ aff. _postangulata_**, _Bairdia cenomanica_*, _Bairdia_ spp.**, _Bythocypris_ sp.*, _Macrocypris siliqua?_*, _Pterygocythere allinensis_**, _"Cythereis" segoviensis_*, _Spinoleberis petrocorica?_**, _Limburgina?_ sp.*, _Oertliella guadalajarensis_**, _Mauritsina soriensis_**, _Mauritsina radiocostata_*

Techo. _Donmacythere hafsuni_**

Formación de Castrojimeno (región 4; C24): Notamos que esta formación está constituida por calcarenitas bioclásticas, dolomías, calizas micríticas etc. Los ostrácodos descritos fueron hallados en muestras recogidas a lo largo del camino de Castrojimeno, sobre todo en el afloramiento situado a la entrada de la aldea.

5. (Techo) _Cytherella_ sp.*, _Pterygocythere_ spp.**, _Pontocyprella?_ spp.**, _"Cythereis"_ sp.*, _Mauritsina radiocostata_*, _Mauritsina speciosa?_**, _Dolocytheridea crassa?_**, _Oertliella_ sp.*

2. _Mauritsina speciosa?_*, _"Ovocytheridea"_ sp. indet-*

1. (Base) _Mauritsina_ sp.*

Columna de Somolinos: Esta sucesión es muy rica en microfauna.

1. (Base) _Parvacythereis ?_ sp.*, _Cornicythereis ? picofren-_

*tensis***, *"Dumontina"* sp.*, *Dumontina* sp. nov.?*, *Oertliella guadalajarensis**

2. *Pterygocythereis allinensis***, *Planileberis* aff. *praetexta***, *Planileberis* sp.*, *Oertliella guadalajarensis***, *Mauritsina soriensis****, *Bairdia* sp.***, *Mauritsina speciosa?***

3. *Dordoniella turonensis***, *Spinoleberis petrocorica?***, *Spinoleberis* sp.*, *Mauritsina soriensis***, *Bairdia* sp.*, *Xestoleberis* sp.*

4. *"Xestoleberis"* sp.*, *Cytherella* sp.*, *Bairdia* sp.*

5. *Asciocythere polita***, *Trachyleberidea alandalusensis***, *Mauritsina soriensis?***, *Mauritsina radiocostata***, *Mauritsina speciosa?**, *Spinoleberis petrocorica?***, *Dolocytheridea crassa***, *Cytherella* spp.**, *Bairdia* sp.*

6. *Dordoniella turonensis**, *Dolocytheridea* sp.*, *Parakrithe?* sp.

7. *Dordoniella turonensis***, *Risaltina aquitanica**, *Mauritsina soriensis**, *Mauritsina* ? sp.*, *Mauritsina speciosa?**, *Cytherella* sp.**, *Bairdia* sp.**, *"Xestoleberis"* sp.*

Además, *Dumontina ? almussatensis* se encontró en el ombligo de un ejemplar de *Choffaticeras* proveniente del corte de Somolinos.

Teniendo en cuenta los datos descritos en el texto anterior, podemos resumir las siguientes deducciones, referidasa la edad de las asociaciones de los fósiles objeto de este estudio.

La edad de los cortes de Carabias y Moral de Hornuez (C15) debe ser Turoniense Inferior (parte superior) datada por los Ammonites de la base de la columna de Moral. Hacia el centro de la Cuenca (Somolinos, Condemios) encontramos, en general, las mismas asociaciones de Ostrácodos y Ammonites. En cuanto a la unidad C7 (Margas de Picofrentes), esta formación corresponde a C15. Encontramos, en general, la misma fauna de ostrácodos.

La Formación de Castrojimeno (C24) pertenece al Coniaciense en la parte del corte estudiada en nuestro trabajo.

Finalmente, observamos que la presencia de *Mauritsina* tiene gran interés para la interpretación de la paleobiogeografía de la Península Ibérica durante el Cretácico Medio. Vemos que las afinidades puestas de manifiesto en este trabajo son con las faunas del suroeste de Francia. Por el contrario son muy pocas las afinidades con Africa del Norte; parece que se trata de dos provincias biológicas diferentes de Ostrácodos, una abarcando Francia y la Península Ibérica y otra el Africa septentrional. Son también pocas las relaciones faunísticas con Europa septentrional (por ejemplo: Gran Bretaña).

Printed by Ekenäs Tryckeri Ab, Ekenäs, Finland October 10th, 1984

PLATES

Plate 1

1. *Pterygocythere* aff. *robusta* (Jones and Hinde). Left side of a valve. Turonian, Moral de Hornuez, sample MH4 (sampled 1980 = levels 276 and 277 of 1981). × 50. PMSp247.

2. Same species. Stereophotographs showing the relationship between the wing and the anterior rim. Sample MH4. × 50. PMSp248.

3. *Pterygocythere allinensis* (Grekoff and Deroo). Stereophotographs showing the dorsal aspect (note the incipient spine on the posterior margin of the wings). Turonian, Somolinos, sample 286. × 60. PMSp249.

4. Same species and provenance. A left valve. × 60. PMSp250.

5. Same species. Left valve, angled to display the wing. Note the connexion of the anterior ridge to the eye-tubercle and the incipient posterior spine on the wing. Condemios de Arriba, sample 281. × 60. PMSp251.

6. Same species and provenance. Right valve. × 60. PMSp252.

7. *Pterygocythere* sp. A. Left and right hinges of the same specimen. × 55. Soria locality 13SO (Alonso), Cenomanian-Turonian. PMSp253 and PMSp254.

8. Same species. A left valve. × 55. PMSp255.

9. *Pterygocythere* sp. B. Stereophotographs of a left valve. Coniacian, Castrojimeno, sample 265. × 60. PMSp256.

10. *Pterygocythere pulvinata* Damotte. Ventral view of a carapace showing the ornament of the ventral margins of the valves. Turonian, Picofrentes, sample DA965-PFA9. × 50. PMSp261.

11. Same species and provenance. Angled view of the right side of a carapace. × 50. PMSp262.

12. Same species and provenance. Ventral view of a lightly etched (citric acid) right valve showing the alar alveoles and the zone of concrescense. × 50. PMSp263.

13. Same species and provenance. Slightly angled left side of a carapace showing the alar spines and the alar rim. × 50. PMSp264.

Plate 1


1


2


2


4


3


3


5

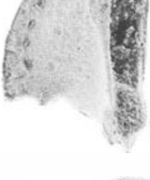

9

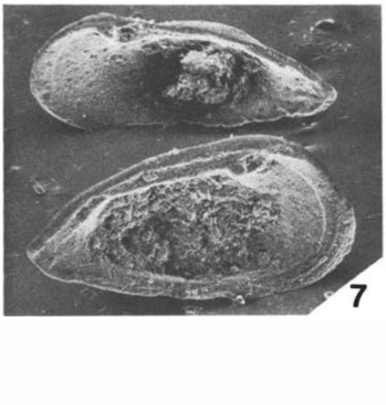

9

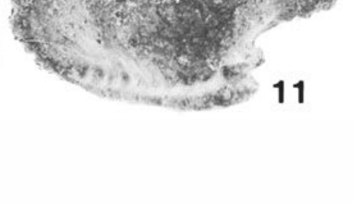

6


8


10


12


7


11


13

Plate 2

1. *"Cythereis" segoviensis* sp. nov. Holotype. Feebly reticulated morph. Left side of a carapace. Turonian. Moral de Hornuez, sample 276. × 90 (length of specimen = 0.72 mm). PMSp257.

2. Same specimen as in Fig. 1. Angled dorsal view showing the ornament of the dorsal surface of the lateral bulge. × 90.

3. Same specimen as foregoing. Anterior zone showing the smooth anterior field and the nature of the lateral ornament. × 190.

4. Same species. Interior of a left valve showing the hinge, the adductor muscle pit, the ocular tube and the ventrolateral niche. Turonian. Moral de Hornuez, sample 276. × 90. PMSp258.

5. Same specimen. Posterior part of the hinge showing the notching and posterior development of the median element. × 190.

6. Same species and provenance. Interior view of a right valve showing the hinge, the ocular tube and the ventrolateral niche. PMSp259.

7. Same specimen as shown in Fig. 4, illustrating the ventral reticulations and the notching of the anterior margin. × 90.

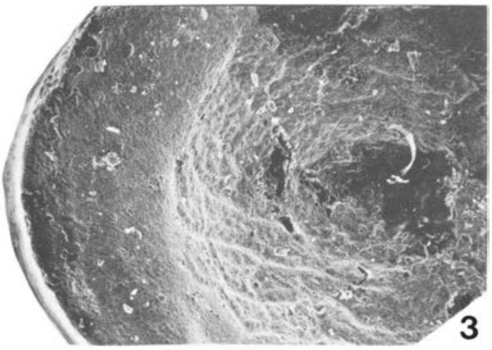
8. *"Cythereis" segoviensis* sp. nov. The more strongly ornamented morph. Stereophotographs of the left side of a carapace. Turonian. Condemios de Arriba, sample 281. × 85 (length of specimen = 0.70 mm). PMSp260.

9. Same specimen. Ventral aspect. × 85.

10. Same specimen. Dorsal aspect. × 75.

Plate 2

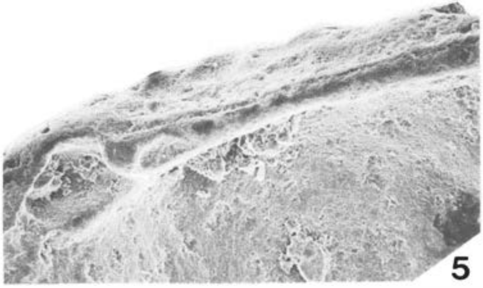

1


3


2


7

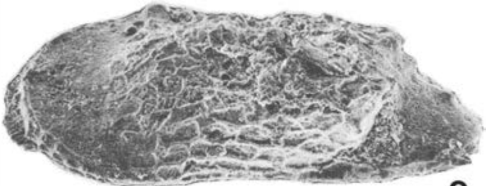

4


5


8


8


6


9

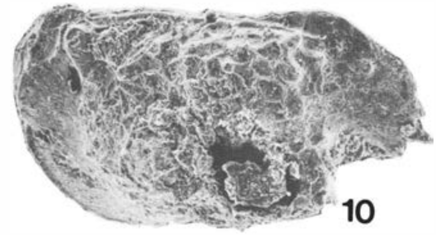

10

Plate 3

1. *"Cythereis"* sp. Stereophotographs of the left side of a carapace. Coniacian. Castrojimeno, sample CAS3 (1980). × 90. PMSp261. (Length = 0.72 mm).

2. Same specimen. Stereophotographs of the carapace in dorsal aspect. × 90.

3. Ventral aspect of same specimen. × 90.

4. Detail of the lateral ornament and the surface of the adductorial tubercle of the same specimen. × 340.

5. *Planileberis* aff. *praetexta* (Damotte). Left side of a carapace. Turonian. Moral de Hornuez, sample 271. × 65. PMSp262. (Length of specimen = 0.96 mm.)

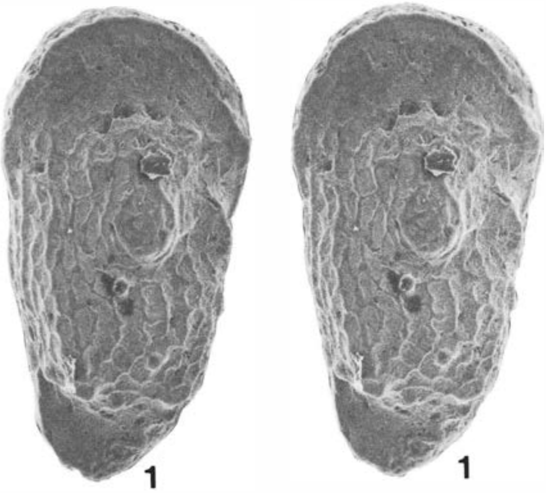
6. Posterior view of the same individual to show details of the lateral ornament. × 200.

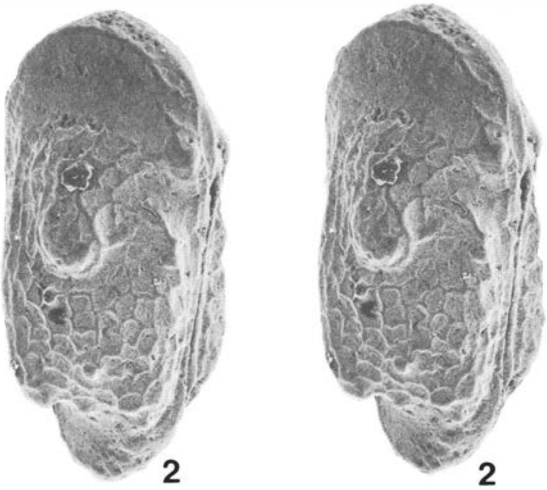
7. Same species. Angled ventral view of a carapace (length = 0.94 mm). Turonian. Somolinos, sample 285. × 65. PMSp263.

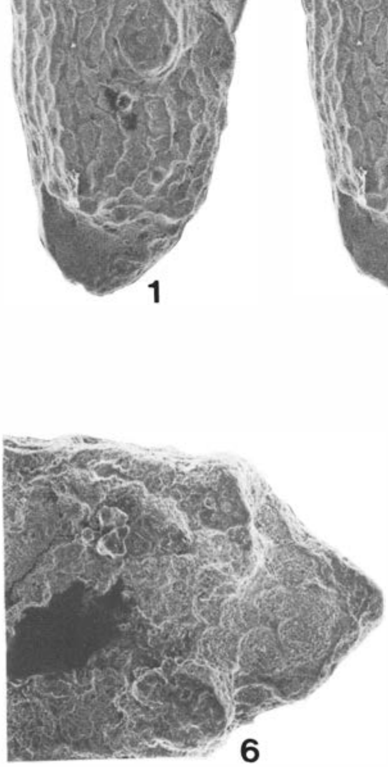
8. Same species and provenance. Dorsal view (length = 0.95 mm). × 65. PMSp264.

9. Same specimen as in Fig. 8. Angled dorsal view. × 65.

Plate 3

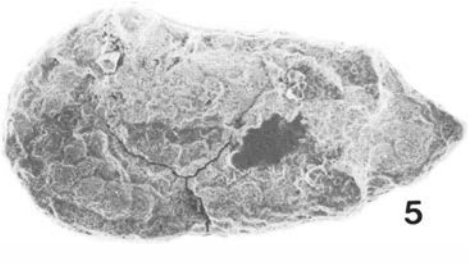

1 1

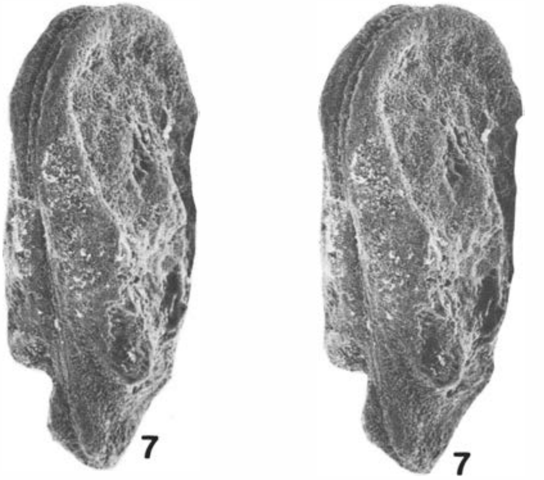

2 2


6


3


4


5


7 7


8


9

Plate 4

1. *Planileberis* sp. Left side of a carapace. Turonian. Somolinos, sample 286. × 60. PMSp265.

2. Same species and provenance; dorsal aspect. × 90. PMSp266.

3. Same species and provenance; angled ventral aspect. × 90. PMSp267.

4. Same specimen as foregoing. Anterior ornament. × 190.

5. Same specimen as foregoing. Posterior ornament. × 190.

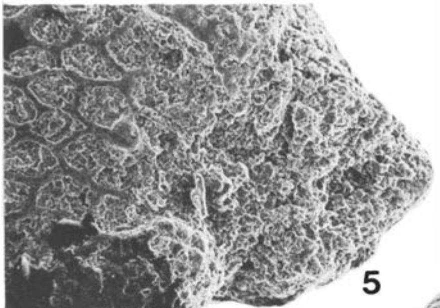
6. *Trachyleberidea alandalusensis* sp. nov. Holotype. Stereophotographs. Turonian. Somolinos, sample 289. × 60. PMSp268.

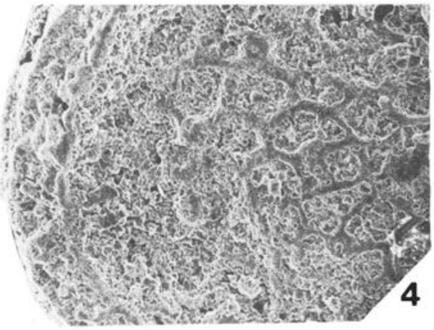
7. Same species. Dorsal view. Turonian. Moral de Hornuez, sample 286. × 90. PMSp269.

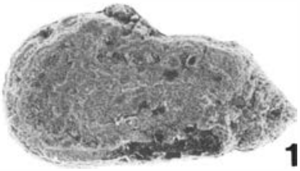
8. Same species and provenance. Dorsal view. × 90. PMSp270.

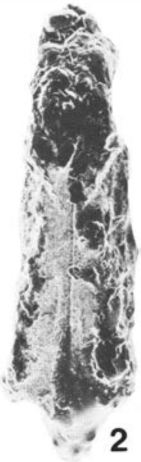
9. Same species and provenance. Ventral view. × 90. PMSp271.

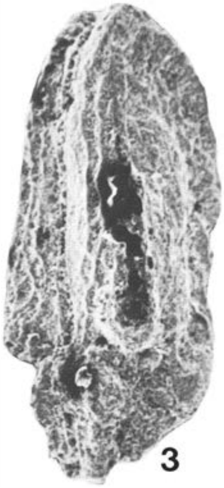
10. Same species and provenance. Interior of a right valve; stereophotographs. × 90. PMSp272.

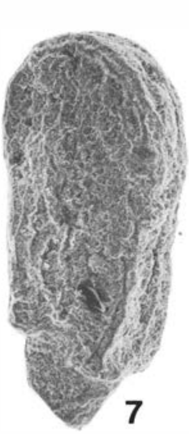

5


4


1

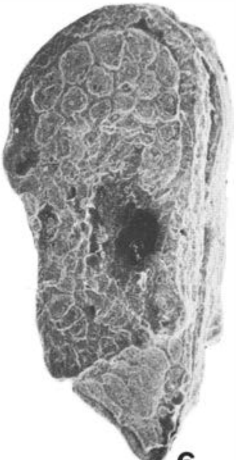

2

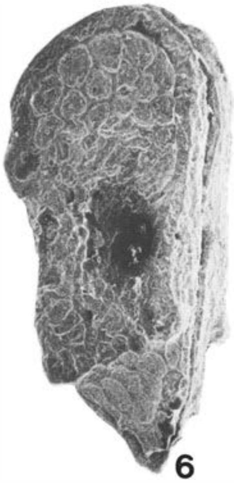

3


7


8


9


6


6


10


10

Plate 5

Trachyleberidea alandalusensis sp. nov.

1. Angled dorsal view. Turonian. Moral de Hornuez, sample 277. PMSp273.

2. Angled ventral view of a carapace. Same provenance. PMSp274.

3. Right side of a female carapace. Turonian. Moral de Hornuez, sample 266. PMSp275.

4. Left side of a male carapace. Same provenance. PMSp276.

5. Angled dorsal view. Turonian. Moral de Hornuez, sample 277. PMSp277.

6. Stereophotographs showing the ventral aspect at an angle to illustrate the posterior expansion of the ventral rib and the concave zone behind the anterior rim. PMSp278. Same provenance.

7. Same provenance. Stereophotographs of a dorsal view of a carapace showing the posteriorly expanded dorsal rib with its proximal serrations. PMSp279.

8. Same provenance. Interior view of a left valve, possibly a male. PMSp280.

9. *Trachyleberidea geinitzi* (Reuss). Collection Babinot. A right valve from Provence, France.

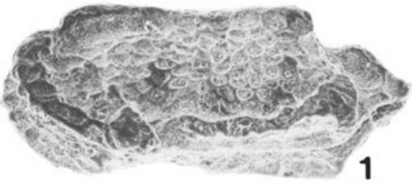
10. *Trachyleberidea arta* (Damotte). Collection Babinot. Left valve, from Provence, France.

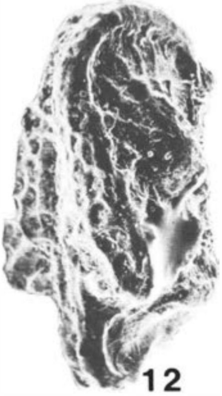
11. *Spinoleberis petrocorica* (Damotte)? Stereophotographs of the left side of a carapace. Turonian. Carabias, sample 257. PMSp282. This may be a female individual.

12. *Spinoleberis petrocorica* (Damotte) *sensu* Babinot (1980) Collection Babinot. Ventrolateral view of a presumed female from Provence, France.

All specimens magnified 90 times.

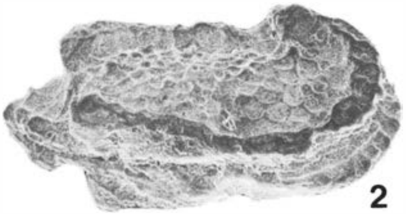
Plate 5


1


12


4


3

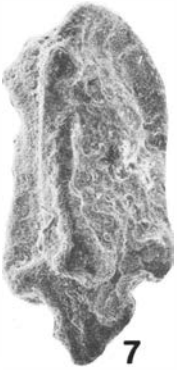

2

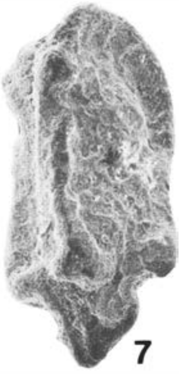

5


6


6


8


7


7


11


11


9

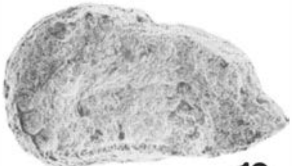

10

Plate 6

1. *Spinoleberis petrocorica* (Damotte)? Stereophotographs of angled view of the ventral side of a carapace. Turonian. Carabias, sample 256. × 90. PMSp283.

2. *Spinoleberis petrocorica* (Damotte). Stereophotographs of a male specimen from Provence, France (Collection Babinot) showing the left side of a carapace. × 90. PMPRo3.

3. *Spinoleberis petrocorica* (Damotte)? Stereophotograph of the right side of a carapace. Turonian. Moral de Hornuez, sample 276. × 90. PMSp284.

4. Same species and provenance. Dorsal aspect of a carapace of a possibly male individual. × 90. PMSp285.

5. Same species and provenance. Detail of the anterodorsal ornamental field of the right side of a carapace (note the secondary ornament which is reminiscent of the shagreen texture displayed by *Mauritsina*). × 190. PMSp286.

6. *Spinoleberis* aff. *petrocorica* (Damotte) Right side of a male individual with well developed posterior spination. Turonian. Condemios de Arriba, sample 281. × 90. PMSp287.

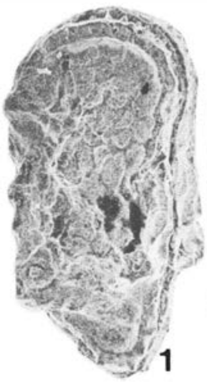
7. *Spinoleberis* sp. Stereophotographs of angled dorsal view of a carapace showing the prominent eye-tubercles. Turonian. Somolinos, sample 287. × 90. PMSp288.

8. Same specimen. Enlarged view of the eye-tubercles. × 190.

9. Same specimen. Lateral aspect showing the prominent adductor muscle tubercle and the secondary ornament of the anterior part of the shell. × 90.

Plate 6


1

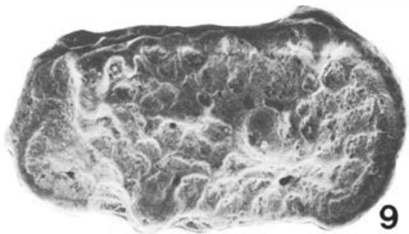

1

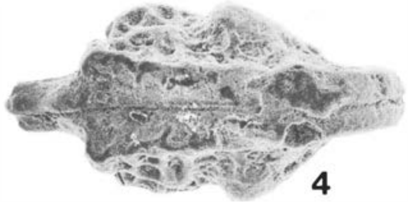

2

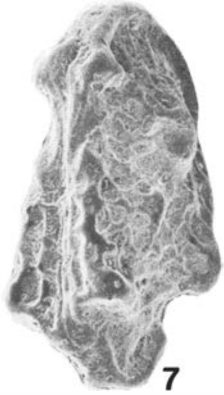

2

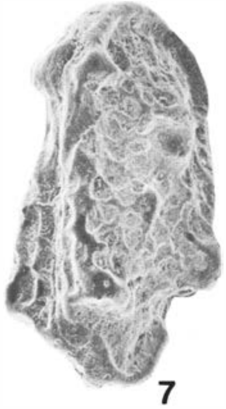

3

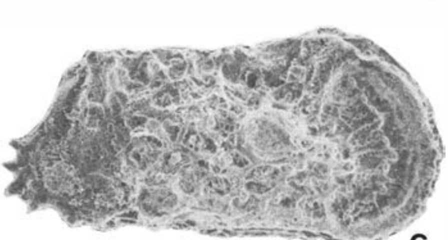

3

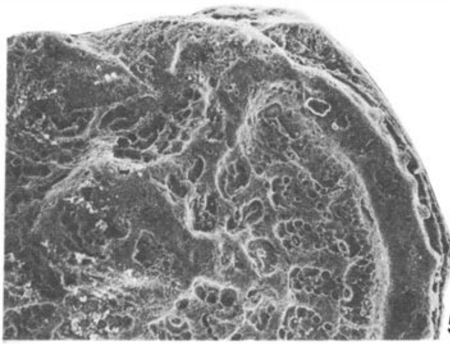

9


4


7


7


6


5

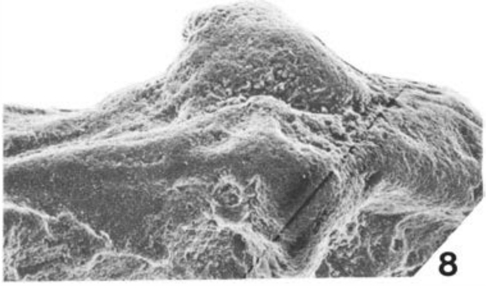

8

Plate 7

1. *Parvacythereis* ? sp. Stereophotographs. Carabias, sample 259. Right side of a carapace. × 90. PMSp289.

2. Same specimen and provenance. Stereophotographs. Specimen angled so as to display the ventral ornamental pattern. × 90.

3. *"Veenia" moralensis* sp. nov. Holotype. Right side of a carapace (length = 0.65 mm). Turonian. Moral de Hornuez, sample 277. × 70. PMSp290.

4. Same species and provenance (length = 0.63 mm). Turonian. × 70. PMSp291. This is an example of a weakly ornamented left valve.

5. Same species and provenance (length = 0.69 mm). Dorsal aspect of a carapace. × 90. PMSp292.

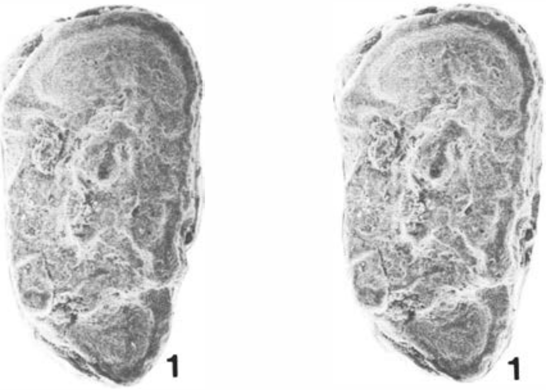
6. Same species and provenance. Ventral aspect of a carapace. × 90. PMSp293.

7. Same species and provenance. Interior of a right valve (length = 0.71 mm; height = 0.37 mm). × 105. Observe faint notching of hinge furrow. PMSp294.

8. Same species and provenance. Stereophotographs of angled ventral aspect. × 105. PMSp295.

9. Same species and provenance. Internal view of a left valve. Observe the faint notching of the hinge-bar. × 105. PMSp296.

10. *Donmacythere hafsuni* sp. nov. A right valve. Turonian. Moral de Hornuez, sample MO17. × 105. PMSp297.

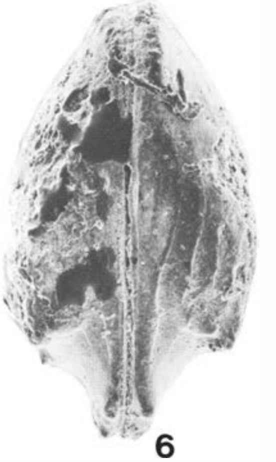

1 1


2 2


3

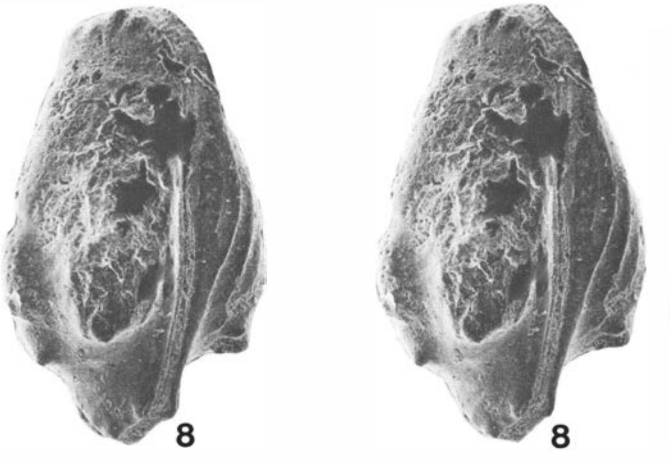

4


5


6


7


10


8 8


9

Plate 8

Donmacythere hafsuni sp. nov.

1. The holotype, a female carapace. Stereophotographs. Turonian. Moral de Hornuez, sample 17MO (Alonso, 1981). × 90. PMSp298.

2. Same species and provenance. Stereophotographs of the interior of a left valve showing a complete hinge, the central muscle field and the zone of concrescence. PMSp299. × 90.

3. The central muscle field of PMSp299. × 340.

4. The same species and provenance. Stereophotographs of a left valve. × 105. PMSp300. A female.

5. Same species and provenance. Ventral aspect of a female specimen showing the bulgy ventral rib. × 90. PMSp301.

6. Same species and provenance. Left side of a carapace. × 90. PMSp302.

Plate 8

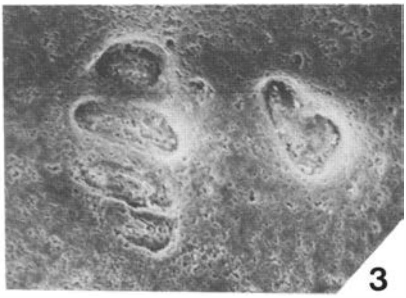


Plate 9

1. *Donmacythere hafsuni* sp. nov. Right side of a male carapace. Turonian. Moral de Hornuez, sample MO17 (Alonso, 1981). × 90. PMSp303.

2. Same species and provenance. Interior view of a female left valve. × 110. PMSp304.

3. Same species and provenance. Stereophotographs. × 90. PMSp305.

4. Same species. Stereophotographs of a female left valve. Turonian. Condemios de Arriba, sample 283. × 90. PMSp306.

5. *Veeniacythereis* ? cf. *xixunensis* (Méndez and Swain). Right side of a carapace. Turonian. Carabias, sample 252 (length = 0.70 mm; height = 0.43 mm). Specimen slightly angled to display the ventral ornament. × 90. PMSp307.

6. *Veeniacythereis* sp. juv. Right valve of an immature specimen. Turonian. Moral de Hornuez, sample 276. × 95. PMSp308.

7. *Cornicythereis* ? *picofrentensis* (Grekoff and Deroo). Right side of a female carapace. Turonian. Somolinos, sample 285. × 90. PMSp309.

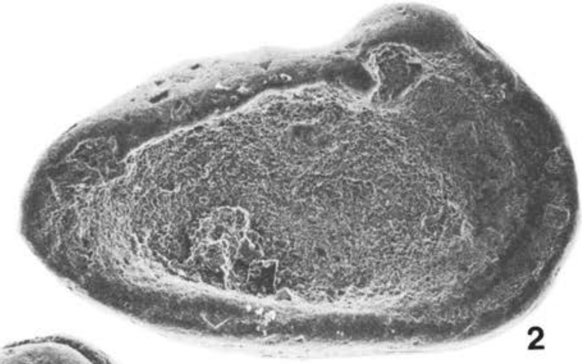
8. Same species. Internal view of a female left valve. Turonian. Carabias, sample 259. × 90. PMSp310.

9. Same species and provenance. A female. × 60. PMSp311.

10. Same species. A male right valve. Turonian. Carabias, sample 2510. × 65. PMSp312.

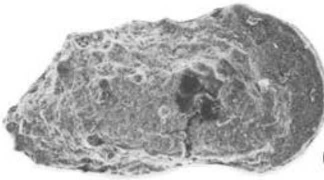
Plate 9


1


2


3


3


6

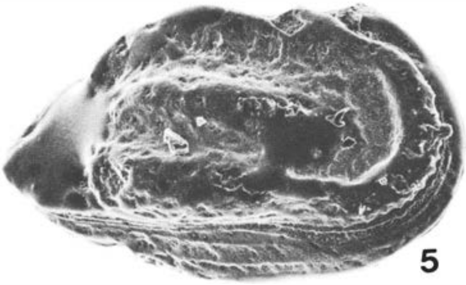

7


4


4


9


10


5

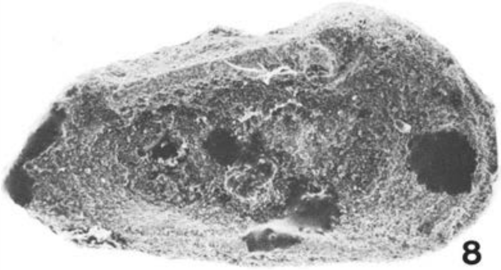

8

Plate 10

1. *Cornicythereis* ? *picofrentensis* (Grekoff and Deroo). Stereophotographs of angled view of the dorsal aspect of a carapace. Turonian. Somolinos, sample 285. × 90. PMSp313.

2. Same species. Turonian. Moral de Hornuez, sample MO21 (Alonso, 1981). Dorsal view of a carapace. × 55. PMSp314.

3. *Dumontina* ? *almussatensis* sp. nov. Holotype, a female (?) individual. Right side of a carapace. Turonian. Moral de Hornuez, sample 276. × 95. PMSp315.

4. Same species and provenance. Stereophotographs of the ventral aspect. × 90. PMSp316.

5. Same species and provenance. Stereophotographs of the right side of a female (?) carapace – possibly a late instar. × 90. PMSp317.

6. "*Dumontina*" sp. Left side of a carapace. (Length = 0.72 mm; height = 0.31 mm). Turonian. Somolinos, sample 285. × 90. PMSp318.

7. Same specimen. View of the ventral surface showing the tuberculoid development of the ventral rib. × 90.

8. Same specimen. View of the eye-tubercle. × 190.

9. Same specimen. View of the posteroventral tuberculation. × 190.

10. Same specimen. Angled view of shell. × 90.

11. *Dumontina* ? sp. Right side of a lightly crushed carapace. Turonian. Carabias, sample 257. × 90 PMSp320.

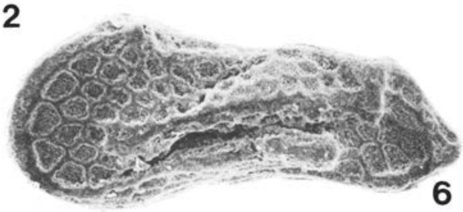
Plate 10

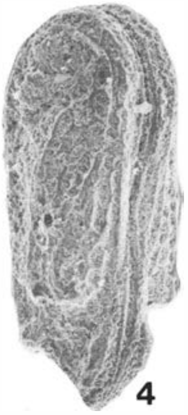

1

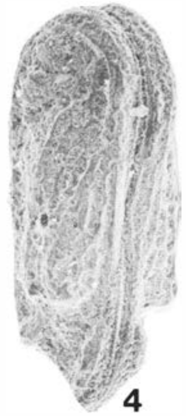

1


2


3


6

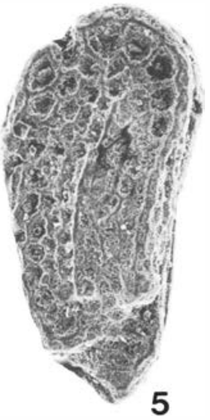

4

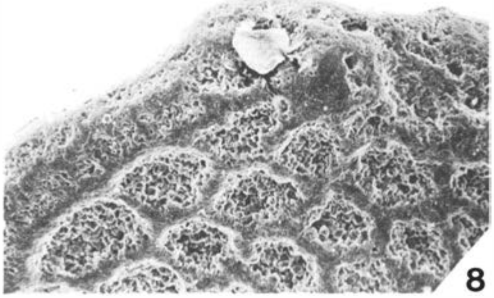

4

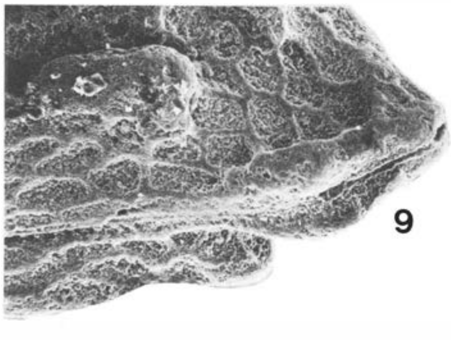

10


7


5


5


8


9


11

Plate 11

1. *Dumontina* ? *almussatensis* sp. nov. Stereophotographs of a male individual. Turonian. Moral de Hornuez, sample 276. × 90. PMSp319.

2. *Dumontina* sp. nov.? Right side of a carapace. Turonian. Somolinos, sample 285. × 100. PMSp321.

3. Same specimen. Stereophotographs of an angled view of the right side of a carapace. × 90.

4. Same specimen. The reticulation pattern of the anterior part of the shell. × 190.

5. Same specimen. The median and ventral ribs and the secondary ornament. × 190.

6. *Paracaudites* ? sp. indet. Right side of a carapace. Turonian. Carabias, sample 254. × 50. PMSp322.

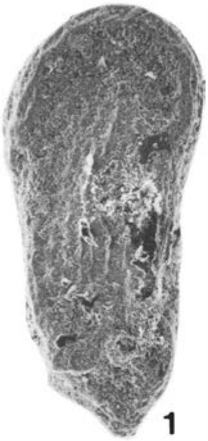
7. *Limburgina galvensis* (Breman). A right valve showing a smooth field in the centre of the reticulate ornamental pattern. Turonian. Carabias, sample 251. × 50. PMSp323.

8. Same species. Stereophotographs of an angled right valve, possibly a late instar. Turonian. Moral de Hornuez, sample 276. × 65. PMSp276.

9. Same species. Left side of a carapace. Turonian. Carabias, sample 2510. × 65. PMSp325.

10. Same species. Left side of a completely ornamented carapace. Turnoan. Carabias, sample 14CB (Alonso, 1981 = levels 273 and 274 of this monograph). This may be a male specimen. × 50. PMSp326.

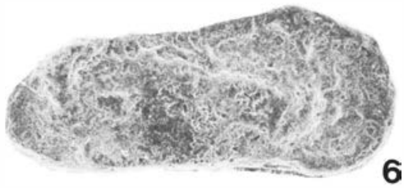
11. Same species and provenance. Right side of a carapace showing smooth fields in the ornament. × 50. PMSp327.



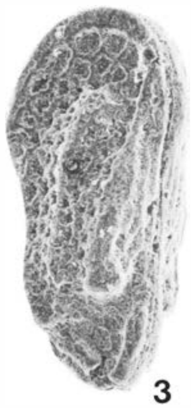
1

1

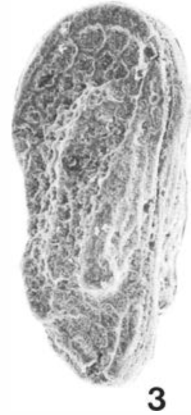
2



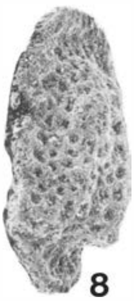
6



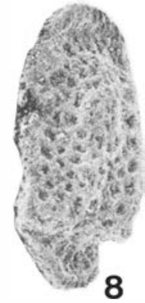
3



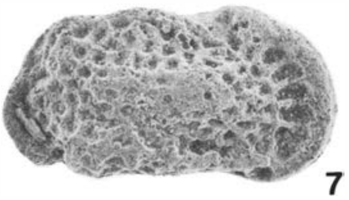
3



8

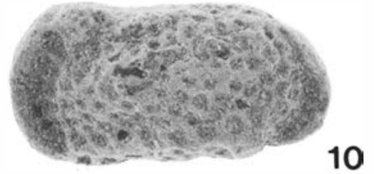


8

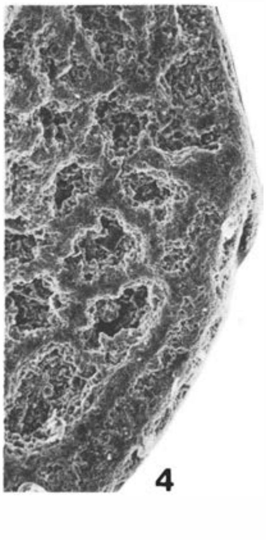


7

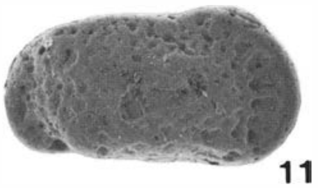
9



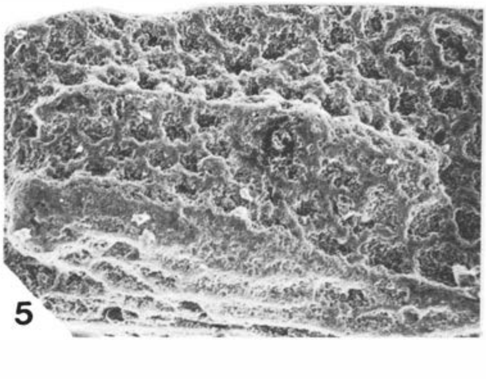
10



4



11



5

Plate 12

1. *Limburgina galvensis* (Breman). Right side of a carapace showing smooth ornamental fields. Turonian. Carabias, locality 14CB (Alonso, 1981). × 50. PMSp328.

2. Same species and provenance. Left side of a carapace showing smooth ornamental fields. × 50. PMSp329.

3. Same species and provenance. Dorsal aspect of a fully reticulated morph. × 90. PMSp330.

4. Same species and provenance. A right hinge. × 90. PMSp331.

5. *Limburgina* ? sp. Stereophotographs of a left valve showing two kinds of secondary lateral ornament. Turonian. Condemios de Arriba, sample 281. × 90. PMSp251.

6. Same specimen. View of the hinge (left) and the zone of concrescence. × 90.

7. Same specimen. The lateral ornament in detail showing the primary and secondary ornament, the eye-tubercle (bottom left) and the adductor muscle tubercle. × 190.

8. *Oertliella guadalajarensis* (Breman). The right side of a male carapace. Turonian. Condemios de Arriba, sample 281. × 90. PMSp333.

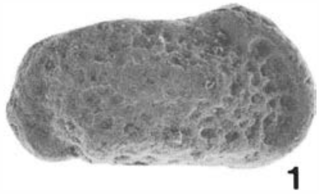
9. Same species. Dorsal view of a female specimen. Turonian. Moral de Hornuez, sample 276. × 60. PMSp334.

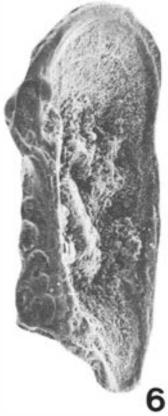
10. Same species and provenance. Ventral view of a female specimen. × 60. PMSp335.

11. Same species. Left side of a carapace. Turonian. Carabias, sample 259. × 90. PMSp336.

12. Same specimen as in Fig. 11. Anterior zone. × 190.

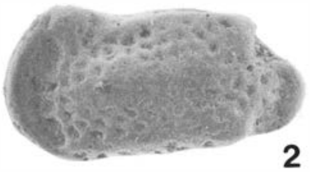
Plate 12


1

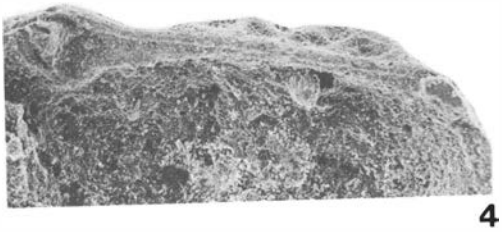

6

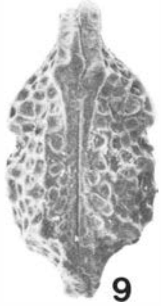

5


5

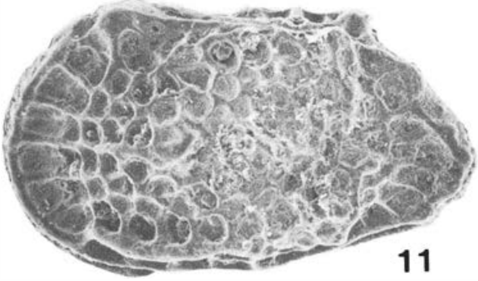

2


10

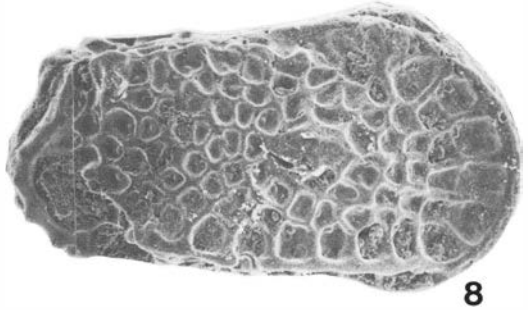

4


9


3


11


7


8

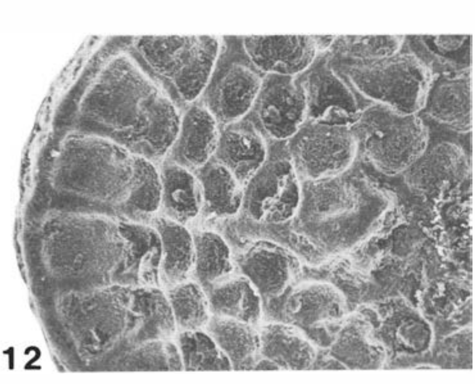

12

Plate 13

1. *Oertliella guadalajarensis* (Breman). Angled dorsal view of a male individual. Turonian. Condemios de Arriba, sample 283. × 90. PMSp336.

2. Same specimen. Ornamental details of the posterior process. × 200.

3. Same species. Right side of a carapace; observe the straight dorsal margin. Turonian. Moral de Hornuez, sample 276. × 90. PMSp337.

4. Same species and provenance. Ventral aspect of a carapace showing deeply incised reticulations. × 60. PMSp338.

5. Same species. Left side of a female carapace; note the concave line of the dorsal margin. Turonian. Somolinos, sample 286. × 60. PMSp339.

6. Same species? Left side of a carapace; note the straight dorsal margin. Turonian. Condemios de Arriba, sample 281. × 60. PMSp340.

7. Same species. Right side of a carapace displaying a concave dorsal margin. Turonian. Carabias, sample 254. × 60. PMSp254.

8. Same species? Right side of a female carapace; observe the straight dorsal margin. Turonian. Condemios de Arriba, sample 281. × 60. PMSp342.

9. Same species. Left side of a male carapace; the dorsal margin is straight and the anterior marginal ridge can be seen to be joined to the eye-tubercle. Turonian. Moral de Hornuez, sample 276. × 65. PMSp343.

10. *Mauritsina soriensis* (Grekoff and Deroo). A right hinge. Turonian. Somolinos, sample 2811. × 90. PMSp345.

11. Same species. Right side of possibly male carapace. Turonian. Somolinos, sample 286. × 50. PMSp346.

12. Same species and provenance. Left side of a possibly male carapace; note the clearly developed shagreen texture and the large adductor tubercle. × 65. PMSp347.

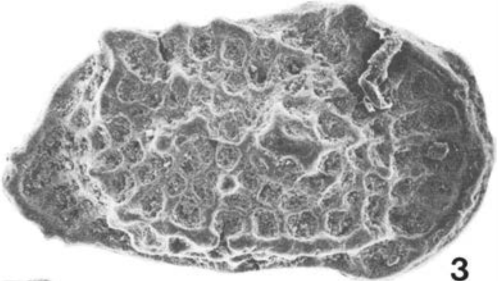
13. Same species and provenance. Dorsal aspect of a carapace. × 55. PMSp348.

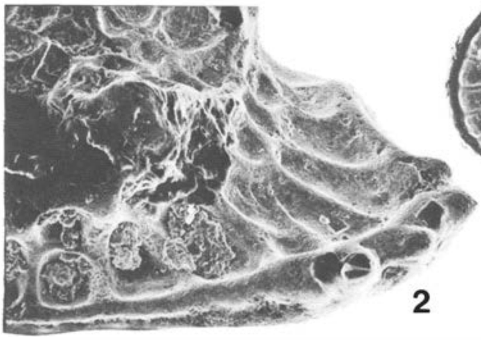
14. Same species. A right hinge, showing the hinge elements, the entrance of the ocular tube, located below the anterior hinge element. Turonian. Condemios de Arriba, sample 281. × 90. PMSp349.

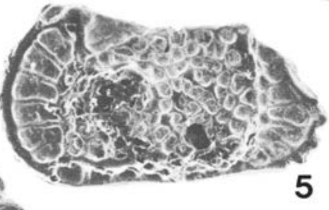
15. Same species. A left hinge showing the location of the ocular tube below the anterior socket. × 90. PMSp350.

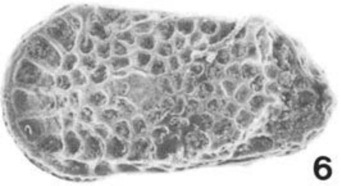
Plate 13


1

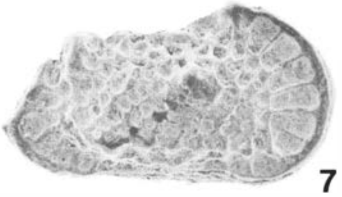

3

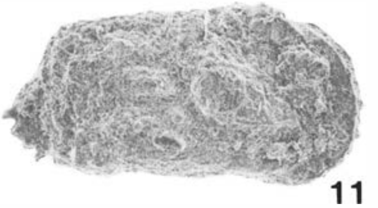

2

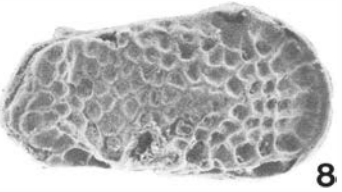

5

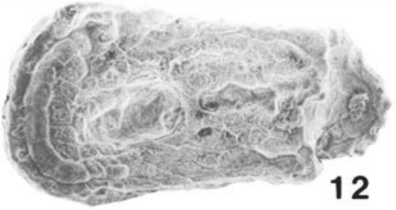

6

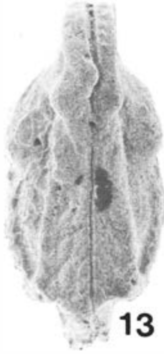

4

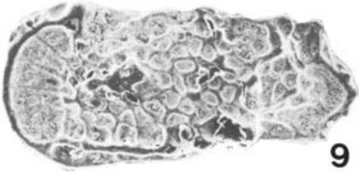

7


11


8


12


13


9


10


15

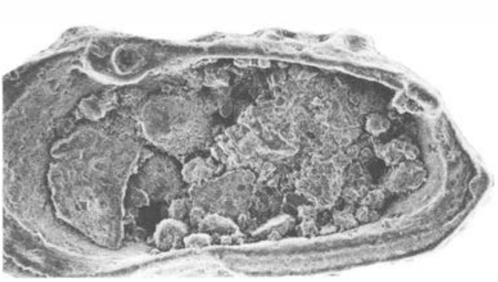

14

Plate 14

Mauritsina soriensis (Grekoff and Deroo)

1. Right side of a carapace; the posterior directed forking of the median rib is noteworthy. Turonian. Somolinos, sample 286. × 60. PMSp351. (See also Fig. 8A.)

2. Right side of a carapace. × 60. Turonian. Somolinos, sample 284. PMSp352.

3. A male specimen. Right side of a carapace showing the median costule joined to the dorsal rib; median rib "branched". Somolinos, sample 285. × 90. PMSp353.

4. Ventral aspect of a female; note the ornamental pattern of the ventral surface. Turonian. Carabias, sample 2510. × 60. PMSp354.

5. Anterior hinge-element of a right valve. Turonian. Moral de Hornuez, sample 276. × 190. PMSp355.

6. Same provenance. A left hinge. × 90. PMSp356.

7. Left side of a valve showing anastomizing pattern of reticulations and the postero-adductorial figure. Turonian. Condemios de Arriba, sample 281. × 60. PMSp357. This specimen has an "embryonal" medio-dorsolateral costule (cf. Babinot, 1980, p. 177).

8. *Mauritsina speciosa* Babinot. Stereophotographs of the right side of a carapace. Collection Babinot (Provence, France). × 50. PMPRo4. Coniacian.

9. Same specimen. Detail of the post-adductorial ornamental element. × 320.

10. *Mauritsina speciosa* Babinot? Right side of a carapace. Turonian. Somolinos, sample 289. × 60. PMSp358.

11. Same provenance: possibly same form. Left side of a carapace. The mode of rounding of the anterior margin and the convex posterodorsal margin are not typical. × 60. PMSp359.

12. Same species and provenance. Left side of a carapace. × 60. PMSp360.

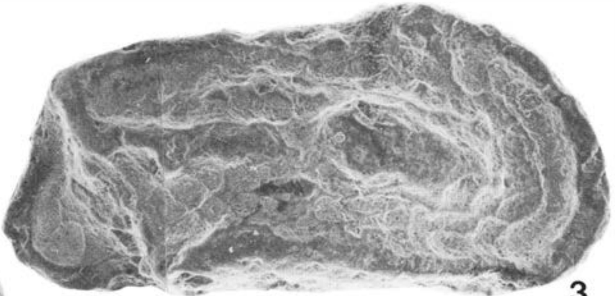
13. Individual possibly transitional to *Mauritsina radiocostata* with respect to ornamental properties. Left side of an angled carapace. Coniacian. Castrojimeno, sample 265. × 55. PMSp361.

14. *Mauritsina speciosa* Babinot? Angled dorsal view. Turonian. Moral de Hornuez, sample 272. × 50. PMSp369.

15. Same species and provenance. Male specimen; angled right side of a carapace – note the secondary ornament and the reticular walls. × 90. PMSp362.

Plate 14


1


3

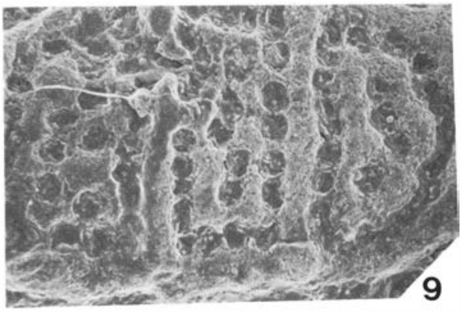

2


4


7


14

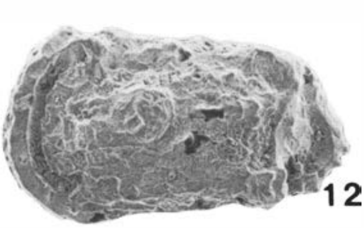

5


9


6

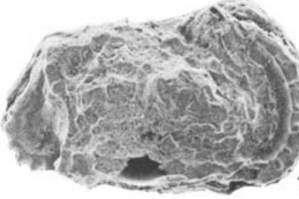

8


8


12


13


15


10


11

Plate 15

1. *Mauritsina speciosa* Babinot? Detail of the ventral ornament showing braided valve margins and the "vesiculose" secondary ornament. Turonian. Moral de Hornuez, sample 276. × 190. PMSp370.

2. Same species. Detail of the anterior margin showing the flattened reticular walls and the coarse secondary ornament "reticulations"). Turonian. Somolinos, sample 2811. × 190. PMSp371.

3. Same species. Ventral aspect of a carapace showing the irregular reticulations, the coarse posterior denticulations and the crimping of the anterior rim. Turonian. Somolinos, sample 286. × 55. PMSp372.

4. *Mauritsina radiocostata* sp. nov. Stereophotographs of a right valve, the holotype. Turonian. Moral de Hornuez, sample 277. × 65. PMSp373.

5. Same species. Posterior development of a male individual. Turonian. Moral de Hornuez, sample 2711. PMSp374.

6. Same species. Left side of a female carapace. Turonian. Moral de Hornuez, sample 273. × 50. PMSp374.

7. Same species and provenance. Angled dorsal view of a female individual. × 55. PMSp375.

8. Same species. Internal view of a right valve – note the deep muscular pit. Turonian. Moral de Hornuez, sample 277. × 55. PMSp376.

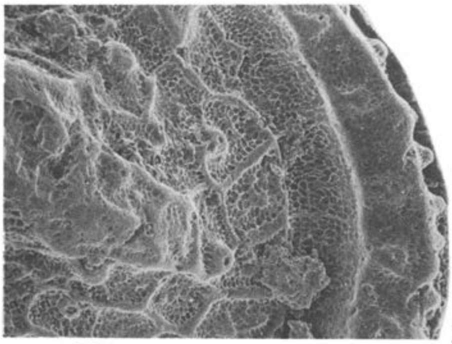
9. Same species and provenance. Note the nature of the secondary ornament and the small size of the conuli; a left valve. × 190. PMSp377.

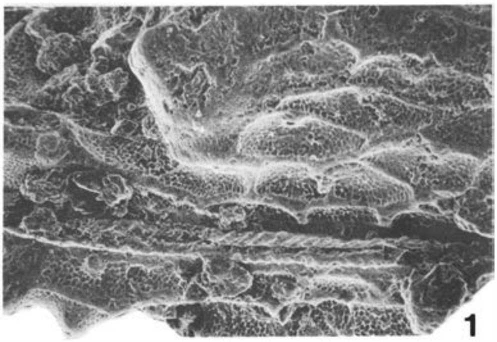
10. Same species. Illustration of the vaguely reticulated surface of the adductor muscle tubercle, the diffuse reticulation of the post-adductorial figure and the small conuli. × 200. PMSp378.

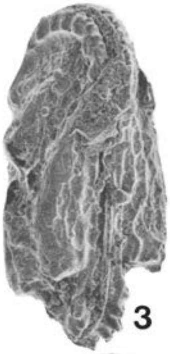
11. Same species. Left valve of a male specimen; note the ladderlike progression of the reticular walls in the intercostal depressions. Turonian. Condemios de Arriba, sample 281. × 90. PMSp379.

12. Same species. Stereophotographs of a left valve, a male. Coniacian. Castrojimeno, sample 265. × 50. PMSp380.

Plate 15


2

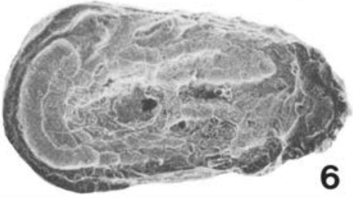

1

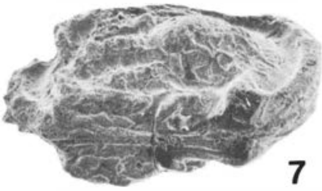

3


4

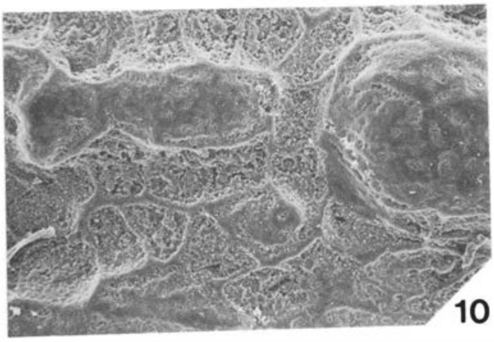

4

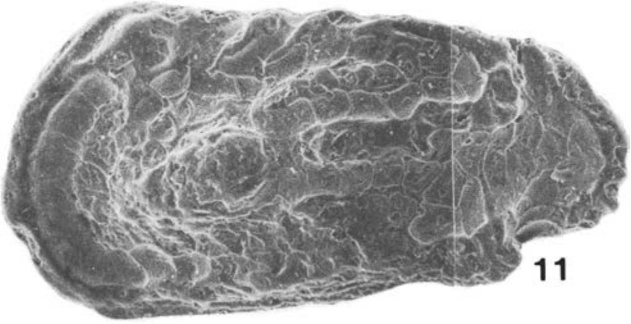

5

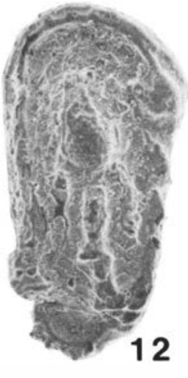

6


7

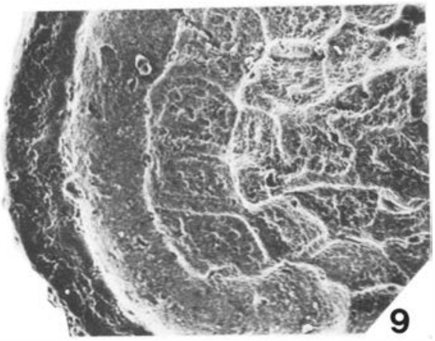

8


10


11


12


12


9