ZOOLOGISCHE MEDEDELINGEN

UITGEGEVEN DOOR HET

RIJKSMUSEUM VAN NATUURLIJKE HISTORIE TE LEIDEN

(MINISTERIE VAN CULTUUR, RECREATIE EN MAATSCHAPPELIJK WERK)

Deel 46 no. 10 27 augustus 1973

NOTE ON THE ECOLOGY OF RECENT OSTRACODS IN THE RIA DE AROSA (GALICIA, N.W. SPAIN)

by

M. J. M. BLESS

Rijks Geologische Dienst, Geologisch Bureau voor het Mijngebied, Heerlen, Netherlands

With 4 plates, 1 table and 12 figures

Introduction

During the summer months of 1962-1964 an extensive survey, covering several biological, oceanographical and sedimentological subjects, was made in the Ria de Arosa (Galicia, N.W. Spain) by a scientific team from the University of Leiden. Numerous observations and intensive sampling yielded valuable data for detailed studies of, for instance, Foraminifera, Diatomacea, Mollusca, sedimentology, etc. For a detailed summary of the investigations undertaken the reader is referred to Brongersma & Pannekoek, 1966. The present report deals with the ostracod fauna recovered from a number of samples taken in brackish and marine environments of this bay. The material was placed at the author's disposal through the courtesy of Drs. M. Brongersma-Sanders (Rijksuniversiteit, Leiden) and J. H. van Voorthuysen (Rijks Geologische Dienst, Haarlem). All samples studied have been stored with the collections of the Rijksmuseum van Natuurlijke Historie, Leiden.

The author wishes to express his sincere gratitude to Mr. D. ter Keurs (Bataafse Internationale Petroleum Maatschappij N.V., The Hague), who performed a preliminary identification of the ostracod species. Mr. L. R. Funcken (Heerlen) prepared the photographs of specimens coated with ammonium chloride.

Taxonomic problems

According to Ter Keurs at least 43 species are present in the Ria de Arosa. Only part of these have been identified with absolute certainty; most of the species here are either compared with similar forms from elsewhere, or are presented in "open" nomenclature. As pointed out by Noordermeer & Wagner (1969) ostracod taxonomy has reached a chaotic state in the last decades.

Apart from inadequate descriptions and illustrations for many species and their types, often insufficient material has been available for detailed population studies. Therefore data on the range of variation within a species are still scarce. Thus a correct identification of many species has become an impossible task. The only solution would be to undertake a complete revision of the type material, distributed over numerous museums and collections throughout the world, complemented by a study of new material from the type localities. This is, however, far from the scope of the present study.

Ecology

Thirty-one of the fifty samples received have yielded one or more ostracods (see fig. 12). Fifteen samples contained more than twenty-five ostracods, and from only ten of these could more than fifty specimens be recovered. This may in part be due to the small size of the original samples. According to Van Voorthuysen, who sieved most of these samples for his study of the Foraminifera, the size of the samples varied enormously and was often virtually too small.

With the exception of two samples near Villajuan, all of the other (ten) stations in the marine facies of the northern area of the bay did not yield any ostracods. Two samples from the polyhaline environment at the mouth of the Ulla river contained only a single specimen of ? *Cytheretta*. In the southwestern area two specimens of ? *Cytheretta* have been collected from one of the five samples, the others being completely barren, although the size of several of the samples obtained exceeded fifty grams. It was therefore concluded that the ostracod fauna in these parts of the bay is poor. Only two of the thirty-one stations in the remaining part of the bay and in the oceanic zone did not yield ostracods. It is presumed that the number of ostracods recovered from these samples depends largely upon the size of the original samples.

Examination of the ostracod fauna from the thirty-one samples has shown that ten morphographically distinct types — each representing one or more species — are present in five or more of the samples (Table 1). They make up 91% of the total ostracod fauna. Their distribution is shown in text figs. 1 to 10. They can roughly be subdivided into smooth-shelled, slightly ornamented and heavily ornamented forms.

Heavily ornamented forms (text figs. 1-4 + pl. 1 figs. 1-15) seem to be restricted to the water between Isla Salvora and Isla de Arosa. They have been found in water with depths varying between 20 and 60 m. They are also present in some samples in the oceanic zone. The morphographic

types recognized are: *Carinocythereis, Pterygocythereis, Costa* and *Quadracythere.*

The slightly ornamented forms (text figs. 5-7 + pl. 2 figs. 16-28) occupy a zone in which the water depth is up to 40 m. In one station east of Isla de Arosa a few specimens have been found at 50 m depth. In the oceanic zone they were recovered from several stations. The morphographic types recognized are: *Aurila, Loxoconcha* and *?Cytheretta.*

Smooth-shelled ostracods (text figs. 8-10 + pl. 3 figs. 29-41) are more or less restricted to shallow waters of less than 20 m depth. In the oceanic zone they have been collected from depths up to 80 m. The morphographic types recognized are: *Bairdia, Xestoleberis, Cytherois* (*Paracytherois*) and *Paradoxostoma* [1]).

All other species (pl. 4 figs. 42-63) (about 55% of the number of species) are only present in small quantities in less than five samples. They constitute only 9% of the total ostracod fauna, and do not seem to have much value as environmental indicators at present.

It can easily be concluded from the distribution maps in text figs. 1-10 that smooth-shelled ostracods and heavily ornamented forms more or less exclude each other within the bay; only in the oceanic zone are they found together in large quantities. Slightly ornamented ostracods are most common in the same environment as the smooth-shelled forms, but often they have also been recognized in assemblages of the heavily ornamented type.

Comparison with the zonation of the Ria de Arosa, as proposed by Cadée (1968) (text fig. 11), shows that the heavily ornamented forms are restricted to the "outer central bay" of that author. The assemblages of smooth-shelled ostracods are restricted to the marginal zones. The slightly ornamented forms seem to prefer the marginal zone, but can commonly be found in the "outer central bay". All these ostracods have also been found in the oceanic zone, presumably as allochthonous elements of the thanatocoenosis. The "inner central bay" and "middle central bay" did not yield any ostracods. The southwestern area (according to Cadée, 1968, part of the "marginal shallow zone") is also poor in ostracods. No explanation has been found for this phenomenon. Differences in salinity or substrate with other parts of the bay have not been detected.

It is interesting to note that the relatively thick-shelled, heavily ornamented ostracods occupy an environment with a very fine substrate (mud — sandy mud), whereas the thin-shelled, smooth forms are restricted to the marginal

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1) Of *Paradoxostoma* only species with an elongated carapace with H/L-ratio <0.50 are here considered.

TABLE I

Distribution of the ostracods in the Ria de Arosa

Sample No.	Depth of water in m	Salinity: M = marine, P = polyhaline	Sediment*	Environment after Cadée (1968)	Number of ostracods	*Carinocythereis* sp. aff. *carinata*	*Pterygocythereis jonesi*	*Costa* spp.	*Quadracythere* sp.	*Aurila convexa*	*Loxoconcha* spp.	"*Cytheretta*"	*Bairdia mediterranea*	*Xestoleberis* spp.	*Cytherois* (*Paracytherois*) spp. + elongated *Paradoxostoma* (H/L < 0.5)	Other ostracods
1901	70	M	C	OC	86			4	2	48	11		8	2		11
1900	85	M	FS + D	OC	5	1						1				3
1776	45	M	FS + D	OC	11					5						6
1774	75	M	FS + D	OC	4					1	2		1			
1772	82	M	CS + D	OC	4											4
1771	78	M	C	OC	10					1				2	2	5
1837	35	M	C + D	OB	129	8	45	54			11	1				
1835	50	M	C	OB	25		2	23								
1579	45	M	C + FS	OB	28	9	11				7	1				
1195	44	M	C + D	OB	48	6	30	12								
151	25	M	C	OB	14	1		6			5	1				1
113	52	M	C	OB	8	1		3			3					1
1201	14	M	CS, D, P	OB/MD	46				2	33	1		1	3	1	5
1200	25	M	C + D	OB/MD	6			1		3						2
1836	45	M	C	MD/OB	1											1
1833	30	M	C + D	MD/OB	10					2	5	3				
1832	25	M	C	MD/OB	108	7	13	53	1	5	6	1		1		21
1187	11	M	CS + P	MD/OB	54			1	2	43	2			2		4
163	18	M	C + P	MD/OB	114				8	67	20		4	2		13
1902	38	M	FS	MD	158	4	1	15		43	31	1	5	24	3	31
1632	11	M	C	MD	5					1	3					1
1156	20	M	C + P	MD	21						5		9	2	1	4
1102	0.80	M	S, C, P	MD	2							2				
166	18	M	C + P	MD	165					63	7		79			16
1174	18	M	C, FS, P	MS/MD	147					7	12		118	1	3	6
17	4-5	M	C	MS	28					11	2		15			
015	0	M	?	MS	37						2			14	19	2
09	0	M	?	MS	89					1	2			50	32	4
1867	8	M	C + D	MS/IB	65					53	2					6
14	8.5	M	C	MS/IB	9			1			2		2			4
1694	1.2-2.0	P	?	RM	2							1				1

* S = Sand; FS = Fine Sand; CS = Coarse Sand; C = Silt; P = Phytobenthos; D = Shelldebris.

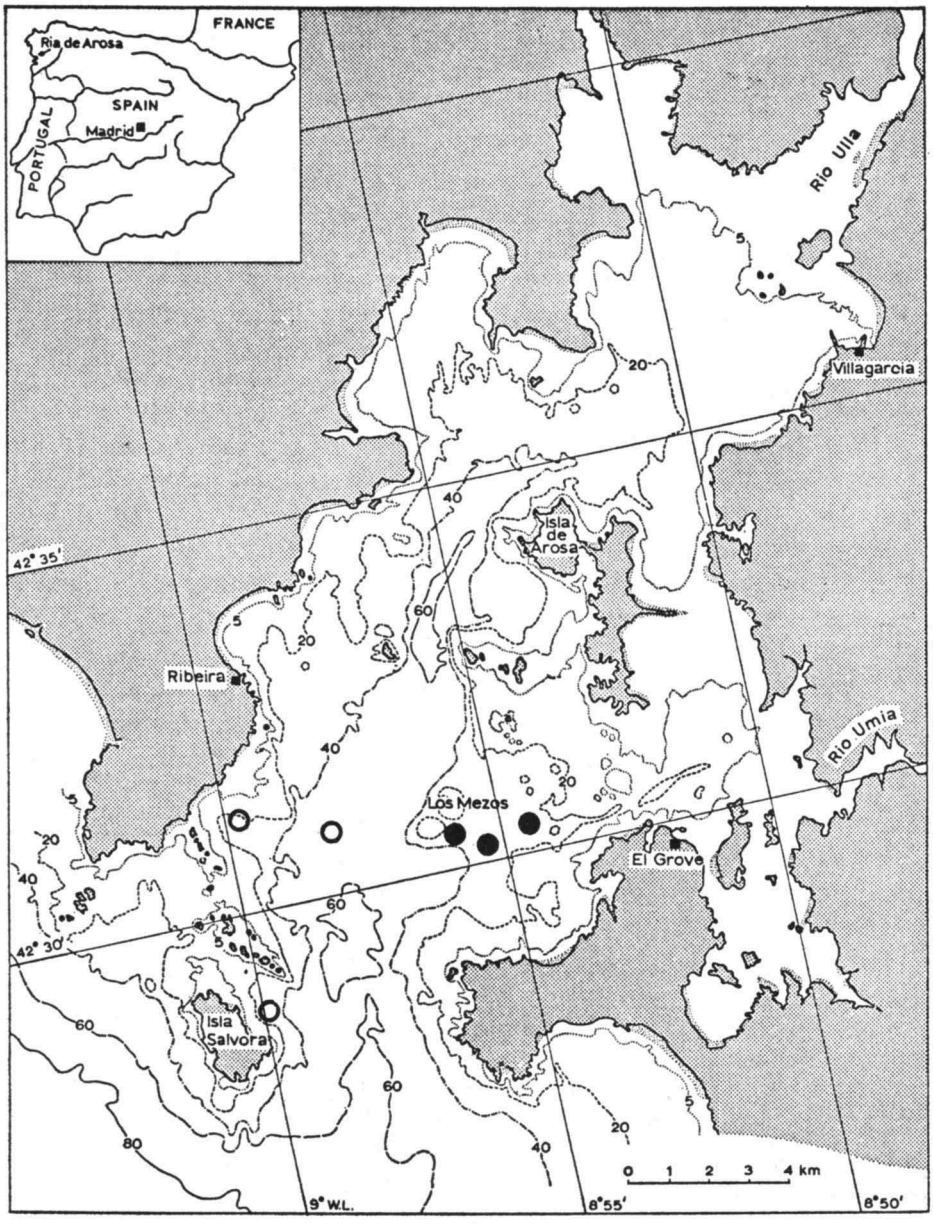

Fig. 1. Distribution of heavily ornamented ostracods of morphographic type *Pterygocythereis*. Open circles: specimens of morphographic type present; black dots: specimens of morphographic type abundant.

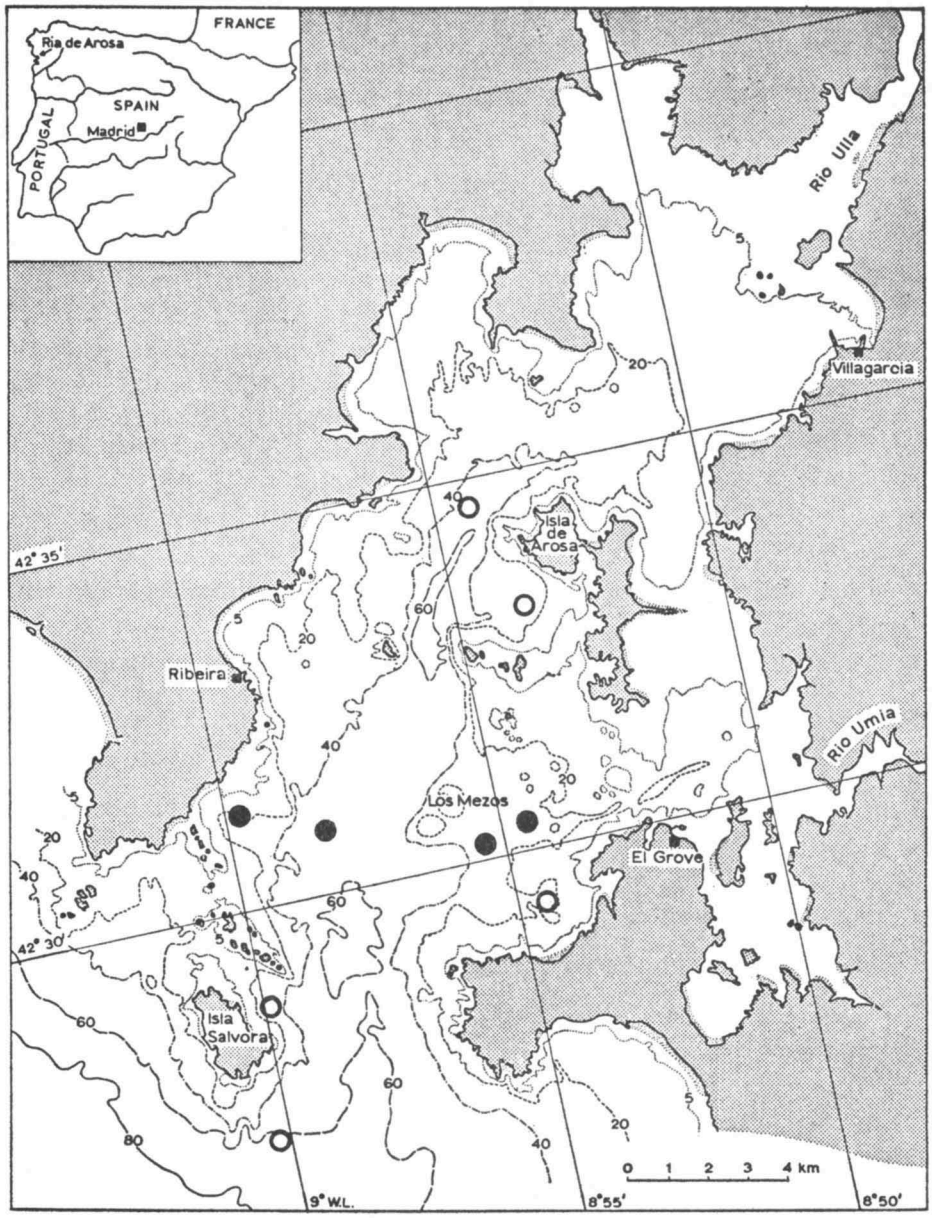

Fig. 2. Distribution of heavily ornamented ostracods of morphographic type *Costa* (for explanation see fig. 1).

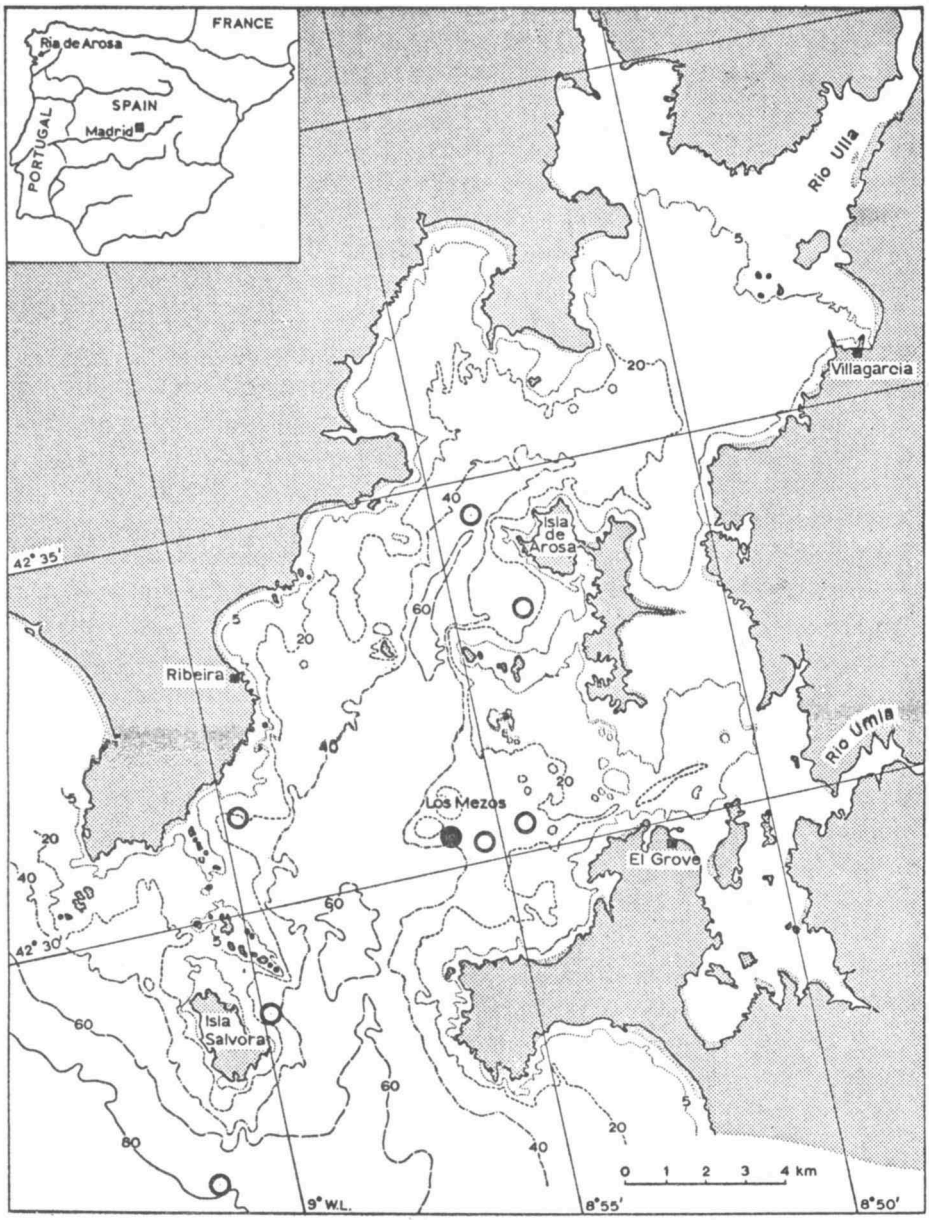

Fig. 3. Distribution of heavily ornamented ostracods of morphographic type *Carinocythereis* (for explanation see fig. 1).

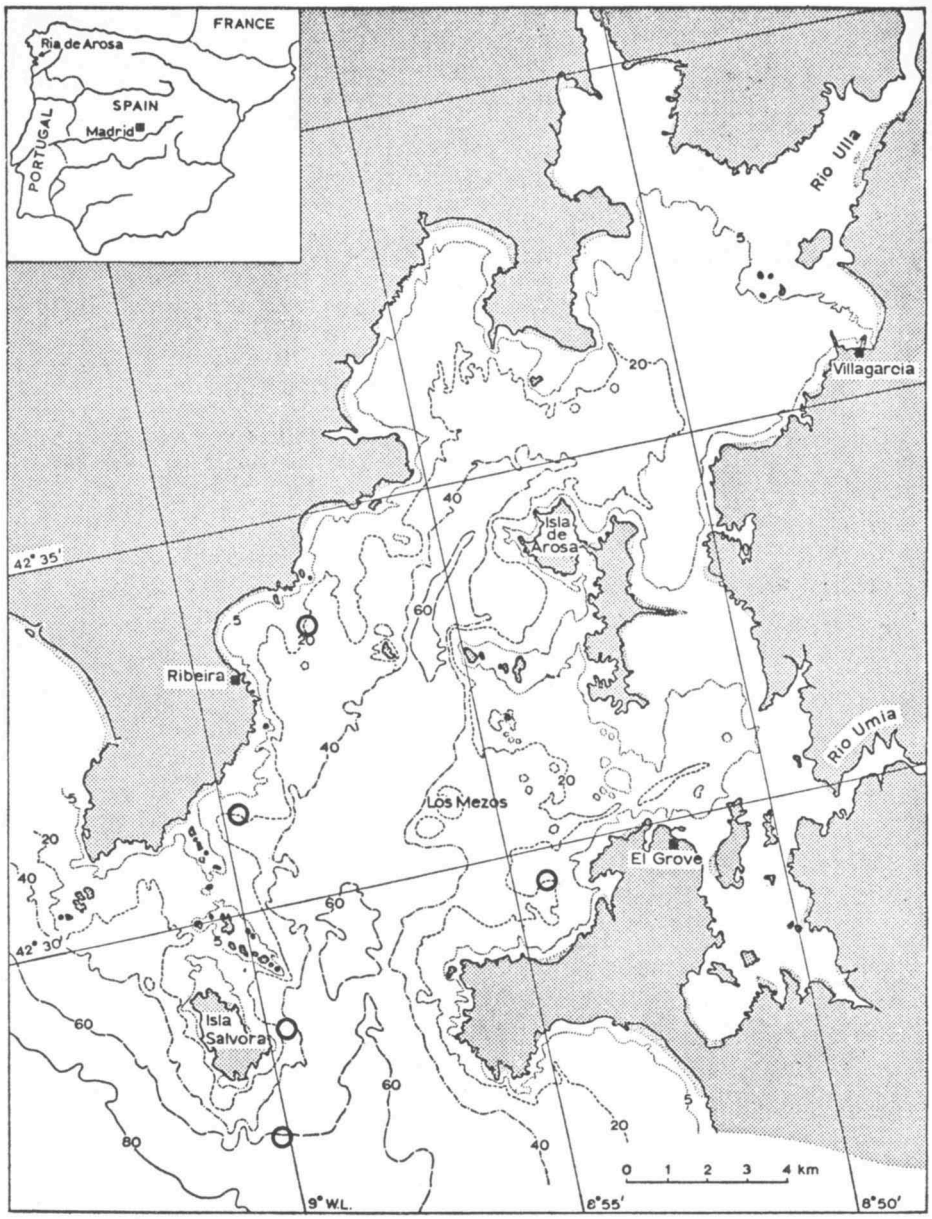

Fig. 4. Distribution of heavily ornamented ostracods of morphographic type *Quadracythere* (for explanation see fig. 1).

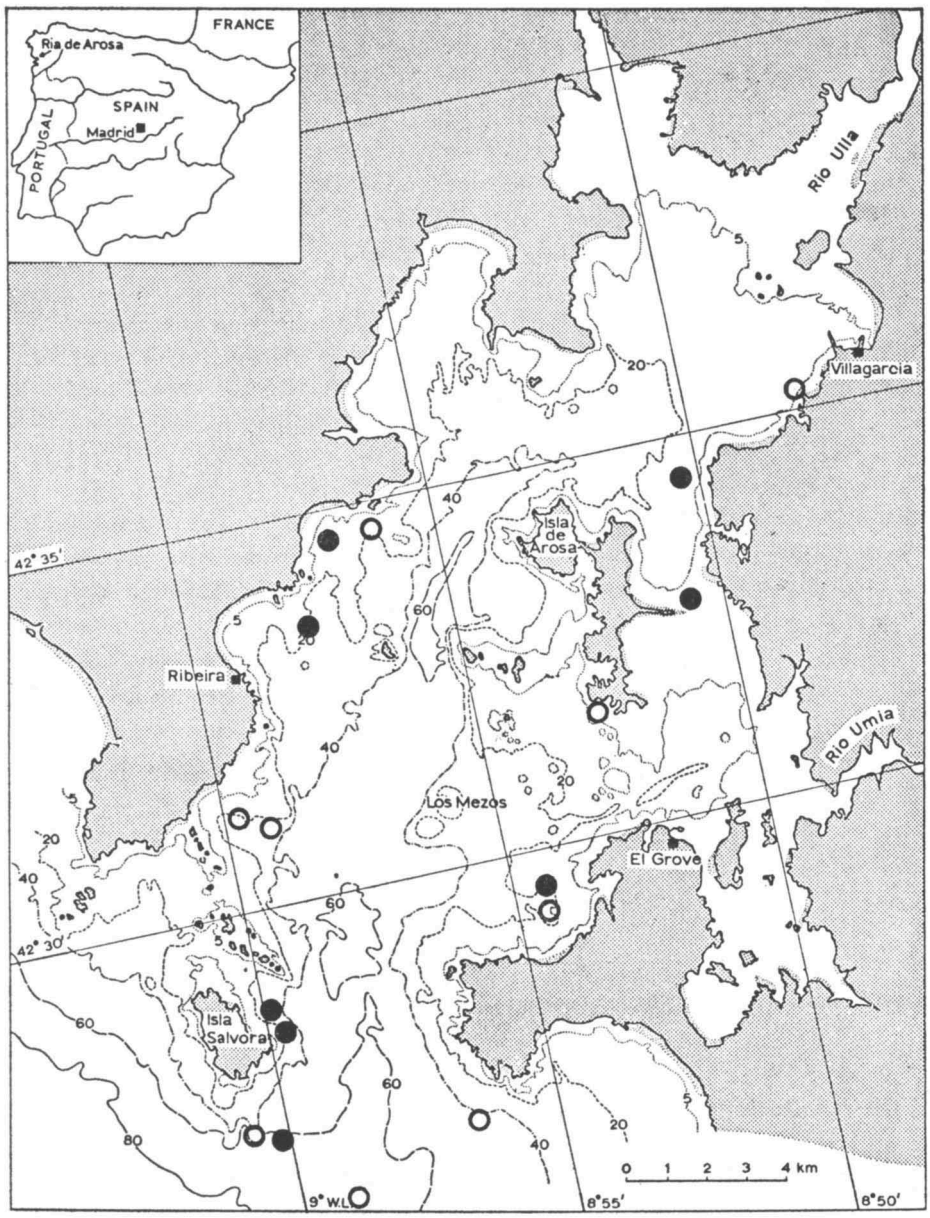

Fig. 5. Distribution of slightly ornamented ostracods of morphographic type *Aurila* (for explanation see fig. 1).

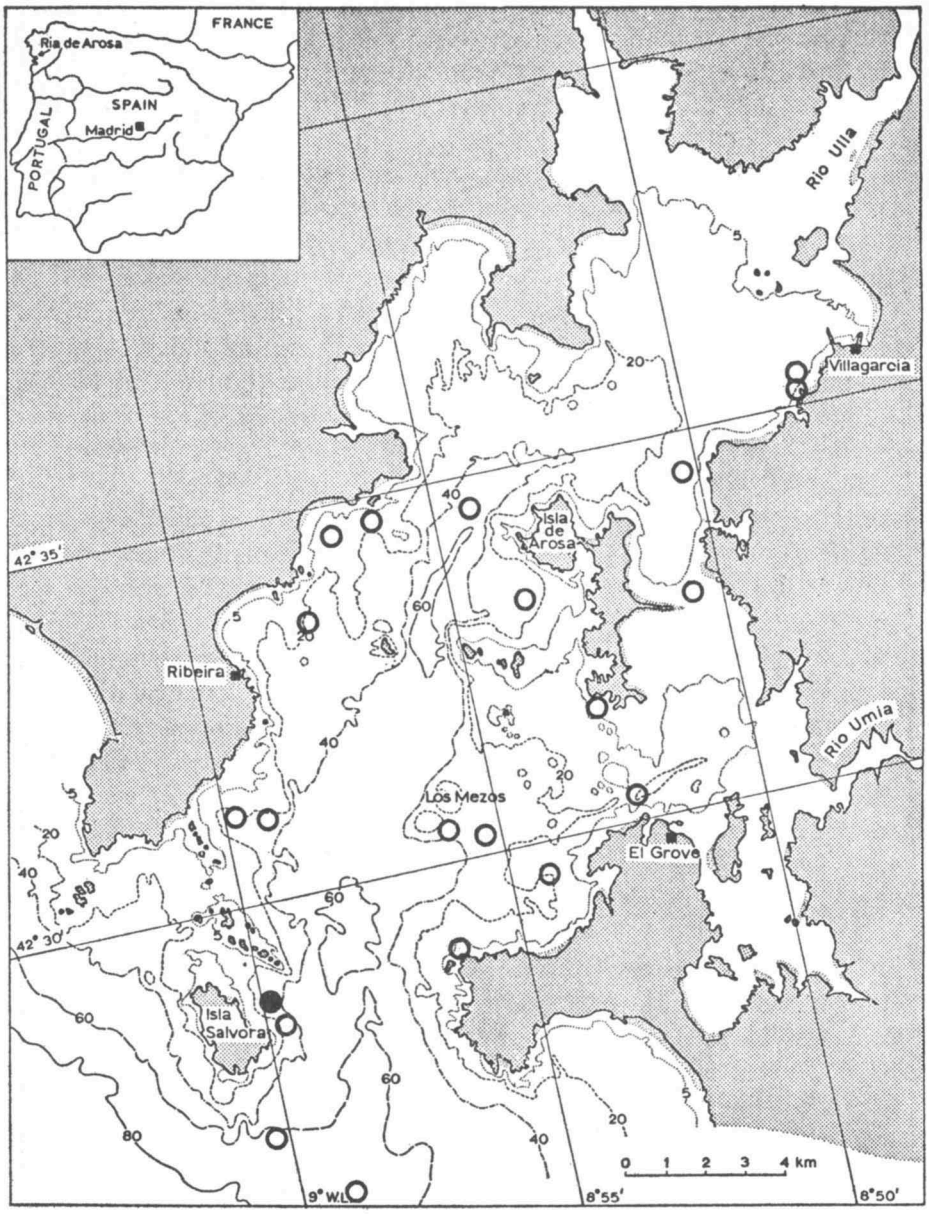

Fig. 6. Distribution of slightly ornamented ostracods of morphographic type *Loxoconcha* (for explanation see fig. 1).

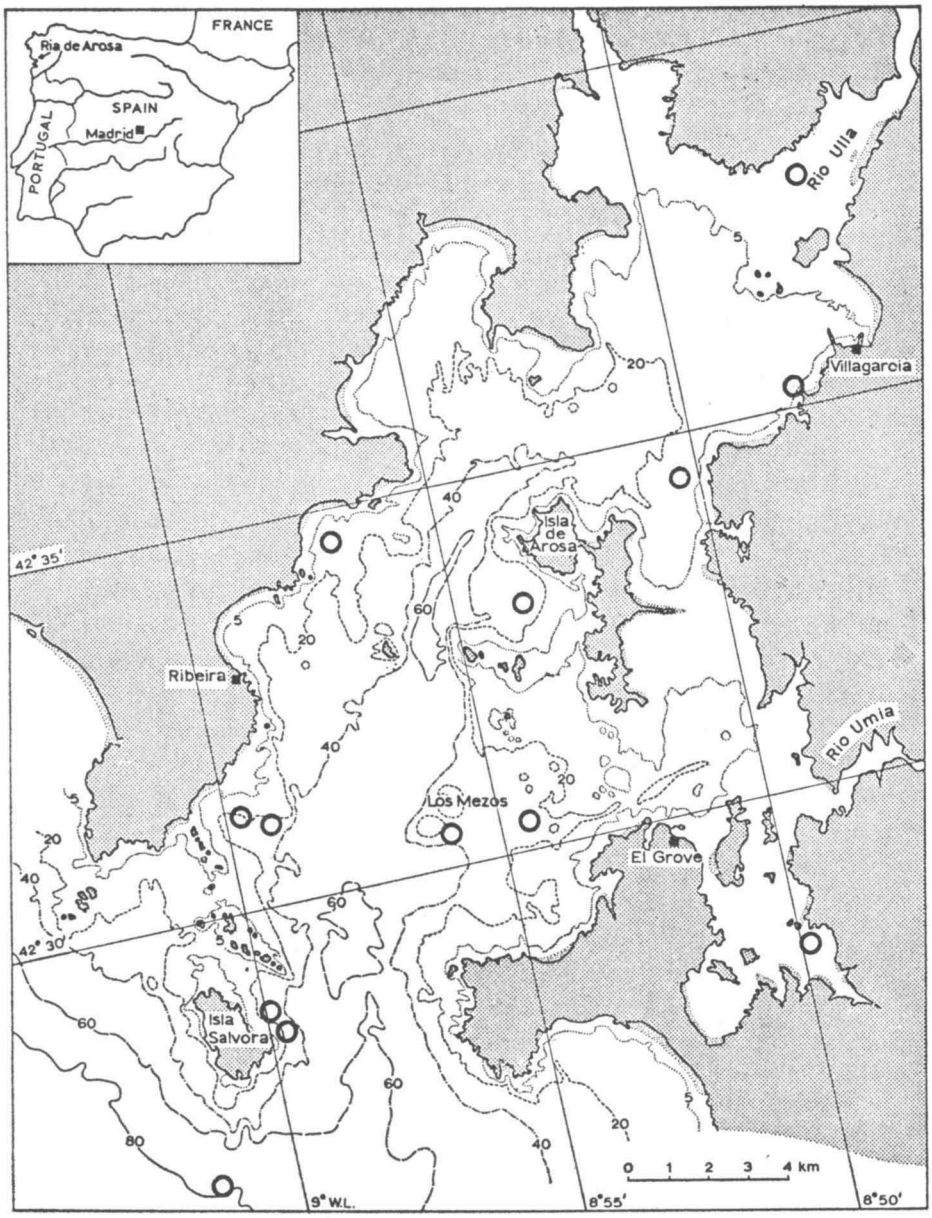

Fig. 7. Distribution of slightly ornamented ostracods of morphographic type ?*Cytheretta* (for explanation see fig. 1).

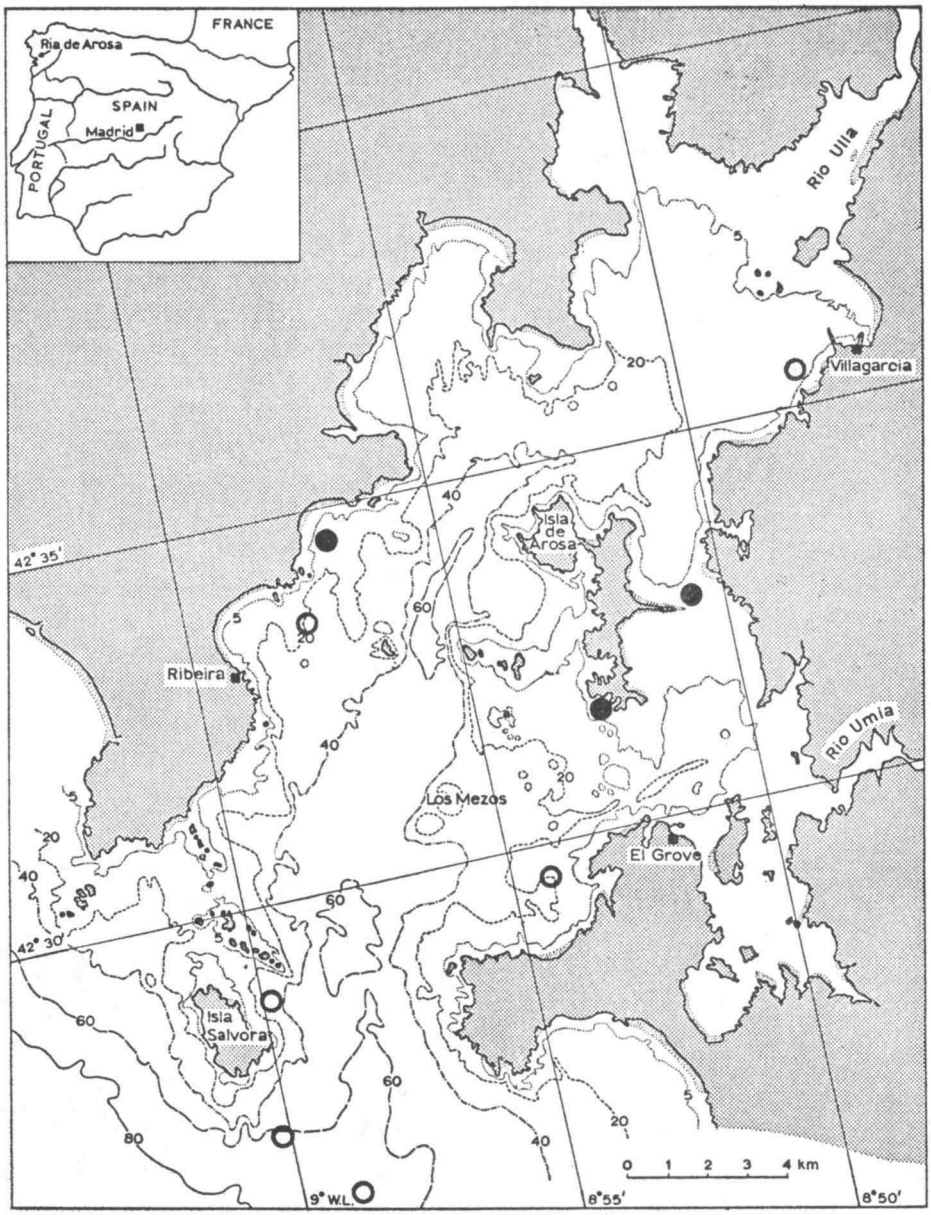

Fig. 8. Distribution of smooth-shelled ostracods of morphographic type *Bairdia* (for explanation see fig. 1).

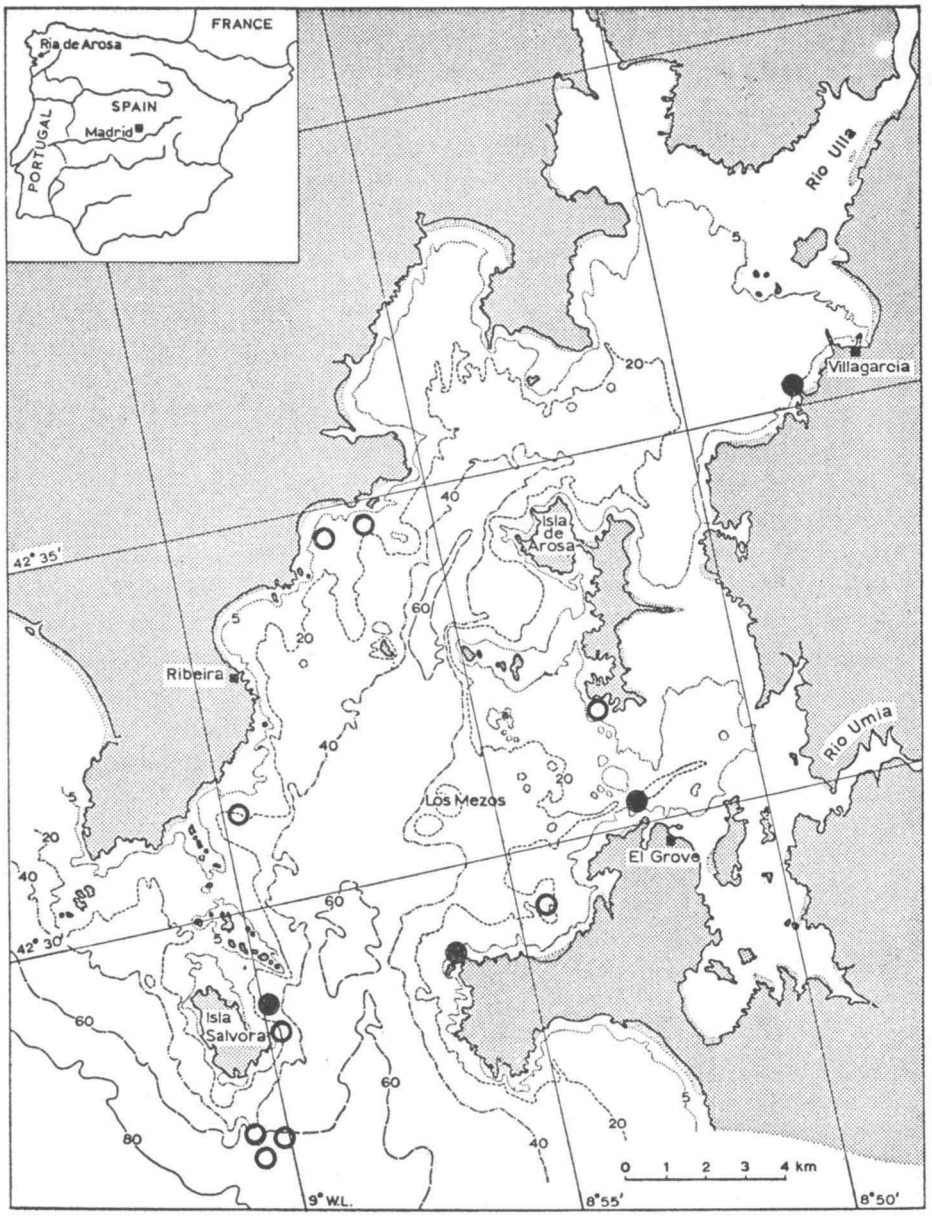

Fig. 9. Distribution of smooth-shelled ostracods of morphographic type *Xestoleberis* (for explanation see fig. 1).

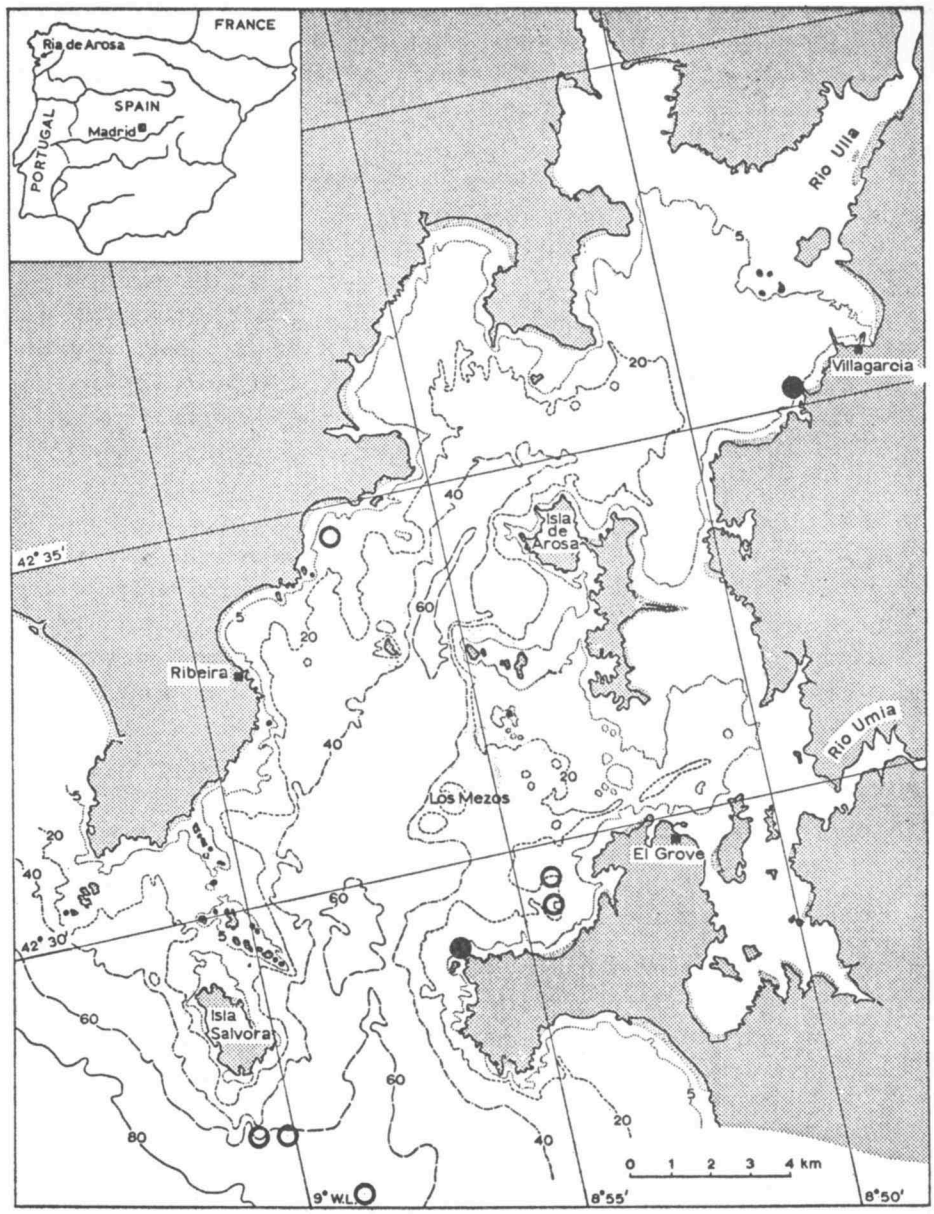

Fig. 10. Distribution of smooth-shelled ostracods of morphographic type *Cytherois* (*Paracytherois*) and *Paradoxostoma* (only species of *Paradoxostoma* with elongated carapace (H/L-ratio less than 0.50)). (for explanation see fig. 1).

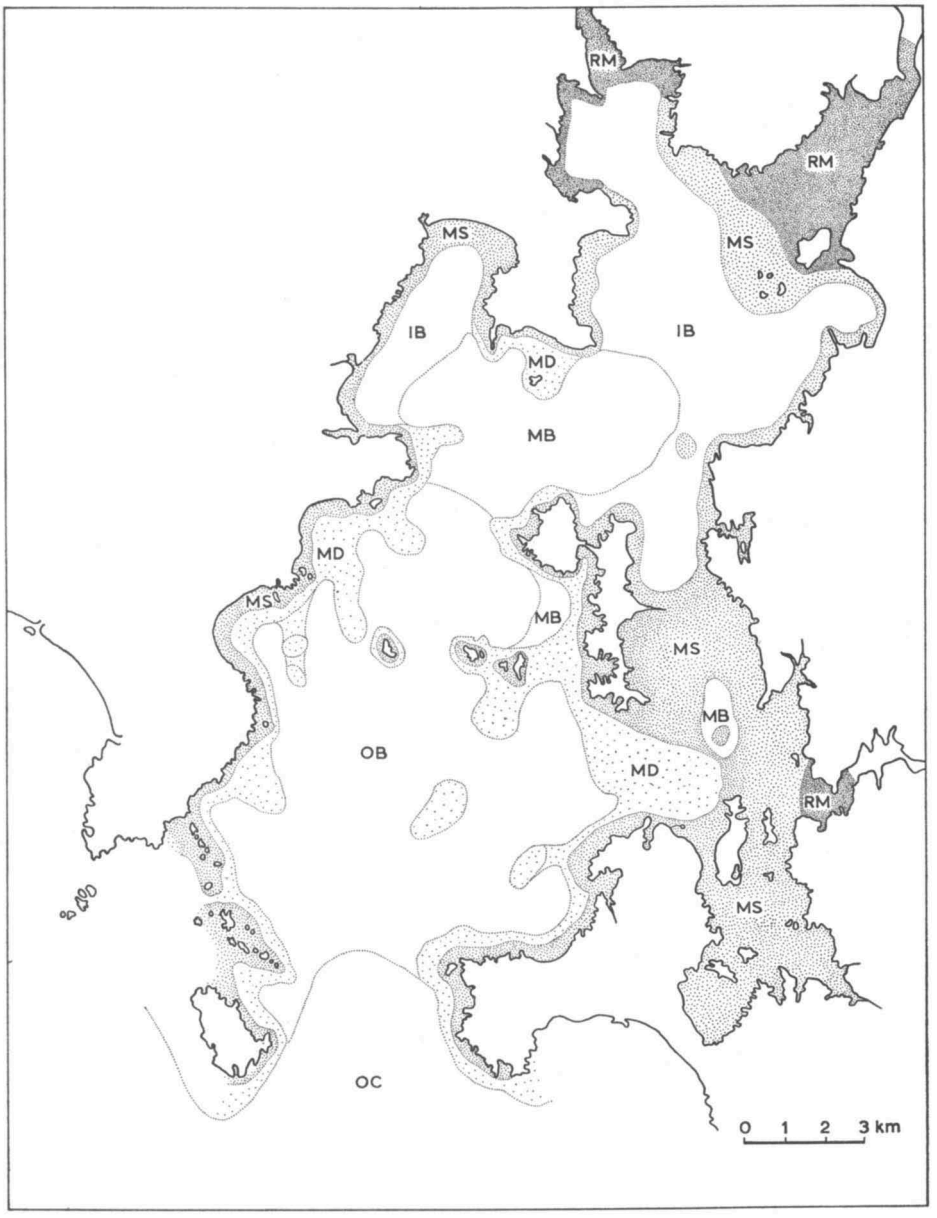

Fig. 11. Zonation of the Ria de Arosa proposed by Cadée (1968). IB, inner central bay; MB, middle central bay; OB, outer central bay; MD, marginal deep zone; MS, marginal shallow zone; OC, oceanic zone; RM, river mouth, polyhaline zone. After Cadée, 1968.

zones with a much coarser substrate (sand — very coarse sand). It is obvious that no relationship exists between the smooth-shelled ostracods and the substrate. This assumption is supported by the fact that several of the samples yielding smooth-shelled ostracods also contained seaweeds and/or calcareous algae, whereas those with an ostracod assemblage of the heavily

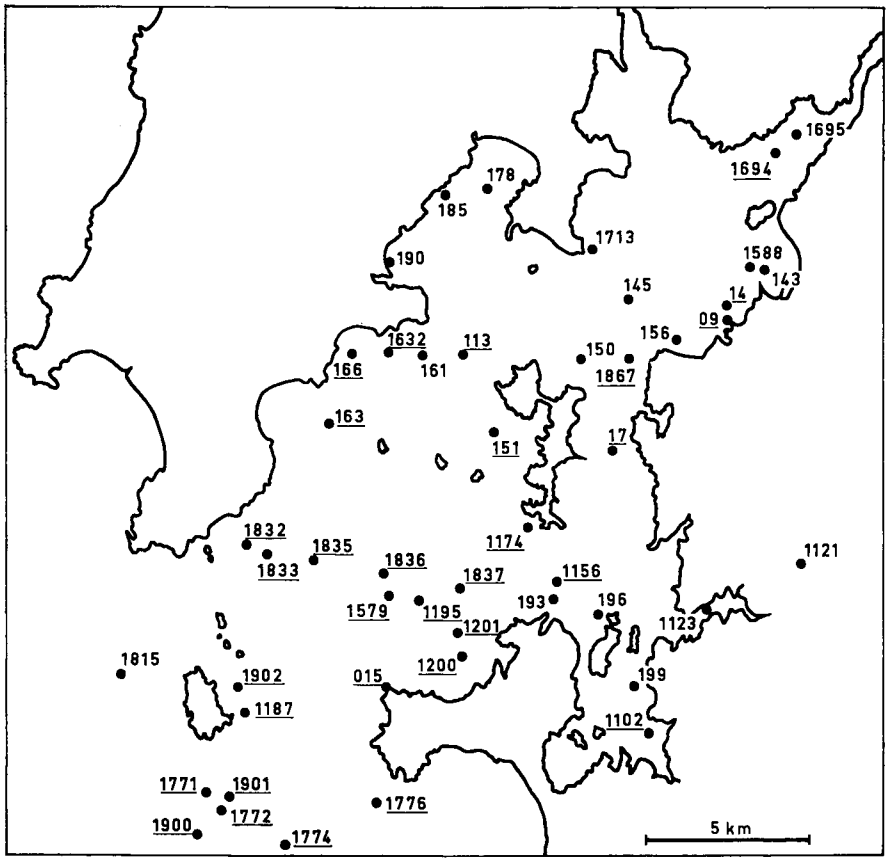

Fig. 12. Location map of samples investigated. Only underlined numbers yielded ostracods.

ornamented type did not. Puri, Bonaduce & Malloy (1964) gave fauna lists of ostracod assemblages in association with the sea-grass *Posidonia*, algae and seaweeds in the Gulf of Naples. They enumerated several species of *Paradoxostoma*, *Bairdia* and *Xestoleberis* characteristic for this environment. Rome (1964) and McKenzie (1964) stated that *Bairdia* and *Xestoleberis* are often associated with the sea-grass *Posidonia*. McKenzie stated that

Loxoconcha is associated also with the phytobenthos. According to Rome, species of *Carinocythereis* and *Pterygocythereis* prefer a sandy or muddy substrate in the Gulf of Monaco; *Aurila* and *Loxoconcha* have been collected both from fine sand and ooze, and from *Posidonia* by that author. After Elofson (1941) *Aurila* lives on sand or shell debris. It is possible that several forms of the group with slightly ornamented carapace actually live between the phytobenthos on the sand. Whether the distribution of marine grasses, algae and seaweed is controlled by other ecological factors than depth or transparency of the water could not be concluded from the data available.

In summary it is impossible to distinguish any ecological factor with dominant influence on marine ostracod distribution in the Ria de Arosa. Most probably several factors are interrelated. It seems, however, that the ostracod distribution within the bay is principally affected by the presence or absence of phytobenthos, which in its turn may be dependent upon depth or clarity of the water, and on the coarseness of the substrate. The oceanic zone of the bay is suggested to be invaded by numerous allochthonous elements. The practical absence of ostracods in large parts of the bay cannot be explained by the present data, although there seems to exist some relation with special environments (the "inner" and "middle central bay" of Cadée).

Further and more detailed studies will be necessary to solve these problems.

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Explanation of the plates

Plate 1

Ostracods of heavily ornamented type, characteristic for the "outer central bay". Figs. 1-4. *Pterygocythereis jonesi* (Baird). Figs. 5-9. *Costa runcinata* (Baird). Figs. 10-12. *Quadracythere* spp. (figs. 10-11 : compare *Cythere hoptonensis* Brady & Norman; *Cythere concinna* Brady, Crosskey & Robertson). Figs. 13-15. *Carinocythereis* sp. aff. *carinata* (Roemer) (compare *Carinocythereis rubra* (Mueller)).

Plate 2

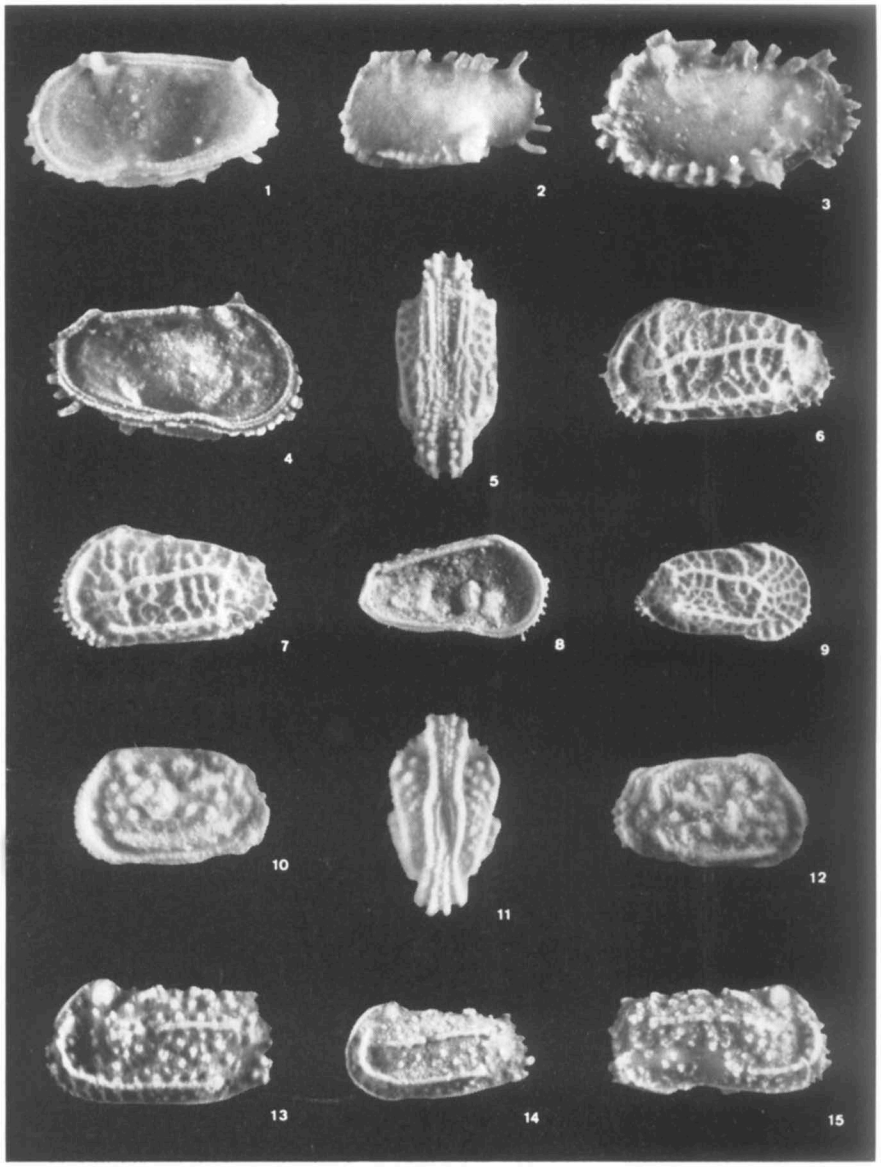
Ostracods with slightly ornamented carapace. Figs. 16-18. *"Cytheretta"* spp. Figs. 19-20. *Loxoconcha guttata* Norman. Fig. 21. *Loxoconcha elliptica* Brady. Figs. 22-24. *Loxoconcha rhomboidea* (Fischer). Figs. 25-28. *Aurila convexa* (Baird).

Plate 3

Thin-shelled ostracods with smooth carapace; apparently related to phytobenthos. Figs. 29-32. *Bairdia mediterranea* Mueller. Fig. 33. *Xestoleberis* sp. 1 (compare *Xestoleberis dispar* Mueller). Fig. 34. *Xestoleberis aurantia* (Baird). Fig. 35. *Xestoleberis* sp. 2. Fig. 36. *Xestoleberis* sp. 1 (compare *Xestoleberis dispar* Mueller). Fig. 37. *Paradoxostoma* sp. aff. *triste* Mueller. Fig. 38. *Cytherois* (*Paracytherois*) sp.(compare *Paracytherois striata* Mueller). Figs. 39-41. *Paradoxostoma* sp. aff. *rarum* Mueller.

Plate 4

Ostracods without apparent value as environmental indicators because of the lack of data. Fig. 42. *Paracypris* sp. (compare *Paracypris polita* Sars). Figs. 43-44. *Paradoxostoma* sp. 1 (compare *Paradoxostoma caesum* Mueller). Figs. 45-46.*Pontocypris* sp. (compare *Pontocypris frequens* Mueller). Fig. 47. *Urocythereis* sp. aff. *margaritifera* (Mueller). Fig. 48. *Heterocythereis albomaculata* (Baird). Figs. 49-50. *Urocythereis* sp. aff. *favosa* (Roemer) sensu Ruggieri. Fig. 51. *Hemicythere villosa* (Sars). Fig. 52. *"Leptocythere"* sp. Fig. 53. *Leptocythere* sp. (compare *Leptocythere crispata* (Brady)). Fig. 54. *Callistocythere pallida* (Mueller). Figs. 55-56. *Semicytherura* sp. (compare *Semicytherura acuticostata* (Sars)). Fig. 57. *Semicytherura angulata* (Brady). Fig. 58. *Cytherura* sp. Fig. 59. *Hemicytherura cellulosa* (Norman). Fig. 60. *Hemicytherura videns* (Mueller). Figs. 61-63. *Cytheropteron* sp. aff. *nodosum* Brady.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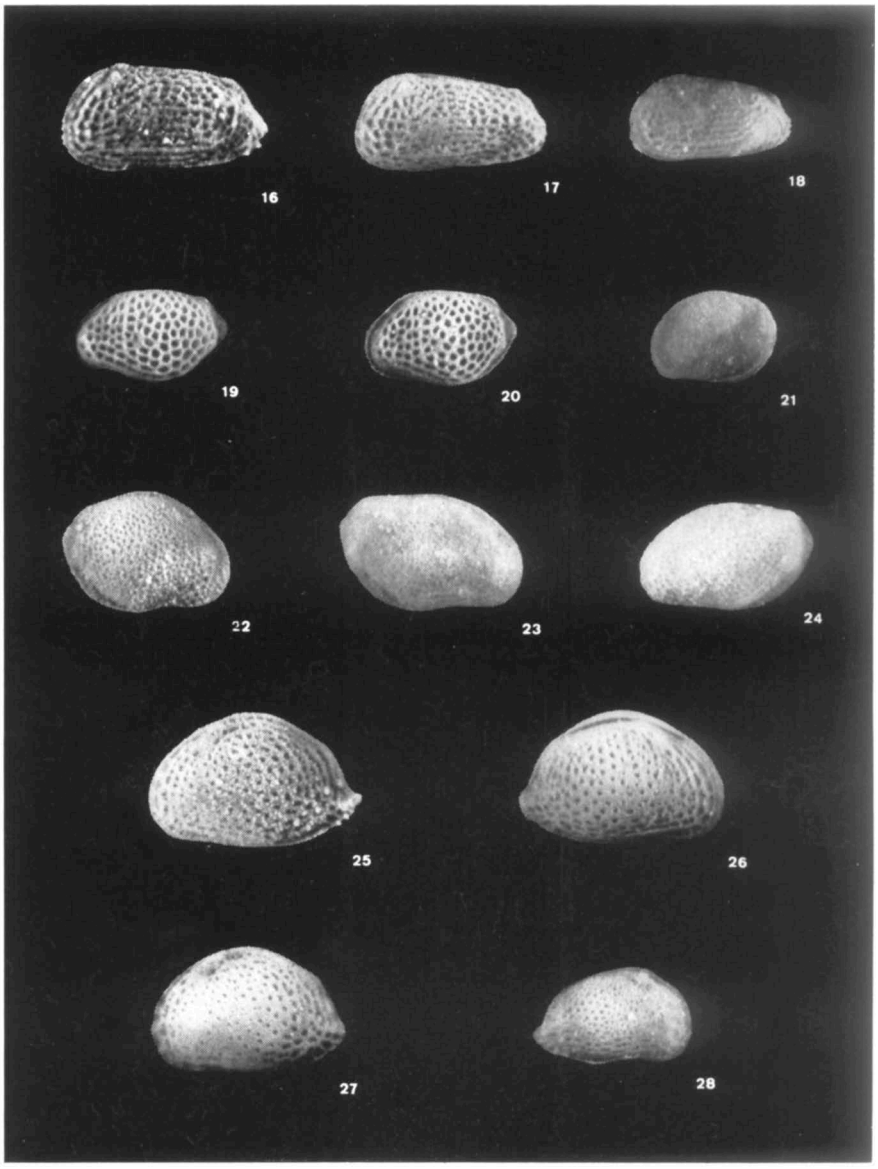
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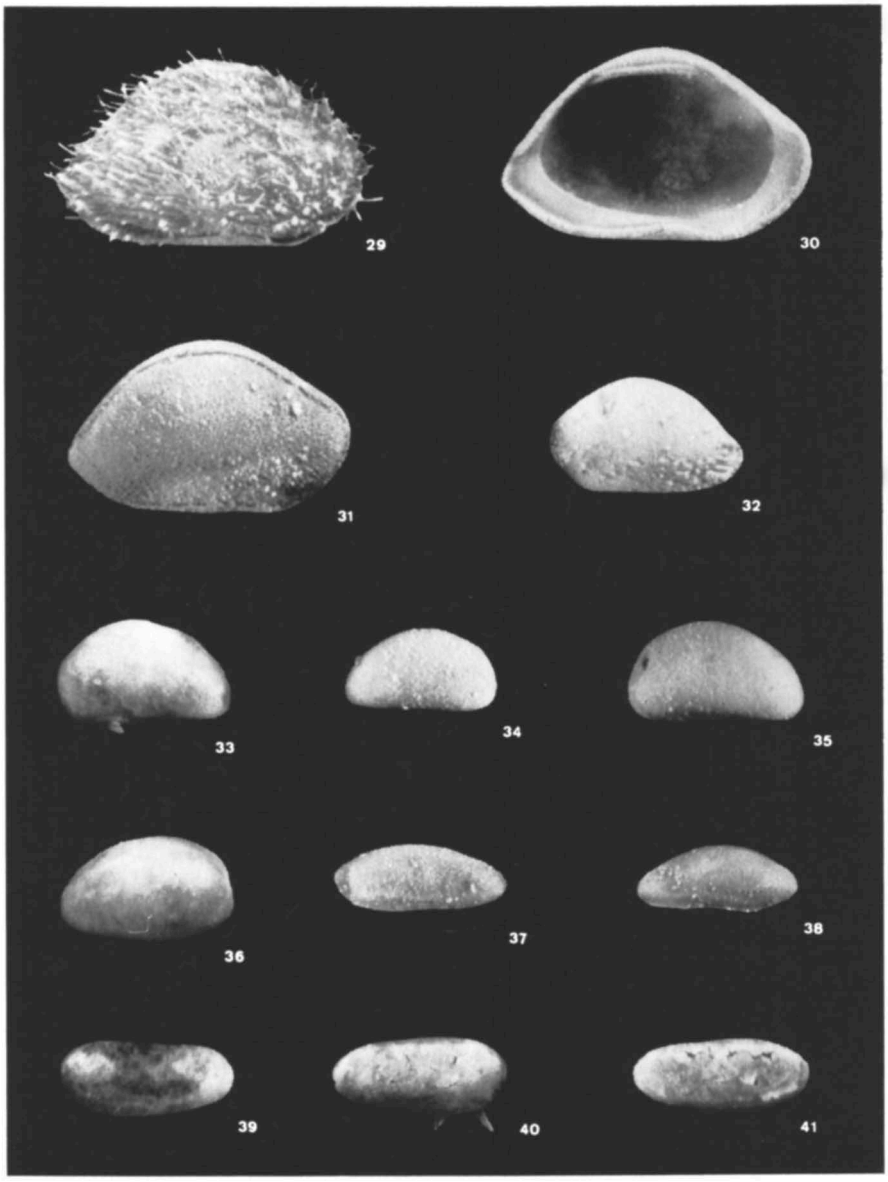
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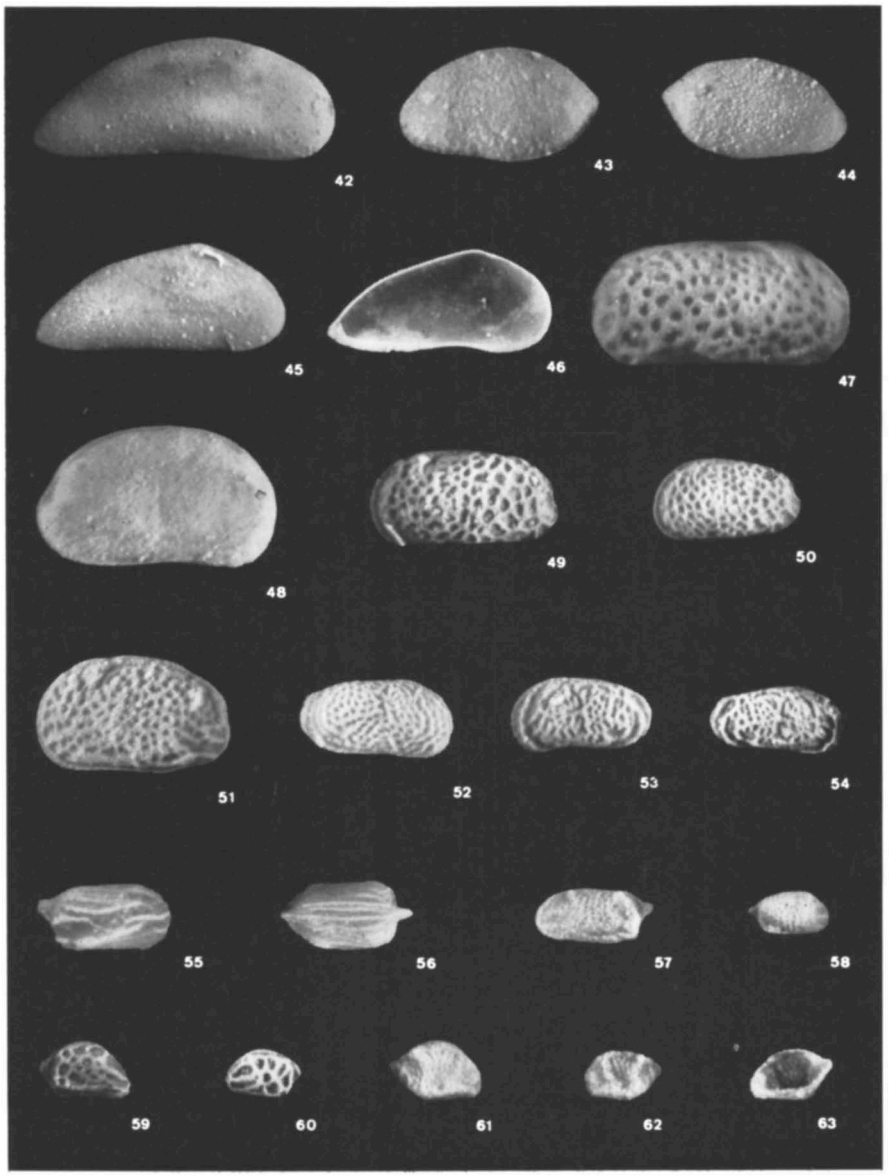
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