ECOPHENOTYPIC ORNAMENTATION OF OSTRACODS SPECIES AND SALINITY OF THE AMBIENT WATER

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Interpretation of ecophenotypic ornamentations of ostracods carapaces in relation with the environmental parameters has given rise to several studies. A first, two parameters have been mainly considered: salinity and temperature.

Ecophenotypism is the morphological answer to the environmental parameters of species having a genetic plasticity. This answer depends on the ecological valence of the species. Ecophenotypism, in the experimental conditions, is replicative.

Salinity is theoretically defined as the total number of grams of inorganic dissolved salt ions present in 1 kg of seawater. (Libes, 1992).

According to Carbonnel (1969), Sandberg (1964), Vesper (1975), Garbett & Maddocks (1979), van Harten (2000), there is a positive correlation between thickness, ornamentation of carapaces and the rise in salinity of the ambient water. Nevertheless, Garbett & Maddocks (1979), Peypouquet (1977), Bodergat (1983), Debenay et al. (1994) note a decrease of thickness and ornamentation of the carapaces, for the same species, in the hyperhaline environments.
Acording to Carbonnel (1975), Peypouquet (1977), Hartman (1982), Ikeya and Ueda (1988), high temperatures could favour the development of ornamentation.
Nutrients inputted in the environment depends on the season; they can also influence the ornamentation of carapaces (Bodergat 1983, Bodergat et al. 1993, Carbonel et Hoibian, 1988, Ruiz et al., 2006).

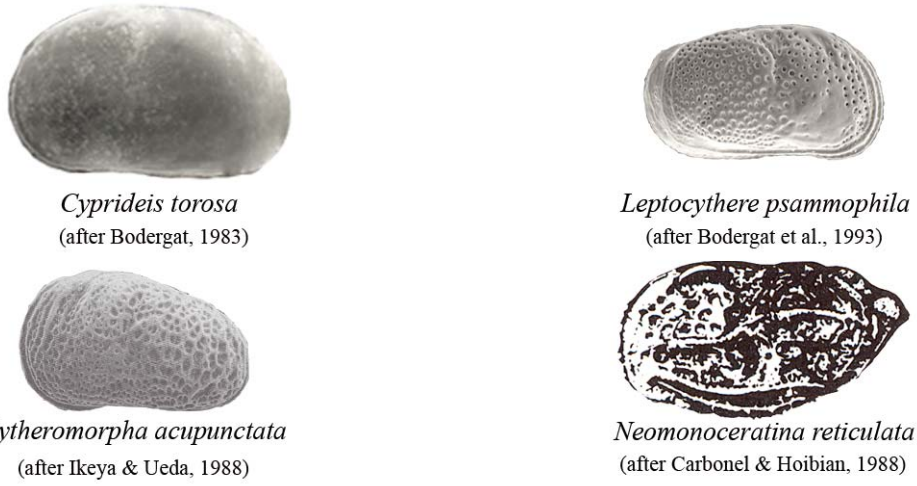


Fig. 1 – Influence of salinity of ambient water on ecophenotypic ornamentations of *Cyprideis torosa*, *Leptocythere psammophila*, *Cytheomorpha acupunctata* and *Neomonoceratina reticulata*.

We examine the effects of salinity on the ornamentation of carapaces of *Cyprideis torosa*, *Leptocythere psammophila*, *Cytheromorpha acupunctata* and *Neomonocratina reticulate* (Fig. 1)

CYPRIDEIS TOROSA

Carapaces of *Cyprideis torosa* have been analyzed by means of the electronic microprobe. They have been collected in France, in Noirmoutier island, on the Atlantic littoral, on the Mediterranean littoral, in France and in Spain, near Alicante. Salinity ranges from 3g/l to 140g/l (Bodergat, 1983).

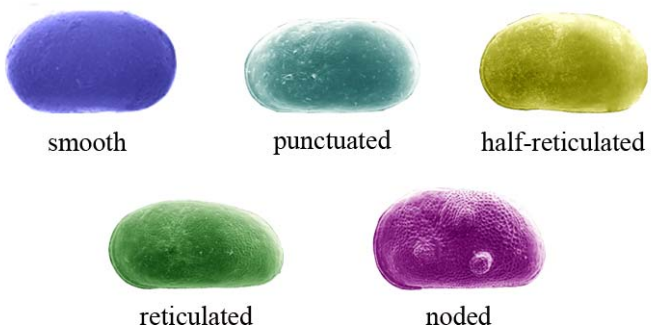


Fig.2 – Types of ecophenotypic ornamentations of the analyzed specimens of *Cyprideis torosa*.

Five types of ornamentation occur among the analyzed specimens (Fig. 2): smooth, punctuated, half-reticulated, reticulated and noded.
Samples have been analyzed by means of the electronic microprobe. Results have been submitted to a Correspondence analysis (CA, Fig.3).

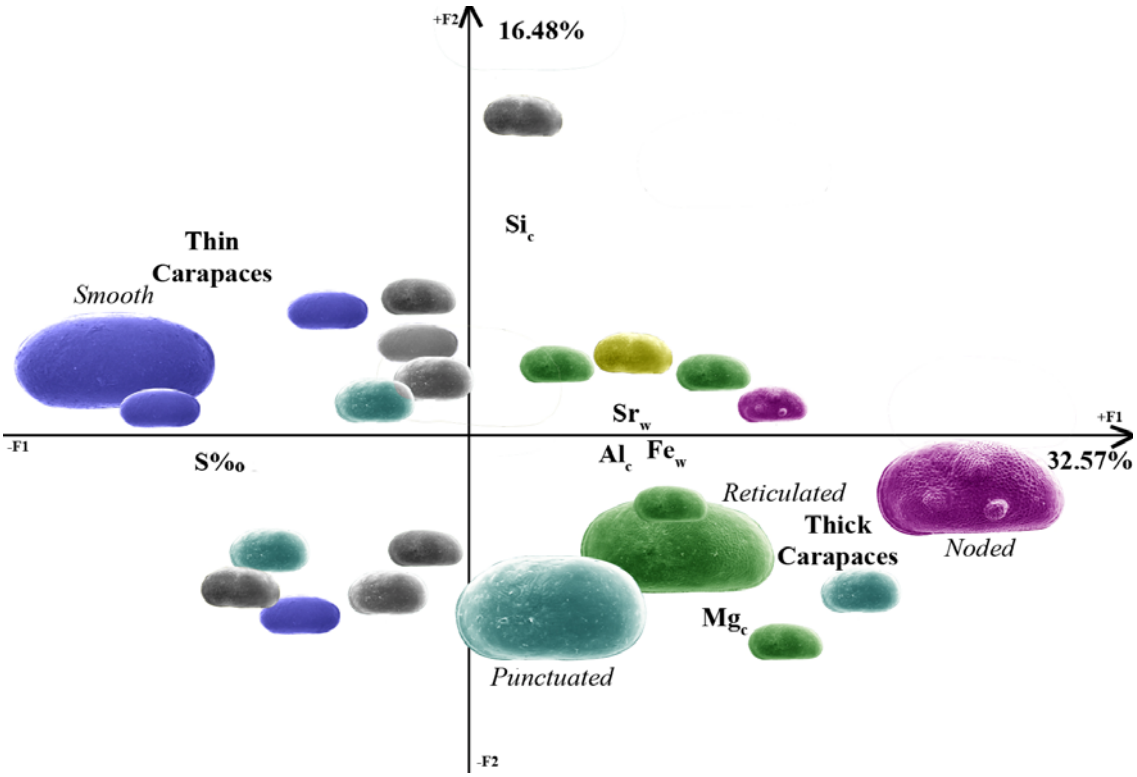


Fig. 3 – F1-F2 plan of a correspondance analysis of the results of the chemical analyze by means of the electronic microprobe of *Cyprideis torosa.*

In this study, salinity is the most important parameter which influences the ornamentation of carapaces although, according to Keyser (2005), high contents in Ca in the ambient water could explain the realization of noded carapaces. The punctuated character is associated with the summer season.

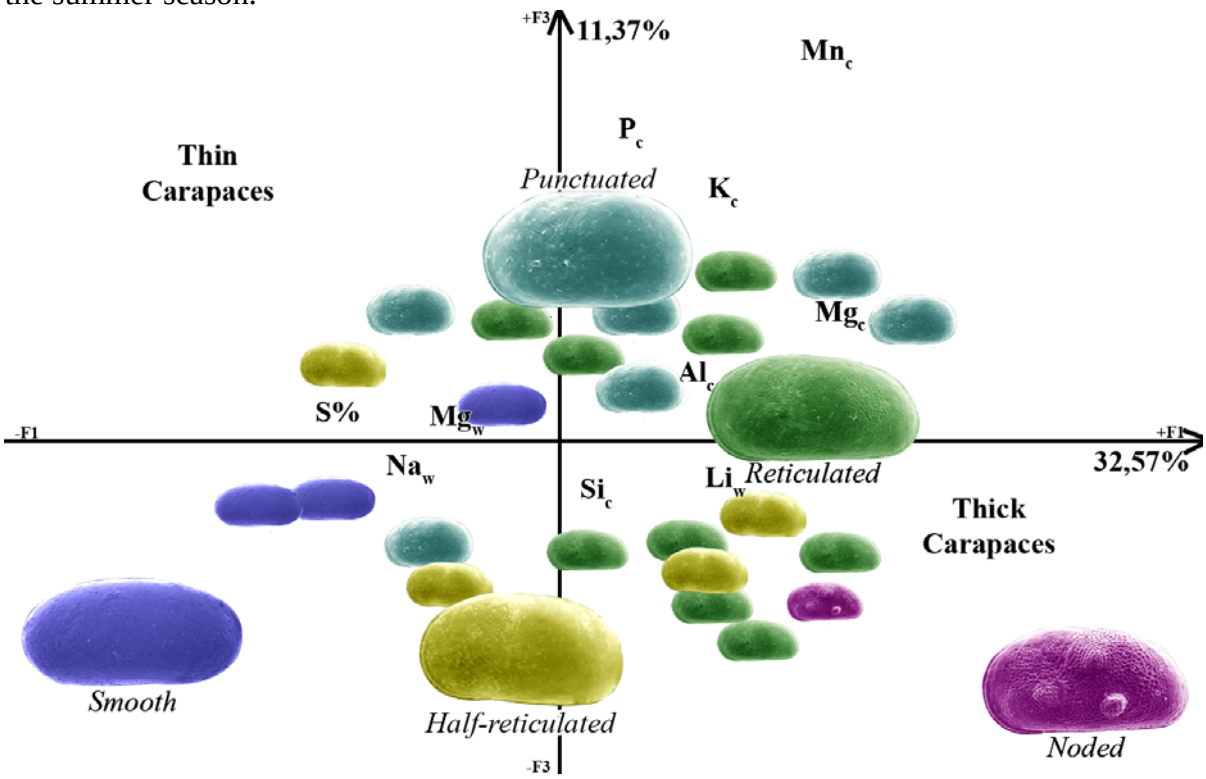


Fig. 4 - F1-F3 plan of a Correspondance analysis of the results of the chemical analyze by means of the electronic microprobe of *Cyprideis torosa.*

On the other hand, on F3 factor (Fig.4), this character is also associated to K-P-Mn which gives evidence of a low rate of sedimentation (Cotillon 1968); as K is linked to the clays, punctuated character could be developed on fine substrates; the half- reticulated character is associated to Si, linked to quartz and consequently could favour a coarser substrate.

LEPTOCYTHERE PSAMMOPHILA

Samples of living *Leptocythere psammophila* have been collected (Bodergat et al., 1993) in the littoral of Baltic sea (salinity: 16g/l), North sea (22g/l<Salinity<35g/l) and English channel, in France (35g/l< Salinity<50g/l), three times a year (spring, end of summer and winter).

Carapaces of *L. psammophila* are reticulated and show a smooth area in the antero-ventral part of the carapace; this surface area is more or less important (Fig. 5). Punctuations are always larger and less numerous on the carapaces of the specimens of the Baltic sea. (low salinity) which do not possess an anterior smooth area, or if it's present, it's insignificant. The same comparison with respect to seasons does not reveal any differences except that variability in the size of the punctuations is greater in the specimens sampled during the summer than those sampled during the spring.

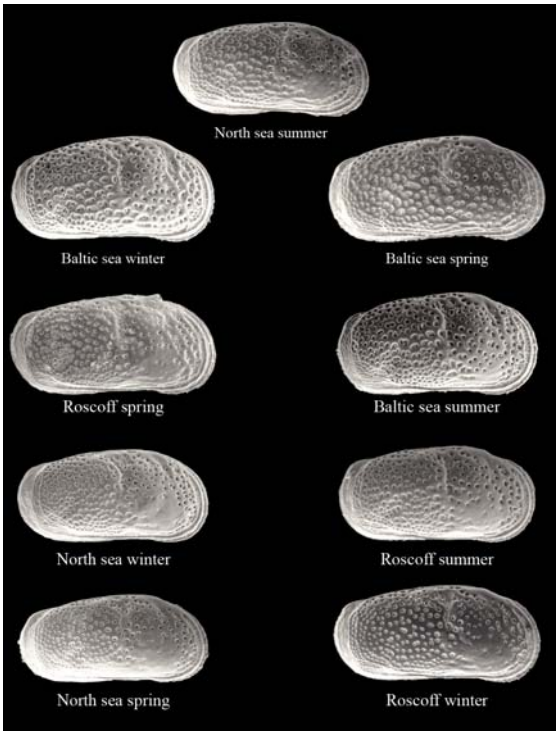
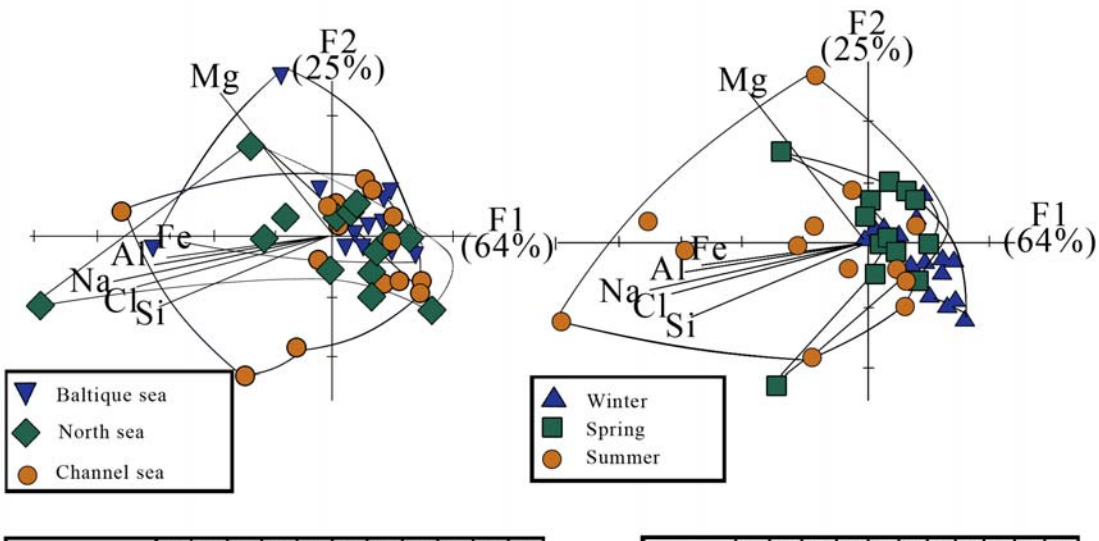


Fig.5 – Ecophenotypic ornamentations of *Leptocythere psammophila* (after Bodergat et al., 1993).

Specimens have been analyzed by means of an electronic microprobe and thirteen chemical elements were detected.



	Al	Fe	Na	Ci	Si	S	Sr	Mn	Mg	P	Ba
North sea Baltic sea	67,1	20,1	2,8	1,6	6,3	5,0	2,0	5,0	1,1	1,2	1,3
Channel sea North sea	25,5	40,2	1,7	1,1	1,7	2,5	2,0	1,0	1,1	1,3	2,0
Baltic sea Channel sea	2,7	2,0	1,7	1,8	3,8	2,0	1,0	5,0	1,3	1,7	2,5

	Al	Fe	Na	Cl	Si	S	Sr	Mn	Mg	P	Ba
Summer winter	25,3	14,2	23,3	21,2	50,6	3,0	2,0	1,1	3,3	1,0	2,3
Winter Spring	2,6	5,5	6,6	6,1	30,3	2,0	2,0	2,0	1,6	1,5	1,5
Spring Summer	10,0	77,8	3,5	3,5	1,7	1,5	4,0	2,2	2,0	1,5	1,5

Fig. 6 - Plan F1-F2 of a Normalized Principal Component Analysis (NCPA) of *Leptocythere psammophila* specimens gathered by stations and by seasons and comparisons of variances (after Bodergat et al. 1991 and 1993).

Results of a Normalized Principal Component Analysis does not make possible to perceive homogeneous ensembles for the stations even if the Baltic specimens are less dispersed; in return, the grouping of the samples by seasons make evident the chemical composition of the summer individuals is controlled by variation in water salinity and in terrigeneous sediment supply.

Comparison of variances shows important differences for the North sea samples and for the summer samples.

Ornamentation has relation with salinity but it is also influenced by variability of the chemical composition of the ambient water.

CYTHEROMORPHA ACUPUNCTATA

Ikeya & Ueda (1988) have monthly collected specimens of *Cytheromorpha acupunctata* in Hamanako-Bay (Pacific coast, Central Japan). In the studied station, a moderately well-sorted sandy silt constitutes the edaphic substrate but it's a little coarser in June. The dissolved oxygen and pH values are rather stable throughout the year. Temperature is higher in summer and salinity lower; rise of temperature starts a little earlier than the decrease of salinity.

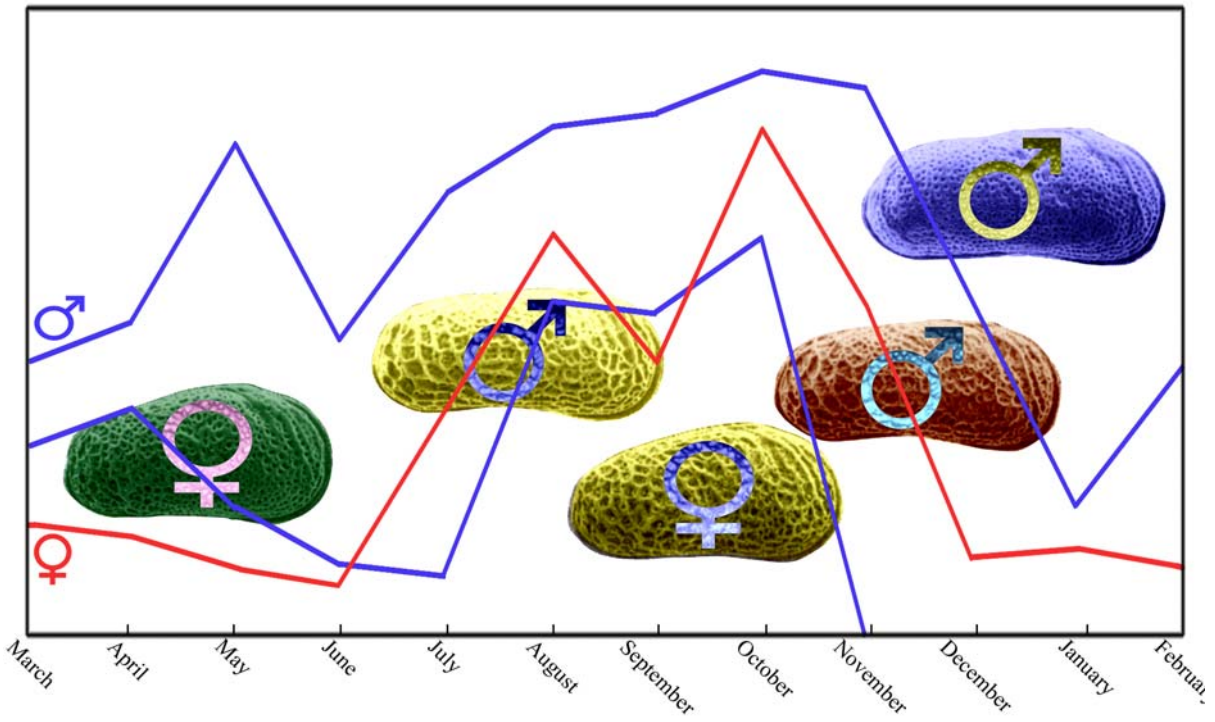


Fig. 7 – Influence of seasons on ecophenotypic ornamentation of *Cytheromorpha acupunctata* in Hamanako-Bay (Japan).(after Ikeya & Ueda, 1988, modified).

In summer samples, individuals with well-developed ornamentation are more numerous than in the winter samples. In these winter samples, specimens with fine ornamentation are dominant. In autumn and spring, an intermediate type of ornamentation is observed.

Development of coarse ornamentation could be related either to higher temperature or lower salinity. In Hamanako Bay, the rise of temperature starts a little earlier than the decrease of

salinity: as the adults survive after the last moulting, development of coarse ornamentation could be related to the temperature. We have to note that the granulometry of the substrate - coaser in June- is not taken into account.

NEOMONOCERATINA MICRORETICULATA

In Mahakam Delta (Borneo Island, Indonesia), specimens of *Neomonceratina microreticulata* show different ornamentations, very faint in front of the delta mouths and coarser between the delta mouths.

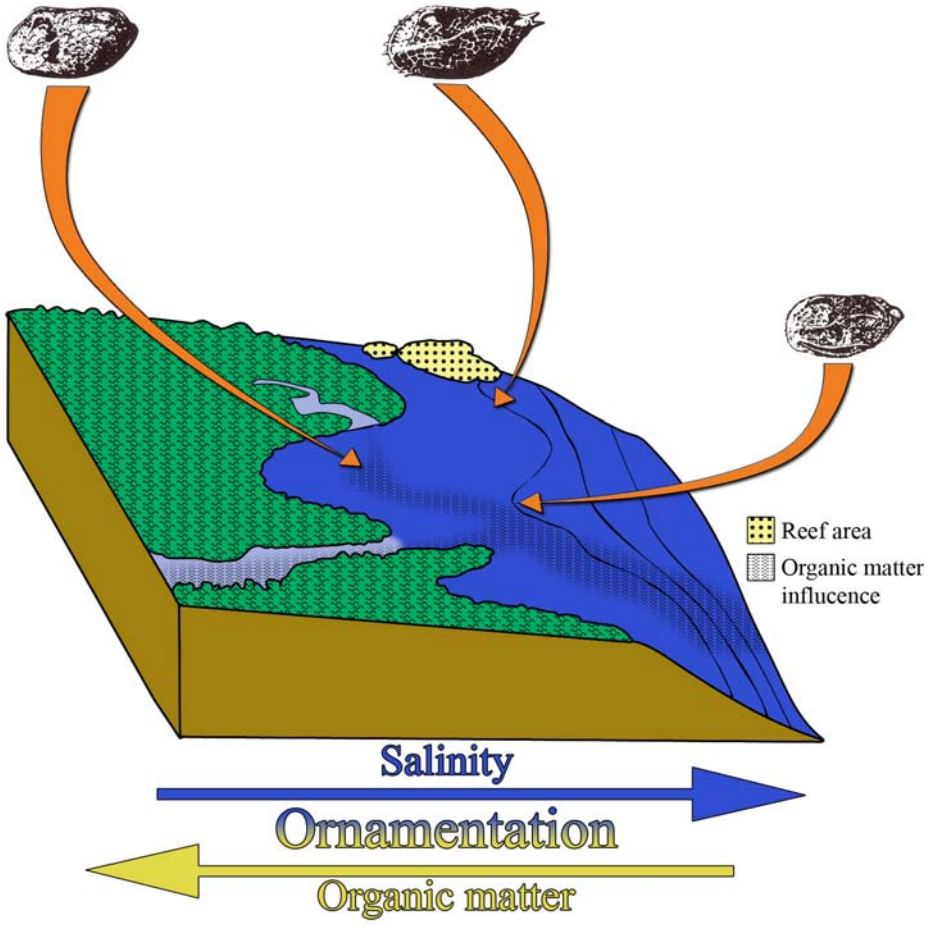


Fig. 8 – Influence of salinity of organic matter and salinity on the ecophenotypic ornamentation of *Neomonoceratina reticulata* (after Carbonel & Hoibian, 1988, modified).

We can think salinity is lower in front of the delta mouths and could favour low ornamentation. Carbonel & Hoibian (1988) consider the effects of organic matter inputs from the rivers having passed through areas of dense vegetation.:
- result of consumption of organic matter by bacterias is decreasing pH;
- consequently, $CaCO_3$ is dissolved and ostracods do not have $CaCO_3$ enough to build their carapace.

In the case of *N. microreticulata*, in Mahakam Delta, inputs of organic matter in the ambient water could favour faint ornamentation as a consequence of a low pH.

CONCLUSION

Salinity, according to Libe's definition, expresses the chemical composition of ambient water. Most of the time, there is a relation between ornamentation of ostracods carapaces and salinity value but some other parameters have to be taken into account:
- contents in calcium of the ambient water;
- granulometry of the substrate;
- seasons which influences nature, amount and regularity of nutrients inputs in the environment;
- temperature;
- pH of the ambient water which could result, in some cases, of the consumption of organic matter by bacterias.

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