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Boring activity of Epibionts in an Early Holocene molluscan fauna of Spanish Catalunya

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SUMMARY

Using X-Ray techniques, the boring activities of various Invertebrates on Bivalvia of würmian age were studied. Emphasis is placed on the boring activity of Porifera and their apparent preselection of the species bored, based on: a) the mineralogical composition, and/or b) the microstucture, and/or c) some special environmental conditions, or d) combinations of these three posibilities.

RESUMEN

Se estudia la actividad perforante de algunos Invertebrados en los Bivalvia de edad würmiense mediante técnicas radiológicas. Se presta especial atención a la actividad perforante de los Porifera y a la aparente preselección de especies perforadas debido posiblemente a: a) composición mineralógica de la concha, y/o b) microestructura de la misma, y/o c) ciertas especiales condiciones del medio ambiente, o d) combinaciones de estas tres posibilidades. Así mismo, se resalta la actividad bioerosiva realizada en materiales de dicha edad por Foraminíferos, Briozoos, Anélidos, Equinodermos y Crustáceos, citándose por vez primera en España la presencia de *Meandropolydora, Radulichnus* y *Gnatichnus pentax.*

INTRODUCTION

This is the first radiological study of samples taken from Würm materials from the littoral of the North of Spanish Catalunya (Girona province), from Cap de Creus and Palamós (fig. 1).

The studied material was obtained from the submarine Canyons of Cap de Creus and Fonera, the latter near the town of Palamós. In both cases, the depths at which the samples were collected ranged from 150 to 250 fathoms (appoximately 255-425 meter). The fossil samples were embedded in soft materials, so they were easy to collect with fishermen's dredges.

These samples suggest a würmian age. In 1972, Froget et al. dated samples of species from an equivalent deposit in the Gulf of Lyon by the Carbon-14 method. The resultant date was - 12.000 years B. P., which would place the samples at the end of the Würm IV period of some authors.

The malacological fauna of the Würm from Cap de Creus was first discovered and studied by Pruvot et Robert (1897), and more recently studied by Bourcard (1955) and Mars (1958). It also has been cited by others authors, notably Maluquer (1915, 1916). Barbaza (1971) studied the würmian fauna from the submarine deposits of Blanes and also mentioned that of the Cap de Creus.

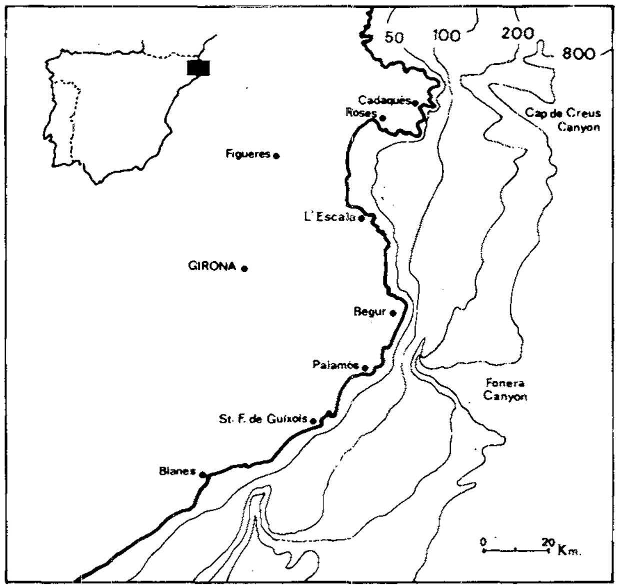

Fig. 1. Geographical localitation of the samples studied. (depth in metres).

The last work published on würmian fauna from the littoral of the Northern Coast of Spanish Catalunya is that of Martinell y Julià (1973). This work, as the aforementioned, did not describe the species, but the authors illustrated the cold fauna that occurs in this area.

Using X-Rays, borings in the interior of the Molluscan valves were studied and differences were observed between bores which, from outside, seemed to have been made by the same species.

The following Bivalvia species were studied: *Modiolus (s.s.) modiolus* (Linne, 1758), *Chlamys (s.s.) islandica* (Müller, 1776), *Pseudamussium septemradiatum* (Müller, 1779), *Acanthocardia (s.s.) echinata* (Linne, 1758), *Arctica islandica* (Linne, 1767), *Glossus (s.s.) humanus* (Linne, 1758), *Circomphalus casina* (Linne, 1767) and *Panopea (Panomya) norvergica* Spengler, 1793.

BORING ACTIVITY OF PORIFERA

The boring activity of Porifera in our samples is represented by clionid sponges. Radiological study and observation


Pl. I
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of the external morphology of the bored shells (size and form of the bore, etc.) suggest that the boring sponge concerned was probably *Cliona celata* Grant, 1826 (spicules were not found in the filling material). This species is common today in the Mediterranean Sea and cited (on the basis of borings alone) in the fossil record after the Upper Cretaceous (Boekschoten, 1966; Robba e Ostinelli, 1976).

From the Bivalvia studied, it was observed that the following species contained borings attributable to *C. celata: Arctica islandica* (Pl. II, fig. 1), *Glossus humanus* (Pl. I, fig. 5), *Circomphalus casina* and *Panopea (Panomya) nor vergica* (Pl. I, fig. 4) while in *Pseudamussium septemradiatum* and *Chlamys (s.s.) islandica,* both very abundant species, the *C. celata* type of boring was not observed.

The apparent selection made by *C. celata* motivated us to study the microstructure and mineralogical composition of the Bivalvia to find the reason behind this possible selection.

Of the species we studied, we noted that the majority of the borings made by *C. celata* were on shells composed of aragonite layers while the shells of the species which weren't bored were composed of alternating layers of calcite and aragonite. Also, it was observed that the shells of all the bored species had homogeneous microstructures while in those which weren't bored, this microstructure was not present. These observations led us to the conclusion that in reality, *C. celata* does make a selection of the species it bores and this selection may be based on: a) the mineralogical composition of the shells (only those composed of aragonite were bored), b) the microstucture (the only shells which were bored had homogeneous microstucture), c) both conditions.

However, this solution is complicated by the fact that it has been noted that Pectinidae are often bored by *C. celata* (Boekschoten, 1966; Bromley, 1970). Also, we ourselves have found recent *Pecten* sp. as well as some from the Pliocene of Italy which showed boreholes attributable to *C. celata.* A similar apparent selection of substrates by boring sponges was observed by Bromley (1978) but again the means of selection by the settling larvae remains uncertain.

Taking this into consideration, it is probable that under some environmental conditions, *C. celata* does select the organisme it bores, and that this selection is based on the mineralogical composition of the shell and its microstructure.

Only in *Circomphalus casina* two different types of borings, made by clionid sponges, were observed: *C. celata,* which is the more abundant, and a camerate *Entobia* sp. (Pl. I, fig. 2), characterized by wide chambers in the interior of the valve, interconnected by thin canals. The distinction between these two types of boring is made possible only by the use of X-Rays as, externally, the boreholes are identical.

PLATE I

Fig. 1. Radiography of *Chlamys (s.s.) islandica* presumed to be bored by an annelid.
Locality: Cap de Creus Canyon.
Fig. 2. Radiography of *Circomphalus casina* with camerate *Entobia* sp.
Locality: Fonera Canyon.
Fig. 3. Radiography of *Acanthocardia (s.s.) echinata* with small *Meandropolydora* sp.
Locality: Cap de Creus Canyon.
Fig. 4. Radiography of *Panopea (Panomya) norvergica* with borings attributable to *Cliona celata.*
Locality: Fonera Canyon.
Fig. 5. Radiography of *Glossus (s.s.) humanus* with boring attibutable to *Cliona celata.*
Locality: Fonera Canyon.
(All figures same magnification scale bar 1 cm.)

BORING ACTIVITY OF OTHER INVERTEBRATES

A wide and smooth depression belived to be made by a discorbacean foraminifer, is very common in the internal surface of the shells of *Arctica islandica* (Pl. II, figs. 6-7). This type of etching occurs also in shells of *Circomphalus casina* and *Chlamys islandica.*

Bryozoa borings networks are abundant. They are found in practically all of the studied species, in Bivalvia as well as in some Gastropoda (*Buccinum undatum* Linne, 1785, for example). We found two types of borings made by bryozoan. One type is branching, and resembles the borings of *Terebripora* or *Spathipora* type; the other type, non branching, is similar to the etchings made by cheilostomatous bryozoan (Pl. II, fig. 9) described by Morris (1976), and to those figured by Bromley & Surlyk (1972). Neither types of borings, in our samples, seem to show a relationship between the types of borer and the chemistry or microstructure of the bored species.

Annelid borings are very common. We found *Meandropolydora* sp. borings in shells of *Modiolus (s.s.) modiolus, Acanthocardia (s.s.) echinata, Arctica islandica, Glossus (s.s.) humanus* (Pl. I, fig. 3), *Panopaea (Panomya) norvergica* and *Buccinum undatum. Lapispecus* sp. is present only in two shells of *Artica islandica. Pseudamussium septemradiatum* (Pl. II, fig. 3) and *Chlamys (s.s.) islandica* (Pl. I, fig. 1) are bored by a presumed annelid, which are very common but only present in these two species.

Molluscan rasping activity is not very common; weak *Radulichnus* sp. traces are present in a few shells of *B. undatum, Arctica islandica* and *Glossus (s.s.) humanus.*

In contrast, echinoid bioerosion is present in many shells. We found *Gnathichnus pentax* Bromley, 1975 in *Chlamys (s.s.) islandica, Arctica islandica* (Pl. II, fig. 4) and *Glossus (s.s.) humanus.* Usually the boring activity of echinoids is centered around holes made by clionid sponges.

In *Chlamys (s.s.) islandica, Pseudamussium septemradiatum* (Pl. II, figs. 2 and 8), *Arctica islandica* (Pl. II, fig. 9) and *Circomphalus casina* we found superficial concentric borings, which are very similar to those described by Radwanski (1977) as made by verrucid barnacles.

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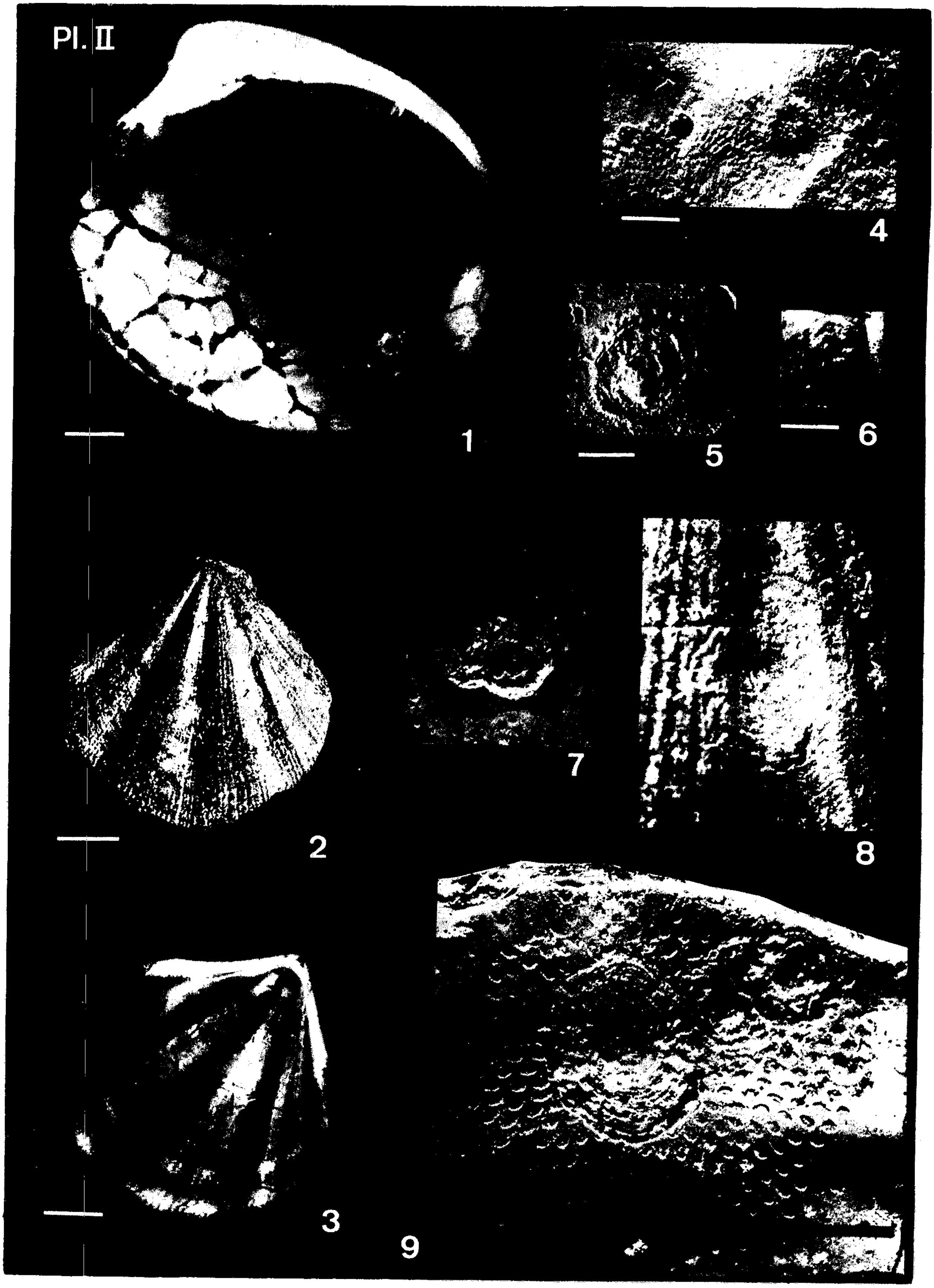
Pl. II
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PLATE II

Fig. 1. Radiography of *Arctica islandica* with borings atributable to *Cliona celata.* (scale bar 1 cm.)
Locality: Fonera Canyon.
Fig. 2. *Pseudamussium septemradiatum* with concentric depressions probably made by verrucid barnacle. (scale bar 1 cm.)
Locality: Fonera Canyon.
Fig. 3. Radiography of *Pseudamussium septemradiatum* bored by a presumed annelid. (scale bar 1 cm.)
Locality: Fonera Canyon.
Fig. 4. *Gnathichnus pentax* in an *Arctica islandica* shell. (scale bar 5 cm.)
Locality: Cap de Creus Canyon.
(Photo by J. Aagaard)
Fig. 5. Concentric boring probably made by verrucid barnacle in a shell of *Arctica islandica.* (scale bar 5 cm.)
Locality: Cap de Creus Canyon.
(Photo by J. Aagaard)
Fig. 6 and 7. Depressions belived to be made by a discorbacean foraminifer, on the internal surface of *Arctica islandica* shells. (Fig. 6, scale bar 5 cm; Fig. 7, scale bar 10 cm.)
Locality: Fonera Canyon.
(Photo by J. Aagaard)
Fig. 8. Detail of the concentric depression in the surface of *Pseudamussium septemradiatum.* (scale bar 2 cm.)
Locality: Fonera Canyon.
(Photo by J. Aagaard)
Fig. 9. Etched depression with concentric structure probably produced by a verrucid barnacle, overprinted at a later date by a regular pattern of pits produced by a cheilostomate bryozoan colony (scale bar 5 cm.)
Locality: Fonera Canyon.
(Photo by J. Aagaard)