

BORINGS PRODUCED BY PRESUMED PLIOCENE BRACHIOPODS FROM L'EMPORDÀ (CATALONIA, SPAIN) *

Jordi Martinell **

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RESUM

Perforacions produïdes per presumibles braquiòpodes del Pliocè de l'Empordà

L'estimulant treball de BROMLEY & SURLIK (1973), on es descriuen en detall les marques produïdes pels braquiòpodes actuals i fòssils (Cretaci), va menar l'atenció dels paleontòlegs cap aquest interessant grup de pistes fòssils. Així veiem que el 1975, en dos treballs es descriuen perforacions similars produïdes per braquiòpodes del Cretaci superior de Bohèmia (NEKVASILOVA, 1975) i al Triàssic de Polònia (MALKOWSKI, 1975). NEKVASILOVA (1976) troba aquestes perforacions en material procedent del Cretaci de Moràvia (Txecoslovàquia) i MICHALIK (1977) les descriu en material procedent del Triàssic dels Carpats.

En el present treball hom assenyalava la presència de **Podichnus centrifugalis** B. & S. a dos jaciments pliocènics de l'Empordà, situats al terme municipal de Vilacolum.

Cal remarcar que aquesta és la primera vegada que se cita aquesta icnospècie sobre material de la península Ibèrica i, alhora, és la primera vegada que es troba en materials del Terciari.

Hom cita igualment algunes traces fòssils trobades en aquests jaciments, com són **Entobia** sp., **Oichnus simplex** Bromley, impressions deixades per possibles braquiòpodes queilostomats, **Meandropolydora** sp., etc.

Hom assenyalava, també, l'abundància d'activitat perforant deguda a mol·luscs litòfags al jaciment de «Els Olivets», la qual afecta tant els clastes calcaris (tant d'origen orgànic com inorgànic) com la matriu que els envolta. Això suggereix l'existència de dues fases de perforació lligades a variacions en el nivell del mar.

* Aquest treball forma part del programa d'investigació *Estudio de la fauna malacològica y de la actividad bioerosiva asociada del Terciario y Cuaternario español*, desenvolupat per l'autor dintre el marc de Ayudas para el Fomento de la Investigación científica en la Universidad.

** Departament de Paleontologia. Facultat de Geologia. Universitat de Barcelona. Gran Via de les Corts Catalanes. Barcelona-7. Spain.

INTRODUCTION

According to BROMLEY & SURLYK (1973), Ekman in 1896 was the first worker to recognize the capacity of brachiopod pedicles to dissolve carbonate substrates. Nevertheless, his observation seems to have been forgotten although his work is cited in the majority of texts on Brachiopods. BROMLEY & SURLYK (1973) have written an interesting paper on the borings produced by recent brachiopod pedicles, comparing them with other similar ones found in fossil material.

In this work, the recent species studied were *Terebratulina retusa* (L.), *T. septentrionalis* (Couthay), *Macandrevia cranium* (Müller), *Dallina septigera* (Loven) and *Hemithyris psittacea* (Chemnitz), all from the west coasts of Norway and Sweden. The five species studied by these authors produced etching traces with comparable morphology; however, the manner of boring was unknown, but supposedly chemical. These authors could also observe that «the etched trace produced by pedicles of Recent brachiopods varies considerably with the nature of the substrate and the form of the pedicle». Similar borings were found by the authors in belemnites and oysters from the English Cretaceous, and the most characteristic from was labeled *Podichnus centrifugalis* (Bromley & Surlyk).

The work by BROMLEY & SURLYK (1973) has enabled other authors to recognize the presence of *Podichnus* in various types of Mesozoic substrates as can be seen from the following:

NEKVASILOVA (1975) described the etching traces produced by pedicles of Upper Cretaceous Brachiopods from Bohemia (Czechoslovakia). All of the etching traces described by Nekvasilova were determined on only one type of substratum, i.e., on the shells of the terebratulid brachiopod *Sellisthyris phaseolina* (Valenciennes in Lamarck) found at Velim near Kolin, and classified as the ichnogenus *Podichnus* (Bromley & Surlyk).

MALKOWSKI (1975) described attachment scars found on shells of the brachiopod *Coenothyris vulgaris* (Schlothheim) from the Muschelkalk in the vicinity of Opole Silesia (Poland). On the basis that both the age of the trace making brachiopod and its species are different from those of Bromley & Surlyk's—an invalid crite-

—a new ichnospecies *P. silesiacus* was proposed. However, *P. silesiacus* (Malkowski) is morphologically identical to, and must be considered as a synonym of *P. centrifugalis* (Bromley & Surlyk).

In another paper of NEKVASILOVA (1976), borings assumed to have been etched by the pedicles of Lower Cretaceous (Valanginian) brachiopods from Štramberk in Moravia (Czechoslovakia), were described and classified as the ichnogenus *Podichnus* (Bromley & Surlyk). The *Podichnus* sp. traces were determined on shells of the rhynchonellid species *Lacunosella hoheggeri* (Suess) from the Upper Triassic of the West Carpathians.

MICHALIK (1977) described *P. centrifugalis* Bromley & Surlyk on shells of the brachiopod *Zeilleria norica* (Suess) from the Uppermost Triassic of the West Carpathians showing that their variability indicates that the pedicle could be differentiated terminally into well-defined «root-lets».

At the «Primer Simposio sobre Diagénesis de Sedimentos y Rocas Sedimentarias», held in Barcelona in December 1980, MARTINELL & DOMÈNECH (1980) enumerated a large number of observable bioerosive processes in the Catalan marine Pliocene, which were not studied in great detail by the authors. In the present work, the presence of *P. centrifugalis* (Bromley & Surlyk) is determined for the first time in materials of the Iberian peninsula, and furthermore, is cited for the first time in Tertiary materials.

MATERIAL

The studied samples are from two Pliocene outcrops situated near the village of Vilacolum (fig. 1). The first outcrop (Vilacolum volcanic locality) can be described as being composed of volcanic materials (traquiandesitic) covered by Pliocene sediments very rich in bivalves (*Crassostrea*, *Pycnodonta*, *Anomia*, *Spondylus*, etc.), Bryozoans (*Crisia strangulata* Buge, *Filisparsa vilacolomensis* Reguant, *Idmonea*, *Cellaria*, etc.) and Brachiopods (*Megathyris decollata* [Chemnitz], *Megerlia truncata* [Linné], *Gryphus*, *Terebratula*, etc.). It is distinguished by the virtual absence of Gasteropods as previously indicated by MARTINELL & VILLALTA (1977). The second outcrop is situated on a hill known by the

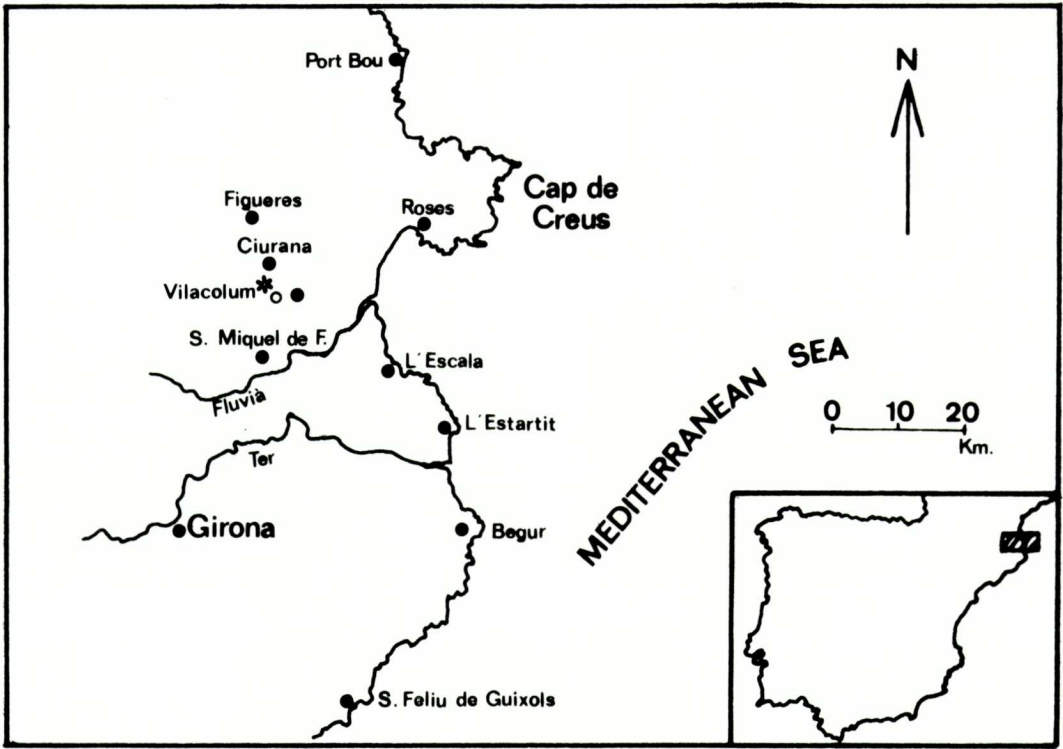


FIG. 1. Geographical situation of the outcrops:
 Situació geogràfica dels jaciments:
 ○ Vilacolum volcanic locality (jaciment volcànic de Vilacolum).
 * «Els Olivets».

name of «Els Olivets» and is composed of materials corresponding to the Upper Pliocene of L'Empordà, namely, fine yellow sands containing abundant Pectinidae and conglomeratic intercalations of varying thicknesses (0.25 cm-1 m). These intercalations possess a number of organisms typical of the epibenthos: oysters, *Hinnites*, *Chlamys*, etc., and are characterized by the large quantity of bioerosive processes which can be observed in them. This outcrop was first cited by MARTINELL & DOMÈNECH (1980).

SYSTEMATICS

Podichnus centrifugalis

Bromley & Surlyk, 1973

(Pl. I, figs. 4-8, Pl. II, figs. 1-2)

1973 *Podichnus centrifugalis* Bromley & Sur-

lyk. BROMLEY & SURLYK, p. 364, fig. 13.

1975 *Podichnus* sp. NEKVASILOVA, pp. 70-71, fig. 1, pl. I-IV.

1975 *Podichnus silesiacus* Malkowski. MAL-KOWSKI, pp. 276-279, figs. 1, 5, 6, pl. I and II.

1976 *Podichnus* sp. NEKVASILOVA, pp. 406-408, fig. 1, pl. I-II.

1977 *Podichnus centrifugalis* Surlyk & Bromley. MICHALIK, pp. 342-343, figs. 14, 4-5, 15.

Diagnosis: More or less compact groups of pits or cylindrical holes in hard, calcareous substrates. The pits at the center of the group are more or less perpendicular to the surface, while the more periferal pits are typically deeper and larger, entering the substrate obliquely and centrifugally. Size of pits up to ca. 200 μ m.

Material: Two traces on shells of *Hinnites ercoliana* (Cocconi), twenty-one on oys-

ter shells from «Els Olivets», seven traces on shells of *Megerlia truncata* (Linné), six on shells of *Megathyris decollata* (Chemnitz) and seventeen traces on oyster shells from the Vilacolum volcanic locality.

Remarks: The borings observed corresponded perfectly to the ichnospecies described by BROMLEY & SURLYK (1973) which made their identification fairly easy. In agreement with MICHALIK (1977), the ichnospecies *P. silesiacus* proposed by MALKOWSKI (1975) resembles very much the type species of the genus, and it may be supposed that *P. silesiacus* is a later synonym of the species *P. centrifugalis*. NEKVASILOVA (1975, 1976) does not attribute to any ichnospecies the *Podichnus* she describes; however, it can be assumed that in the light of the documented characteristics they can be confirmed as *P. centrifugalis*.

ICHOLOGICAL COMMENTS ON THE OUTCROPS

As MARTINELL & DOMÈNECH (1980) have shown, a large number of bioerosive processes can be observed at «Els Olivets» and the Vilacolum volcanic locality, some of which are impossible to attribute to a specific ichnotaxon. It is convenient to cite here the more frequent forms which are found in these outcrops, amplifying, in this sense, data on the ichnology of the Spanish Neogene.

The boring activity attributed to Clionid sponges is very common in the outcrop at «Els Olivets»: *Entobia* sp. can be found in oyster shells (Pl. II, fig. 8), *Hinnites* and *Spondylus*, as well as in calcareous clasts (Pl. II, fig. 7).

Entobia sp. was also observed in oyster shells at the Vilacolum volcanic locality, but with much less frequency (Pl. II, fig. 5).

Meandropolydora sp. is very common in oyster shells from «Els Olivets» and the Vilacolum volcanic locality.

Unnamed traces comparable to those etched by Cheilostomatous bryozoans of the *Electra* genus are found on oyster shells from the Vilacolum volcanic locality (Pl. II, fig. 3) and «Els Olivets» (Pl. II, fig. 4). Very similar traces have been described by MARTINELL & DOMÈNECH (1981) in material from the Catalan marine Holocene.

In two oyster shells from «Els Olivets», superficial concentric borings occur that are very similar to those described by RADWANSKI (1977) as made by Verrucid barnacles.

Oichnus simplex Bromley is very common in shells from both localities; this ichnospecies is very abundant in oyster shells (Pl. II, fig. 6) from the Vilacolum volcanic locality. From a sample of 521 oyster shells, 143 (31 %) of them contained *O. simplex*.

The outcrop of «Els Olivets» is notable for the abundance of boring activity due to the action of lithophagous molluscs. This activity affects shells as well as calca-

PLATE I

FIG. 1. *Terebratulina retusa* with a long pedicle penetrating the shell substrate. Off the Norwegian coast (Courtesy of R. G. Bromley). Scale bar, 2 mm.

Terebratulina retusa amb un llarg pedicle penetrant una closca. Procedent de la costa noruega (Cortesia de R. G. Bromley). Escala gràfica, 2 mm.

FIG. 2. SEM picture of the shell fragment seen in fig. 1 with *Terebratulina retusa* holes (Courtesy of R. G. Bromley). Scale bar, 200 μ m.

Micrografia electrònica del fragment de closca vist a la fig. 1 amb les perforacions de *Terebratulina retusa* (Cortesia de R. G. Bromley). Escala gràfica, 200 μ m.

FIG. 3. SEM picture of a trace of *Macandrevia cranium* in the shell of another of the same species (Courtesy of R. G. Bromley). Scale bar, 200 μ m.

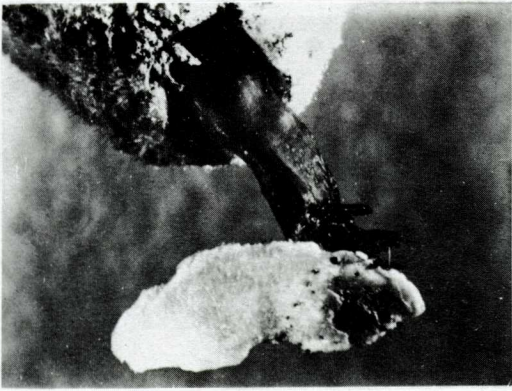
Micrografia electrònica d'una perforació de *Macandrevia cranium* sobre una closca d'una altra de la mateixa espècie (Cortesia de R. G. Bromley). Escala gràfica, 200 μ m.

FIGS. 4, 7, 8. *Podichnus centrifugalis* Bromley & Surlyk in oyster shell from the Vilacolum volcanic locality. Scale bar, figs. 4-7, 0,5 cm, and fig. 8, 2 mm.

Podichnus centrifugalis Bromley & Surlyk sobre una closca d'ostreïd procedent de l'aflorament volcànic de Vilacolum. Escala gràfica, figs. 4-7, 0,5 cm, i fig. 8, 2 mm.

FIGS. 5, 6. Two different *P. centrifugalis* Bromley & Surlyk in the same oyster shell. Locality: «Els Olivets». Scale bar, 1 mm.

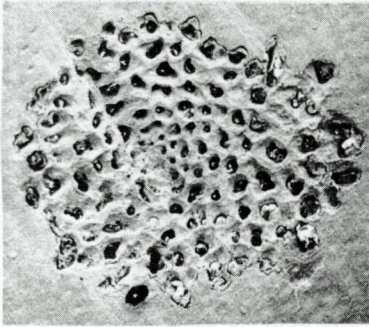
Dos *P. centrifugalis* diferents sobre la mateixa closca d'ostreïd. Localitat: «Els Olivets». Escala gràfica, 1 mm.



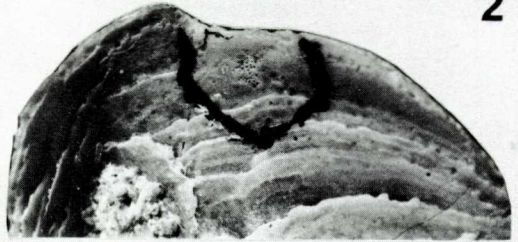
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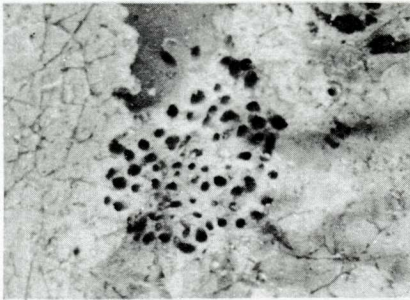
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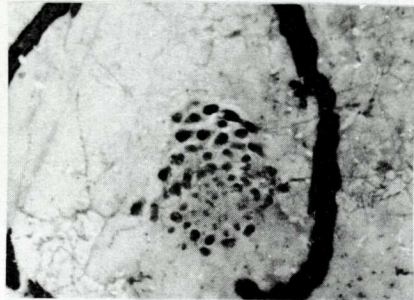
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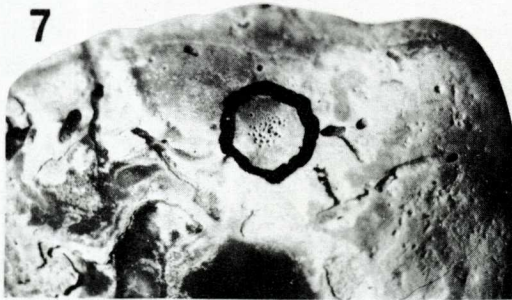
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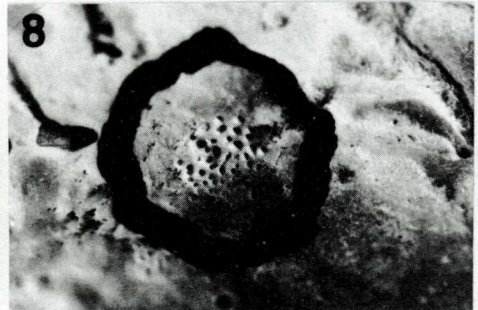
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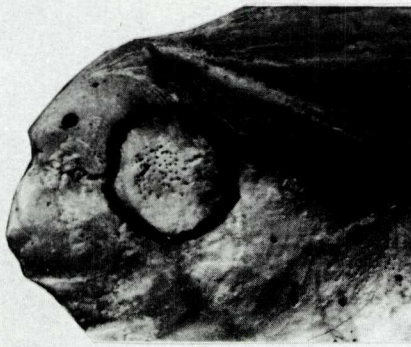
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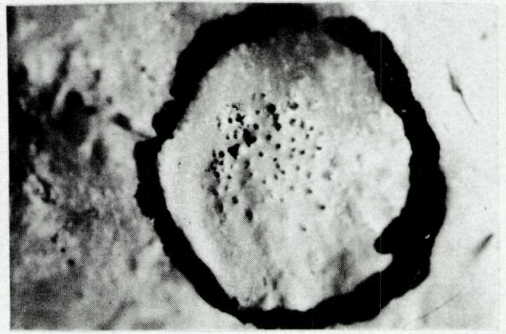
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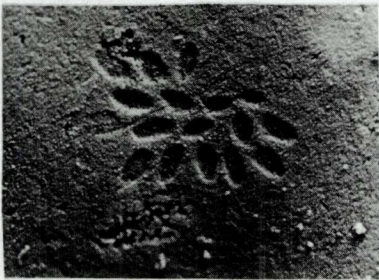
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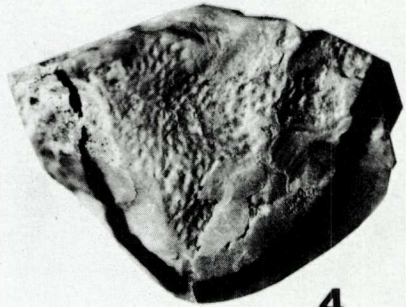
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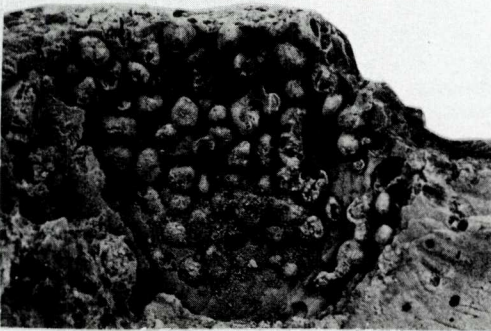
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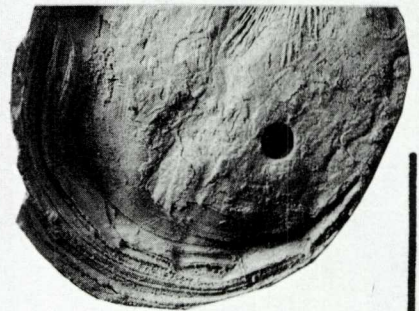
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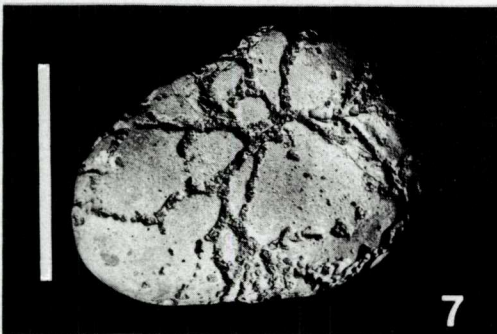
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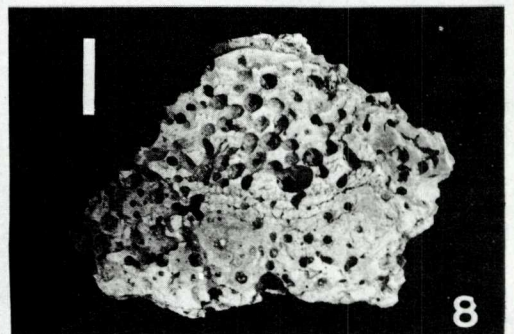
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reous clasts in addition to the matrix which engulfs the clasts and shells. This fact could suggest that there were two boring phases: one taking place before the deposition of the sediments and another occurring after the deposition and consolidation of these.

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PLATE II

FIGS. 1, 2. *Podichnus centrifugalis* Bromley & Surlyk in oyster shell from the Vilacolum volcanic locality. Scale bar, Fig. 1, 3 mm, and Fig. 2, 2 mm.

Podichnus centrifugalis Bromley & Surlyk sobre una closca d'ostrèid procedent del jaciment volcànic de Vilacolum. Escala gràfica, fig. 1, 3 mm, i fig. 2, 2 mm.

FIGS. 3, 4. Unnamed traces in oyster shells comparable to those etched by cheilostome bryozoans of the genus *Electra*. Fig. 3 from the Vilacolum volcanic locality. Fig. 4 from «Els Olivets». Scale bar, Fig. 3, 2 mm, and Fig. 4, 0,5 cm.

Perforacions sense nom sobre closques d'ostrèids comparables a les produïdes pels briozous queilostomats del gènere *Electra*. Fig. 3 procedent del jaciment volcànic de Vilacolum, i fig. 4, procedent de «Els Olivets». Escala gràfica, fig. 3, 2 mm, i fig. 4, 0,5 cm.

FIG. 5. *Entobia* sp. in mould preservation in an oyster shell from the Vilacolum volcanic locality. Scale bar, 1 cm.

Entobia sp. preservada en forma de motlle sobre una closca d'ostrèid, procedent del jaciment volcànic de Vilacolum. Escala gràfica, 1 cm.

FIG. 6. *Oichnus simplex* Bromley, in an oyster shell from the Vilacolum volcanic locality. Scale bar, 0,5 cm.

Oichnus simplex Bromley sobre una closca d'ostrèid procedent del jaciment volcànic de Vilacolum. Escala gràfica, 0,5 cm.

FIG. 7. *Entobia* sp. in a calcareous pebble from «Els Olivets». Scale bar, 5 cm.

Entobia sp. sobre un còdol calcari procedent de «Els Olivets». Escala gràfica, 5 cm.

FIG. 8. *Entobia* sp. in an oyster shell from «Els Olivets». Scale bar, 1 cm.

Entobia sp. sobre una closca d'ostrèid procedent de «Els Olivets». Escala gràfica, 1 cm.