13. EVIDENCE OF CLIONID SPONGES IN SEDIMENTS OF THE WALVIS RIDGE, SOUTHEASTERN ATLANTIC SITE 526, DEEP SEA DRILLING PROJECT, LEG 74[1]

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ABSTRACT

Pelagic carbonate oozes of DSDP Site 526 contain remnants of the activity of boring sponges of the family Clionidae: (1) the borings themselves = ichnogenus *Entobia* and (2) the characteristically shaped boring chips as a fine-grained sediment component.

INTRODUCTION

Sponges of the family Clionidae have long been known to penetrate the limestones or carbonate shells they inhabit. Because of their damage to oyster cultures, these sponges have been the subject of a very extensive zoological literature (e.g., Topsent, 1887; 1900) and are stimulating field and experimental research (Hopkins, 1956a, b; Hartman, 1958; Rützler and Rieger, 1973; Rützler, 1975). Taxonomy of modern Clionidae is based primarily on spiculation, color, and histology of the soft parts, and the characteristics of the borings, the patterns of oscula and galleries, and the wall ornamentation have received little attention from zoologists.

Dealing with fossil boring sponges the geologist can work (1) with the remnants of the sponge itself, the spicules; (2) with evidence of the borings, considering them as trace fossils; or (3) with the clasts or chips produced during the boring process. Isolated clionid sponge spicules are not very significant, and spicules are very rarely found in fossil clionid borings. Even if they were, they might not be the remnants of the animal that had lived there.

Sponge borings of the clionid type have attracted little attention as trace fossils, though they can be traced back at least through the Tertiary and Cretaceous. All borings attributable to the activity of clionid sponges are combined in the ichnogenus *Entobia* (for further discussion, see Bromley, 1970). However, the study of clionid sponges as trace fossils requires larger fragments in the scale of centimeters of the shells or rocks they inhabit.

It is well known from modern environments that clionid sponges play a considerable role in calcareous rock destruction, or bioerosion (Neumann, 1965; Warme and McHuron, 1978). The boring mechanism has been studied in detail by Warburton (1958), Cobb (1969), and Rützler and Rieger (1973). The excavation is performed by the chemical etching by special cell types that carving out carbonate chips in characteristic shapes. Calculations indicate that only 2–3% of the bored material is removed in dissolved form during the etching process (Rüztler and Rieger, 1973); the vast majority of the eroded substratum is expelled through the oscula of the sponge and subsequently carried away by water currents and/or distributed to the sediment.

It is therefore not surprising that in regions such as coral reefs (Goreau and Hartman, 1963) or the limestone coasts of the tropical and subtropical environment (Neumann, 1965; 1966), where sponge borers are main agents of bioerosion, a considerable amount of fine-grained sediment accumulates as a result of their activity. Classification by shape of the sponge-produced particles and quantitative estimations were carried out on modern fine-grained carbonate sediments from the Northern Adriatic Sea, the Persian Gulf, and the Fanning Island lagoon. There was a sponge-generated sediment portion of 2–3% and up to 30% in the last area (Fütterer, 1974). No boring chips were reported from fossil sediments hitherto, though we know of a large number of clearly clionid bored Cretaceous and Tertiary fossils.

OBSERVATIONS AND DISCUSSION

During sedimentological investigations of Leg 74 cores (Fig. 1) it became evident that late Eocene to late Miocene sediments recovered from Site 526 contain a fairly abundant number of small, characteristically shaped particles identified as boring chips of clionid boring sponges (Table 1; Plate 1, Figs. 1–6). This is the first time that such particles could be separated from fossils in diagenetically altered sediments. Diagenesis in this sediment is still weak but in progress, as evidenced by coccolith overgrowth and recrystallization. The clionid boring chips, probably excavated from molluscan shells, show in their ultrastructural pattern distinct traces of recrystallization (Plate 1, Figs. 3, 5, 6). Their overall characteristic morphology is a circular to ellipsoidal outline with surfaces composed mainly of small concave facets (Plate 1, Fig. 4) and one large convex surface (Plate 1, Fig. 2) representing the portion of the chip that had been excavated from the untouched substratum. The particles are concentrated mainly in the coarse silt fraction, however, contributing only a minor portion of the total sediment.

[1] Moore, T. C., Jr., Rabinowitz, P. D., et al., *Init. Repts. DSDP*, 74: Washington (U.S. Govt. Printing Office).

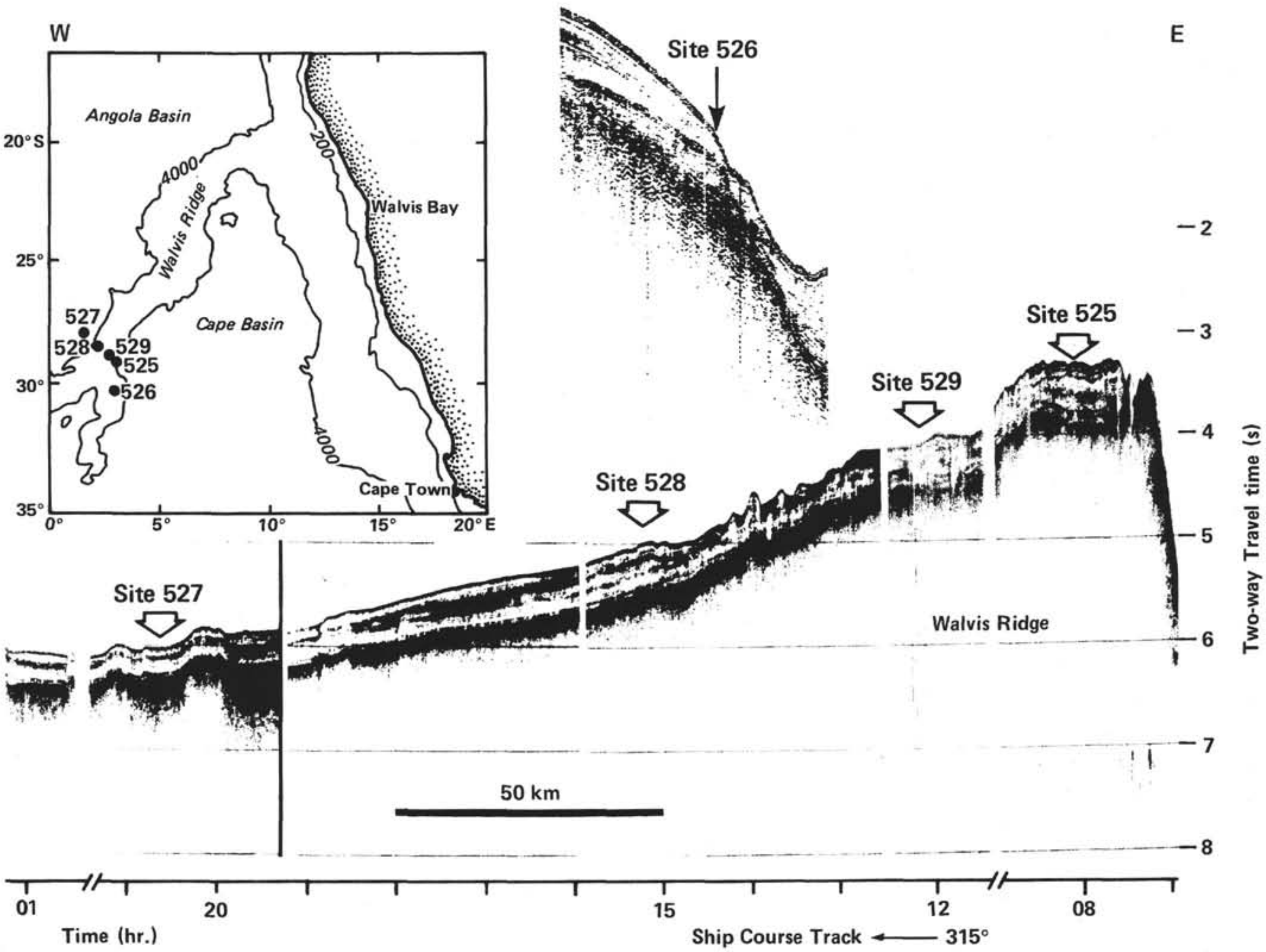

Figure 1. Index map showing geographic position and bathymetry of the Walvis Ridge and locations of Leg 74 Sites 525 to 529.

Table 1. Borings chips and/or borings of the ichnogenus *Entobia* in samples from Hole 526A.

Core/Section (interval in cm)	Sub-bottom Depth (m)	Biostratigraphic Zone Foram.	Biostratigraphic Zone Nanno.	Time-Rock Unit	Clionid Borings (*Entobia*)	Traces, Chips
6-1, 100–102	51.0	N17	NN11	late Miocene	– –	+ +
25-2, 113–115	137.23	N5	NN1	early Miocene	+ +	– –
28-2, 95–97	147.23	N4	NN1	early Miocene	+ +	– –
30-1, 16–18	155.76	N4	NN1	E. Miocene–L. Oligocene	+ +	– –
31-1, 96–98	160.96	N4	NP25	E. Miocene–L. Oligocene	+ +	+ +
32-1, 50–52	164.90	P21b	NP25	late Oligocene	+ +	– –
33-1, 95–97	169.75	P21	NP24	late Oligocene	+ +	– –
36-1, 105–107	183.05	P20	NP 23/24	late Oligocene	– –	+ +
44-3, 74–76	217.64	P15	NP 19/20	late Eocene	– –	+ +

Note: + + = present, – – = absent.

Subsequent investigation of the coarse fraction (>500 μm) of the samples revealed a number of shell fragments exhibiting the characteristic traces of the clionid boring process (Table 1; Plate 1, Figs. 7–9). These are hard substrate trace fossils and are assigned to the ichnogenus *Entobia*. The large concave surfaces seen on *Entobia* sp. (Plate 1, Fig. 7) are identical with the large convex surface of a clionid boring chip.

In modern environments the occurrence of clionid boring chips is indicative of shallow marine conditions, though some species are reported to occur as deep as 1500 m (Carter, 1874). Most of the species of the family Clionidae however, flourish in the shallow sublittoral (Volz, 1939; Hartman, 1958), and only a few reach deeper than 100 m. Nevertheless, small, silt-sized boring chips can easily be winnowed out by water currents or be displaced by gravity in connection with biological reworking (Bein and Fütterer, 1977). On the other hand, the occurrence of larger shell fragments containing *Entobia* sp. indicates that the clionid traces are still in place. This would indicate a paleo-water-depth at Site 526 of a few hundred meters during late Oligocene and early Miocene times, which is in agreement with other paleontological findings at this site. Apparently the site, now at a water depth of 1054 m, did not sink below sea level until the late Paleocene. Neither clionid traces nor boring chips were observed in cores from other sites, which presumably lay in too deep water throughout their history.

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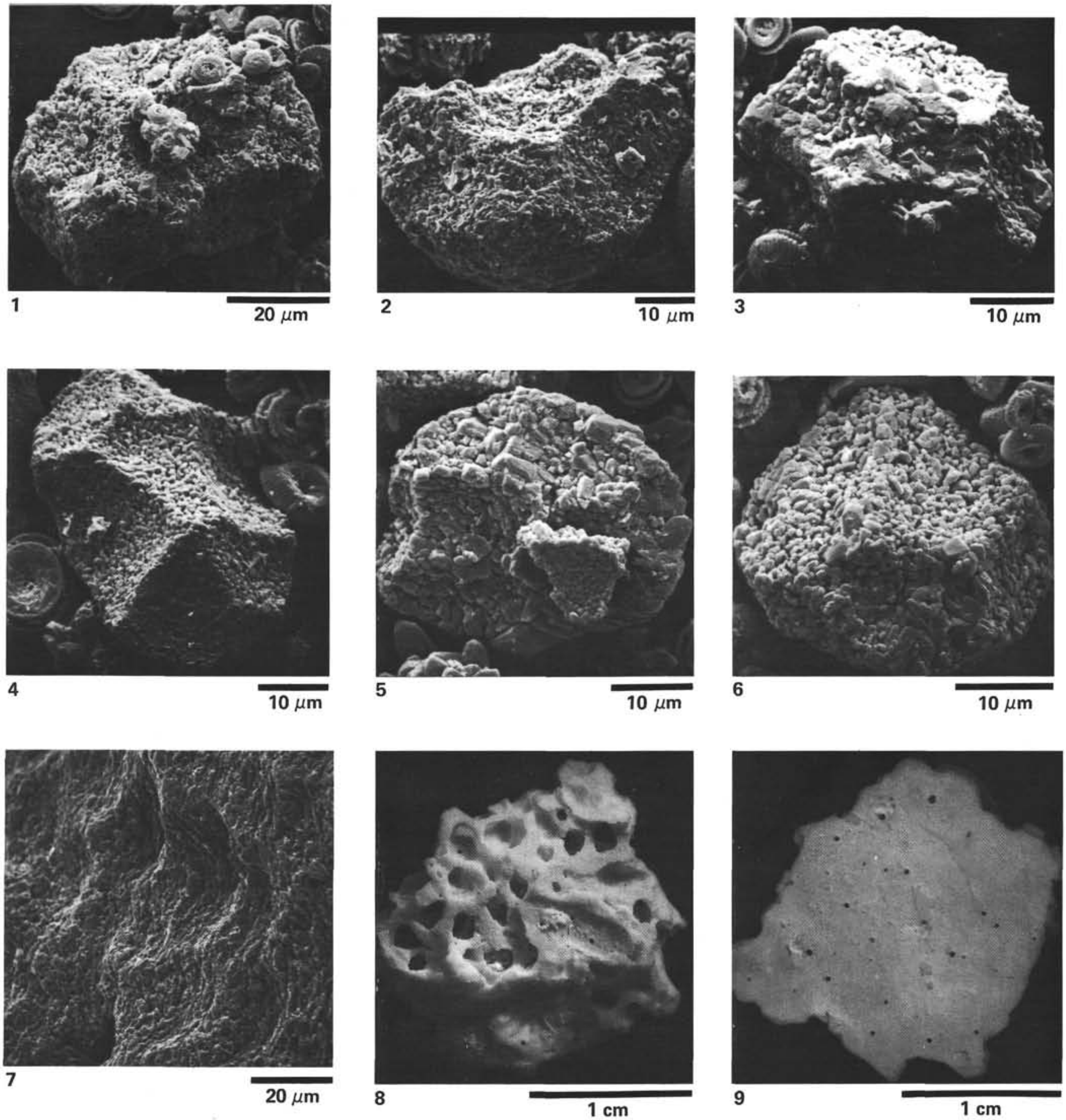

Plate 1. **1–6.** SEM photographs (accelerating voltage 10 kV) of boring chips of boring sponges of the family Clionidae from sediments at Site 526, showing general morphology and different stages of preservation; (1) Sample 526A-31-1, 96–98 cm; early Miocene–late Oligocene; (2) Sample 526A-6-1, 100–102 cm; late Miocene; (3) Sample 526A-36-1, 105–107 cm; late Oligocene; (4) Sample 526A-31-1, 96–98 cm; early Miocene–late Oligocene; (5) Sample 526A-44-3, 74–76 cm; late Eocene; (6) Sample 526A-31-1, 96–98 cm; early Miocene–late Oligocene. **7–9.** *Entobia* sp. from Sample 526A-44-3, 74–76 cm; (7) SEM photograph (accelerating voltage 10 kV) of wall structure, showing concave surfaces of the boring pits; (8) light photograph of top side showing open chambers of galleries; (9) light photograph, back side of same specimen as Fig. 8, showing oscula through which the boring chips were expelled by the sponge.