Crustacean coprolites of the Late Triassic Tethys: Biogeography from the Mediterranian to the Middle East

By

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with 5 figures and 1 plate

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Contents

Abstract

The crustacean microcoprolites *Helicerina siciliana* SENOWBARI-DARYAN, SCHÄFER & CATALANO, *Palaxius hydranensis* SENOWBARI-DARYAN & KUBE, and *Palaxius* sp. are described from the Norian-Rhaetian reefal limestones of the Northern Oman Mountains. The Oman locality (Fig. 1) ist the third occurence of *H. siciliana* and the second occurrence of *P. hydranensis* in the world indicating the paleogeographic distribution of the coprolite producing animals in this region.

Zusammenfassung

Aus den Norisch-rhätischen Riffkalken des nördlichen Oman Gebirges werden die Crustaceen-Mikrokoprolithen *Helicerina siciliana* SENOWBARI-DARYAN, SCHÄFER & CATALANO, *Palaxius hydranensis* SENOWBARI-DARYAN & KUBE und *Palaxius* sp. beschrieben. Die Oman-Lokalität ist das dritte triassische Vorkommen von *H. siciliana* und das zweite Vorkommen von *P. hydranensis* und zeigt die paläogeographische Verbreitung des Koprolithen-erzeugenden Tieres in dieser Region.

1. Introduction

The internally structured microcoprolites produced by decapod crustaceans may occur - very abundantly as rock building taxa - worldwide in shallow water sediments not only during Paleozoic, but especially in Mesozoic times (MOLINARI PAGANELLI et al. 1986, BLAU & GRÜN 2000). Due to increasing investigations on shallow water carbonates, numerous taxa of crustacean coprolites have been published during the last 50 years. The following ichnogenera (the number of species is given in parenthesis), attributed to four families are known (for more information see BLAU & GRÜN 2000):

Canalispalliatum BLAU, GRÜN & JAGT, 1997 (1)
Favreina BRÖNNIMANN, 1955 (24)
Fundalutum SENOWBARI-DARYAN & KUSS, 1992 (2)
Helicerina BRÖNNIMANN & MASSE, 1968 (7)
Lercarina SENOWBARI-DARYAN 1988 (1)
Octotriangulella BLAU, LUKAS & STEIN, 1987 (2)
Palaxius BRÖNNIMANN & NORTON, 1960 (including *Agantaxia* KRISTAN-TOLLMANN, 1989) (21)
Parafavreina BRÖNNIMANN, CARON & ZANINETTI, 1972 a (3)
Payandea BLAU, GRÜNN & SENFF, 1993 (1)
Petalina LEINFELDER (in SCHWEIGERT et al., 1997) (1)
Thoronetia BRÖNNIMANN, CARON & ZANINETTI, 1972b (3)

The oldest structured crustacean coprolite is from the Carboniferous (MASSE & VACHARD 1996). *Favreina prima* bearing boulders from Morocco described by HERBIG (1993) seem to be Triassic in age (see MASSE & VACHARD 1996; SENOWBARI-DARYAN & BERNECKER 2000; SENOWBARI-DARYAN & KUBE 2003). Three crustacean coprolite genera, including *Favreina*, *Palaxius*, *Thoronetia* are also still known from the Paleozoic (Permian: SENOWBARI-DARYAN et al. 1992) and

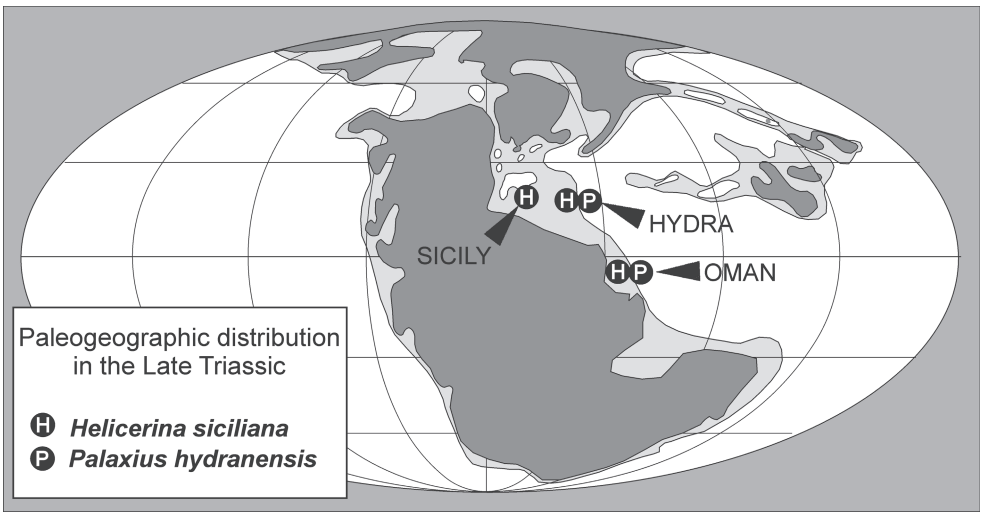

Fig. 1: Paleogeographic map of the Late Triassic (based on SCOTESE & GOLONKA 1992) with the distribution of crustacean coprolithes *Helicerina siciliana* and *Palaxius hydranensis* in the Mediterranean (Italy: Sicily and Greece: Hydra) and in the Middle East (Oman: Musandam).

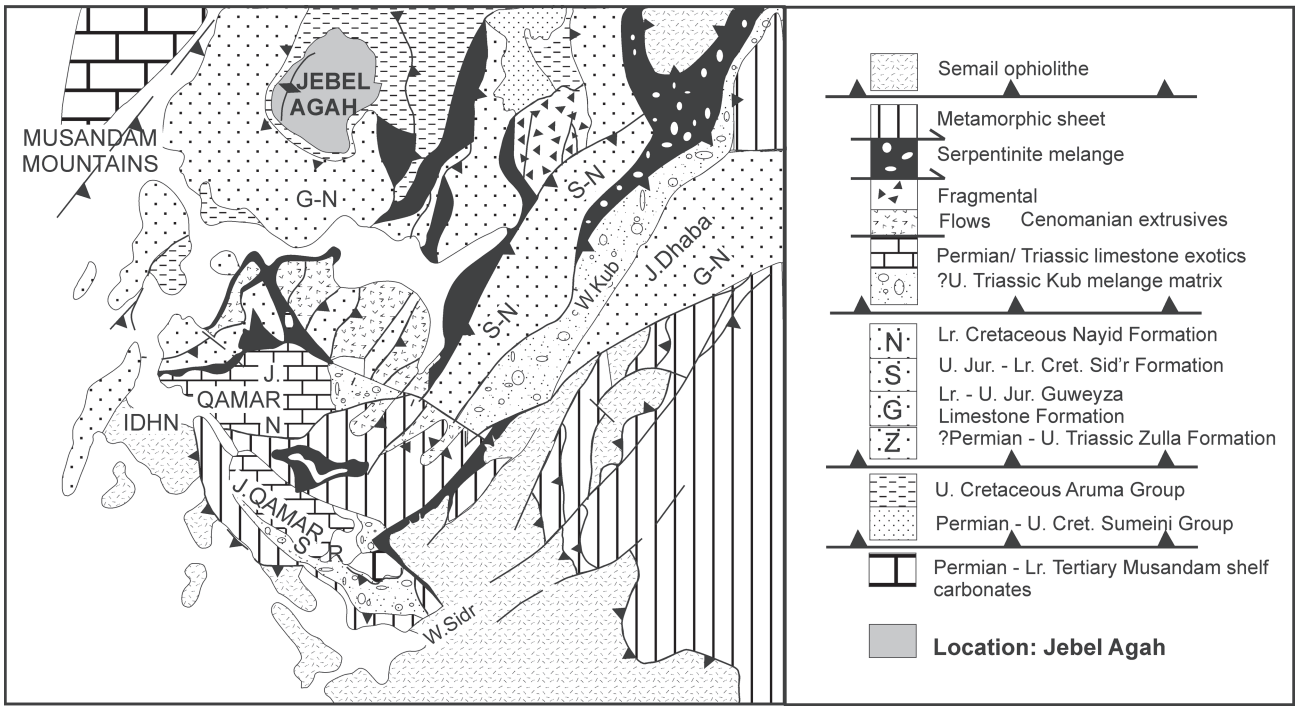

Fig. 2: Geological map of the Agah Crumple Zone based on maps of GLENNIE et al. (1974) and ROBERTSON et al. (1990) with the location at Jebel Agah.

Mesozoic (Triassic: SENOWBARI-DARYAN & BERNECKER 2000) of the Oman Mountains. In this paper we describe for the first time the ichnogenus *Helicerina* from Oman.

2. Geological setting

The Dibba Zone in the Northern Oman Mountains exposes a transition between a Late Palaeozoic – Mesozoic continental margin and an ocean basin. This elongate, 10 km wide northeast – southwest trending topographic depression between the carbonate successions of the Musandam shelf to the northwest and the Semail Ophiolite to the southeast (Fig. 2). The history and tectonic development of the continental margin in this area have been sumarized and interpreted by ROBERTSON et al. (1990). The location of field log and samples (taken by C. TOLAND) is on the crest of Jebel Agah, situated in the Agah Crumple Zone south of the Musandam Mountains (Fig. 3). The exposed reefal limestone seems to be part of the in-situ shelf margin. The reefbuilders and associated fauna found in Jebel Agah is comparable with the Norian/Rhaetian fauna from Jebel Wasa in the Sumeini area further south, described by BERNECKER (1996).

3. Systematic Paleontology

Ichnofamily Favreinidae VIALOV, 1978
Ichnogenus *Helicerina* BRÖNNIMANN & MASSE, 1968

Type species: *Helicerina spinosa* BRÖNNIMANN & MASSE, 1968.

Emended Diagnosis: "The form genus *Helicerina* is characterized by triangular or diamond-shaped canals within the symmetry plane of cross sections. Laterally, rounded shaped canals can be developed from spine-like extensions of the central canals on each side of the symmetry plane." (SCHWEIGERT, in SCHWEIGERT et al. 1997: 52).

Remarks: The ichnogenus *Helicerina* was established with two species (*H. spinosa* and *H. alata*) by BRÖNNIMANN & MASSE (1968). SENOWBARI-DARYAN et al. (1979) added the species *H. siciliana* to the existing species. Later, *H. kainachensis* was described by FENNINGER & HUBMANN (1994), *H. ruttei* bei SCHWEIGERT (in SCHWEIGERT et al. 1997) and *H. keuperina* by SEEGIS (in SCHWEIGERT et al. 1997). We agree with FENNINGER & HUBMANN (1994) and SEEGIS (in SCHWEIGERT et al. 1997) to attribute the species *Favreina kalankyra* EBLI (1990) to *Helicerina*. Therefore the ichnogenus *Helicerina* contains following species:

H. alata BRÖNNIMANN & MASSE, 1968 (Barremian-Aptian, France)
H. kainachensis FENNINGER & HUBMANN, 1994 (Upper Santonian - Lower Campanian, Austria)
H. kalankyra (EBLI, 1990) (Norian, Northern Calcaeous Alps, Sothern Germany)
H. keuperina SEEGIS (in SCHWEIGERT et al., 1997) (Middle Keuper = Upper Carnian, Germany)
H. ruttei SCHWEIGERT (in SCHWEIGERT et al., 1997) (Early Miocene, Southern Germany)
H. siciliana SENOWBARI-DARYAN, SCHÄFER & CATALANO, 1979 (Norian, Sicily/Italy)
H. spinosa BRÖNNIMANN & MASSE, 1968 (Barremian-Aptian, France)

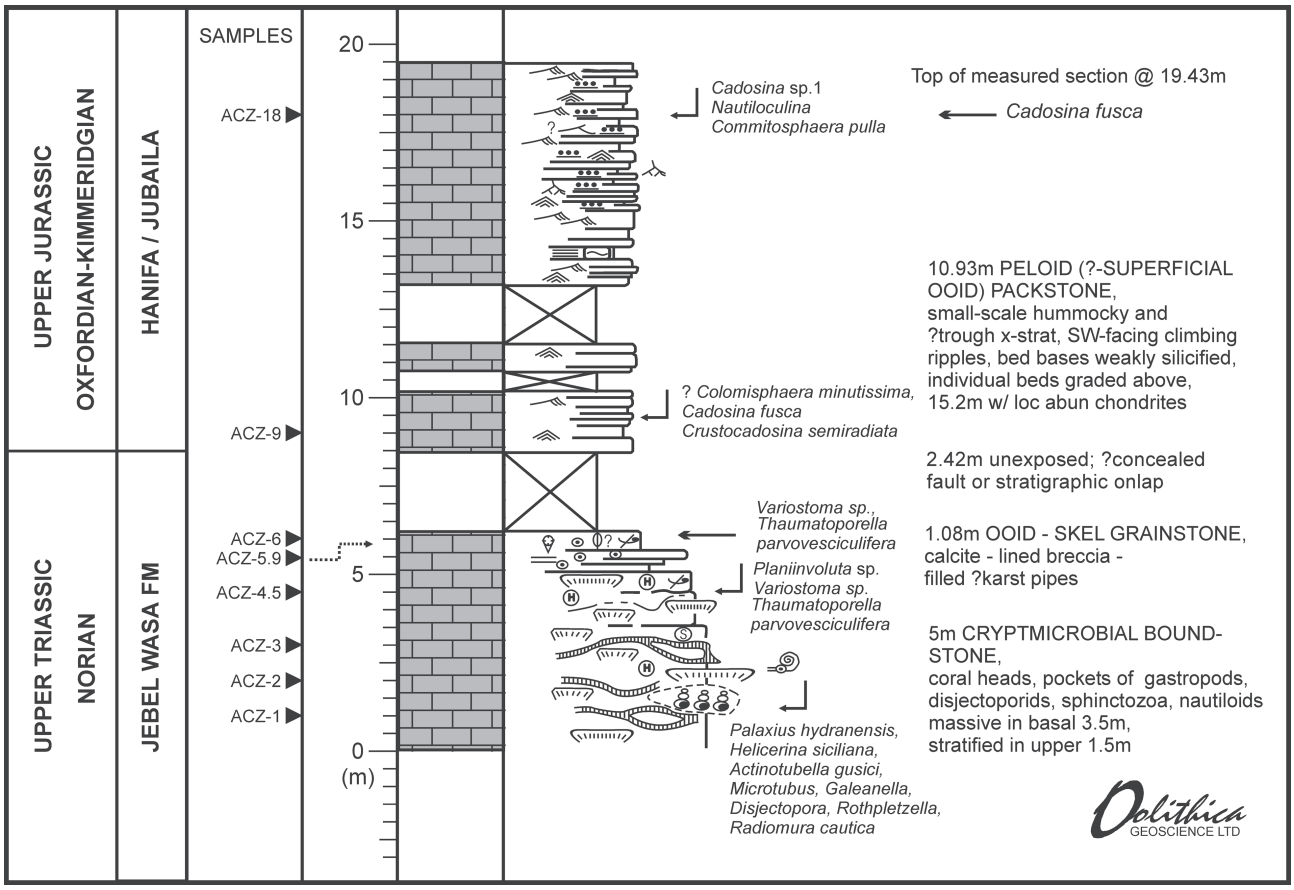

Fig. 3: Outcrop section from the crest of Jebel Agah (fieldlog and sampling: CHRISTOPHER TOLAND of Oolithica Geoscience). The lower part containing the microcoprolites (sample ACZ-1) could be biostratigraphically dated as Norian/Rhaetian.

As shown by SEEGIS (in SCHWEIGERT et al. 1997: Fig. 2) and in Figure 4 in this paper the different species of *Helicerina* show a different construction of canals. *H. siciliana* has the most simple canal system consisting of a diamond- and a triangular-shaped canal which are connected together outside of the coprolite. The canal system became more complicated over *H. alata, H. spinosa,* to *H. keuperina* but is still relatively simple in comparision with *H. kalankyra, H. ruttei* and *H. kainachensis* (Fig. 4). Most probably these two groups belong to a different genus or subgenus. *H. kainachensis* has the most complicated canal system composed of two dimond-shaped, one triangular and four lateral branches containing 10 canals with circular outline in cross section. *H. keuperina* from Upper Carnian is the oldest species of the genus followed by the both Norian species *H. siciliana* and *H. kalankyra.* The chronological order of species, however does not show any evolutionary trend for the *Helicerina*-species through time.

Helicerina siciliana SENOWBARI-DARYAN, SCHÄFER & CATALANO, 1979
(Pl. 1, figs.1-5, 13, text-figs. 4a)

1979 *Helicerina siciliana* n. sp.- SENOWBARI-DARYAN, SCHÄFER & CATALANO, p. 316, pl. 1, figs. 1-9.
1986 *Helicerina siciliana* SENOWBARI-DARYAN, SCHÄFER & CATALANO.- MOLINARI PAGANELLLI et al. p. 314, fig. 4c; pl. 1, fig. 3.
1997 *Helicerina siciliana* SENOWBARI-DARYAN, SCHÄFER & CATALANO.- FELS (in: SCHWEIGERT et al., p. 62, figs. 8g, i-k, 10c).

Description: The specimens in cross section are circular and smaller than the specimens described from the type locality in Sicily (SENOWBARI-DARYAN et al. 1979). Most specimens have a diameter of 250 µm (200-400 µm). The specimens have a longitudinal canal system passing through the whole coprolite. Like the type material from Sicily the canal system of specimens from Oman are characterized by a diamond-shaped dorsal canal and triangular ventral canal in cross section. The dorsal canal is connected with a ventral canal and with the outside of the coprolite by a narrow canal. The length of the canal system occupied almost 2/3 of the coprolite diameter. In longitudinal sections the coprolite exhibits only one narrow white line, usually in the center of cylindrical coprolite (pl. 1, figs. 1, 13) and can be distinguished from the accompaning specimens of *Palaxius* which exhibits oval or several parallel running white lines (pl. 1, fig. 12).
Except the small dimensions of specimens from Oman, all other features of coprolites correspond to the original description of *H. siciliana* from Sicily by SENOWBARI-DARYAN et al. (1979).

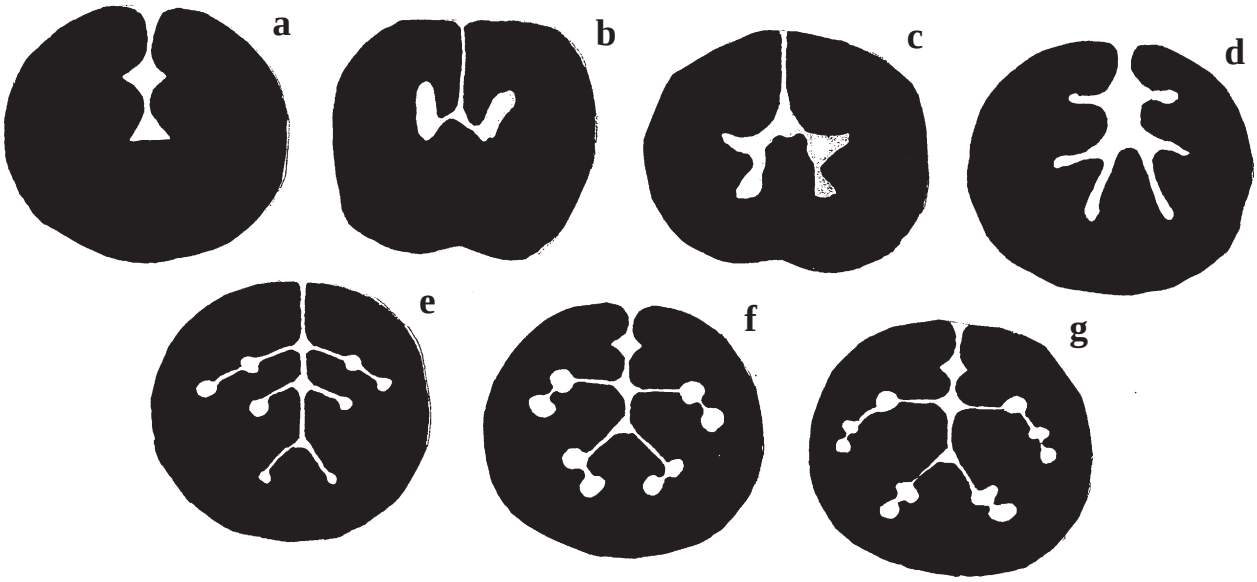

Fig. 4: All species of the genus *Helicerina* arranged according to their compound canal system. a) *H.siciliana*, b) *H. alata*, c) *H. spinosa* (type species), d) *H. keuperina*, e) *H. kalankyra*, f) *H. kainachensis*, g) *H. ruttei* (modified after BRÖNNIMANN & MASSE 1968 and SEEGIS (in SCHWEIGERT et al. 1997). All figs. not to scale.

Occurence and stratigraphic range: In Sicily *H. siciliana* occurs within the Norian reef limestones. The coprolite-bearing sample from Oman should be classified also as Norian-Rhaetian reef limestone (see organism assemblage after the description of species). We found *H. siciliana* also in bedded limestones (Loferitic Facies, Norian) of Pantokrator-limestones within a cavity (not published material of M. VARTIS-MATARANGAS). The occurence of *H. siciliana* in Greece and Oman indicates the paleogeographic distribution of the microcoprolite producing crab during the Upper Triassic time.

Helicerina siciliana is described from the Middle Jurassic (Bajocian) limestones of Southern Spain by FELS (in SCHWEIGERT et al. 1997). The stratigraphic range of *H. siciliana* should be extended from Norian to Bajocian although the species is not known from the Liassic (Hettangian-Aaleanian) interval.

Ichnogenus *Palaxius* BRÖNNIMANN & NORTON, 1960

Type-species: *Palaxius habanensis* BRÖNNIMANN & NORTON, 1960

*Palaxius hydranens*is SENOWBARI-DARYAN & KUBE, 2003
(Pl. 1, figs. 6-9, 12, text-fig. 5)

2003 *Palaxius hydranensis* n. sp.- SENOWBARI-DARYAN & KUBE, p. 117, figs. 2, 3C, 4A-I.

Description: This rod-like coprolite has a circular to oval outline in cross section. Having a diameter of 300-600 µm the specimens from Oman are smaller than those of type locality in Hydra (400-800 µm) described by SENOWBARI-DARYAN & KUBE (2003). The best preserved specimen has a diameter of 600 µm (pl. 1, fig. 6). Six longitudinal V-shaped canals are arranged bilaterally to a symmetry plane in two

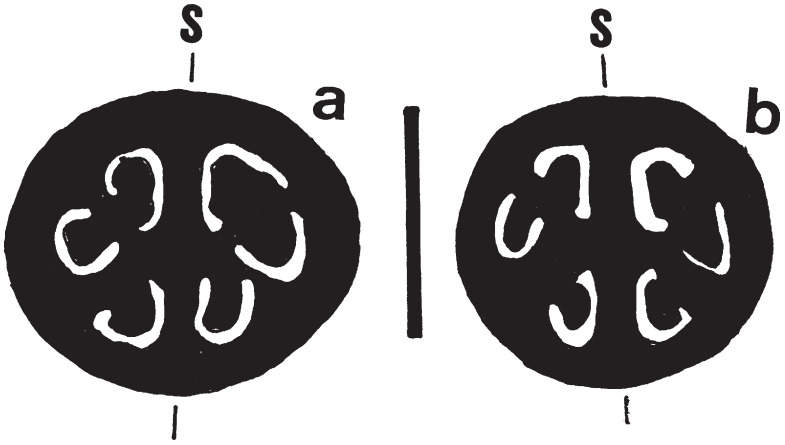

Fig. 5: *Palaxius hydranensis* SENOWBARI-DARYAN & KUBE. a) holotype from Island Hydra/Greece (after SENOWBARI-DARYAN & KUBE, 2003: Fig. 2A) and b) one specimen from Oman (compare pl. 1, fig. 6) show the two groups of three V-shaped canals arranged bilaterally to the symmetry plane (S). Scale bar 0.5 mm.

groups of three canals. The arrangement of canals to the symmetry plane and to other canals in specimens from Oman corresponds totally to those of the original description (compare text-fig. 5).

Occurence: Until now *P. hydranensis* was known from the Norian part of Pantokrator reef limestones of the island Hydra (Greece). Oman is the second locality of this microcoprolite. The samples of both localities are Norian-Rhaetian in age.

Palaxius sp.
(pl. 1, fig. 10)

Description: This microcoprolite has a circular outline in cross section with a diameter of about 600 µm. The number of canals in this species is higher (10?) than in the preceding species. Because of poor preservation and not sufficient specimens, we described it here as species indet.

Assemblage: All three species of microcoprolites described above occur in the micritic and laminated internal sediments deposited in the cavities between microbial crusts (typically Norian-Rhaetian Spongiostromata) surrounding the following reef organisms: *Disjectopora* sp., undeterminable inozoid and chaetetid sponges, sphinctozoid sponges *Uvanella norica* (SENOWBARI-DARYAN & SCHÄFER), foraminifers [(*Galeanella* sp., *Ophthalmidium* sp., *Hirsutospirella pilosa* ZANINETTI et al. (pl. 1, fig. 11), *Alpinophragmium perforatum* FLÜGEL)] and problematic organisms (*Microtubus communis* FLÜGEL, *Radiomura cautica* SENOWBARI-DARYAN & SCHÄFER). All mentioned organisms indicate a Norian-Rhaetian age for the coprolite-bearing limestone.

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Plate 1

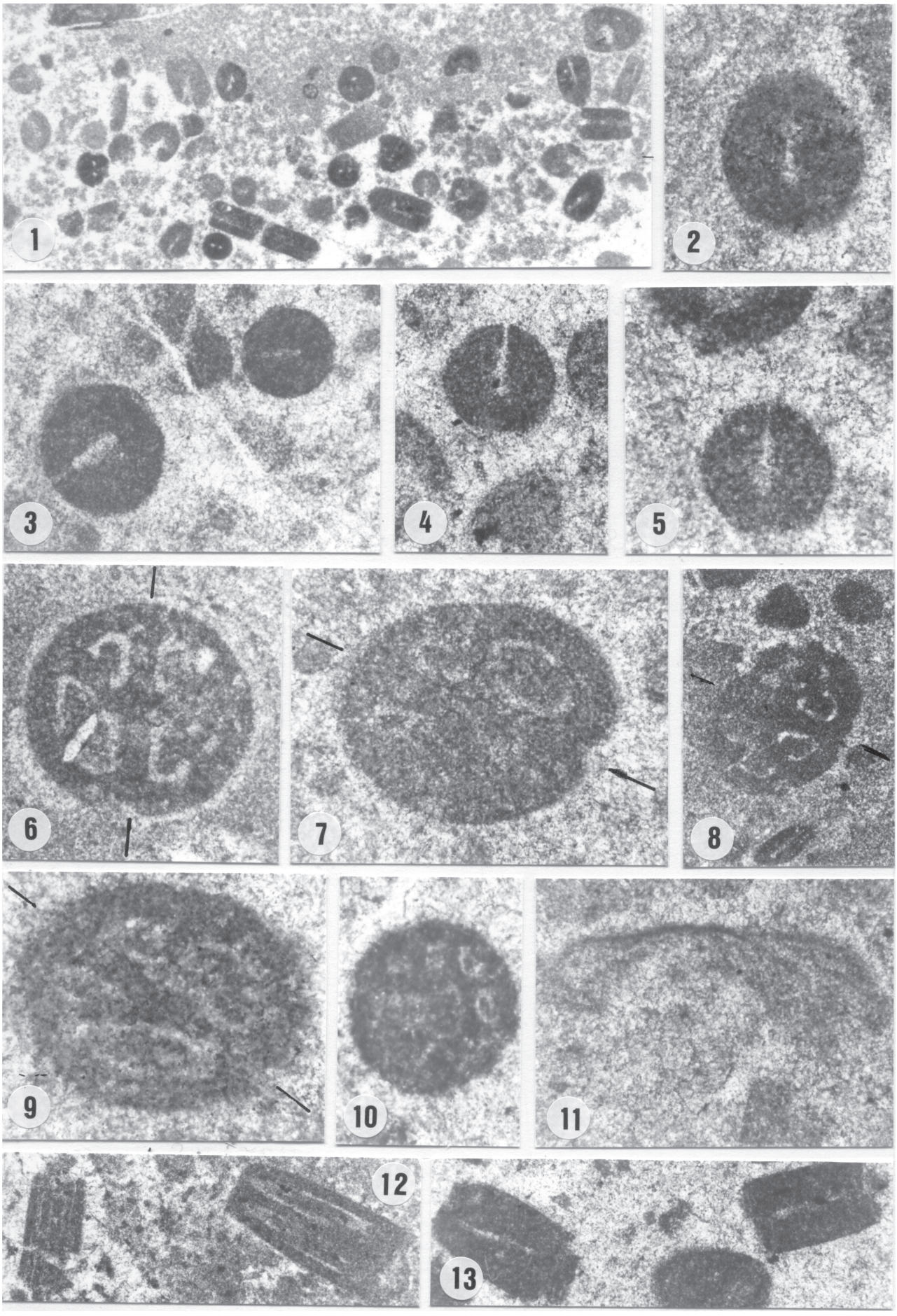
Figs. 1-5, 13: *Helicerina siciliana* SENOWBARI-DARYAN, SCHÄFER & CATALANO.

Fig. 1: General view of the abundance of microcoprolites. x25.
Figs. 2-5: Cross sections exhabit the canals system which are connected with the outside of coprolite by a narrow canal. 2**,** 4 and 5: x100, 3: x63.
Fig. 13: two oblique to longitudinal sections exhabiting the canal as only one white line in the center of coprolite. x63.

Figs. 6-9, 12: *Palaxius hydranensis* SENOWBARI-DARYAN & KUBE. Cross sections exhibit the V-sahped canals in cross section. The lines indicate to the symmety plane. 6-7: x63, 8: x35, 9: x100. 12: Two longitudinal sections exhabiting the V-shaped canals, are cut in oblique or longitudinal sections appearing as oval or several parallel running white lines. x32.

Fig. 10: *Palaxius* sp. Cross section. This species exhibits a higher number of canals as in *P. hydranensis*. x63.

Fig. 11: The foraminifere *Hirsutospirella pilosa* ZANINETTI et al. is associated with mocrocoprolites in cavities between the reef organisms. x100.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