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ICHNOGENUS *RHIZOCORALLIUM* IN THE PALEOGENE FLYSCH (OUTER WESTERN CARPATHIANS, POLAND)

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Abstract: Ichnogenus *Rhizocorallium* widespread in shallow marine deposits occurs also in deep water Paleogene flysch of the Magura Nappe. It coexists with ichnogenera of the *Zoophycos* and *Nereites* ichnofacies in both distal and proximal flysch facies. Such a mode of *Rhizocorallium* occurrence does not conform with classical bathymetric and facial models of distribution of trace fossils. This leads to a conclusion that *Rhizocorallium* is a facies-crossing form.

Key words: Western Carpathians, Paleogene, trace fossils, flysch, paleoecology.

Introduction

Rhizocorallium is widely known from shallow marine deposits (e.g. Ager & Wallace 1970; Sellwood 1970; Fürsich 1974, 1981). It is a typical form of littoral *Skolithos* ichnofacies as well as neritic *Cruziana* one, according to the model of Seilacher (1967). However, *Rhizocorallium* was also reported from deep-marine deposits at a few places in the world. Data collected by the present author on *Rhizocorallium* occurrence in deep-marine Paleogene deposits of the Magura Nappe, confirm Ksiażkiewicz's reports (Książkiewicz 1977) on the appearance of this form in the Polish Carpathian Flysch.

The Magura Nappe in Poland consists of 3 000 *m* thick Albian-Oligocene siliciclastic flysch deposits. Its facies differentiation and stratigraphy have lately been described in detail by numerous authors, e.g. Cieszkowski & Oszczypko (1986), Birkenmajer & Oszczypko (1989), Oszczypko et al. (1990).

Rhizocorallium and its occurrence in deep marine deposits

Ichnogenus *Rhizocorallium* Zenker 1836 is a horizontal or oblique, protrusive (sensu Goldring 1962) spreite structure, situated between the arms of U-shaped parallel or sub-parallel cylindrical canal (cf. Fürsich 1974). Wide marginal canal differs *Rhizocorallium* from poorly preserved specimens of *Zoophycos insignis* Squin. (cf. Crimes et al. 1981).

Some authors regard *Rhizocorallium* as feeding structure (*Pascichnia*) of deposit feeders (e.g. Basan & Scott 1979). Selwood (1970) distinguishes two stages of formation of the *Rhizocorallium* structure. During the first stage a tracemaker is regarded as a deposit feeder and during the second one as a suspension feeder. After Fürsich (1974), *Rh. janese* was produced by suspension feeders whereas *Rh. irregulare* - by deposit feeders.

There is not agreement in determining of *Rhizocorallium* tracemaker. It was produced by an animal cylindrical in shape and with parapodia (Basan & Scott 1979). The tracemaker belongs probably to crustaceans (e.g. Seilacher 1967) or to annelids (vide Basan & Scott 1979), or exceptionally to insects such as ephemerids (*Empheroptera*) (Fürsich & Mayr 1981).

Rhizocorallium occurs from Tommotian (Crimes 1987) till Miocene (Hayward 1976).

According to the hitherto published data, *Rhizocorallium* occurs in deep water deposits, in the following settings:

1 - Walls of deep marine ancient canyon in the Waithakere Group (Miocene), New Zealand (Hayward 1976);

2 - Flysch deposits in northern Spain (Eocene) (Crimes 1977);

3 - Flysch deposits of the Magura Nappe in Poland; *a* - the Variegated Shales at Bladzonka (Fig. 1) (Upper Paleocene-Eocene), one specimen at the sole of sandstone bed (Fig. 2.2); the Magura Beds at Klimkówka (Fig. 1) (Eocene), one specimen at top of sandstone bed (Fig. 2.1); both the specimens were determined as *?Rhizocorallium* sp. indet. (Książkiewicz 1977);

4 - The Gurnigel Flysch (Eocene), Switzerland (Crimes et al. 1981);

5 - Flysch deposits of the Peary Land (Cambrian – Silurian), Greenland (Pickerill et al. 1982);

6 - Flysch deposits of the Saraceno Formation (Eocene), Italy (d'Alessandro et al. 1988).

The occurrences of *Rhizocorallium* are not restricted only to deep-marine environment ones. It was also noted in fresh-water deposits of the Alpine molasse (Fürsich & Mayr 1981).

The present author observed *Rhizocorallium* in such places as (see Fig. 1):

1. Thin and medium-bedded flysch of the Szczawnica Formation (Upper Paleocene – Lower Eocene) (geological description - Birkenmajer & Oszczypko 1988), Krościenko-Lakcica, Wierchomla Mala - two specimens (Fig. 3.1); epichnial forms at 3.5 *cm* thick sandstone beds. Size: total width 3.0 – 3.5 *cm*, width of the marginal canal 1.0 *cm*, total length 13.0 *cm*;

2. Thin-bedded flysch of lower part of the Beloveža Beds (Eocene) (geological description - Oszczypko et al. 1989), Zasadne - one specimen (Fig. 3.2); endichnial form within dark-gray mudstones. Fecal mud pellets occur along some spreite laminae. Size: total width 4.0 *cm*, width of the marginal canal 1.2 *cm*, total length 6.5 *cm*;

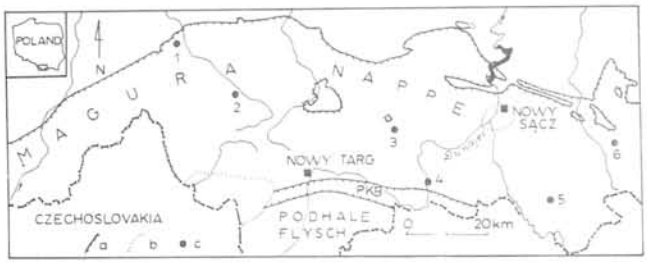

Fig. 1. Location scheme. a - main overthrusts, b - extent of the Neogene postorogenic cover, c - *Rhizocorallium* occurrences.
(1 - Bladzonka; 2 - Osielec; 3 - Zasadne; 4 - Krościenko-Lakcica; 5 - Wierchomla Mala; 6 - Klimkówka).

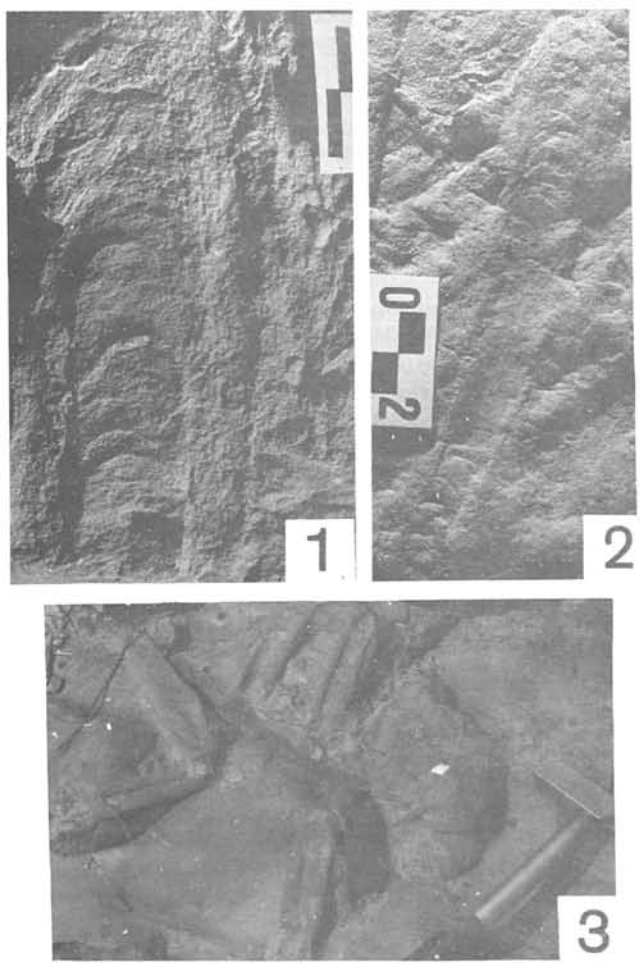

Fig. 2. *Rhizocorallium* ichnosp. 1 - Klimkówka, Magura Sandstones (Eocene), coll. M. Książkiewicz, Geological Museum. Jagellonian University. Scale bar = 2 *cm*; 2 - Bladzonka, variegated shales (Upper Paleocene-Eocene), coll. M. Ksiazkiewicz, Geological Museum. Jagellonian University; 3 - Osielec quarry, Magura sandstones (Eocene). The "head" of hammer is 2.5 *cm* wide.

3. Medium and thick bedded flysch of the Magura Sandstones (Eocene), Osielec quarry (geological description - Cieszkowski 1985) - fifteen observations (Fig. 2.3) hypichnial casts on medium grained sandstone bed 23 – 28 *cm* thick, with uneven sole surface.

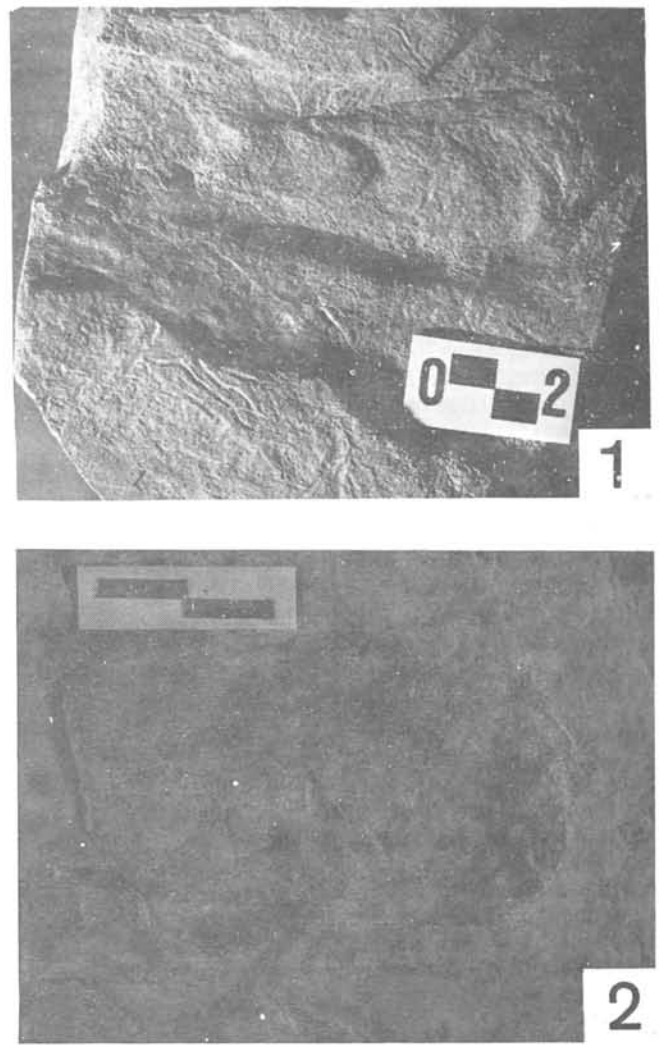

Fig. 3. *Rhizocorallium* ichnosp. 1 - Krościenko-Lakcica, Szczawnica Formation (Paleocene-Lower Eocene); 2 - Zasadne, Beloveza Beds (Eocene). Scale bar = 2 *cm*.

Size: total width 2.5 – 5.5 *cm*, width of the marginal canal 1.5 – 1.8 *cm*, total length 6.0 – 20.0 *cm*. Two smaller specimens showing size 2.0 *cm* total width and 0.8 *cm* width of the marginal canal, have also been observed. They were produced probably by juvenile tracemakers.

At this same outcrop of the Szczawnica Formation in Krościenko-Lakcica, together with *Rhizocorallium* have been found numerous ichnogenera such as: *Chondrites, Phycosiphon, Tubulichnium, Helminthoida, Sabularia, Planolites, Spirorhaphe, Zoophycos,* as well as less numerous: *Megagrapton, Paleodictyon, Thalassinoides, Strobilorhaphe, Helminthopsis, Subphyllochorda, Taphrhelminthopsis, Spirophycus, Taphrhelminthoida* and *Urohelminthoida.* At Wierchomla Mala, together with *Rhizocorallium* appear numerous: *Chondrites, Planolites, Sabularia, Helminthoida,* and less frequently: *Tuberculichnus, Spirophycus, ?Bergaueria, ?Gordia.*

To the most frequent trace fossils of the Beloveža Beds at Zasadne belong: *Planolites, Sabularia, Chondrites* and *Helminthoida.* Less numerous are: *Subphyllochorda, Taphrhelminthopsis, Taphrhelminthoida, Spirorhaphe, Thalassinoides, Zoophycos, Tuberculichnus, ?Gordia, Halymenidium, Spirophycus, Circulichnis, Cosmorhaphe, Protopaleodictyon, Paleodictyon* and *Megagrapton.*

In the Osielec quarry, beside *Rhizocorallium* occur numerous: *Zoophycos, Planolites, Sabularia, Helmintoida,* and rarely: *Protopaleodictyon, Taphrhelminthopsis, Scolicia* and *Spirorhaphe.*

Discussion

According to the above presented description, *Rhizocorallium* occurs together with bathymetrically diversified ichnofacies i.e., *Zoophycos* ichnofacies, *(Zoophycos, Phycosiphon)* and *Nereites* one *(Paleodictyon, Cosmorhaphe, Spirorhaphe, Helminthoida,* and others). This is not with agreement with the classical model of bathymetric distribution of trace fossils (Seilacher 1967). These same differences display also other trace fossils occurring in flysch deposits, such as: *Thalassinoides, Ophiomorpha, Pelecypodichnus* (cf. e.g., Crimes et al. 1981) noted also in the Carpathian Flysch (Uchman 1989).

The Paleogene flysch deposits of the Magura Nappe were deposited in deep-sea environment. This is indicated, among others, by sedimentological features of some deposits (e.g. Koszarski 1967; Książkiewicz 1975) and foraminiferal assemblages (e.g. Książkiewicz 1975; Olszewska 1984). Hence, the Magura Nappe is the another place of occurrence of *Rhizocorallium* in deep marine conditions.

According to Crimes et al. (1981), the occurrence of pseudo-shallow water trace fossils in flysch deposits is limited to the inner fan setting. However, the *Rhizocorallium*-bearing the Variegated Shales were deposited in counterpart to the basin plain whereas the lower part of the Beloveža Beds - in external fan zone counterparts (cf. Oszczypko 1986). Therefore, *Rhizocorallium* tracemakers occurred outside the inner fan environment.

Conclusions

1. *Rhizocorallium* is a cosmopolitic form produced probably by taxonomically diversified animals living in differenciated environments and bathymetric zones.

2. Distribution of single genera of trace fossils differs from both the bathymetric model of Seilacher (1967) and the "facial" one of Crimes et al. (1981). Single trace fossils are not useful in bathymetric reconstructions of flysch deposits.

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