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NATURE OF GRAPTOVERMIDS (GRAPTOLITHINA)

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Graptovermids are redefined as resting terminal portions of unknown encrusting graptolites stolothecae. Presumably, their biological significance was an adaptation allowing to survive the periods of unfavourable or adverse conditions. SEM observations are made on *Graptovermis intestinalis* Kozłowski, 1949 from the lower Ordovician of Öland (Sweden).

K e y w o r d s: graptolites, taxonomy, Ordovician, Sweden.

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INTRODUCTION

The Graptovermida are poorly known early Ordovician organic microfossils. Their systematic assignment presents a problem which so far has not been solved. These enigmatic forms were described by Kozłowski (1949) as a provisional group of invertebrates in some way related to pterobranchs or graptolites. Bulman (1970) tentatively placed graptovermids in the Graptolithina *incertae sedis*.

To date, sole graptovermids have been known from the upper Tremadoc outcrop in Wysoczki (Holy Cross Mts., Central Poland) and comprise only one genus with two species (Kozłowski 1949). Skevington (1965) reported the second finding of these fossils from the Ontikan Limestone of Öland (Sweden), but his alleged graptovermids were recognized as rhabdopleurid zooidal tubes by Andres (1977) and Mierzejewski (1977) independently.

The aim of this paper is to give a description of real graptovermids from the lower Ordovician of Öland and to discuss their nature and taxonomic assignement.

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MATERIAL AND METHODS

Specimens described in this paper were obtained with use of 10—15% acetic acid from grey glauconitic limestones of the Valaste age (lower Llanvirn) collected at a locality known as Gillbergabrottet 1 (northern Öland). For detail information on the location, lithology, fauna and biostratigraphy of the outcrop, see Bohlin (1949) and Grahn (1980). The specimens were chemically cleaned of mineral impurities and studied with a Cambridge Stereoscan 180 at 30 kV. The SEM pictures were taken at the Institute of Historical Geology and Palaeontology, University of Copenhagen.

All the described graptovermids are deposited at the Institute of Palaeobiology, Polish Academy of Sciences, Warsaw (ZPAL).

SYSTEMATIC DESCRIPTION

Class **Graptolithina** Bronn, 1846
Order and family unknown
Group **Graptovermida** Kozłowski, 1949
Genus *Graptovermis* Kozłowski, 1949

Type species: *Graptovermis spiralis* Kozłowski, 1949

Graptovermis intestinalis Kozłowski, 1949
(pl. 14—15)

? 1930. *Melanostrophus signum* [redacted] Öpik: 12, pl. 3: 3.
1949. *Graptovermis intestinalis* Kozłowski: 206, pl. 35: 5—12.

Material. — Four specimens (ZPAL GXII/1).

Description. — All specimens are irregularly bent tubes made of black, non-transparent organic substance. The tubes reveal rather numerous swellings and constrictions. In spite of these frequent changes in their diameter, they distinctly expand towards one end (pl. 14: 1, pl. 15: 1—2). The largest specimen is 3.1 mm long, varying from 0.25 to 0.63 mm in diameter (pl. 14: 1). Its wider end is closed and rounded. The wider ends of remaining specimens are partly damaged.

The upper tube surface is convex and exhibits series of ridges closely resembling the arrangement of graptolite fuselli with the characteristic zig-zag suture (pl. 14: 2—3). The width of these "fuselli" varies between 10 and 33 μm. On the contrary, the lower tube surface is more or less concave, devoid of any traces of "fuselli" and often cracked (pl. 15: 2—3). SEM studies did not show the presence of the fusellar and cortical layers in the tube wall. The substance of the tube appears structureless.

Remarks. — Kozłowski (1949) suggested that *Melanostrophus signum* Öpik, 1930, an enigmatic organic fossil from the Middle Ordovician of Estonia, might be related to graptovermids. Howell (1962), however, placed *M. signum* among poly-

chaete annelids. Unfortunately, during my stay at the Geological Institute (Estonian SSR Academy of Sciences, Tallinn) in 1984, it has appeared that the holotype of this species was lost. Nevertheless, there is a distinct similarity between *M. signum* tubes illustrated and described by Öpik (1930) and *G. intestinalis* tubes. I suppose that both discussed forms may be not only related but even conspecific. It should be noted here that *Melanostrophus fokini* Öpik, 1930, has nothing in common with graptovermids (Mierzejewski, unpublished SEM observations).

Graptovermis intestinalis Kozłowski appears strikingly similar to *Kozlowskisyrinx graptovermiformis* Mierzejewski known from Ordovician glacial boulders from the area of Poland. The similarity between these forms appears merely superficial and not connected with their systematic position (see Mierzejewski 1986).

Occurrence. — Poland, Świętokrzyskie Mts., upper Tremadoc. Sweden, Öland: lower Llanvirn.

ADAPTIVE ROLE OF GRAPTOVERMIDS

SEM observations throw a new light on the problem of graptovermid nature. The most important information is a structureless character of the tube wall. Lack of any traces of fusellar and cortical tissues precludes homology of the graptovermid tube wall and the typical graptolite periderm. On the other hand, the fusellar-like pattern on the convex surface of graptovermid tubes suggests a close relation to the graptolite fusellar tissue. I am of the opinion that this alleged paradox is to dissolve if one compares graptovermids to graptoblasts.

Graptoblasts are peculiar and rarely found elements of crustoid graptolite colonies (Kozłowski 1962). According to Urbanek, Mierzejewski and Rickards (1986) the graptoblast wall is composed of two layers: blastocrypt (inner layer) and blastotheca (outer layer). The blastocrypt is made of electron dense and homogeneous material whereas the blastotheca is composed of fuselli. Fuselli of the blastotheca produce imprints on the upper surface of the blastocrypt in the form of shallow furrows and gentle elevations (see Urbanek *et al.* 1986: fig. 2 A—B). This phenomenon was pictured also by Kozłowski (1962: fig. 12).

In my opinion, these similarities in the fine structure of the blastocrypt and discussed graptovermid tubes should be regarded as homologous. Moreover, I suppose that graptovermids, similarly as graptoblasts, should be treated as resting stolothecae of encrusting graptolites (comp. Urbanek 1984). Consequently, one may expect finding of graptovermids with preserved fusellar layer corresponding to the graptoblast blastotheca.

Presumably, the biological significance of graptovermids was similar to that of graptoblasts, i.e. it was an adaptation allowing to survive the periods of unfavourable or adverse conditions. However, this adaptation was realized in two different ways. Urbanek (1984: 313) supposed "that after germination the graptoblasts produced small propagules ejected

through a narrow cryptopyle and forming new colonies after they settled on the substrate". Thus, graptoblasts allowed the species to survive but not their own colony and played simultaneously an important role in a reproduction (see also Kozłowski 1949, 1962). On the contrary, graptovermids should be regarded as an adaptation which enables survival of their own colony. One may suppose that graptovermids were able to continue the growth and budding as normal stolothecae when adverse conditions passed.

In my opinion, graptovermids have their equivalent in colonies of the genus *Rhabdopleura* Allman. As pointed by Urbanek (1984: 317) on the basis of Schepotieff's observations, "A complete colony may exhibits a number of growing tips most of which concurrently ceased to grow and are closed". I think that there is a striking similarity with graptovermids interpreted as resting stolothecae of encrusting graptolites. In this situation mentioned above *Melanostrophus signum* Öpik could be interpreted as follows (for illustrations see Öpik 1930: pl. 3: 3 or Howell 1962: 104, fig. 14): the plate-like fragment of the fossil was an initial part of the colony and its tubular irregular offshoots were nothing more but graptovermids, i.e. resting stolothecae.

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NATURA GRAPTOWERMIDÓW (GRAPTOLITHINA)
(pls. 14, 15)

Streszczenie

Graptowermida zostały opisane przez Kozlowskiego (1949) z górnego tremadoku Wysoczek jako nieformalna grupa skamieniałości związanych w bliżej nieokreślony sposób z graptolitami. W pracy opisano drugie z kolei znalezisko graptowermidów, tym razem z dolnego lanwirnu wyspy Öland. Wyrażono pogląd, że graptowermidy były terminalnymi partiami stolotek nierozpoznanych dotąd graptolitów inkrustujących. Podobnie jak graptoblasty, graptowermidy stanowiły przypuszczalnie przystosowanie niektórych graptolitów do przeżycia niekorzystnych warunków.

EXPLANATION OF PLATES 14 AND 15

Plate 14

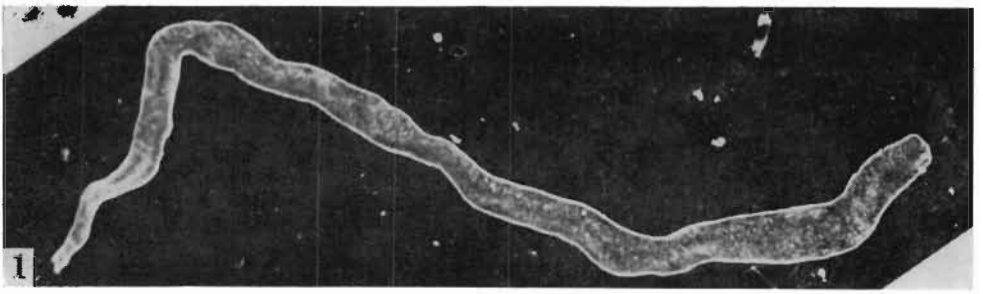
Graptovermis intestinalis Kozłowski, 1949. Lower Llanvirn, Gillbergabrottet 1, Öland. ZPAL GXII/1.

1. General (ventral) view of the largest specimen, ×28.
2. Fuselli impressions on the ventral surface of the same specimen. *2a* ×360; *2b* ×280.

Plate 15

Graptovermis intestinalis Kozłowski, 1949. Lower Llanvirn, Gillbergabrottet 1, Öland. ZPAL GXII/1.

1. General (ventro-lateral) view of the specimen with narrow end strongly curved, approx. ×43.
2. Lower (dorsal) tube surface devoided of any traces of fuselli impressions. *2a* general view of specimen, approx. ×60. *2b* details of the corroded surface, ×600.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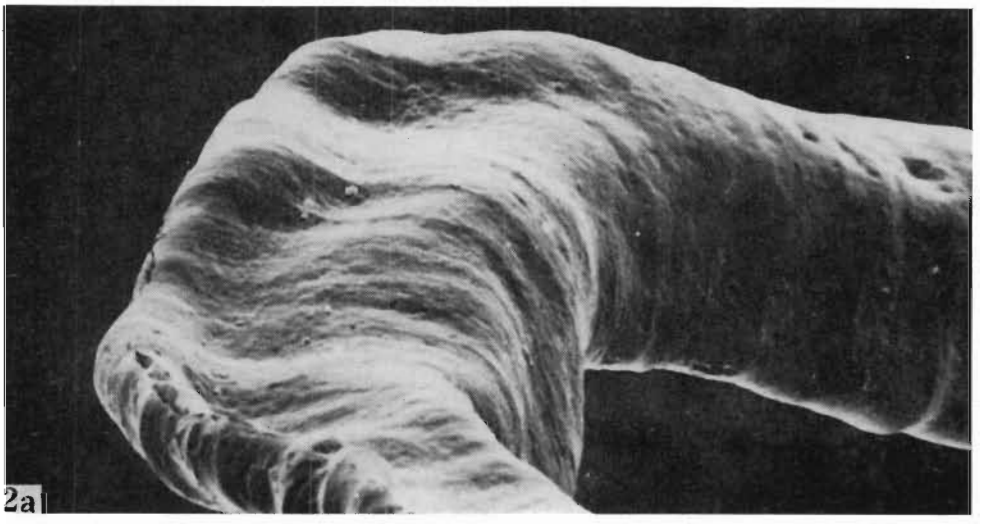
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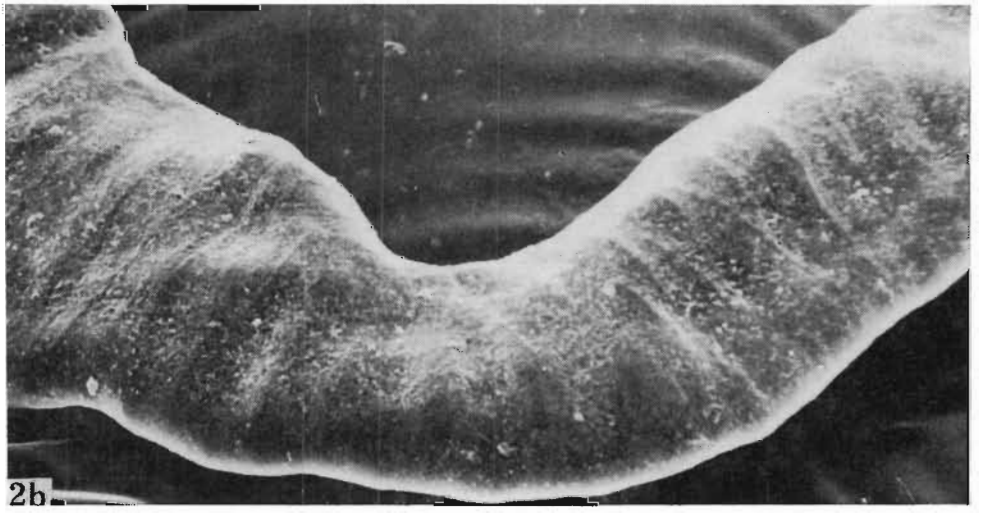
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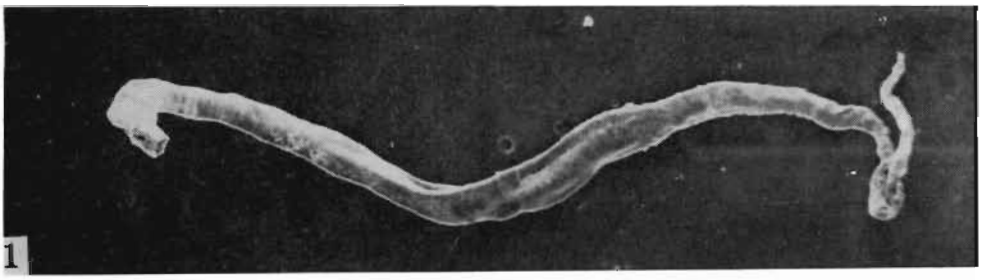
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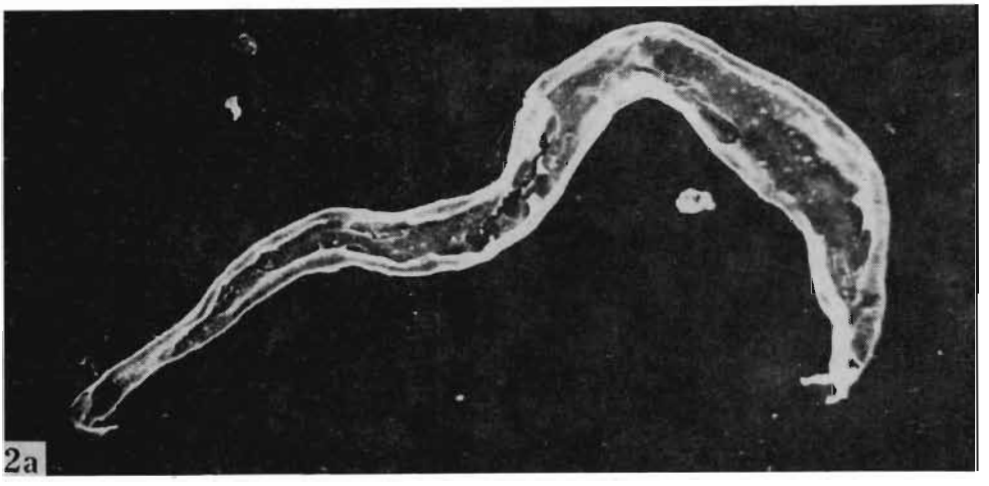
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2b