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A unique, "trilobite-like" fossil – the isopod *Cyclosphaeroma malogostianum* sp.n. from the Lower Kimmeridgian of the Holy Cross Mountains, Central Poland

ABSTRACT: The new species of the isopod crustacean (order Isopoda, superclass Crustacea), *Cyclosphaeroma malogostianum* sp.n., is established upon a specimen from the Lower Kimmeridgian of the Holy Cross Mountains, Central Poland. This specimen, being a well preserved exoskeleton of the anterior part of the animal, is interpreted as buried during, or soonafter, its molting when the posterior part has not yet been crusted. Such mode of preservation, as well as the morphology of the cephalic unit, are compared with those of the three other species of the genus, *C. trilobatum* H. WOODWARD, 1890, *C. uhligi* (REMEŠ, 1903), and *C. woodwardi* VAN STRAELEN, 1928, whose taxonomy is revised, and possible phyletic affinities are discussed.

INTRODUCTION

The Middle, and Upper to topmost Jurassic cratonic, marine deposits of Central Poland have long been known to yield ubiquitous fossils, primarily the ammonites which subjected to many monographic descriptions by such prominent authors as J. SIEMIRADZKI, J. LEWIŃSKI, H. MAKOWSKI, J. KUTEK, A. ZEISS, A. WIERZBOWSKI, or B.A. MATYJA. Similar descriptions were devoted to the sponges, corals, brachiopods, belemnites, and a part of gastropods and bivalves. The other groups of marine invertebrates have, however, remained still underrecognized (*e.g.*, crustaceans, echinoderms of any kind).

The scope of the present paper is to report on one of the most unique Upper Jurassic fossils, namely an isopod crustacean of a peculiar "trilobite-like" shape. Its quite well preserved, although fragmentary exoskeleton has recently been found in the huge quarry at Małogoszcz, western part of the Holy Cross Mountains, Central Poland. This quarry exposes now the Lower Kimmeridgian sequence of a carbonate platform development (*see* MATYJA 1991, pp. 66-70; KUTEK, MATYJA, RADWAŃSKI & WIERZBOWSKI 1992, pp. 30-34), paenecordantly overlain by the mid-Cretaceous transgressive deposits (*see* Text-fig. 1; *cf. also* MARCINOWSKI & RADWAŃSKI 1989, p. 156 and Fig. 8).

The isopod crustaceans (order Isopoda, superclass Crustacea), vernacularly called the sea-slaters, are extremely rare fossils, as already stated by VAN STRAELEN (1928), the author of the first systematic revision of the fossil representatives of that group. The majority of them are known from single specimens, usually more or less incomplete, and being the posterior parts of the exoskeleton (*see* H. WOODWARD 1870; VAN STRAELEN 1928; BACHMAYER 1949; IMAIZUMI 1953; HESSLER 1969; MATSUOKA & KOIDE 1980; WIEDER & FELDMANN 1989; FELDMANN, JAGT & TSHUDY 1990; KARASAWA, NOBUHARA & MATSUOKA 1992). The more complete specimens, with their anterior part and the cephalon preserved are quite exeptional (*see* CARTER 1889; H. WOODWARD 1890, 1898; REMEŠ 1903a,b, 1909; BACHMAYER 1947; TAUBER 1950; WIEDER & FELDMANN 1992; FELDMANN, WIEDER & ROLFE 1994).

The collected specimen, composed of the anterior and medial parts of the exoskeloton, has an English affinity, as it represents the genus *Cyclosphaeroma*, first recognized by Henry WOODWARD (1890, 1898) in the Middle and Upper Jurassic strata of England. The occurrence of this genus in Poland not only extends its geographic distribution, but also allows to discuss the morphologic features of its species, related to their biology (molting) and, possibly, to phylogeny.

All the extinct and extant isopods that constitute the family **Sphaeromidae** WHITE, 1847, to which the genus *Cyclosphaeroma* H. WOODWARD, 1890, belongs, are more or less similar in their body size and general morphology (*see* H. WOODWARD 1898, VAN STRAELEN 1928, HESSLER 1969). The genus *Cyclosphaeroma*, as already noticed by H. WOODWARD (1898), remains the largest of all ancient and present-day sphaeromids (*see* VAN STRAELEN 1928; BACHMAYER 1947, 1949; TAUBER 1950; HESSLER 1969). On the other hand, the present-day sphaeromids are morphologically so close to their extinct ancestors, as also noticed by H. WOODWARD (1898, p. 388), that they are to be regarded as *the living fossils*. The presence of such a living fossil in the sedimentary sequence of Małogoszcz enriches valuably the knowledge on its assemblages of ubiquitous extinct biota.

THE PROVENANCE OF THE ISOPOD STUDIED

The studied isopod comes from the much fossiliferous, but yet undescribed Upper Jurassic sequence exposed at the Małogoszcz Quarry, western part of the Holy Cross Mountains, Central Poland (*see* KUTEK, MATYJA, RADWAŃSKI & WIERZBOWSKI 1992). This sequence, the paleontologic content of which is the subject of extensive research, has been exposed in the early mid-seventies during the quarry exploitation in the Małogoszcz Cement Works. The preliminary results of sedimentologic, paleontologic, ecologic, and biostratigraphic studies, presented already (SEILACHER, MATYJA & WIERZBOWSKI 1985; MACHALSKI

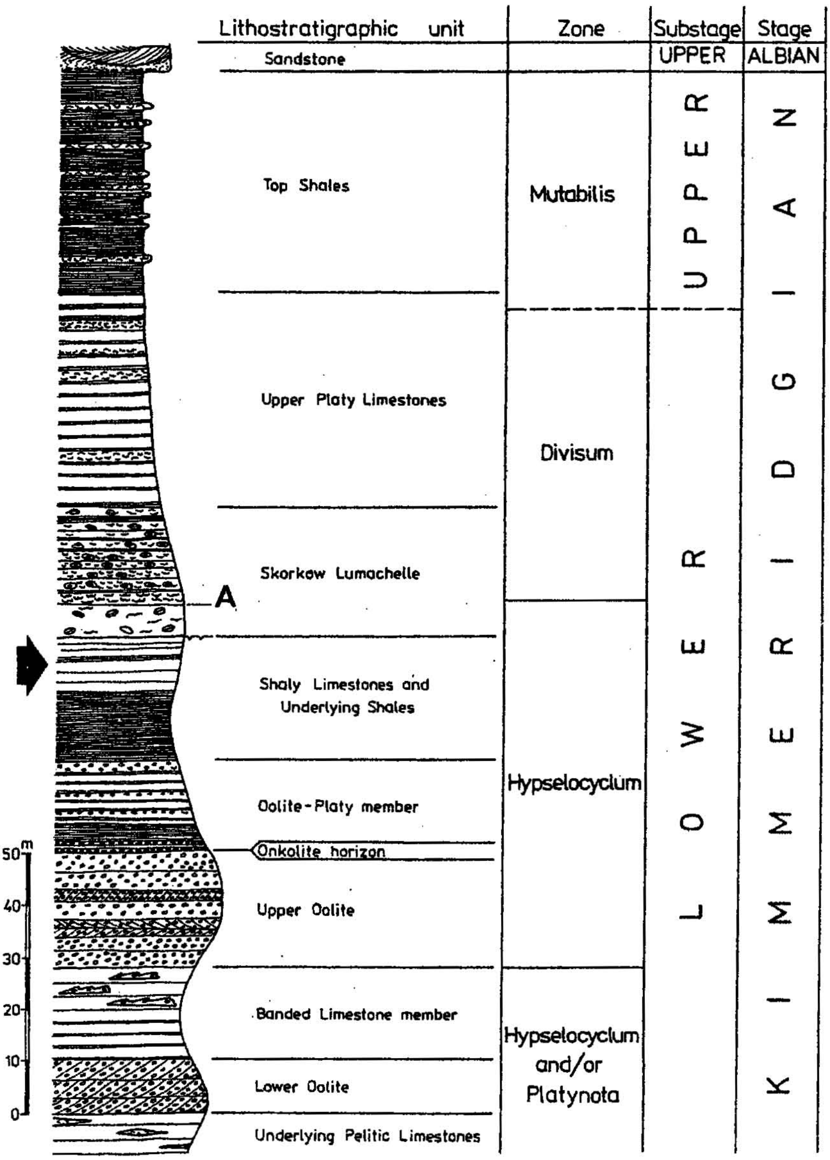


Fig. 1

Lower Kimmeridgian sequence exposed at the Małogoszcz Quarry, western part of the Holy Cross Mts, Central Poland (*taken from*: KUTEK, MATYJA, RADWAŃSKI & WIERZBOWSKI 1992, Fig. 5), to show the occurrence site (*arrowed*) of the studied isopod *Cyclosphaeroma malogostianum* sp.n.
The base of the *Lopha* coquinas = *Actinostreon* Beds of MACHALSKI (1996) is indicated by letter *A*

1989; KUTEK, MATYJA, RADWAŃSKI & WIERZBOWSKI 1992) will shortly be followed by successive reports on particular groups of fossils. Of these, the first results of investigation of the dinoflagellate cysts and their biostratigraphic approach have issued quite recently (POULSEN 1993, pp. 257-259), and the other reports will concern ammonites and their fine-biostratigraphy (WIERZBOWSKI, *in prep.*), ostreid bivalves and their ecology (MACHALSKI 1996), free-living crinoids (U. RADWAŃSKA, *in prep.*), stemmed crinoids and their myzostomid parasites (RADWAŃSKI, *in prep.*), ubiquitous echinoids (U. RADWAŃSKA, *in prep.*), as well as the associates of various kind (calcareous sponges, corals, serpulids, bryozoans, brachiopods, lobsters, gastropods, non-ostreid bivalves, asteroids, fishes, and a reptile) that all form unique "*Fossillagerstätten*" in the Małogoszcz sequence (RADWAŃSKI, *in prep.*).

The Upper Jurassic fossiliferous sequence exposed at the Małogoszcz Quarry (Text-fig. 1) embraces an interval since the Ataxioceras hypselocyclum Zone through the Aulacostephanus mutabilis Zone of the Lower to low-Upper Kimmeridgian (*see* KUTEK, MATYJA, RADWAŃSKI & WIERZBOWSKI 1992, Fig. 5).

The Małogoszcz section, unexposed at the time of regional recognition of the Oxfordian and Kimmeridgian sequence by KUTEK (1968), should be placed between the sections of Kościółek Hill and Mt. Krzyżowa (*see* KUTEK 1968, Chart 2; MATYJA 1991, Fig. 40).

The lithostratigraphic unit that yielded the studied isopod specimen is the member of *Shaly Limestones and Underlying Shales*, the Ataxioceras hypselocyclum Zone in age, and shallow-marine in depositional conditions (*see* KUTEK 1968; *and* 1969, Fig. 7).

The occurrence site of the isopod is placed in the topmost part of the Shaly Limestones, about 10 meters below the *Lopha* (=*Alectryonia*) coquinas (*see* KUTEK, MATYJA, RADWAŃSKI & WIERZBOWSKI 1992, Fig. 5), recently called the *Actinostreon* Beds by MACHALSKI (1996), being a part of the *Skorków Lumachelle* distinguished by KUTEK (1968, 1969) in the studied region (*see* Text-fig. 1).

In the newly published tectono-stratigraphic interpretation of the Jurassic sequences of Central Poland, presented by KUTEK (1994, pp. 182-189), this occurrence site is comprised within the topmost part of the "*COK Sequence*" underlying the Coquina Formation, that is the *Lopha* (=*Alectryonia*) coquinas of the "*LUK Sequence*".

THE GENUS *CYCLOSPHAEROMA* AND ITS SPECIES

The genus *Cyclosphaeroma*, represented by the species *trilobatum*, was established by H. WOODWARD (1890) upon a specimen from the Great Oolite Series (Bathonian; *see* ARKELL 1956, pp. 27-28) of Northamptonshire. This specimen was of a more or less rounded outline what induced H. WOODWARD to use the genus name *Cyclosphaeroma*, to differentiate it from the living sphaeromids that is, the representatives of the family **Sphaeromidae** WHITE, 1847, characterized by a generally more elongated shape. Several years later H.

WOODWARD (1898), when received a much better preserved specimen from the Purbeck Beds near Aylesbury (Buckinghamshire), noticed that the former one was compressed together posteriorly; thus, he amended the diagnosis of the genus but, obviously, retained the generic name which lost its direct reference to the body shape of the animal. This was certainly the reason why REMEŠ (1903a), when the ICZN had not been founded yet, proposed to name a similar specimen from Moravia as *Palaeosphaeroma*. This latter name, according the ICZN rules, is regarded by HESSLER (1969, p. *R*377) as a junior subjective synonym of *Cyclosphaeroma*, and it is treated so by the Author of the present paper.

Nevertheless, some confusion about taxonomic interpretation of these three specimens still exists, and it may be clarified as follows.

Firstly, it is quite evident that REMEŠ (1903a), when established the new genus and species "*Palaeosphaeroma Uhligi*", from the Štramberk (=Stramberg) limestones of Tithonian age in Moravia, did not know the two papers of WOODWARD (1890, 1898); these new taxa were established upon one specimen, very inadequately illustrated (REMEŠ 1903a, Figs 1-3), and thus soonafter re-illustrated in another paper in the same volume of the journal (REMEŠ 1903b, Pl. 22, Figs 2a-2e). When acquainted with the papers by WOODWARD (1890, 1898), REMEŠ (1909, pp. 177-180) enlarged the description to include the new specimens (REMEŠ 1909, Pl. 8, Figs 1 — 4a-4b) of a quite different morphology (? another genus of an isopod), the nature of which cannot be recognized unequivocally. Through these specimens, REMEŠ (1909) argued on the distinction of his "*Palaeosphaeroma*" from the WOODWARD'S genus *Cyclosphaeroma*. This very argumentation was, unfortunately, accepted by VAN STRAELEN (1928, pp. 33-35) in his comprehensive revision of all Meso- and Cenozoic isopods.

In the discussed revision, VAN STRAELEN (1928) has also indicated precisely that the two specimens described successively by H. WOODWARD (1890, and 1898) are non-conspecific (!), and thus he introduced the new species name for the Purbeck-Beds specimen, *Cyclosphaeroma woodwardi* VAN STRAELEN, 1928. It happened, however, that this very specimen has erroneously been referred, in the *Treatise on Invertebrate Paleontology*, by HESSLER (1969, p. *R*378, Fig. 195/*3*) as *C. trilobatum*, the type species of the genus (!).

To note, HESSLER (1969, p. *R*377), when synonymized *Palaeosphaeroma* with *Cyclosphaeroma*, reported erroneously to its occurrence in Austria. All the specimens of *Palaeosphaeroma* described by REMEŠ (1903a,b, 1909) come from Moravia, a country which belonged lately to Czechoslovakia, and presently lies in the Czech Republic. Insofar, there is no report on the *Cyclosphaeroma* occurrence in Austria, and all the specimens therefrom recognized in deposits coeval to those of Moravia represent quite distinct taxa (*see* BACHMAYER 1949).

To sum up, the specimens hitherto attributed to the genus *Cyclosphaeroma* H. WOODWARD, 1890, have a slightly perplexed synonymy, as scanned hereafter, and they all three represent separate taxa at the species level, everyone of which is represented by one specimen. To avoid any further misunderstanding, the types of these species are herein re-illustrated (Text-fig. 2).

The synonymy lists of the hitherto established species in the genus *Cyclosphaeroma* H. WOODWARD, 1890, include:

Cyclosphaeroma trilobatum H. WOODWARD, 1890

1890. *Cyclosphaeroma trilobatum*, H. Woodw., gen. et sp. nov.; H. WOODWARD, p. 530 and Pl. 15, Figs 1a-1c.

1898. *Cyclosphaeroma trilobatum*, H. Woodw., 1890; H. WOODWARD, p. 385 and Pl. 14, Fig. 1.
non 1898. *Cyclosphaeroma trilobatum*, H. Woodw., 1890 (emended 1898); H. WOODWARD, p. 385 and Pl. 14, Fig. 2.
1928. *Cyclosphaeroma trilobatum*, H. Woodward, 1890; V. VAN STRAELEN, p. 31.
non 1969. *Cyclosphaeroma trilobatum*; R.R. HESSLER, p. *R*378 and Fig. 195/*3*.

Cyclosphaeroma uhligi (REMEŠ, 1903)

1903a. *Palaeosphaeroma Uhligi* n. gen. et sp.; M. REMEŠ, pp. 43-44 and Figs 1-3.
1903b. *Palaeosphaeroma Uhligi* Remeš; M. REMEŠ, p. 220 and Pl. 22, Figs 2a-2e [referred as Figs 7-10 in the text, p. 220].
non 1909. *Palaeosphaeroma Uhligi* Remeš; M. REMEŠ, pp. 177-180 and Pl. 8, Figs 1 – 4a-4b.
non 1909. *Palaeosphaeroma* sp.; M. REMEŠ, p. 178 and Pl. 8, Figs 5a-5b.
1928. *Palaeosphaeroma Uhligi*, Remeš, 1903; V. VAN STRAELEN, p. 34.
1969. *Cyclosphaeroma*; R.R. HESSLER, p. *R*377.

Cyclosphaeroma woodwardi VAN STRAELEN, 1928

1898. *Cyclosphaeroma trilobatum*, H. Woodw., 1890 (emended 1898); H. WOODWARD, p. 385 and Pl. 14, Fig. 2.
1928. *Cyclosphaeroma Woodwardi*, nov. sp.; V. VAN STRAELEN, p. 32.
1969. *Cyclosphaeroma trilobatum*; R.R. HESSLER, p. *R*378 and Fig. 195/*3*.
1992. *Cyclosphaeroma woodwardi* van Straelen; C. WALKER & D. WARD, p. 68 (text and two photos).

REMARKS: The two specimens (internal mold, and external cast) recently illustrated by WALKER & WARD (1992, p. 68), according to a kind information of the co-author, David WARD, and another information kindly supplied by David N. LEWIS, Collections Menager at the Department of Palaeontology, *The Natural History Museum* in London, are the original material of Henry

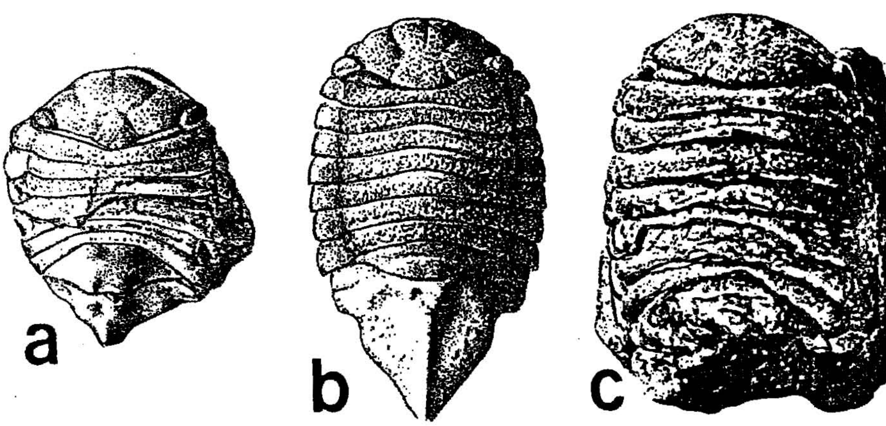


Fig. 2

The types (holotypes, the sole specimens) to the heretofore recognized species of the genus *Cyclosphaeroma* H. WOODWARD, 1890

a – *Cyclosphaeroma trilobatum* H. WOODWARD, 1890; actual size
Reproduced from H. WOODWARD (1898, Pl. 14, Fig. 1 = 1890, Pl. 15, Fig. 1a)

b – *Cyclosphaeroma woodwardi* VAN STRAELEN, 1928; actual size
Reproduced from H. WOODWARD (1898, Pl. 14, Fig. 2)

c – *Cyclosphaeroma uhligi* (REMEŠ, 1903); magnified twice
Reproduced from REMEŠ (1903b, Pl. 22, Fig. 2d)

WOODWARD (*see* H. WOODWARD 1898, p. 385: "*the intaglio and the relievo*"), and are presently kept at that Museum under the Catalogue Number *BM(NH) I. 3485a* (internal mold) and *BM(NH) I. 3485b* (external cast).

All these three, above-reviewed, valid species of the genus *Cyclosphaeroma* H. WOODWARD, 1890, are morphologically very close. The specific differences are not very great indeed, and particular features overlap each other. Some of them are also shared with those of the studied isopod, whose set of features justifies a separate species to be established. This is also based on a sole specimen, apparently to comply well with a Roman phrase "*Omnia praeclara rara*".

SYSTEMATIC ACCOUNT

The taxonomy of the studied isopod is given as that used by MOORE & McCORMICK (1969) and HESSLER (1969), supplemented by some data given by the subsequent authors.

Phylum **Arthropoda** SIEBOLD & STANNIUS, 1845
Superclass **Crustacea** PENNANT, 1777
Class **Malacostraca** LATREILLE, 1806
Subclass **Eumalacostraca** GROBBEN, 1892
Superorder **Peracarida** CALMAN, 1904
Order **Isopoda** LATREILLE, 1817
Suborder **Flabellifera** G.O. SARS, 1882
Family **Sphaeromidae** WHITE, 1847

[Family name authorship as given by HESSLER (1969, p. *R*374); *or* H. MILNE-EDWARDS, 1840, according to MARTINI (1972, p. 71); *or* **Sphaeroma*ti*dae** BURMEISTER, 1834, according to MOORE & McCORMICK (1969, p. 114) and WIEDER & FELDMANN (1992, p. 966)]

Genus *Cyclosphaeroma* H. WOODWARD, 1890

TYPE SPECIES: *Cyclosphaeroma trilobatum* H. WOODWARD, 1890; *OD*

DIAGNOSIS: As given by HESSLER (1969, pp. *R*377–*R*378).
SPECIES INCLUDED: *Cyclosphaeroma trilobatum* H. WOODWARD, 1890
Cyclosphaeroma uhligi (REMEŠ, 1903)
Cyclosphaeroma woodwardi VAN STRAELEN, 1928
Cyclosphaeroma malogostianum sp.n.

STRATIGRAPHIC RANGE and GEOGRAPHIC DISTRIBUTION: Middle Jurassic of England (H. WOODWARD 1890), Upper Jurassic of England (H. WOODWARD 1898, WALKER & WARD 1992), Moravia in Czech Republic (REMEŠ 1903a,b), and Poland (*this paper*).

Cyclosphaeroma malogostianum sp.n.
(Plate 1)

HOLOTYPE: The specimen presented in Pl. 1.

TYPE LOCALITY: Małogoszcz Quarry, south-western margin of the Holy Cross Mountains, Central Poland.

TYPE HORIZON: Lower Kimmeridgian.

DERIVATION OF THE NAME: Adjectival name, from neo-Latinized name of the medieval town of Małogoszcz.

DIAGNOSIS: The trilobed cephalon large, broad anteriorly, with a truncated anterior margin, the axial anterior lobe much larger than the posterior one, with the axial mesial lobe well outlined, the axial furrow short and shallow, and the ophthalmic ridges distinct, broad axially but short laterally, inclined posteriorly at the cephalon axis; epimeres well defined by furrows on all pereionites, the first including; compound eyes large, elongated transversally to the cephalon axis; antennae articulate, arcuately shaped.

MATERIAL: The holotype only, kept in the Author's collection.

DESCRIPTION: The specimen is the anterior part of the exoskeleton, partly damaged in its axial part. The posterior part is preserved very imperfectly and can hardly be interpreted.

The exoskeleton is almost white, slightly yellowish in color, well contrasted against the bluish-gray matrix of a marly limestone. The ornamentation consists of wrinkled warts scattered more or less uniformly allover the exoskeleton.

Within the anterior part of the specimen, well distinguishable is the cephalon fused with the *1st* pereionite, followed by the three (*2nd*, *3rd*, and *4th*) pereionites. The *5th* pereionite is cracked and displaced laterally, the *6th* one is hardly discernible, the same as the last (*7th*) one and the pleon. The cephalon is rimmed, both anteriorly and laterally, by a narrow limbus that continues onto the *1st* pereionite.

In front of the cephalon, a fragment of the articulate antenna is exposed from the matrix. This fragment, oriented backwardly, is probably the distal part of the peduncle (two segments are preserved), devoid of the flagellum.

The trilobed cephalon is relatively large and broad anteriorly, with a truncated anterior (forehead) margin. Due to such a shape, it forms, together with the fused *1st* pereionite that is relatively wide, an almost trapezoid unit of the exoskeleton, distinctly contrasting with the remaining pereionites. This is called here *the cephalic unit*, which is wholly rimmed by the limbus (*see* Text-fig. 3).

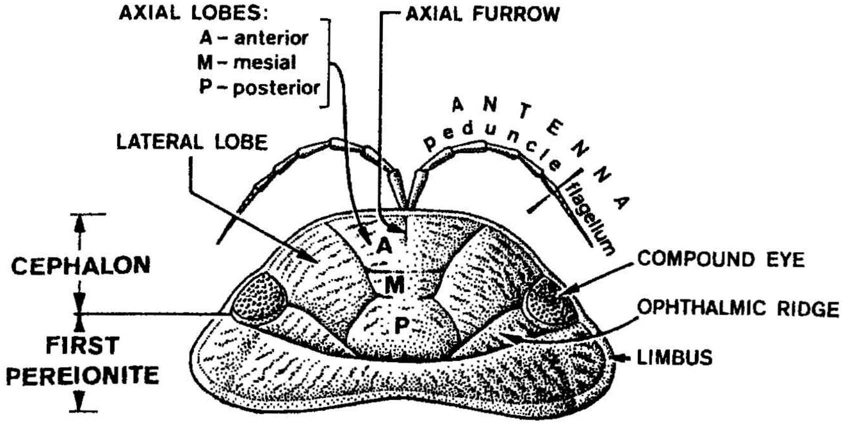
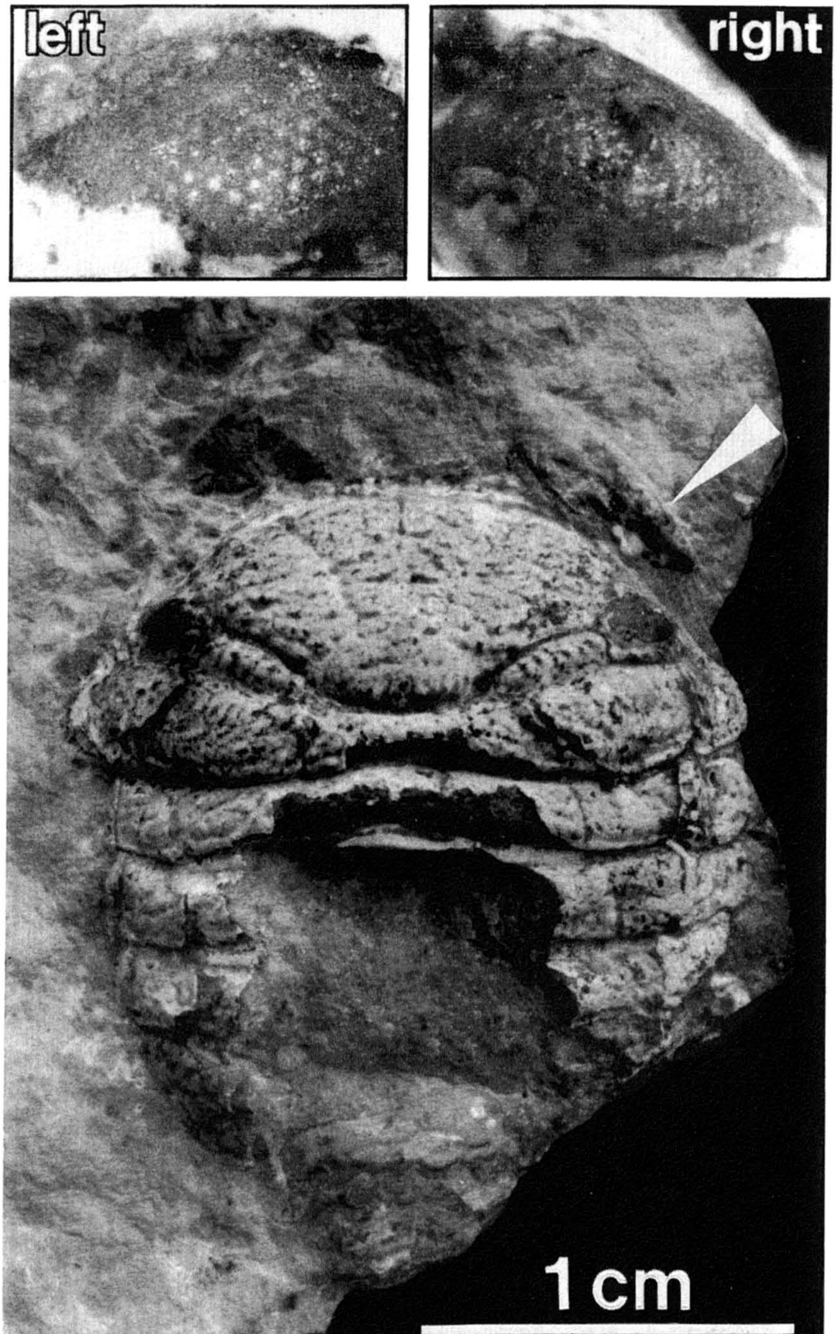


Fig. 3. Morphologic terminology, as used in the text, to describe the cephalic unit of *Cyclosphaeroma malogostianum* sp.n. from the Małogoszcz Quarry (*compare* Text-fig. 4 and Pl. 1)



Cyclosphaeroma malogostianum sp.n.

An overall view of the **holotype** from the Lower Kimmeridgian at Małogoszcz, western part of the Holy Cross Mountains, Central Poland

Arrowed is the exposed part of the right antenna; upper insets show close-up views of the eyes (taken *c.* × 25)

The pereionites are flexuously bent anteriorly in their axial part, and the flat, flap-like epimeres are preserved (exposed) only at the right side.

The whole exoskeleton, apart from flat epimeres, is slightly vaulted with the axial part almost flat.

The diagnostic features are displayed by the cephalon, whose axial anterior lobe (*see* terminology given in Text-fig. 3) is much larger than the posterior one. The axial mesial lobe is well outlined, but with its border at the anterior lobe indistinct. The axial furrow is very short and shallow, almost indiscernible. The ophthalmic ridges are very distinct, broad axially, but short laterally, inclined posteriorly at the mid-line of the cephalon.

The compound eyes, situated near the side margin, are large, reniform in outline, quite well preserved to exhibit distinct facets, as if vitreous, colored yellowish-brown. The eyes are elongated transversely to the mid-line of the cephalon. The number of facets may be estimated as not less than 300 of each eye (*see* insets in Pl. 1).

The posterior part, poorly preserved, is interpreted as "ghosts" of pereionites *5th*, *6th*, and *7th*, followed by a damaged pleon, more or less triangular in its shape and furnished with a sharper ending (? pleotelson). Any appendages (pereiopods, and/or pleopods) are not recovered.

As concerns an overall shape of the specimen, an impression arises, that due to the trapezoid shape of the cephalic unit, and the presence of a trilobed cephalon, a generally "trilobite-like" appearance is acquired by the studied fossil.

REMARKS: The newly established species, *Cyclosphaeroma malogostianum* sp.n., differs from the above-reviewed congeners (*see* Text-fig. 2) whose distinct features are as follows.

The type species of the genus, *Cyclosphaeroma trilobatum* H. WOODWARD, 1890, has a triangular cephalic unit, with a more pronounced limbus, the axial anterior lobe much larger than the posterior one, the axial furrow long, the ophthalmic ridges very narrow and long adaxially, almost conjoining themselves at the mid-line backwardly, and the eyes oriented backwards axially.

The type of *Cyclosphaeroma woodwardi* VAN STRAELEN, 1928, as figured in the line-drawings by H. WOODWARD (1898, Pl. 14, Fig. 2) and HESSLER (1969, Fig. 195/*3*; *see* synonymy), has a semicircular anterior margin of the cephalon, with the limbus vanishing laterally, the axial lobes (anterior, and posterior) of nearly equal size, the axial furrow long, the ophthalmic ridges short, nearly perpendicular to the mid-line, and the eyes oriented onwards axially.

The recently published photos of this type specimen (WALKER & WARD 1992, p. 68) show that the epimeres, especially those of the posterior pereionites, are much wider (almost twice) than axially long, rounded, and tiled posteriorly, not having been so angular as given in the above-referenced line-drawings by H. WOODWARD, and by HESSLER.

Moreover, it is clear that the external cast of the type (left photo *in* WALKER & WARD 1992, p. 68) displays the pleotelson much longer (about 41% of the body length, instead of 34% as in the referenced line-drawings presented by H. WOODWARD, and by HESSLER).

As judged from the two photos of the discussed type, given by WALKER & WARD (1992, p. 68), the external cast (left photo) represents a replica of the exoskeleton much better than does the internal mold (that is, the type specimen of the species), a feature evidently overlooked by H. WOODWARD (1898).

The Moravian species, *Cyclosphaeroma uhligi* (REMEŠ, 1903), displays a generally rectangular outline of the pereion, a short semicircular cephalon, with a long axial furrow, and the ophthalmic ridges short, nearly perpendicular to the mid-line; epimeres (those of the *1st* pereionite including) not distinct. The type specimen is much vaulted, both laterally and axially, due to which the cephalon is inclined anteriorly, as if tending to enroll the whole body.

Of the features displayed by the studied specimen, being the type of *Cyclosphaeroma malogostianum* sp.n., the three are to be commented.

Firstly, the epimeres are well defined by furrows on all the pereionites, contrary to the statement by HESSLER (1969, p. *R*378) that they are absent from the *1st* pereionite. Such furrows on the *1st* pereionite are also well marked in the types of the two English species, as illustrated by H. WOODWARD (1890, Pl. 15, Fig. 1a; *and* 1898, Pl. 14, Figs 1-2), although less readable in the photos presented by WALKER & WARD (1992, p. 68).

Secondly, the exposed fragment of the right antenna allows to recognize its general course. In the former species the presence of only the basal parts was noted, both in *Cyclosphaeroma trilobatum* H. WOODWARD, 1890, from England (*see* H. WOODWARD 1890, Pl. 15, Fig. 1c) and in *C. uhligi* (REMEŠ, 1903) from Moravia (*see* REMEŠ 1903a, Fig. 3, *and* 1903b, Pl. 22, Fig. 2b).

Thirdly, the vaulting of the exoskeleton in the species under comparison cannot be discussed precisely. In the revised diagnosis of the genus given by HESSLER (1969, p. *R*377), the body shape is stated as "strongly vaulted" what, however, cannot be evidently demonstrated in the hitherto described specimens.

Of the two English species, *Cyclosphaeroma trilobatum* H. WOODWARD, 1890, is dorso-ventrally flattened, as illustrated well by H. WOODWARD (1890, Pl. 15, Fig. 1c), whereas *C. woodwardi* VAN STRAELEN, 1928, seems to be low-broadly arched, as may be ascertained from the photos presented by WALKER & WARD (1992, p. 68).

Highly vaulted is only the Moravian species, *C. uhligi* (REMEŠ, 1903), as well documented in the photos presented by REMEŠ (1903b, Pl. 22, Fig. 2b). It is not hardly thinkable that HESSLER (1969, p. *R*377) when synonymized the genus *Palaeosphaeroma* to which this species was formerly ascribed, with *Cyclosphaeroma*, introduced the feature of this very species into the diagnosis of the revised genus.

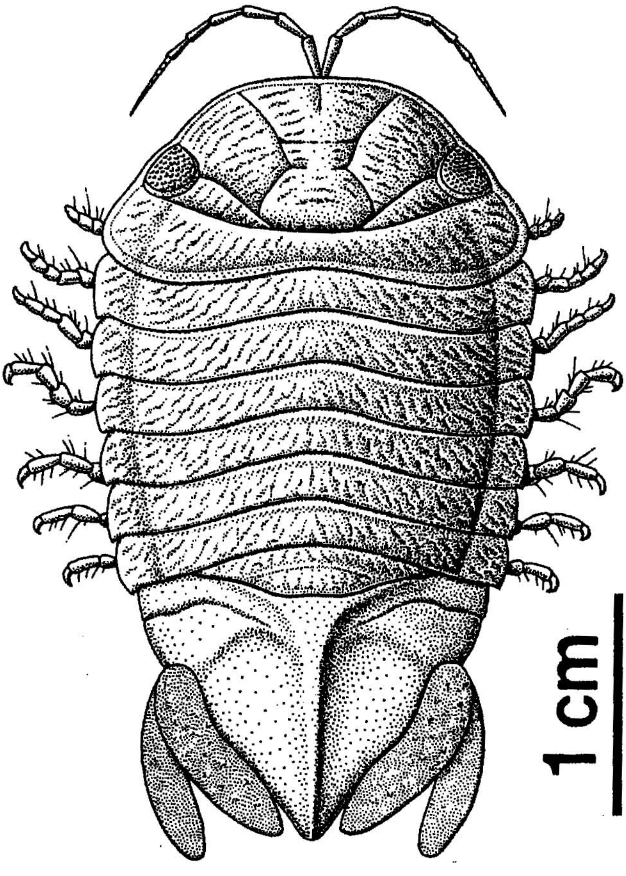


Fig. 4

Reconstruction of *Cyclosphaeroma malogostianum* sp.n., based on the holotype of the species (*see* Pl. 1); detailed data on the restoration and their references are given in a separate subchapter of the text

Designed by B. WAKSMUNDZKI, M.Sc.

The herein presented type of the newly established species *Cyclosphaeroma malogostianum* sp.n. is flattened dorso-ventrally to an extent comparable to that in the type of *C. trilobatum* H. WOODWARD, 1890.

RESTORATION of the ANIMAL: The described parts of the exoskeleton allow to reconstruct an overall structure of the animal that once lived in the Late Jurassic (early Kimmeridgian) sea of the present-day Małogoszcz area (Text-fig. 4).

The shape of the posterior part of the pereion is extrapolated with an assumption of a similarity of its pereionites (*5th, 6th,* and *7th*) to those anterior ones. A general poise is taken the same as in *Cyclosphaeroma woodwardi* VAN STRAELEN, 1928, figured by H. WOODWARD (1898; *see also* an outline-drawing *in* HESSLER 1969, Fig. 195/*3*), and photographed by WALKER & WARD (1992, p. 68), but the circumference of the pereion is given more rectangular, as appears from the studied specimen (*see* Pl. 1). The pleon and pleotelson are roughly adapted from an original drawing of H. WOODWARD (1898, p. 386), showing the posterior part with appendages, that is pleopods (exopodits and endopodits) restored. The antennae, as evident from the preserved part (*see* Pl. 1), are well arcuate what has not hitherto been noted in the ancient sphaeromids. The pereiopods are taken from a present-day sphaeromid illustrated by H. WOODWARD (1898, Pl. 14, Fig. 6).

PALEOBIOLOGIC INTERPRETATION

An attention has recently been paid, by WIEDER & FELDMANN (1989), that all but a few present-day isopods exhibit biphasic molting, intervalled by one to six days (*see* TAIT 1917, GEORGE 1972), in which the posterior part of the exoskeleton is shed first and almost intact, followed by the anterior part having been broken into smaller fragments. This posterior part is then composed of the pleon and three pereionites, separated altogether by a split from the anterior four pereionites.

This peculiar molting style results in the preservation largely of posterior parts of the isopod exoskeletons in the fossil record, whilst those anterior ones become disintegrated (*see* WIEDER & FELDMANN 1989). Consequently, such mode of disintegration is postulated by WIEDER & FELDMANN (1989) as responsible for the rarity of anterior exuviae in the fossil record and, on the other hand, the completely preserved specimens are thought to represent carcasses (*see also* MATSUOKA & KOIDE 1980, p. 56).

Many fossil isopods are really known (as mentioned at the beginning of this paper) from their posterior exuviae which are much more common than other parts of the exoskeleton (*see* BACHMAYER 1949; HESSLER 1969, p. *R*380; MATSUOKA & KOIDE 1980, p. 56; WIEDER & FELDMANN 1989). To exemplify, the species *Protosphaeroma ernstbrunnense* BACHMAYER, 1949, from the Upper Jurassic (Tithonian) of Austria, when established by BACHMAYER (1949) was documented by 16 pleons and one fragmented cephalon (!); moreover, the species *Bathynomus goedertorum* (WIEDER & FELDMANN, 1989) from the Tertiary (Eocene to Miocene) of Washington state, when established by WIEDER & FELDMANN (1989), was based upon forty-one posterior parts and only one specimen nearly complete.

In the studied specimen, preserved as one entity is the anterior part with four pereionites in position, and with the fifth one cracked and, in its medial part, displaced posteriorly, and the epimere laterally (to the right, *see* Pl. 1). Such a displacement was possible when a split between the frontal and the rear part of the exoskeleton did exist. The posterior part of the fossil is much blurred in the surrounding rock, presumably because the hind part of the animal was just after the first phase of its molting, and thus not having as yet its exoskeleton mineralized sufficiently to yield good fossilization potential.

From the aforegoing, the studied isopod is interpreted as having been buried during its molting, when the posterior part of the exoskeleton had been shed off, but the anterior one was still kept on the animal. This explains the preservation of the anterior part in a not disintegrated state, with a split between the *4th* and *5th* pereionite, and parts of the *5th* pereionite displaced both laterally and posteriorly. The animal is thus thought to have died either just at the molting action, or having been buried alive soonafter the molting.

Most likely, a similar mode of preservation is displayed by the holotype of the type species of the genus, *Cyclosphaeroma trilobatum*, illustrated by H. WOODWARD (1890, Pl. 15, Fig. 1a; *and* 1898, Pl. 14, Fig. 1), and whose exoskeleton is cracked behind the *4th* pereionite whilst its posterior part is displaced anteriorly (*cf.* Text-fig. 2*a*), thus much shortening the whole specimen longitudinally; the specimen thus acquired an almost circular outline which involved to Henry WOODWARD a false impulse to name it as *Cyclosphaeroma.*

Moreover, it is to note that the discussed, peculiar mode of molting may be recognized as responsible for fossilization of many other isopod taxa. For instance, of the nine species of the genus *Palaega* H. WOODWARD, 1870, revised by VAN STRAELEN (1928, pp. 21-25), five have been known, up to that date, solely from posterior parts composed of three posterior pereionites joined with the pleon and pleotelson, and their anterior parts remaining unknown (!).

PHYLETIC AFFINITIES

As seen from the aforegoing review, the hitherto recognized representatives of the genus *Cyclosphaeroma* H. WOODWARD, 1890, are more or less similar to each other, both as concerns their overall shape and particular characters, as well as their size. The distinguished species are thus thought to have certainly been closely related, to form an individualized stock ranging since the Middle Jurassic (Bathonian) to the topmost Jurassic (Purbeckian and/or Tithonian), that is spanning through a period of time that lasted about 30 million years. Both the earlier, and subsequent, history of that stock, that is of the genus *Cyclosphaeroma*, remains unknown, the same as the history of the whole family Sphaeromidae WHITE, 1847, across the Cretaceous Period. The Tertiary till Recent forms of that family differ markedly from those of the

Jurassic *Cyclosphaeroma* species (*see* WOODWARD 1879, 1890, 1898; CARTER 1889; VAN STRAELEN 1928; BACHMAYER 1947; TAUBER 1950; HESSLER 1969; MARTINI 1969, 1972, 1988).

When analyzing particular features of the *Cyclosphaeroma* species through Jurassic time, a few tendencies are recognizable which may be interpreted as phyletically controlled. This is exemplified primarily by:

(*i*) The shape of the cephalon that changes from triangular in *Cyclosphaeroma trilobatum*, through trapezoid in *C. malogostianum* sp.n., to semicircular anteriorly in *C. woodwardi* and *C. uhligi*;

(*ii*) The longitudinal shortening of the cephalon, as expressed by its width/length ratio that increases from 2.1 in *Cyclosphaeroma trilobatum*, through 2.6 in *C. malogostianum* sp.n. and *C. woodwardi*, to 3.0 in *C. uhligi*;

(*iii*) Proportion of the anterior to the posterior axial lobe of the cephalon, with the anterior one being larger in *Cyclosphaeroma trilobatum* and *C. malogostianum* sp.n., and equal to the posterior one in *C. woodwardi*;

(*iv*) Position of the eyes, inclined posteriorly in *Cyclosphaeroma trilobatum*, transversely placed in *C. malogostianum* sp.n., and inclined anteriorly in *C. woodwardi*.

The above review shows, that in the half of the characters under discussion, the species *Cyclosphaeroma uhligi* is missing, since some of its features do not follow the changes displayed by the remaining *Cyclosphaeroma* species arranged stratigraphically. Moreover, some other characters of that species, *e.g.* vaulting (as discussed above), and the size, the smallest (25 mm in length) of all *Cyclosphaeroma* species, differentiate it within the genus. This certainly means that the species *Cyclosphaeroma uhligi* forms a separate phyletic line of the genus *Cyclosphaeroma*, possibly the youngest stratigraphically. The stratigraphic age of the Štramberk facies, traditionally assigned to the Tithonian, has recently been extended up into the Berriasian (*see* OLORIZ & TAVERA 1982, KUTEK 1994), and down at least to the base of the Autissiodorensis Zone of the uppermost Kimmeridgian (KUTEK 1994, p. 209). To the truth, a more precise age of that facies at the type locality (Skalička) of the species *C. uhligi* is not determined.

In its phyletic relation to the English species of the genus *Cyclosphaeroma*, the newly established species *C. malogostianum* sp.n. of early Kimmeridgian age is situated, due to its morphologic features, more closely to the latest Jurassic (Purbeckian) species *C. woodwardi*, than to the Middle Jurassic *C. trilobatum* from which it has certainly evolved.

REMARKS ON ENVIRONMENTAL CONDITIONS

As the genus *Cyclosphaeroma* exceeds all the living sphaeromids in size, H. WOODWARD (1898) made its comparison to the giant, deep-sea isopod from the West Indies, *Bathynomus giganteus* A. MILNE-EDWARDS, 1879, of the relative family Cirolanidae HANSEN 1890 [as given by HESSLER (1969, pp. *R*374), but recently ascribed to J.D. DANA, 1853, by WIEDER & FELDMANN (1992, p. 958)]. This species was noted to attain almost 30 cm or even more in length (*see* HOLTHUIS & MIKULKA 1972, pp. 577-578; SHIH 1972, p. 31), the data of which were supplemented by WETZER (1986, p. 26) who recorded a figure of 46 cm, and called the species *a living sea monster* (!).

The genus *Bathynomus* A. MILNE-EDWARDS, 1879, has recently been postulated by WIEDER & FELDMANN (1989; *see also* 1992) to be synonymous with *Palaega* H. WOODWARD, 1870, what has strongly been objected by MARTIN & KUCK (1990). Following a lengthy discussion, and procedure, the International Commission on Zoological Nomenclature declared in its *OPINION 1668* (of March 1992) that the name *Bathynomus* A. MILNE-EDWARDS, 1879, shall take precedence over *Palaega* H. WOODWARD, 1870 (*see also* FELDMANN, WIEDER & ROLFE 1992, p. 89; *and* KARASAWA, NOBUHARA & MATSUOKA 1992, p. 12).

When making the above-indicated comparison of his *Cyclosphaeroma* with *Bathynomus*, H. WOODWARD (1898, p. 388) concluded that the fossil *Cyclosphaeroma* "was in all probability also a deep-water form".

All further data on environmental conditions upon which the *Cyclosphaeroma*-bearing formations of England, that is both the Great Oolite Series and the Purbeck Beds, were formed clearly indicate a shallow-marine zone of their deposition (*see* ARKELL 1956, pp. 19 and 27-28). The same concerns the whole Małogoszcz sequence, particularly the isopod-yielding interval (*see* KUTEK, MATYJA, RADWAŃSKI & WIERZBOWSKI 1992) which has recently been ascribed by KUTEK (1994, pp. 185 and 187) to a regressive, restricted environment. Similarly, all the Upper Jurassic sphaeromids from the Tithonian limestones of the Štramberk area in Moravia, and Ernstbrunn in Austria, do occur in shallow-marine reefal deposits (*see* REMEŠ 1903a,b, 1909; BACHMAYER 1949; KUTEK 1994, pp. 208-209).

Consequently, it is concluded that the discussed Late Jurassic isopods of the genus *Cyclosphaeroma* H. WOODWARD, 1890, the same as the others of the family Sphaeromidae WHITE, 1847, were extremely shallow-marine, presumably shallow-subtidal animals.

To note, most of the Jurassic (and Cretaceous) isopod species are recorded by single specimens from marine sequences. The mass occurrence of any fossil isopods is displayed either by brackish or by fresh-water (limnic) forms, stratigraphically much younger, as exemplified by the genus *Eosphaeroma* H. WOODWARD, 1879, represented by two species in the low-Tertiary (Eocene — Oligocene) deposits of western Europe (England, France, and Germany: *see* H. WOODWARD 1879; CARTER 1889; MARTINI 1969, 1972, 1988).

A NOTE ON OTHER LATE JURASSIC ISOPODS FROM POLAND

The newly established species, *Cyclosphaeroma malogostianum* sp.n., is not the only isopod that lived in the Late Jurassic sea of Poland. The occurrence of other isopods has, however, been stated by indirect evidences.

Firstly, these are traces of infection in the prosoponid crabs whose branchial cavity was occupied by parasitic isopods of the family Bopyridae. The most common species is that one which has traditionally been referred to as *Pithonoton marginatum* (H. VON MEYER, 1842), and which in modern taxonomy (COLLINS & WIERZBOWSKI 1985, WEHNER 1988) is regarded as *Pithonoton serratum* (BEURLEN, 1929). The isopod-infected specimens of that species, coming from the Oxfordian limestones of the Holy Cross Mountains and of the Polish Jura, reported by the Author formerly (RADWAŃSKI 1972), have recently been referenced and/or re-illustrated in several paleoecologic monographs (CONWAY MORRIS 1981, p. 495; *and* 1990, p. 378 and Fig. 1*D*; BOUCOT 1990, pp. 60-63 and Fig. 48*B*). The less common species, *Nodoprosopon heydeni* (H. VON MEYER, 1860), also possesses the isopod-infected specimens (*see* RADWAŃSKI 1972; re-illustrated by BOUCOT 1990, Fig. 48*A*).

Secondly, there also are traces of life activity of the wood-borers (xylophags), comparable to the present-day forms of the genus *Limnoria*, and occurring in deposits coeval to those of Małogoszcz, but exposed in the northern margin of the Holy Cross Mountains, at the locality Wierzbica (*see* SEILACHER, MATYJA & WIERZBOWSKI 1985, Figs 2-3; MACHALSKI 1989, 1996; GUTOWSKI 1996). The borings in driftwood therein represent an ichnotaxon, undescribed yet, but new both at its (ichno)genus and (ichno)species level. The fossil borings in wood, comparable to those of the present-day *Limnoria*, have hitherto been reported only once, by PAPP (1949), from the Miocene deposits of the Vienna Basin in Austria.

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