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Isopodichnus AND OTHER TRACE FOSSILS FROM MARINE KOPIENIEC FORMATION (RHAETIAN–SINEMURIAN) IN THE TATRA MTS., POLAND

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Abstract: Trace fossils: *Planolites, Palaeophycus, Chondrites, Asteriacites, Thalassinoides* and *Isopodichnus*, occur in the marine fauna of fossiliferous Kopieniec Formation of the Krížna Nappe in the Polish Tatra Mts. The latter is described mainly in non-marine deposits. This assemblage resembles the *Cruziana* ichnofacies.

Key words: trace fossils, marine sandstones, Lower Jurassic, West Tatra Mts., West Carpathians.

Introduction

Trace fossils which occur in the Kopieniec Formation in the Tatra Mts. have been known since Goetel's research (1916, 1917). Nevertheless, beside single references to their occurrence (op. cit.: Gaździcki, 1974), their detailed description is still not available. The occurrence of ichnogenus *Isopodichnus* within the marine Kopieniec Formation is the reason for taking this topic.

The area of field research embraces exposures of the Kopieniec Formation in the Krížna Nappe, in the Polish part of the Tatra Mts., except for Kopy Sołtysie region east of the Dolina Suchey Wody Valley (Fig. 1.).

All specimens are housed in the Institute of Geological Sciences of the Jagiellonian University under symbol TF GR.

Geological setting

The Kopieniec Formation (Gaździcki et al., 1979; Gaździcki and Lefeld, 1985) of Rhaetian to Sinemurian age (Gaździcki and Iwanow, 1976) is known mainly from the Krížna Nappe.

The Kopieniec Formation is subdivided into four informal units: basal clastics, lower limestones, main claystones, upper limestones (Gaździcki et al., 1979). The first is richest in trace fossils.

The Kopieniec Formation in the Tatra Mts., consist mainly of shales alternating with sandstones and limestones. Their thickness is about a few dozen metres, being frequently reduced by tectonic processes (cf. Gaździcki, 1975, 1983). There prevail olive-green muddy and clayey carbonate shales intercalated by thin- to medium-bedded quartzitic, muscovitic sandstones, and by thin- to medium- bedded dark, organodetritic, mainly crinoidal limestones (cf. op. cit.).

In the Kopieniec Formation of the Polish Tatra Mts. foraminifers, ostracodes (Błaszczyk and Gaździcki, 1982; Gaździcki, 1983), marine pelecypods and gastropods, crinoids (Goetel, 1916, 1917) and ammonites occur.

Basing on faunistic data, Gaździcki (1974, 1975) determined sedimentary environment of the Kopieniec Formation as shallow-marine, nearshore one.

Description of trace fossils

Ichnogenus *Isopodichnus* BORNEMANN, 1899
Ichnospecies *Isopodichnus ?stromnessi* TREWIN, 1976
Figs. 2.4, 4

Material: Three slabs of sandstones with about ten differently preserved reliefs.

Description: Convex, straightly or slightly curved hypichnial furrow casts, width 2.5 to 3.3 *mm*, length to 15 *cm* with distinct central furrow and transverse segmentation. Width of single segment is about 1 *mm*.

Occurrence: Thin-bedded muscovitic sandstones, Dolina Białego Valley – slopes of Mt. Mała Świnica, Dolina Długa Valley.

Remarks: *Isopodichnus* differs from *Gyrochorte* by segmentation distincly perpendicular to the axis of relief (cf. Häntzschel, 1975). It was included to *Cruziana problematica* (Bromley and Asgaard 1979, Fig. 16A). However, but *Cruziana problematica* differs from *Isopodichnus* (sensu Trewin, 1976) by presence very narrow scratch marks and must be separated. *Isopodichnus* is known from non-marine Palaeozoic deposits of Australia (Glaessner, 1957), and

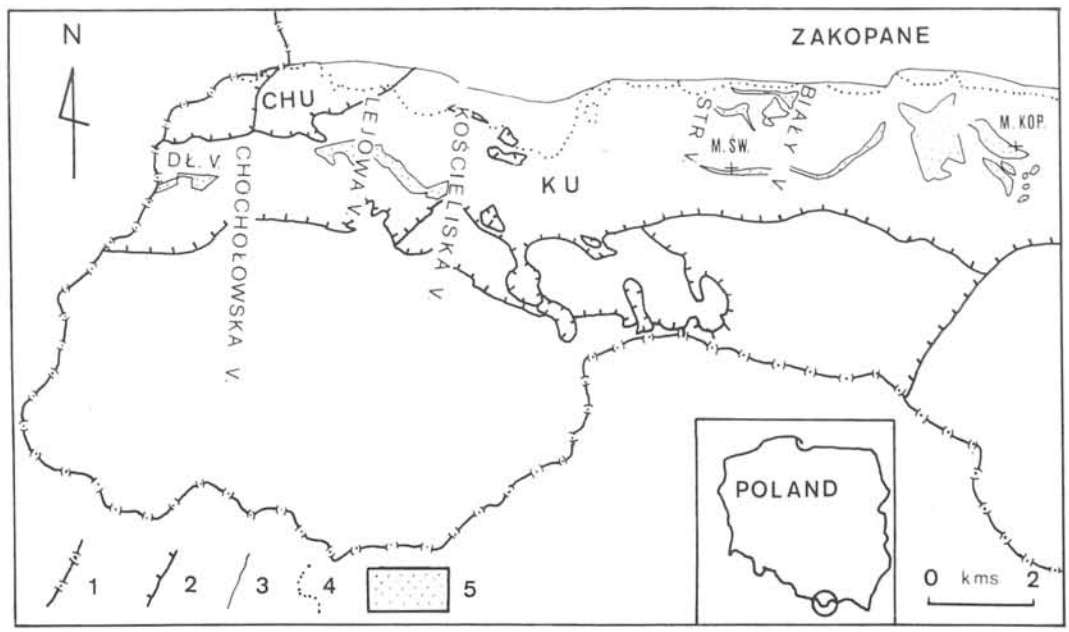

Fig. 1. Location scheme of the most important outcrops of the Kopieniec Formation in the Polish Tatra Mts. east of the Kopy Sołtysie region. 1 – national border; 2 – the most important overthrusts; 3 – northern border of the Tatra Mts.; 4 – border of the Eocene post-tectonic cover; 6 – the Kopieniec Formation; V – Valley, DŁ. V – Dolina Długa Valley, STR. V. – Dolina Straążyska Valley, M. SW. – Mt. Mała Świnica (Sarnia Skała), M. KOP. – Mt. Mały Kopieniec, KU – the Krížna Unit, CHU – Choč Unit. Based on: Bac-Moszaszwili et al. (1979).

Scotland (Trewin, 1967), from Mesozoic deposits in Greenland (?) (Bromley and Asgaard, 1972, 1979), Germany (Schindewolf, 1921), Scotland (Pollard, 1985), France (Demathieu, 1985) and Poland (Pieńkowski, 1985). However, its occurrence in marine deposits (vide Bromley and Asgaard, 1979) should be not confirmed. Occurrence of *Isopodichnus* in the marine deposits of the Kopieniec Formation allow to exclude it as the fresh-water indicator. *Isopodichnus* was probably produced by arthropods (cf. Trewin, 1976; Pollard, 1985).

Ichnogenus: *Thalassinoides* EHRENBERG, 1944
Ichnospecies *Thalassinoides* ichnosp.
Figs. 2.1, 2.2

Material: Four poorly preserved specimens.

Description: Hyporeliefs and endichnial cylindrical or semi-cylidrical forms, semireliefs and full reliefs, width to 2.5 cm, with characteristic Y-shape bifurcation.

Occurrence: Thin bedded sandstones, Kuźnice – slopes of Mt. Krokiew, Dolina Lejowa Valley, Dolina Białego Valley – slopes of Mt. Mała Świnica.

Remarks: Dimension and Y-shape bifurcations assign this material to *Thalassinoides*. This ichnogenus was produced mainly by crabs (Frey et. al., 1984) and is widely known from shallow-marine environments (cf. Fürsich, 1974; Ekdale and Bromley, 1984, and others) and rarely from deep-marine environments (cf. Crimes et al., 1981; Wetzel, 1983).

Ichnogenus *Planolites* NICHOLSON, 1873
Ichnospecies *Planolites punctatus* RONIEWICZ et PIEŃKOWSKI, 1977
Figs. 2.8, 3

Material: About fifteen specimens showing diverse degree of preservation.

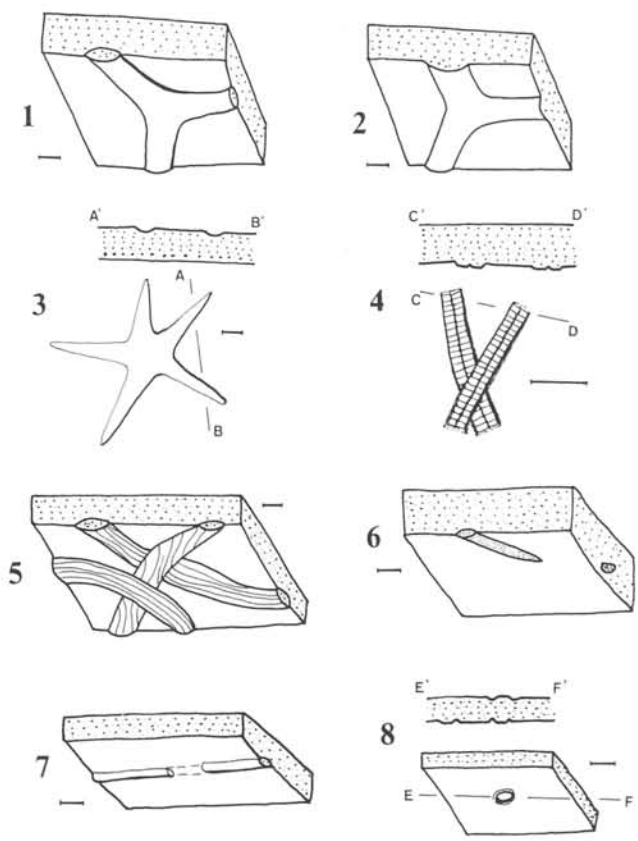

Fig. 2. Trace fossils from the Kopieniec Formation.
1 – *Thalassinoides ichnosp.*, full relief; 2 – *Thalassinoides ichnosp.*, semirelief; 3 – *Asteriacites lumbricalis*; 4 – *Isopodichnus ?stromnessi*; 5 – *Palaeophycus ?alternatus*; 6 – *Planolites ichnosp.*; 7 – *Palaeophycus ?tubularis*; 8 – *Planolites punctatus*.

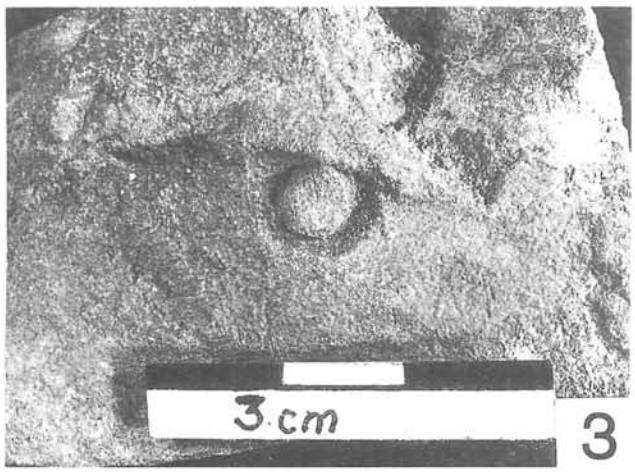

Fig. 3. *Planolites punctatus*. Kopieniec Formation. Hyporelief.

Description: Oval, convex hypo- and epi-reliefs, 3–8 mm in diameter, on sandstone beds, sometimes surrounded by shallow (less than 0.5 mm) depression. This relief is termination of vertical burrow.

Occurrence: sandstones in the whole area under investigation.

Remarks: This ichnospecies was included to *Planolites montanus* RICHTER, 1937 (Pemberton and Frey, 1982), but *P. punctatus* stand out entirely vertical development of burrows with comparison to *Planolites montanus* (Pieńkowski and Westwalewicz-Mogilska, 1986)

Ichnospecies *Planolites montanus* RICHTER, 1937
not illustrated

Material: One specimen.

Description: Short cylindrical full reliefs on both surfaces of beds, width about 3 *mm*, deeping in the beds.

Occurrence: Sandstones, southern slopes of Mt. Mała Świnica.

Remarks: It differs from *Planolites punctatus* by more horizontal development of burrows (Pieńkowski and Westwalewicz-Mogilska, 1986).

Ichnospecies *Planolites* ichnosp.
Fig. 2. 6

Material: One specimen.

Description: Cylindrical hyporeliefs (semireliefs) and endichnial forms (full reliefs) without distinct walls, width to 4 *mm*, differ lithologicaly from surrounding sediment by lithology and/or colour.

Occurrence: Sandstones, rarely mudstones.

Remarks: Described above morphology and structure of burrows is characteristic for *Planolites* (cf. Pemberton and Frey, 1982).

Ichnogenus *Chondrites* STERNBERG, 1883
Ichnospecies *Chondrites* ichnosp.
not illustrated

Material: Two poorly preserved specimens.

Description: Branched convex hyporeliefs, width 0.5 *mm*.

Occurrence: Fine-grained sandstone, Mt. Nosal, southern slopes of Mt. Mała Świnica.

Remarks: The material resembles one type of *Chondrites* preservation, called burial preservation (Simpson, 1957).

Ichnogenus *Palaeophycus* HALL, 1847
Ichnospecies *Palaeophycus ?alternatus* PEMBERTON et FREY, 1982
Fig. 2.5

Material: Fragment of a bed with numerous reliefs.

Description: Convex cylindrical hyporelief (full relief) densely covering surface of the bed, crossing each other, with diverse width, maximum 2.5 *cm*, covered with longitudinal ornamentation.

Occurrence: Sandstones, Dolina Kościeliska Valley – slopes of Mt. Zadnia Kopka Kościeliska.

Remarks: Longitudinal ornamentation is characteristic of *Fucusopsis angulata* PALIBIN, 1932, included to *Palaeophycus* (Pemberton and Frey, 1982).

Ichnogenus *Palaeophycus ?tubularis* HALL, 1847
Fig. 2.7

Material: Eight specimens.

Description: Convex cylindrical hyporeliefs (semireliefs and full reliefs), width 2.5–7 *mm*, with distincly marked smooth surface. Breaks in continuity of the relief, caused probably by collapse of the burrow walls, are visible at some places.

Occurrence: Sandstone in the whole studied area.

Remarks: Distincly marked walls of the relief, collapse structures allow to account described material to *Palaeophycus* (cf. Pemberton and Frey, 1982).

Ichnogenus *Asteriacites* SCHLOTHEIM, 1820
Ichnospecies *Asteriacites lumbricalis* SCHLOTHEIM, 1820
Fig. 2.3

Material: One specimen found by the author and two specimens on a slab of thin bedded sandstones from the Prof. Goetel's collection housed at Institute of Geological Sciences, Polish Academy of Science in Cracow.

Description: Author's specimen – concave stellate epirelief on a sandstone bed with five slight curved arms lenght about 2 *cm*, width at base about 3 *mm*. Prof. Goetel's specimens – (a) – stellate convex hyporelief, preserved only three arms, lenght about 10 *mm* and width at the base from 2.5 to 3.0 *mm*, (b) – stellate convex hyporelief, visible four arms, lenght about 8 *mm* and width about 1 *mm*.

Occurrence: authors's specimen – thin bedded sandstones, Dolina Białego Valley – slopes Mt. Mała Świnica, Prof. Goetel's specimens – Mt. Mały Kopieniec.

Remarks: *Asteriacites* was mentioned by Goetel (1917) from the Kopieniec Formation on Mt. Mały Kopieniec under the name *Asteriacites lumbricalis* PLATTEN (specimen a ?) and *Ophiurites* (specimen b?). The specimens found by Goetel was illustrated by Gaździcki (1974, Pl. 24). *Asteriacites* are regarded imprints of asteroids and ophiuroids bodies and widely occur in Liassic deposits of Germany (cf. Seilacher, 1953).

Discussion

It appears from description of ichnofauna that the assemblage from the Kopieniec Formation is rather of low diversity and low density. The most commonly represented ichnogenera are *Planolites* and *Palaeophycus*. These are simple, facies crossing forms, resistant to stress environment (cf. Ekdale, 1985; Savrda and Bottjer, 1986). Other ichnogenera are in small quantities. Forms connected with suspension feeders are lacking.

The ichnoassemblage from the Kopieniec Formation is distincly different that of overlying spotted limestones of the Sołtysia Marlstone Formation (Iwanow, 1985) represented mainly by *Chondrites, Planolites* and *Zoophycos* (Wieczorek, 1984).

The paucity of this ichnoassemblage was probably due to stress environmental conditions characterized by: low oxygen concentration in the sediment, paucity of nutrients as well as low preservation potential. It is difficult to determine which agent was the most important one. The majority of trace fossils occur in sandstone beds. Bottom currents probably slightly eroded the sediments and preparing animals burrows whereas the transported material casted this burrows as semireliefs. The transported material rich in nutrients was a basis to existence of organism preserved as full reliefs inside sandstone beds. High concentration of shales in the Kopieniec Formation reduce the preservation potential. Synsedimentary (?) deformations were probaly caused by low degree of clay and mud consistence, saturated by water, and forming the so called "soupgrounds" not suitable either for preservation nor for burrowing (cf. Pickerill, 1975; Ekdale, 1985).

The ichnoassemblage from the Kopieniec Formation resembles most the *Cruziana* ichnofacies, representing soft bottom, shallow (shelf) marine condition (cf. Seilacher, 1967; Frey and Seilacher, 1980; Frey and Pemberton, 1985). It confirms Gaździcki's conclusions (1974, 1983) about bathymetry of the Kopieniec Formation sedimentation environment.

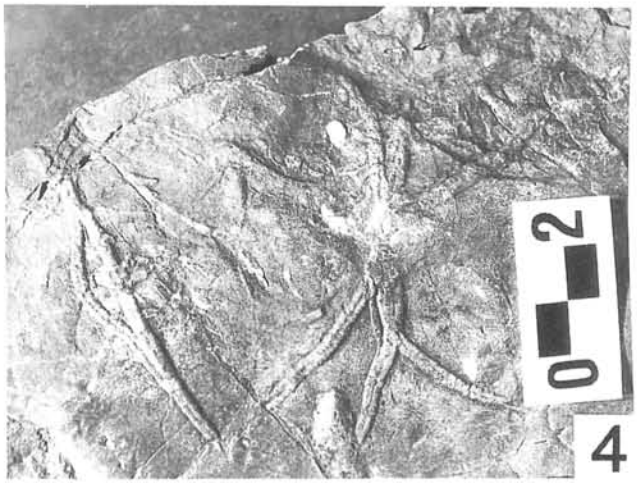

Fig. 4. *Isopodichnus ?stromnessi*. Kopieniec Formation. Hyporelief.

The occurrence of ichnogenus *Isopodichnus* within undoubtedly marine Kopieniec Formation does not allow for regarding it as an indicator of non-marine environment (cf. vide Bromley and Asgaard, 1979). Taxonomically diversed arthropods, living in different environments can produce similar structures during a long geological time-span.

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