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CARBONIFEROUS HOLOTHUROIDEA SCLERITES IN THE  
 UPPER SILESIA COAL BASIN (SOUTHERN POLAND)

(2 Figs.)

*Karbońskie skleryty Holothuroidea w Zagłębiu Górnos Śląskim*

(2 fig.)

Abstract: Holothuroidea sclerites found for the first time in Palaeozoic rocks in Poland — in shales of the Grodziec beds (Namurian A) in the Upper Silesia Coal Basin are determined as *Protocaudina kansasensis* (Hanna) and *Microantyx botoni* Gutschick. These species were noted hitherto from the Mississippian, Pennsylvanian and Lower Permian of North America.

INTRODUCTION

The microfauna of the marine intercalations in Namurian A rocks of the Upper Silesia Coal Basin is poorly known. Foraminifers have been described only from two localities, and in both cases they were found in the X-th marine band „Franciszka” in the Hrušow beds (S. Duszyńska 1958, Z. Alexandrowicz 1959).

The author expresses thanks to Mrs G. Kuchcińska M. Sc., and to Mr R. Szymoniak M. Sc. Eng. from the State Geological Co. in Katowice who provided material for micropalaeontological studies from bore-holes in the area of Jaworzno (Fig. 1).

Samples taken from cores of bore-holes drilled in the area of Jaworzno yielded numerous foraminifers and ostracods, some skeletal elements of Holothuroidea and a few conodonts. Special attention was given to holothurian sclerites which are well preserved, and hitherto were unknown from the territory of Poland. The presence of holothurian sclerites has been stated in dark-grey shales (bore-hole Jaworzno 2902, depth 686—687 m), assigned by R. Szymoniak (1970) to the V-th marine band of the Grodziec beds (uppermost member of Namurian A in the north-east part of the Upper Silesia Coal Basin) on the basis of macrofossils. In the Jaworzno area these beds consist of shales and claystones, grey and dark grey, with intercalations of fine- and medium-grained feldspathic sandstones. Locally the claystones contain sphaerosiderite concretions. Intercalations with marine, brackish, and fresh-water fauna and with flora can be distinguished. The described beds contain thin rare coal seams and layers of coal shales (R. Szymoniak 1970).

The Grodziec beds, developed in the north-eastern part of the Upper Silesia Coal Basin, contain five intercalations of shales with marine fauna

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numbered I—V from top to bottom (Fig. 1). The lowest V-th marine band is richest in fossils, containing brachiopods from the genera *Spirifer*, *Chonetes*, and *Camarotoechia*, gastropods *Straparolus*, and corals, besides other fossils found also in the remaining marine bands (Ł. Musiał and M. Tabor 1964, K. Bojkowski 1967, R. Szymoniak 1970). In the western part of the Upper Silesia Coal Basin the corresponding marine band is known as the V-th „Barbara” band, being widespread and containing a rich and diversified assemblage of fossils (K. Bojkowski

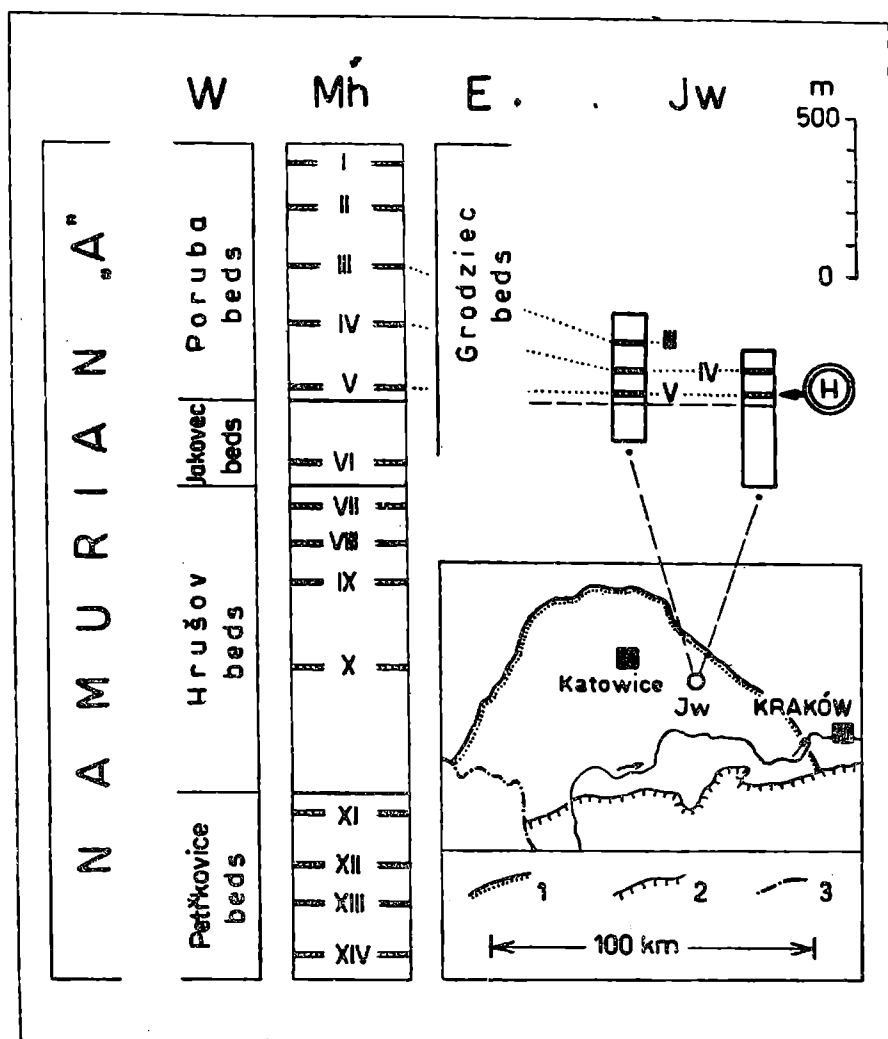


Fig. 1. Lokalizacja i pozycja stratygraficzna stanowiska sklerytów Holothuroidea w karbonie polskiej części Zagłębia Górnośląskiego. W — podział stratygraficzny namuru A w zachodniej części Zagłębia Górnośląskiego; Mh — poziomy morskie (I—XIV) w osadach namuru A; E — pozycja stratygraficzna warstw grodzieckich we wschodniej części Zagłębia Górnośląskiego; Jw — profile z okolic Jaworzna i ich lokalizacja; H — miejsce występowania sklerytów Holothuroidea; 1 — granica Zagłębia Górnośląskiego; 2 — północny brzeg Karpat; 3 — granica państwa

Fig. 1. Location and stratigraphic position of the occurrence of Holothurian sclerites in the Upper Carboniferous of the Polish part of the Upper Silesia Coal Basin. W — stratigraphic division of the Namurian A in the western part of the Upper Silesia Coal Basin; Mh — marine horizons (I—XIV) in the profile of the Namurian A; E — stratigraphic position of the Grodziec beds in the eastern part of the Upper Silesia Coal Basin; Jw — profiles from the area of Jaworzno and their location; H — site of occurrence of the Holothurian sclerites; 1 — boundary of the Upper Silesia Coal Basin; 2 — northern border of Flysch Carpathians; 3 — state boundary

1958, 1967). This band occurs in the lower part of the Poruba beds, which are corresponding to the Grodziec beds of the eastern part of the Basin (Fig. 1).

#### REVIEW OF RESEARCH ON CARBONIFEROUS HOLOTHUROIDEA SCLERITES

The presence of holothurian sclerites in Palaeozoic rocks was stated first by R. Etheridge (1881) who published descriptions and drawings of sclerites of various shapes found in Carboniferous limestone of Scotland. The majority of these specimens was assigned to the genus *Cheirodota* (E s c h s c h o l t z) and to the genus *Achistrum* gen. nov.

After a long pause the investigations on Carboniferous Holothuroidea were undertaken again in the United States of America. Their first results were published by D. G. Hanna (1930) who described the new species *Laetmophasma* (?) *kansasensis* found in Lower Permian and Pennsylvanian limestones in Kansas. G. Croneis (1931) discussed the systematic position of the *Laetmophasma* genus. Later, an important paper was published by C. Croneis and J. McCormack (1932) who described index species from the genera: *Protocaudina*, *Palaeochiridota*, *Etheridgella* and *Ancistrum* (*Achistrum* according to Etheridge) typical for the Carboniferous strata of North America. Further data on the occurrence of holothurian sclerites in Carboniferous strata of this continent were published by W. F. Bailey (1935).

Holothurian sclerites, especially those having the form of circular plates („rotiformes” and „disciformes”) occurring also in Carboniferous strata were discussed by M. Deflandre-Rigaud (1950, 1952, 1962) who introduced new parataxonomic units with names taken from the structure of the Roman army.

The monography by D. L. Frizzell and H. Excline (1955a) contains descriptions of 23 Holothuroidea species known from the Carboniferous, and separate lists of species for Europe and North America.

The number of species known from Europe is small as compared with North America. This disproportion increased recently as new species were described from the Carboniferous of North America by R. L. Langenheim and R. C. Epis (1957), Ch. H. Summerson and L. J. Campbell (1958), R. C. Gutschick (1959), and G. F. Carini (1962). Instead, studies of Carboniferous Holothuroidea did not develop in Europe since the pioneer paper by R. Etheridge (1881), and this is the presumed cause of the small number of species known from this continent.

The photographs published by E. F. Vangerow (1964, Taf. 3, Figs. 26—28) suggest, that this author found four holothurian sclerites in the paralic Westphalian strata of the Ruhr basin, and determined them erroneously as foraminifers *Haplophragmoides* cf. *ciscoensis* Harlton. These sclerites resemble forms belonging to the species *Protocaudina kansasensis* (Hanna).

Recent investigations of holothurian sclerites of other Palaeozoic systems in Europe are reported in papers by A. Seilacher (1961) on Lower Devonian sclerites, by H. Jordan (1967) (Zechstein) and by R. Schallreuter (1968) (Ordovician). Recent papers stress upon the importance of holothurian sclerites for correlation in stratigraphic and palaeogeographic research.

DESCRIPTION OF SPECIES

The samples taken from the Namurian A beds in the area of Jaworzno yielded 20 well preserved Holothuroidea sclerites, represented by two species: *Protocaudina kansasensis* (Hanna) and *Microantyx botoni* Gutschick. The first of these species was described and mentioned several times from Pennsylvanian and Lower Permian strata of North America.

The possibility of its occurrence in Carboniferous strata of Europe was suggested by C. Croneis (1931), who stated that one of the specimens of *Cheirodota* (?) *traquairii* described by Etheridge corresponds to the species *Laetmosphasma* (?) *kansasensis* Hanna. The revision undertaken by C. Croneis and J. McCormack (1932) resulted in assigning this form to *Protocaudina traquairii* (Etheridge). The occurrence of *Microantyx botoni* was noted hitherto only from Mississippian limestones of North America.

The discovery of these species in Carboniferous strata of Europe proves their widespread distribution. The Late Palaeozoic holothurian sclerites were usually found in marine shelf sedimentary rocks. Their presence in a marine band in the paralic coal-bearing series of Upper Silesia is characteristic in that respect.

The systematics of Holothuroidea established by D. L. Frizzell and H. Exline (1955a, 1966) is followed in the detailed description of the species. According to this systematics the described species belong to the family Theeliidae fam. nov. Instead, in the parataxonomic division proposed by M. Deflandre-Rigaud (1962) they belong to *Protocaudinidae* *cohors* nov. vel parafam. nov.

Family: Theeliidae Frizzell, Exline, 1955

Genus *Protocaudina* Croneis, 1932

Type species: *Protocaudina traquairii* (Etheridge). Syn. *Cheirodota* (?) *traquairii* Etheridge (Etheridge, 1881, p. 196, Pl. 6, Fig. 1).  
Diagnosis of genus: Sclerites in form of concavo-convex wheels divided by 8—10 short spokes. Four perforations in the central part.

*Protocaudina kansasensis* (Hanna), 1930

Fig. 2 (1, 2)

- 1930 *Laetmosphasma* (?) *kansasensis* Hanna (in part); D. G. Hanna, Remains of Holothuroidea..., pp. 413—414, Pl. 40, Figs. 1—2, 4—7.
- 1931 *Caudina traquairii* (Etheridge) (in part); C. Croneis, Late Paleozoic Holothuroidea, pp. 47—48.
- 1932 *Protocaudina kansasensis* (Hanna); C. Croneis and J. McCormack, Fossil Holothuroidea, pp. 138—139, Pl. 20, Figs. 2, 6.
- 1935 *Protocaudina kansasensis* (Hanna); W. F. Bailey, Micropaleontology and stratigraphy of the lower Pennsylvanian..., p. 496, Pl. 55, Figs. 18—20.
- 1955 *Protocaudina kansasensis* (Hanna); D. L. Frizzell and H. Exline, Monograph of Fossil Holothurian Sclerites, pp. 137—138, Pl. 8, Fig. 16.
- 1955 *Protocaudina kansasensis* (Hanna); D. L. Frizzell and H. Exline, Micropaleontology of fossil holothurian sclerites, p. 339.

1958 *Protocaudina kansasensis* (Hanna); Ch. H. Summerson and L. J. Campbell, *Holothurian sclerites from the Kendrick...*, p. 969, Pl. 125 (nie 126), Figs. 14—17.

**M a t e r i a l:** Six complete specimens.

**D i m e n s i o n s** (mm): (Specimens 2 and 5 presented in Fig. 2 (1—2)).

| Specimens  | 1      | 2      | 3      | 4      | 5      |
|--|--------|--------|--------|--------|--------|
| max. diameter of wheel   | 0,347— | 0,34   | 0,274  | 0,244  | 0,24   |
| thickness of wheel   | 0,07   | 0,07   | 0,04   | 0,045  | 0,04   |
| distance between periphery of wheel and external perforations  | 0,025— | 0,023— | 0,020— | 0,020— | 0,023— |
|  | 0,038  | 0,043  | 0,028  | 0,030  | 0,045  |
| width of spokes  | 0,033— | 0,028— | 0,032— | 0,035— | 0,030— |
|  | 0,048  | 0,05   | 0,043  | 0,040  | 0,045  |
| diameters of external perforations                             | 0,038— | 0,037— | 0,030— | 0,030— | 0,033— |
|  | 0,048  | 0,05   | 0,043  | 0,038  | 0,040  |
| diameters of the pair of larger central perforations           | 0,032  | 0,033  | 0,027  | 0,028  | 0,033  |
|  | 0,033  | 0,037  | 0,028  | 0,032  | 0,035  |
| diameters of the pair of smaller central perforations          | 0,017  | 0,020  | 0,018  | 0,022  | 0,017  |
|  | 0,023  | 0,023  | 0,022  | 0,025  | 0,022  |
| distance between outer margins of larger central perforations  | 0,067  | 0,078  | 0,050  | 0,072  | 0,073  |
| distance between outer margins of smaller central perforations | 0,082  | 0,094  | 0,073  | 0,095  | 0,089  |

**D e s c r i p t i o n:** Sclerite in the form of wheel nearly circular, sometimes with wavy or polygonal outline; 8 external and 4 central perforations visible on both sides of the wheel; belt between the external perforations and the central ones wider than the diameter of the largest central perforation; spokes wide and short, interspoke external perforations of various size, oval, circular or nearly triangular in shape; two pairs of perforations differing in location and size in the central part of the wheel; the area occupied by the central perforations elliptical in outline, with the pair of smaller perforations on the longer axis, and the pair of larger perforations on the shorter axis of the ellipse; the central perforations co-radial with external perforations; periphery usually smooth, slightly raised on the concave (top) side of the wheel; bottom side of wheel slightly convex; in vertical position the periphery rounded.

**R e m a r k s:** D. G. Hanna (1930) in his description of holotype of *Laetmophasma* (?) *kansasensis* remarked that small individual variation is visible in syntypes. Studies of C. C. Cronis (1931), and C. Cronis and J. McCormack (1932) resulted in the assigning of the specimens described by D. G. Hanna (1930) to two species, established finally as *Protocaudina kansasensis* (Hanna) and *Protocaudina traquairii* (Etheridge). The descriptions of *Protocaudina kansasensis* (Hanna) published hitherto are not univocal, and often inexact. The following table illustrates the specific features differing in descriptions and illustrations by various authors.

Specimens from the Carboniferous strata of Poland determined as *Protocaudina kansasensis* show the following features characteristic for

| authors                                    | number of external perforations | shape of external perforations   | shape of central perforations            | diameter of wheel (mm) |
|--|---------------------------------|--|--|------------------------|
| C. Croneis and J. Mc Cormack (1932)        | various not 8                   | inner edge arched, outer edge straight or slightly arched (acc. to Fig.) | nearly triangular or oval (acc. to Fig.) | 0,24; 0,317            |
| W. F. Bailey (1935)                        | 10                              | nearly triangular (acc. to Fig.)   | nearly triangular (acc. to Fig.)         | 0,35                   |
| D. L. Frizzell and H. Exline (1955a)       | 8—11<br>10 in typical specimens | inner edge arched outer edge nearly straight                             | nearly triangular                        | 0,25—0,52              |
| Ch. H. Summerson and L. J. Campbell (1958) | 10                              | oval or nearly triangular  | triangular                               | 0,15—0,27              |

this species: shape of wheel, shape of external and central perforations, number and location of central perforations. The number of external perforations lies in the range of variability indicated by various authors. The dimensions of wheels do not differ from published data.

Specimens of *Protocaudina kansasensis* from Poland differ in one feature from the published descriptions: in the central part of the wheel there are two pairs of perforations of unequal size. It is possible that this feature exists in the American specimens but has not been noted. Moreover, in the Polish specimens the inner edge of the wheel in the interspoke portions is relatively smooth, and only rarely dentate, while in the American specimens the dentation is more pronounced. The variability of shapes of the perforations, especially of the external ones is greater in the Polish specimens than in forms presented by C. Croneis and J. Mc Cormack (1932).

The sclerites described in the present paper differ clearly from other species of the *Protocaudina* genus. The most similar *Protocaudina traquairii* (Etheridge) has a sinuous periphery and central perforations equally spaced. *Protocaudina hexagonaria* Martin differ from the specimens described here in hexagonal outline and very narrow belt between the external perforations and the field of central perforations.

Occurrence: *Protocaudina kansasensis* (Hanna) was described from Pennsylvanian and Lower Permian strata of Kansas, Texas, Missouri and Kentucky (D. H. Hanna 1930, C. Croneis and J. Mc Cormack 1932, W. F. Bailey 1935, Ch. H. Summerson and L. J. Campbell 1958). The Polish specimens described here were found in the shales of the Grodziec beds (Namurian A) in the V-th marine band „Barbara” at

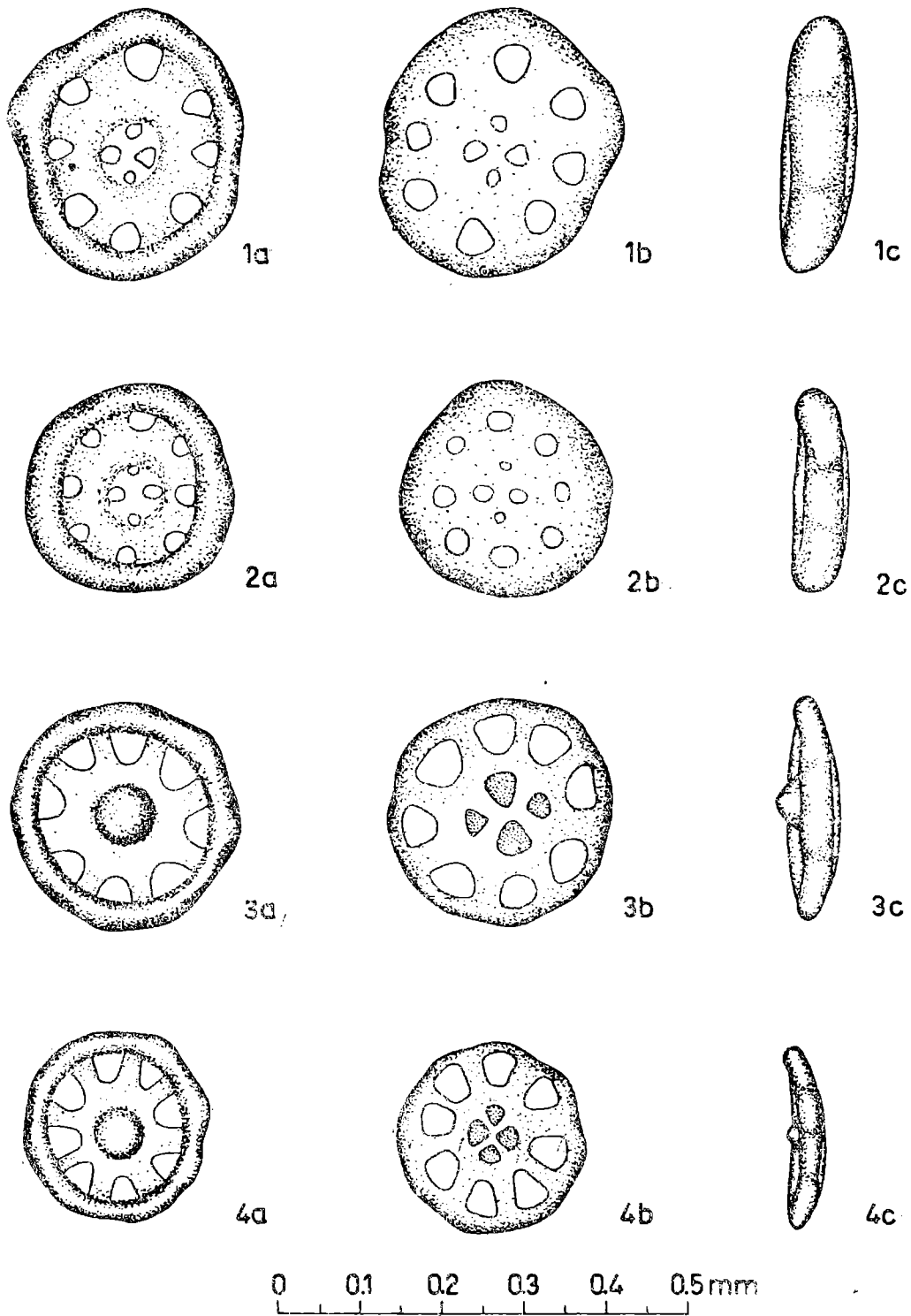


Fig. 2. 1a, m, c, 2a, b, c — *Protocaudina kansasensis* (Hanna): a — strona górna; b — strona dolna; c — z boku. Łupki namuru A — warstwy grodzieckie (porębskie), poziom morski V Barbara; Jaworzno — Górny Śląsk; 3a, b, c, 4a, b, c — *Microantyx botoni* Gutschick: a — strona górna; b — strona dolna; c — z boku. Łupki namuru A — warstwy grodzieckie (porębskie), poziom morski V Barbara; Jaworzno — Górny Śląsk

Fig. 2. 1a, b, c, 2a, b, c — *Protocaudina kansasensis* (Hanna): a — top view; b — bottom view; c — side view. Namurian A shales — Grodziec (—Poruba) beds, V-th marine band Barbara; Jaworzno — Upper Silesia; 3a, b, c, 4a, b, c — *Microantyx botoni* Gutschick: a — top view; b — bottom view; c — side view. Namurian A shales — Grodziec (—Poruba) beds, V-th marine band Barbara; Jaworzno — Upper Silesia

Jaworzno in Upper Silesia. A single specimen has been found in the same marine band at Burki near Szczakowa, c. 7 km North of Jaworzno.

Genus *Microantyx* Kornicker and Imbrie, 1958

Type species: *Microantyx permiana* Kornicker and Imbrie from Permian of Kansas U.S.A. (Kornicker and Imbrie, 1958, p. 94, Pl. 1, Figs. 1—6).

Diagnosis of genus: Sclerites in form of wheels divided by short spokes. Periphery of wheel raised, and protruding hub on top side of the wheel. Four depressions in central part on the bottom side of the wheel.

Remarks: in the description of genus by L. S. Kornicker and Imbrie 1958, p. 93, the top side of the wheel is described as the bottom one and vice versa. A proper definition of this species was given by M. Deflandre-Rigaud (1962, pp. 99—100), not mentioning this mistake.

*Microantyx botoni* Gutschick, 1959

Fig. 2 (3—4)

1959 *Microantyx botoni* Gutschick; R. C. Gutschick, Lower Mississippian holothurian..., pp. 134—135, Pl. 26, Figs. 22, 23, 28, 29.

Material: 15 specimens, including 13 complete, well preserved.

Dimensions (mm): Measurements taken on the bottom (convex) side specimens 2 and 4 are presented in Fig. 2 (3—4).

| Specimens   | 1      | 2      | 3      | 4      | 5      |
|---|--------|--------|--------|--------|--------|
| diameter of wheel   | 0,277  | 0,255  | 0,247  | 0,222  | 0,167  |
| thickness of wheel with hub                                   | 0,09   | 0,08   | 0,07   | 0,05   | 0,04   |
| thickness of wheel without hub                                | 0,05   | 0,04   | 0,04   | 0,03   | 0,025  |
| distance between periphery of wheel and external perforations | 0,022— | 0,020— | 0,018— | 0,015— | 0,013— |
| width of spokes   | 0,027  | 0,028  | 0,021  | 0,025  | 0,018  |
|   | 0,030— | 0,023— | 0,018— | 0,021— | 0,018— |
| diameter of external perforations                             | 0,037  | 0,04   | 0,023  | 0,025  | 0,022  |
|   | 0,047— | 0,038— | 0,045— | 0,038— | 0,028— |
|   | 0,067  | 0,06   | 0,058  | 0,042  | 0,033  |
| diameters of the pair of larger central depressions           | 0,032  | 0,038  | 0,038  | 0,030  | 0,024  |
| diameters of the pair of smaller central depressions          | 0,033  | 0,042  | 0,038  | 0,032  | 0,028  |
| distance between outer margins of larger depressions          | 0,028  | 0,035  | 0,037  | 0,023  | 0,022  |
| distance between outer margins of smaller depressions         | 0,030  | 0,036  | 0,037  | 0,024  | 0,025  |
|   | 0,073  | 0,097  | 0,1    | 0,06   | 0,067  |
|   | 0,067  | 0,1    | 0,087  | 0,075  | 0,062  |

Description: sclerite in form of wheel with 8 perforations near the periphery, and central part non-perforated, differently shaped on the two sides of the wheel; peripheral edge often sinuous, with convexities in axes of the perforations, spokes short, straight with nearly constant width; interspoke perforations of constant shape and size, nearly triangular; peripheral rim sloping towards the centre of the wheel clearly



visible on the upper (concave) side of the wheel; the rim partly covers the outer edges of the perforations; a conical hub occupies the central part of the top side of the wheel. Bottom side of sclerite slightly convex, with flat or somewhat recessed central part occupied by four triangular depressions, lying in axes of external perforations and separated by an X-shaped bridge; one pair of opposite depressions is usually larger than the other pair; the distance between the larger depressions is shorter than the distance between the smaller ones. In vertical position of the sclerite the rounded sinuous periphery and the conical hub protruding above the edge of the upper side of the wheel are conspicuous.

**Remarks:** the described sclerites correspond well to the diagnosis of the species *Microantyx botoni* published by R. C. Gutschick (1959). Some differences exist in the size of specimens, the specimens described by the quoted author being larger than the Polish ones. The diagnosis do not mention the difference of size of the pairs of central depressions.

**Occurrence:** *Microantyx botoni* was described first from Lower Mississippian Rockford limestones in the north part of Indiana (R. C. Gutschick 1959). The second occurrence of this species is known from shales of the Grodziec beds (Namurian A), V-th marine band „Barbara” at Jaworzno in Upper Silesia.

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## STRESZCZENIE

W próbkach ciemnoszarych łupków karbońskich pochodzących z wiercenia usytuowanego w okolicy Jaworzna na Górnym Śląsku (wiercenie Jaworzno 2902, głęb. 686—687 m) zostało znalezionych 20 sztuk dobrze zachowanych, wapiennych elementów szkieletowych strzykw, które występowały obok licznych otwornic, małżoraczków i sporadycznych kono-dontów. W oparciu o oznaczenia składu makrofauny R. Szymoniak (1970) wspomniane łupki uznał za poziom morski V warstw grodzieckich namuru A, odpowiadający prawdopodobnie poziomowi morskiemu V-Barbara warstw porębskich zachodniej części Zagłębia Górnośląskiego (fig. 1).

Opracowane przez autorkę skleryty holoturii są dotychczas pierwszymi okazami znalezionymi w utworach paleozoicznych Polski. Mają one postać płytek perforowanych o zarysie kolistym i reprezentują dwa gatunki: *Protocaudina kansasensis* (Hanna) i *Microantyx botoni* Gutschick

(fig. 2). Wymienione gatunki są znane z osadów mórz szelfowych mississippi, pensylwanu i dolnego permu Ameryki Północnej (D. G. Hanna 1930, C. Croneis, J. McCormack, 1932; W. F. Bailey 1935, Ch. H. Summerson, L. J. Campbell 1958; R. C. Gutschick 1959). Stwierdzenie tych form we wkładce morskiej w węglonośnej formacji paralicznej na Górnym Śląsku, świadczy o ich nie tylko szerokim rozprzestrzenieniu, ale także możliwości występowania w różnych warunkach ekologicznych.

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