Remarks. — The bigger a specimen the more confined is its central lamella and the pores do not penetrate the plate completely. Such sclerites take the shape of rods (Pl. 16: 10–14; Text-fig. 49X–Z). This species differs from others described here by the large size of its sclerites, their shape, and by the development of the anal teeth which are most commonly provided with two lateral processes in the shape of prominent spines.

Occurrence. — Mid (Late?) Givetian: set B of Jaźwica; set A of Szydłówek. Late Givetian: trench II at Marzysz; set C of Sowie Górki. Mid Frasnian: layer W6 of Szczukowskie Górki, Holy Cross Mountains, Poland.

Devonothyonites exporrigus sp. n.
(Pl. 16: 5, 10; Text-fig. 45G–L)

Holotype: GIUS 4-439 Śni./963/4, Text-fig. 45J.

Type horizon: Early Givetian, *Polygnathus hemiansatus* Zone.

Type locality: Outcrop III at Śniadka, Holy Cross Mountains.

Derivation of the name: From Latin *exporrigo* – to widen, expand, in connection with the strongly expanded processes of the anal teeth.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Plates with head: 142	Width	280	140	280	315
	Height	290	150	290	335
Anal teeth: 14	Width	–	230	350	440
	Length	–	520	950	1465

Diagnosis. — Sclerites from the body wall in the shape of irregular plates with small spiny heads.

Description. — Sclerites from the body wall. Pores in the body wall plates are of various size; their number is up to 45. The plates have only slightly developed margins (Text-fig. 45G–L).

Anal teeth. These sclerites may be of two shapes: some are dagger-shaped with strong lateral processes (Pl. 16: 5), the others, most probably belonging to large individuals, have the broader termination in the form of a spoon (Pl. 16: 10). A common feature for both the morphotypes is their narrower end, which has a rod-like appearance and very similar perforation.

Remarks. — The species has an extremely delicate body wall lattice and a unique type of anal teeth.

Occurrence. — Early Givetian: outcrop III at Śniadka; sets XXIII, XXIV, XXV of the Skały Beds at Skały, Holy Cross Mountains, Poland.

Devonothyonites polymorphus sp. n.
(Text-fig. 48J–O)

Holotype: GIUS 4-656 Ska./973/5, Text-fig. 48K.

Type horizon: Late Eifelian, set XVII of the Skały Beds, *Tortodus kockelianus* Zone.

Type locality: Skały, Holy Cross Mountains.

Derivation of the name: From Greek *polymorfos* – with numerous shapes.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Anal teeth: 25	Width	165	160	170	260
	Length	715	565	725	910

Diagnosis. — Narrower ends of the anal teeth reaching up to half of the sclerite length, rod-like, and only weakly perforated, with blind pores.

Description. — The species is represented in the collections only by strongly variable anal teeth. The spines are of various shape, and may be long and arranged in triplets, symmetrically on both sides, asymmetrical short spines and/or blades and rosettes, or may be absent (Text-fig. 48J–O). The broader end is weakly bifurcated or without bifurcation and spoon-shaped.

Remarks. — These specimens differ from all the others by their peculiar lateral spines and by their rod-like narrower end.

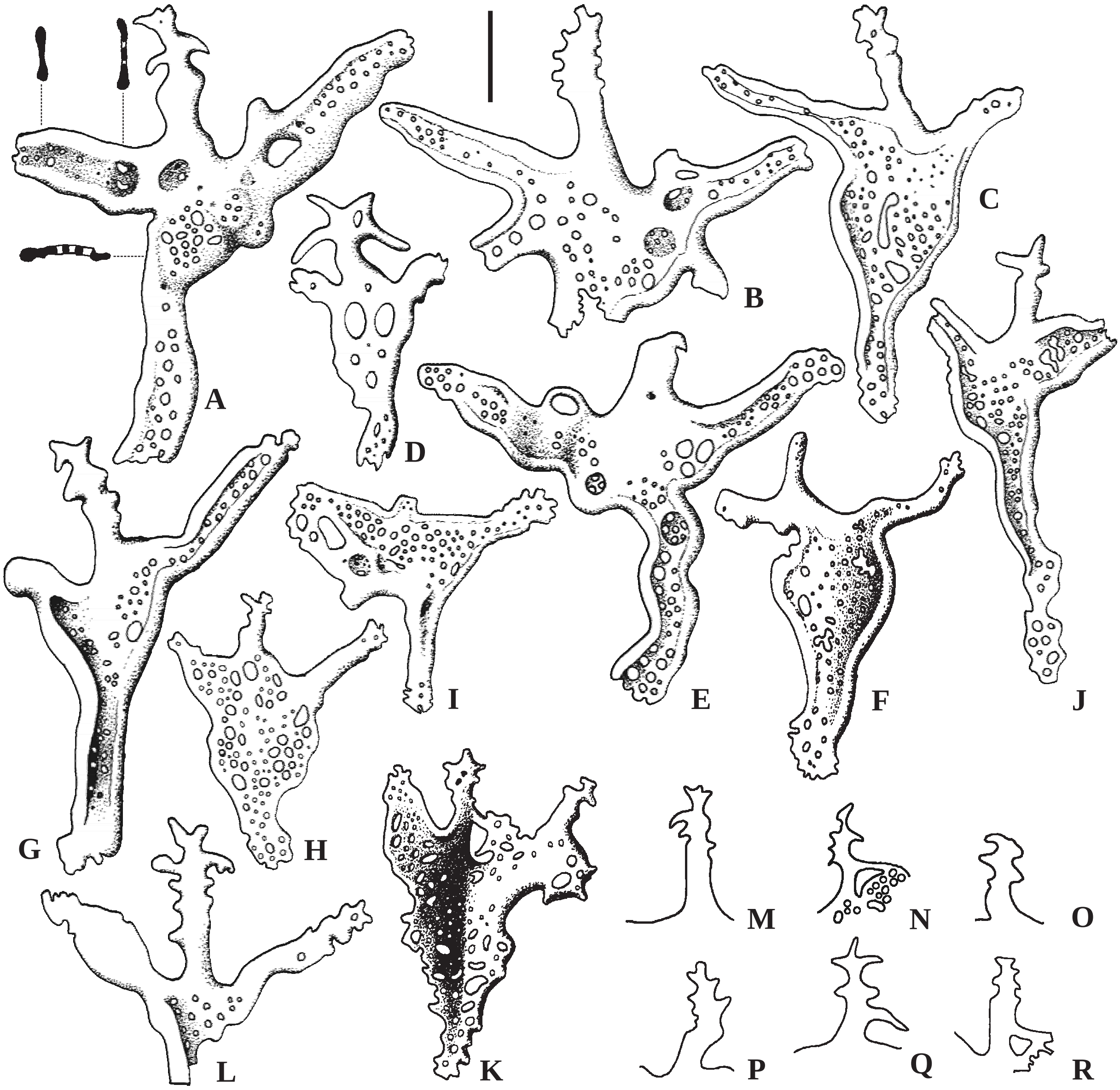

Fig. 46. Sclerites of *Devonothyonites avis* sp. n. from the Givetian of the Holy Cross Mountains, side views. **A**–**K**. Specimens from the Late Givetian .of Marzysz, samples Marzysz II/13 (A, E, F, I), Marzysz II/W/6 (B–D), and Marzysz II/4 (G, H, J, K) **A**. Holotype GIUS 4-584 Mrz./209/1. **B**. GIUS 4-568 Mrz./78/3. **C**. GIUS 4-568 Mrz./78/1. **D**. GIUS 4-568 Mrz./78/2. **E**. GIUS 4-584 Mrz./209/2. **F**. GIUS 4-584 Mrz./209/4. **G**. GIUS 4-575 Mrz./316/2. **H**. GIUS 4-575 Mrz./316/3. **I**. GIUS 4-584 Mrz./209/5. **J**. GIUS 4-575 Mrz./316/1. **K**. GIUS 4-575 Mrz./316/4. **L**. Fragmentary specimen from the Middle Frasnian of Szczukowskie Górki, sample W6, GIUS 4-610 Szg./550/1. **M**–**R**. Different kinds of processes from the Late Givetian, sample Marzysz II/13. **M**. GIUS 4-584 Mrz./207a/9. **N**. GIUS 4-584 Mrz./207a/11. **O**. GIUS 4-584 Mrz./207a/7. **P**. GIUS 4-584 Mrz./207a/8. **Q**. GIUS 4-584 Mrz./207a/10. **R**. GIUS 4-584 Mrz./207a/12. Scale bar 200 μm.

Occurrence. — Late Eifelian: sets XVII, XVIII of the Skały Beds at Skały, Holy Cross Mountains, Poland.

Devonothyonites spiritus sp. n.
(Pl. 16: 19; Text-fig. 45M–R)

Holotype: GIUS 4-801 Kos./534/2, Text-fig. 45N.

Type horizon: Mid Frasnian, Early *Palmatolepis rhenana* Zone.

Type locality: set H of Kostomłoty quarry IV, Holy Cross Mountains.

Derivation of the name: From Latin *spiritus* – ghost, as the plates are shaped like ghosts in animated cartoons.

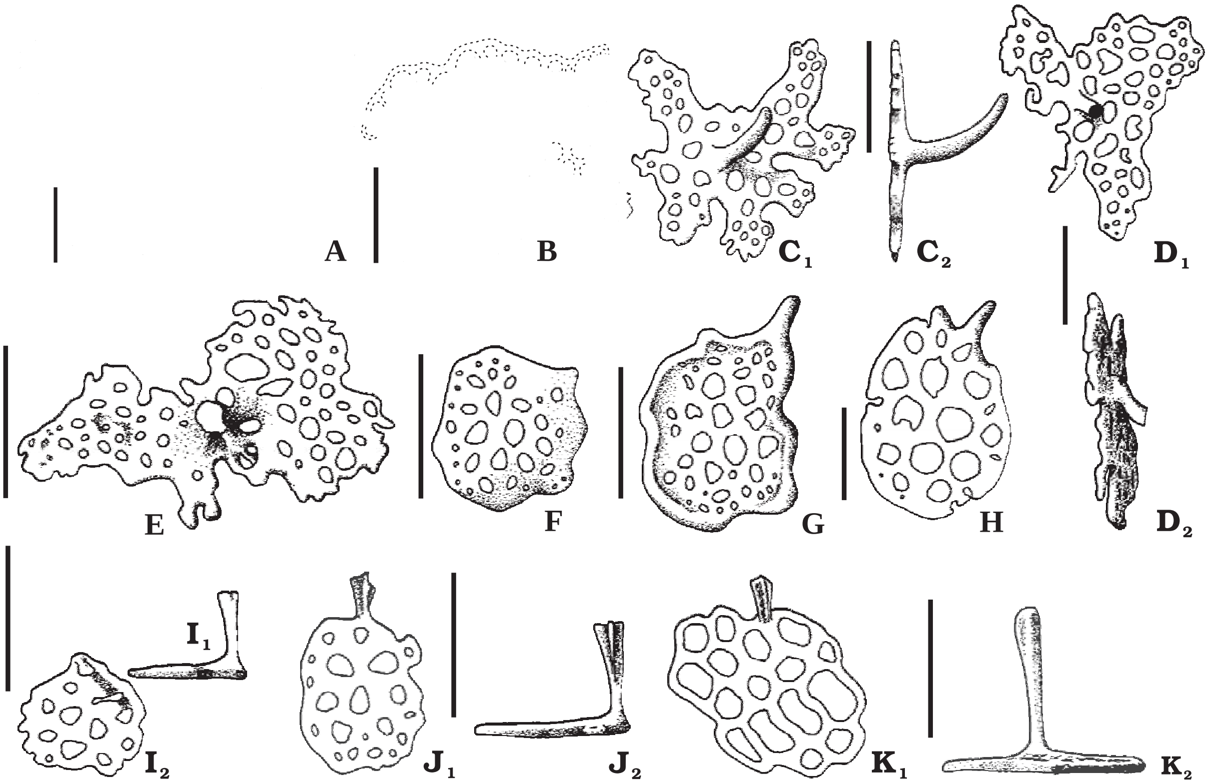

Fig. 47. Holothurian sclerites from the Devonian of the Holy Cross Mountains. **A**. *Devonothyonites accipitris* sp. n. from the earliest Eifelian *Chimaerothyris dombrowiensis* horizon, set VIII of Grzegorzowice, GIUS 4-618 Grz./380/4, outer view. **B–E**. *Devonothyonites avis* sp. n. from the Late Givetian of Marzysz, samples Marzysz II/13 (B, D) and Marzysz II/6 (C, E). **B**. GIUS 4-584 Mrz./218/3, outer view. **C**. GIUS 4-577 Mrz./22/1; C_1 outer view, C_2 lateral view. **D**. GIUS 4-584 Mrz./218/1; D_1 outer view, D_2 lateral-oblique view. **E**. GIUS 4-577 Mrz./22/2, outer view. **F–K**. *Devonothyonites tudorowiensis* sp. n. from the Mid (Late?) Frasnian of Tudorów. **F**. GIUS 4-791 Tud./492/18, outer view. **G**. Holotype GIUS 4-791 Tud./492/19, outer view. **H**. GIUS 4-791 Tud./492/17, outer view. **I**. GIUS 4-791 Tud./492/1; I_1 outer view, I_2 lateral view. **J**. GIUS 4-791 Tud./492/2; J_1 outer view, J_2 lateral view. **K**. GIUS 4-791 Tud./492/3; K_1 outer view, K_2 lateral view. Scale bar 200 μm.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Plates with head: 12	Width	515	390	410	595
	Height	500	405	420	500

Diagnosis. — Sclerites from body wall weakly perforated in the shape of triangular lamella, with three spines at their narrower end.

Description. — Heads of these sclerites have no lateral processes and the number of pores penetrating these small sclerites is up to eleven. There are two to four imperforate lateral processes on the lamella (Pl. 16: 19; Text-fig. 45M–R). Flat plates are without spines, but have broad processes of massive calcite (Text-fig. 45R).

Remarks. — The specimens, though significally different from the species described so far, display all the simplified features typical for the genus.

Occurrence. — Only known from the type locality.

Devonothyonites tudorowiensis sp. n.
(Text-figs 47F–K, 49A–D, T, U)

Holotype: GIUS 4-791 Tud./492/19, Text-fig. 47G.

Type horizon: Mid (Late?) Frasnian, Early *Palmatolepis hassi* – Early (Late?) *Palmatolepis rhenana* Zones.

Type locality: Tudorów, Holy Cross Mountains.

Derivation of the name: From Latin *tudorowiensis* – from the type locality.

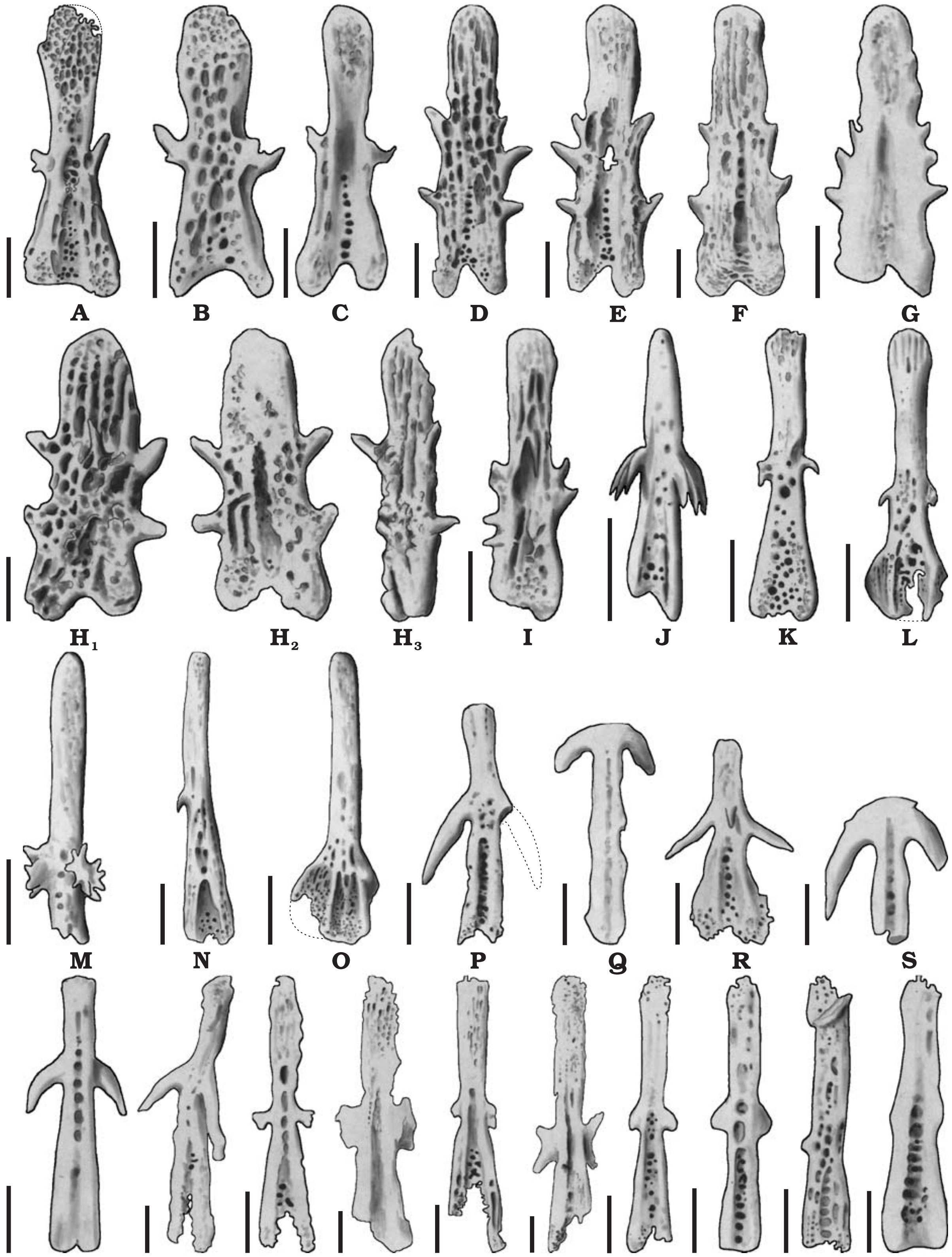

Fig. 48. Holothurian sclerites from the Devonian of the Holy Cross Mountains. **A**–**I**. Anal teeth of *Devonothyonites accipitris* sp. n. from the earliest Eifelian *Chimaerothyris dombrowiensis* horizon of Zbrza (A–B) and set VIII of Grzegorzowice (C–I). **A**. Specimen with two processes, GIUS 4-779 Zba./353/1. **B**. Specimen with two processes, GIUS 4-779 Zba./353/2. **C**. Specimen with two processes, GIUS 4-618 Grz./375/6e. **D**. Specimen with five processes, GIUS 4-618 Grz./375/8. **E**. Specimen with five processes, GIUS 4-618 Grz./375/10. **F**. Specimen with four processes, GIUS 4-618 Grz./375/5. **G**. Specimen with six processes, GIUS 4-618 Grz./375/7. **H**. Specimen with one vertical and four horizontal processes, GIUS 4-618 Grz./375/4; H_1 side ➛

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Plates with head: 10	Width	275	225	230	275
	Height	385	235	295	385
Anal teeth: 2	Width	–	305	345	385
	Length	–	815	1000	1195
Plates with process: 5	Diameter	–	180	220	315
	Length of process	–	90	130	205

Diagnosis. — Oval plates from the body wall with simply structured head, without lateral teeth or processes. Marginal thickening on one side only. Anal teeth delicate and weakly perforated.

Description. — Sclerites from the body wall. Plates from the body wall have up to 40 pores. The plates have only one process; the spiny sclerites have their spines in marginal arrangement, by their ends the spines change from a simple cylinder to three coaxially arranged bars (Text-fig. 47F–K).

Anal teeth. These sclerites have two flat hooked processes. The central lamella is weakly perforated or can display no perforation at all, in which case the hooked processes are perforated (Text-fig. 49D). Marginal ridges are parallel to each other.

Remarks. — The simplified structure, oval plates and three bars in a spine are sufficient to distinguish this species from others. Anal teeth, even the larger ones, resemble juvenile structures of other species. Among fossil holothurians, similar forms with processes have been described as *Eocaudina spicata* (Gutschick, 1959); also in the latter species all the pores are similar and lack the bordering (cf. Gutschick 1959; Gutschick *et al.* 1967).

Occurrence. — Mid Frasnian: set C of Górno; set F of Psie Górki. Mid (Late?) Frasnian: Tudorów, Holy Cross Mountains, Poland.

Subfamily **Palaeohemioedemiinae** subfam. n.

Diagnosis. — Radial plate is M-shaped with deep distal incision. Sclerites from the body wall are lamellar in shape.

Remarks. — The skleritome described below contains a varied assemblage of sclerites, which is most similar to that seen in the extant *Hemioedema* Hérouard, 1929 (cf. Cherbonnier 1973). Cherbonnier (1957) places *Hemioedema* into the subfamily Cucumariinae. Its plates are in the form of perforated buttons. The main difference is in the form taken by "baskets"; in living forms they do not form flat, simple wheels, but are more complicated spatially. Also the radial plates from Marzysz, as in other lineages of Dendrochirotida (e.g. *Eocaudina*), have a simpler structure than those of living forms (Boczarowski 1997b). The sklerotome of the cucumariid *Trachythyone* Studer, 1876 (subfamily Colochirinae, cf. Cherbonnier 1958a, 1961) is also very similar. The radial plates are most similar to those of an other dendrochirotid *Cladodactyla senegalensis* Panning, 1940 (cf. Cherbonnier 1950). From the Triassic very similar scleritomes have been described as *Calclamnella regularis* Stefanov, 1970 (plates) together with a few little wheels included into the genera *Canisia* Mostler, 1972 and *Triradites* Mostler, 1969 (cf. Kozur and Mock 1972, 1974; Mostler 1969, 1972a). These sclerites commonly co-occur and may belong forms transitional be-

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view, H_2 opposite side view, H_3 lateral view. **I**. Specimen with five processes, GIUS 4-618 Grz./375/9. **J**–**O**. Anal teeth of *Devonothyonites polymorphus* sp. n. from the Late Eifelian set XVII of Skały. **J**. Specimen with six sharp processes, GIUS 4-656 Ska./973/4. **K**. Holotype specimen with two processes, GIUS 4-656 Ska./973/5. **L**. Specimen with two short processes, GIUS 4-656 Ska./973/6. **M**. Specimen with two spreaded processes, GIUS 4-656 Ska./973/1. **N**. Specimen with the single process, GIUS 4-656 Ska./973/3. **O**. Specimen without processes, GIUS 4-656 Ska./973/2. **P**–**AC**. Anal teeth of *Devonothyonites avis* sp. n. from the Late Givetian of Marzysz, samples Marzysz II/13 (P, Z–AC) and set C of Sowie Górki (Q–Y). **P**. Specimen with two long processes, GIUS 4-584 Mrz./210/2. **Q**. Specimen with two long processes, GIUS 4-744 Sow./694/3. **R**. Specimen with one vertical and two long horizontal processes, GIUS 4-744 Sow./694/1. **S**. Specimen with two long processes, GIUS 4-744 Sow./694/4. **T**. Holotype, specimen with two long processes, GIUS 4-744 Sow./694/7. **U**. Specimen with two long processes, GIUS 4-746 Sow./704/1. **V**. Specimen with two flat processes, GIUS 4-744 Sow./694/2. **W**. Specimen with two flat and wide processes, GIUS 4-744 Sow./694/5. **X**. Specimen with two flat and small processes, GIUS 4-744 Sow./694/6. **Y**. Specimen with two big and flat processes, GIUS 4-746 Sow./704/4. **Z**. Specimen with two short and blunt processes, GIUS 4-584 Mrz./210/3. **AA**. Specimen with two short processes, GIUS 4-584 Mrz./210/4. **AB**. Specimen with the single process, GIUS 4-584 Mrz./210/1. **AC**. Specimen without processes, GIUS 4-584 Mrz./210/8. Scale bar 200 μm.

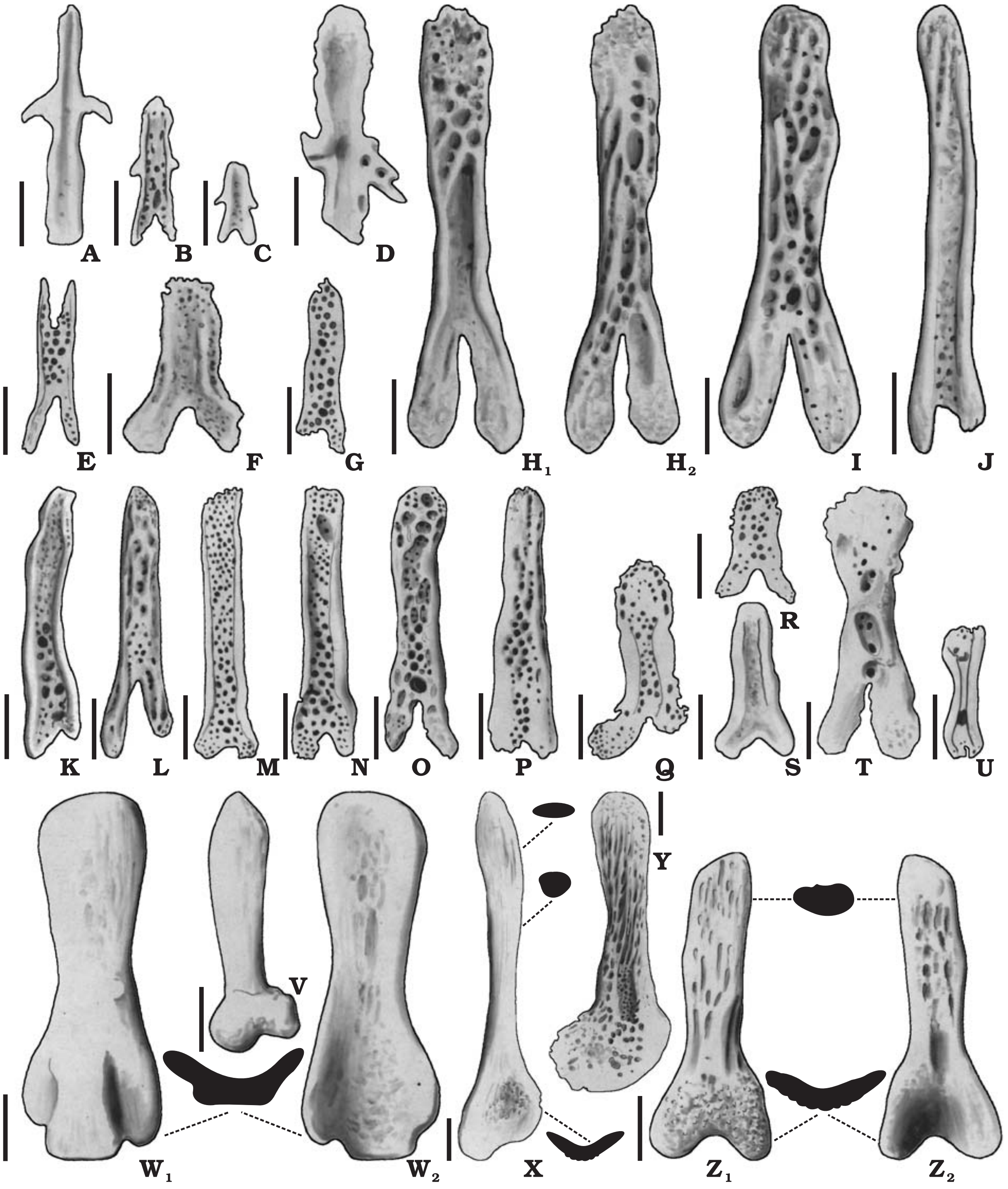

Fig. 49. Holothurian sclerites from the Devonian of the Holy Cross Mountains. **A**–**D**. Anal teeth of *Devonothyonites tudorowiensis* sp. n. **A**. Specimen with two long processes, GIUS 4-791 Tud./491/1 from the Mid (Late?) Frasnian of Tudorów. **B**. Specimen with two short processes, GIUS 4-607 Grn./529/1 from the Mid Frasnian set C of Górno. **C**. Specimen with two short processes, GIUS 4-607 Grn./529/2, same sample. **D**. Specimen with two perforated processes, GIUS 4-791 Tud./491/2 from the Mid (Late?) Frasnian of Tudorów. **E**–**S**. Anal teeth of *Devonothyonites avis* sp. n. of different shapes from the Late Givetian of Marzysz, samples Marzysz II/W/6 (E–L), Marzysz II/13 (M–R), and from the Mid (Late?) Givetian set A of Szydłówek (S). **E**. GIUS 4-568 Mrz./9/3. **F**. GIUS 4-568 Mrz./9/5. **G**. GIUS 4-568 Mrz./9/6. **H**. GIUS 4-568 Mrz./9/1; H_1 side view, H_2 opposite side view. **I**. GIUS 4-568 Mrz./9/2. **J**. GIUS 4-568 Mrz./9/8. **K**. GIUS 4-568 Mrz./9/7. **L**. GIUS 4-568 Mrz./9/4. **M**. GIUS 4-584 Mrz./211/1. **N**. GIUS 4-584 Mrz./211/2. **O**. GIUS 4-584 Mrz./211/3. **P**. GIUS 4-584 Mrz./211/7. **Q**. GIUS 4-584 Mrz./211/4. **R**. GIUS 4-584 Mrz./211/5. **S**. GIUS 4-749 Szy./523/1. **T**–**U**. Anal teeth of *Devonothyonites tudorowiensis* sp. n. **T** Holotype GIUS 4-791 Tud./498/1 from the Mid (Late?) Frasnian of Tudorów. **U**. Juvenile specimen, GIUS 4-599 Psi./512/1 from the Mid Frasnian set F of Psie Górki. **W**–**V**. Anal teeth of *Devonothyonites accipitris* sp. n. from the earliest Eifelian *Chimaerothyris* ➛

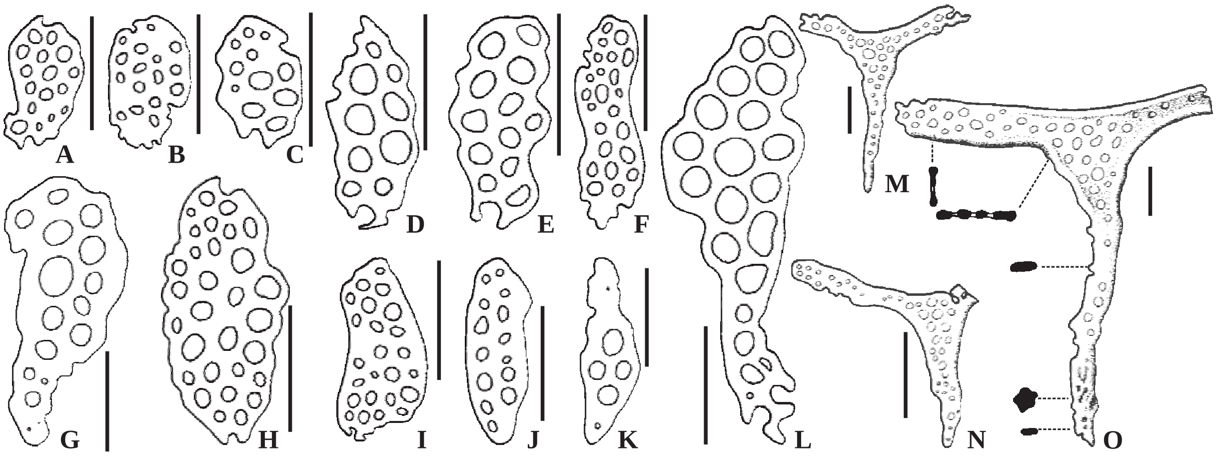

Fig. 50. Holothurian sclerites from the Late Givetian of Marzysz, samples Marzysz II/W/6 (A–G, I–J, L), Marzysz II/13 (H, M–O), and set B of Posłowice (K), Holy Cross Mountains. **A**–**L**. Side views of sclerites of *Palaeohemioedema cognata* sp. n. **A**. GIUS 4-568 Mrz./89/5. **B**. GIUS 4-568 Mrz./89/6. **C**. GIUS 4-568 Mrz./89/7. **D**. GIUS 4-568 Mrz./89/1. **E**. GIUS 4-568 Mrz./89/3. **F**. GIUS 4-568 Mrz./89/8. **G**. GIUS 4-568 Mrz./89/2. **H**. GIUS 4-584 Mrz./219/1. **I**. GIUS 4-568 Mrz./89/9. **J**. GIUS 4-568 Mrz./89/10. **K**. GIUS 4-759 Pos./1023/1. **L**. GIUS 4-568 Mrz./89/4. **M**–**O**. *Devonothyonites avis* sp. n., side views. **M**. GIUS 4-584 Mrz./215/2. **N**. GIUS 4-584 Mrz./215/3. **O**. GIUS 4-584 Mrz./215/1. Scale bar 200 μm.

tween the Palaeozoic *Palaeohemioedema* gen. n. and the living forms. The phylogenetic relationships are presented in Text-fig. 76.

Genus *Palaeohemioedema* gen. n.

Type species: *Palaeohemioedema cognata* sp. n.

Derivation of the name: From Greek: *palaios* – ancient; the second part of the name is due to similarity of the sklerotome with the extant genus *Hemioedema*.

Diagnosis. — High radial plate with a deep distal incision and lacking radial channel. Proximal processes thin and connected with each other by a thin lamella up to two-thirds of their height. Sclerites, in shape of thin, commonly elliptical plates, irregularly perforated.

Palaeohemioedema cognata sp. n.
(Text-figs 50A–L, 57I, 75E)

Holotype: GIUS 4-564 Mrz./487/4, Text-fig. 57I.

Type horizon: Late Givetian, Early *Mesotaxis falsiovalis* Zone.

Type locality: Trench II, layer W/2, Marzysz, Holy Cross Mountains.

Derivation of the name: From Latin *cognatus* – related, similar (with the modern *Hemioedema*).

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Radial plates: 1	Height	785	785	–	–
	Width	480	480	–	–
Sieve plates: 77	Length	–	200	290	715
	Number of pores	–	6	21	30
Wheels: 2	Diameter	–	130	–	–
	Number of pores	–	3	–	–

Diagnosis. — As for the genus.

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dombrowiensis horizon, set VIII of Grzegorzowice. **W**. GIUS 4-618 Grz./377/11; W_1 side view, W_2 opposite side view. **V**. GIUS 4-618 Grz./377/12. **X**–**Z**. Anal teeth of *Devonothyonites avis* sp. n. from the Late Givetian set C of Sowie Górki (X, Z) and sample Marzysz II/13 (Y). **X**. GIUS 4-747 Sow./682/2. **Y**. GIUS 4-584 Mrz./1137/3. **Z**. GIUS 4-747 Sow./682/1; Z_1 side view, Z_2 opposite side view. Scale bar 200 μm.

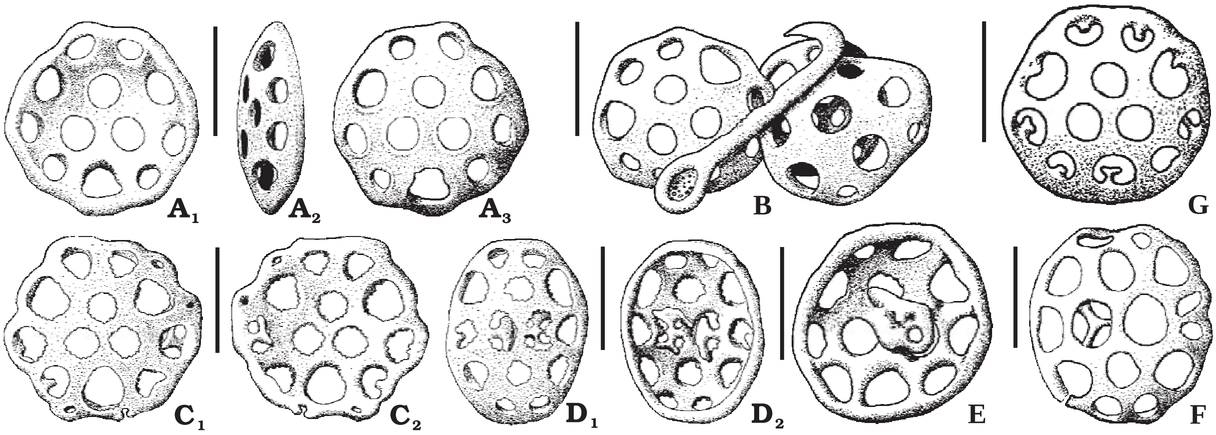


Fig. 51. Sclerites of *Mercedescaudina langeri* sp. n. from the Late Givetian of Marzysz, Holy Cross Mountains, samples Marzysz II/13 (A–D), Marzysz II/15 (E–F), and Marzysz II/W/6 (G). **A**. Holotype GIUS 4-584 Mrz./217/26; A_1 inner view, A_2 lateral view, A_3 outer view. **B**. Aggregate of different kinds of *Mercedescaudina langeri* sp. n. sclerites and *Achistrum multiperforatum* Beckmann, 1965, GIUS 4-584 Mrz./217/1. **C**. Irregular specimen with three pores in the central zone, and four additional pores in marginal ring, GIUS 4-584 Mrz./217/7; C_1 outer view, C_2 inner view. **D**. Flat specimen with four pores in the central zone and stirrups, GIUS 4-584 Mrz./217/6; D_1 outer view, D_2 inner view. **E**. Inner view of the sclerite with some irregular processes, GIUS 4-587 Mrz./860/2. **F**. Specimen with four pores in the central zone, with additional pores in marginal zone and with stirrup, GIUS 4-587 Mrz./860/1. **G**. Circular specimen with three pores in the central zone, and marginal process, GIUS 4-568 Mrz./88/10. Scale bar 200 µm.

Description. — Calcareous ring. Proximal processes of radial plates bear two ridges on the outer side, while on their outer side there are wing-like processes. Ventrally there is a distinct Y-shaped concavity (Text-fig. $57I_1$).

Plates. The sclerites of the plates have pores of various size and number; most commonly the pores are irregularly arranged, which precludes their classification into Eocaudiniinae subfam. n. Besides the elliptical forms there are also ribbons, rosettes and spindles (Text-fig. 50A–L).

Wheels. They form little, rounded, flat plates with a distinct border. Their centre is penetrated by three symmetrically and abaxially arranged pores. The spokes are flat (Text-fig. 75E).

Occurrence. — Late Givetian: trench II at Marzysz; set B of Posłowice, Holy Cross Mountains, Poland.

Subfamily **Staurocaudininae** subfam. n.

Diagnosis. — Oval sclerites with distinctly outlined central and marginal zones. At the centre there are usually three to four pores (rarely one to eight). The marginal zone is perforated by pores, arranged in a ring and delimited from the central pores by the hub. The marginal edge of the girdle and/or pore margins fringed with fine toothlets or spaghetti-like outgrowths.

Remarks. — There are two independent lineages within *Palaeocaudina* gen. n., both steming from the ancestral *Mercedescaudina* Schallreuter, 1975 (Text-figs 56, 76). One of the lineages leads to the Cucumariidae and it is among the living representatives of this group (e.g. *Staurocucumis* Ekman, 1927) where sclerites of the same type can be found.

The most primitive Devonian descendant of *Mercedescaudina* is *Staurocaudina dombrowiana* sp. n. The affinity of *Mercedescaudina* with ophiocistioids, suggested by Gilliland (1993) is apparent. There is a ventral convexity to their sclerites, and quasi-pores, as in *Rotasaccus*, which are totally absent in *Mercedescaudina*. In the evolution of this lineage the structure of the sclerites simplifies. First duplication of the marginal girdle is reduced and its indentation passes onto the lateral margins of the pores. The Jurassic *Staurocaudina mortenseni* represents a separate lineage, in which the central pores of its sclerites are framed by a cross. *Mercedescaudina langeri* sp. n. belonged to another lineage close to the earliest palaeocaudinids. Plates of the modern Synaptidae, e.g. *Leptosynapta* Verrill, 1867, *Opheodesoma* Fischer, 1907, and *Euapta* Oestergren, 1898 (cf. Cannon and Silver 1986; Cherbonnier 1951, 1953; 1955) also resemble the wheels of *Mercedescaudina*. During growth of the anchor plate there occurs a stage closely similar to typical *Staurocaudina* (Stricker 1985, 1986).

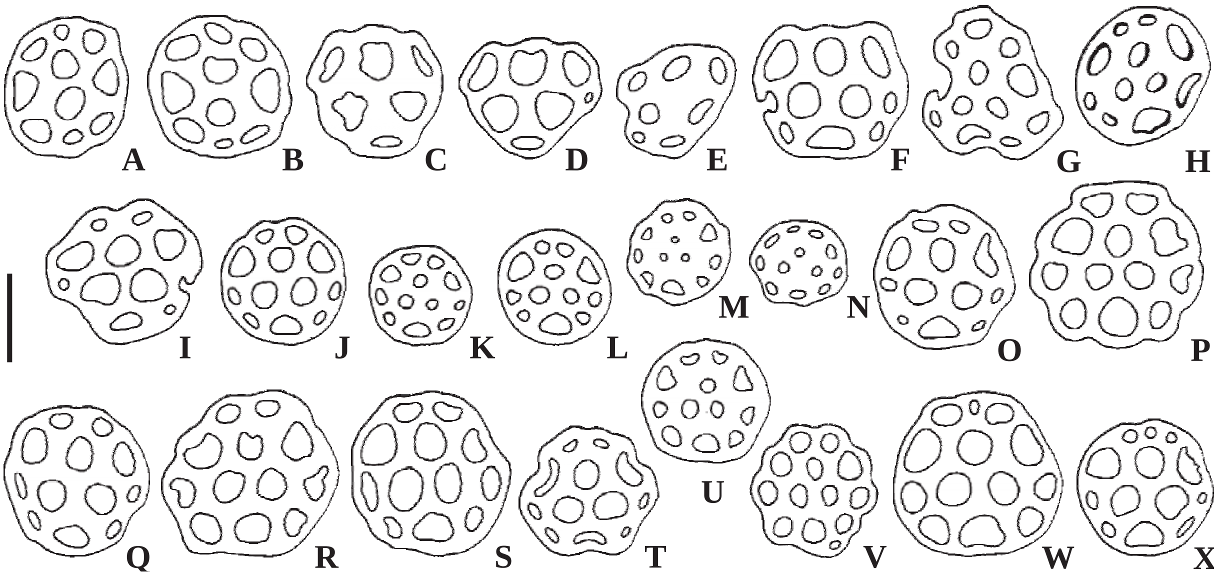


Fig. 52. Sclerites of *Mercedescaudina langeri* sp. n. from the Late Givetian of Marzysz, Holy Cross Mountains, samples Marzysz II/W/6 (A, C–E, G–J, L–M, Q, T) and Marzysz II/13 (B, F, K, N–P, R–S, U–X). Outer views. **A**. Elliptical specimen with two central and eight marginal pores (four big and four small), GIUS 4-568 Mrz./88/23. **B**. Circular specimen GIUS 4-584 Mrz./217/4. **C**. Triangular specimen GIUS 4-568 Mrz./88/22. **D**. Triangular specimen GIUS 4-568 Mrz./88/21. **E**. Irregular specimen GIUS 4-568 Mrz./88/20. **F**. GIUS 4-584 Mrz./217/5. **G**. Triangular specimen GIUS 4-568 Mrz./88/3. **H**. Circular specimen GIUS 4-568 Mrz./88/5. **I**. Irregular specimen GIUS 4-568 Mrz./88/4. **J**. Circular specimen GIUS 4-568 Mrz./88/9. **K**. GIUS 4-584 Mrz./217/19. **L**. GIUS 4-568 Mrz./88/7. **M**. GIUS 4-568 Mrz./88/11. **N**. GIUS 4-584 Mrz./217/22. **O**. GIUS 4-584 Mrz./217/18. **P**. Flat, lobate specimen GIUS 4-584 Mrz./217/16. **Q**. Flat, elliptical specimen GIUS 4-568 Mrz./88/6. **R**. GIUS 4-584 Mrz./217/15. **S**. GIUS 4-584 Mrz./217/17. **T**. Trilobate specimen GIUS 4-568 Mrz./88/8. **U**. GIUS 4-584 Mrz./217/20. **V**. GIUS 4-584 Mrz./217/24. **W**. GIUS 4-584 Mrz./217/23. **X**. GIUS 4-584 Mrz./217/21. Scale bar 200 µm.

Genera included. — *Staurocaudina* gen. n. (Boczarowski 1997b); *Mercedescaudina* Schallreuter, 1975 (Boczarowski 1997b; Schallreuter 1968, 1975).

Genus *Staurocaudina* gen. n.

Type species: *Staurocaudina canina* sp. n.

Derivation of the name: similar to the living genus *Staurocucumis*.

Diagnosis. — Sclerites typically with four central pores and fine toothlets at the pore margins.

Species included. — *Staurocaudina canina* sp. n., *Staurocaudina dombrowiana* sp. n. *Staurocaudina khadirensis* (Soodan, 1977) (Soodan 1977); *Staurocaudina mortenseni* (Deflandre-Rigaud, 1946) (Deflandre-Rigaud 1946, 1952, 1953, 1962; Frizzell and Exline 1955, 1966; non Lipiec 1992).

Staurocaudina canina sp. n.
(Pl. 18: 22–23; Text-fig. 54A–Q)

Holotype: GIUS 4-601 Psi./518/2, Text-fig. 54A.

Type horizon: Late Frasnian, *Palmatolepis rhenana* to *Palmatolepis linguiformis* Zones.

Type locality: Set G1 of Psie Górki, Kielce, Holy Cross Mountains.

Derivation of the name: From Latin *caninus* – canine, from the type locality – Psie Górki.

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Wheels: 29	Diameter	485	410	440	530
	Number of pores	14	11	19	31

Diagnosis. — Hubs with a star-like depression on their outer side. Marginal pores commonly display fine indentations.

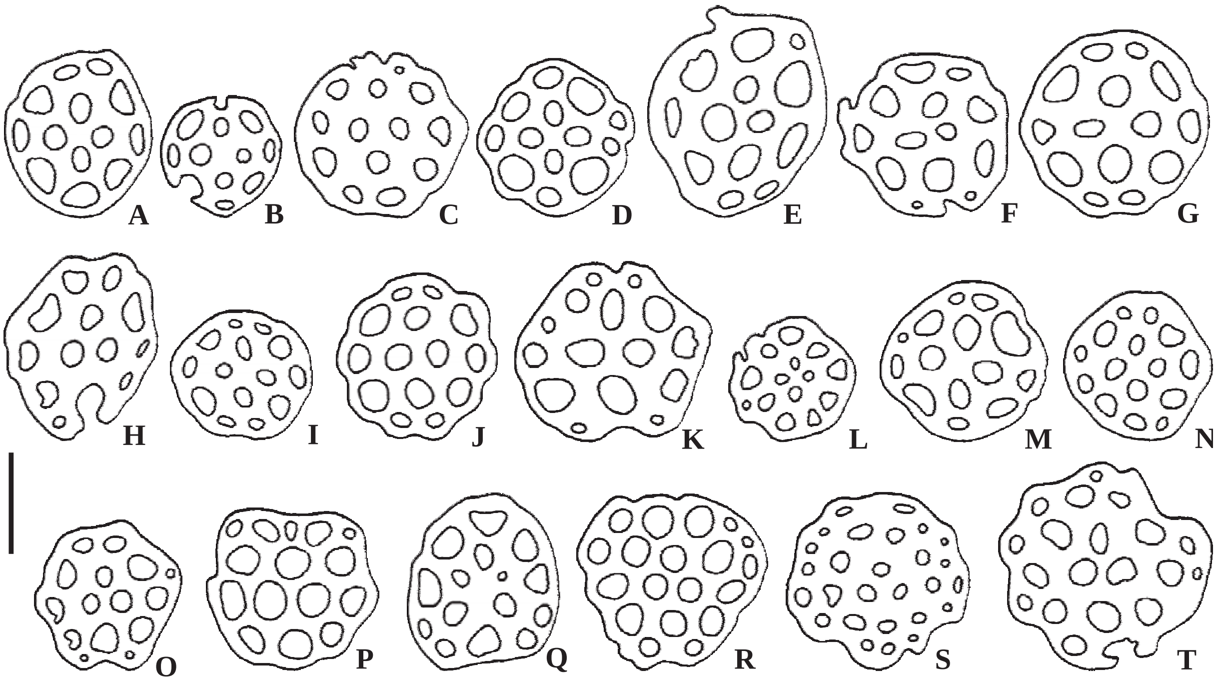


Fig. 53. Sclerites of *Mercedescaudina langeri* sp. n. from the Late Givetian of Marzysz, Holy Cross Mountains, samples Marzysz II/13 (A, D–G, J, O–P, R–S) and Marzysz II/W/6 (B–C, H–I, K–N, Q, T), outer views. **A**. Circular specimen with four central and nine big marginal pores, GIUS 4-584 Mrz./217/8. **B**. GIUS 4-568 Mrz./88/12. **C**. GIUS 4-568 Mrz./88/2. **D**. Lobate specimen GIUS 4-584 Mrz./217/12. **E**. Irregular specimen GIUS 4-584 Mrz./217/9. **F**. GIUS 4-584 Mrz./217/25. **G**. GIUS 4-584 Mrz./217/14. **H**. GIUS 4-568 Mrz./88/1. **I**. GIUS 4-568 Mrz./88/13. **J**. Lobate specimen GIUS 4-584 Mrz./217/13. **K**. GIUS 4-568 Mrz./88/18. **L**. GIUS 4-568 Mrz./88/19. **M**. GIUS 4-568 Mrz./88/15. **N**. GIUS 4-568 Mrz./88/14. **O**. Hexagonal specimen GIUS 4-584 Mrz./217/10. **P**. Flat, irregular specimen GIUS 4-584 Mrz./217/11. **Q**. GIUS 4-568 Mrz./88/17. **R**. GIUS 4-584 Mrz./217/2. **S**. GIUS 4-584 Mrz./217/28. **T**. GIUS 4-568 Mrz./88/16. Scale bar 200 μm.

Description. — Sclerites typically with four central pores which are oval, almost hexagonal or lobate in outline. However, strongly variable, with central pores ranging from three in underdeveloped specimens to eight in aberrant forms (Pl. 18: 22–23; Text-fig. 54A–Q). Additional rings can accompany the marginal pores and, as a result, indentation at the borders of marginal pores may be only weakly visible. Typically there are ten marginal pores. The marginal girdle does not form a duplication and occurs as a roll.

Remarks. — Crenulation is the main feature that distinguishes the present species from the co-occurring wheels of *Eocaudina*, although, specimens with double external rings may be difficult to tell apart. Another difference is the presence of the starlike hub.

Occurrence. — Mid–Late Frasnian: sets F, H1b of Psie Górki, Kielce, Holy Cross Mountains, Poland.

Staurocaudina dombrowiana sp. n.
(Pl. 18: 15–17; Text-fig. 55A–T)

Holotype: GIUS 4-779 Zba./358/1, Text-fig. 55O.

Type horizon: Early Eifelian, *Polygnathus partitus* Zone.

Type locality: Zbrza, Holy Cross Mountains.

Derivation of the name: From Latin *dombrowiana* – from the Dombrowa horizon.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Wheels: 42	Diameter	375	225	360	440
	Number of pores	17	10	17	20

Diagnosis. — Sclerites with doubled marginal girdle, internally serrated along their entire length when mature.

Description. — Sclerites are oval, hexagonal or irregularly rounded in outline. The typical specimens (ca. 55% of the collection) have four central and ten marginal pores. The spokes are flat. The marginal girdle is usually provided with additional fine pores (Pl. 18: 15–17; Text-fig. 55J–O, R–T). Underdeveloped specimens have two or three pores at their centre; poorly developed ones have additional large pores arranged in incomplete additional rings and can be devoid of serrated margins (Text-fig. 55A–T). Spaghetti type outgrowths may accompany the typical serration (Text-fig. 55S).

Remarks. — The species differs from all the others by its doubled and wholly serrated marginal ring.

Occurrence. — Early Eifelian: brachiopod *Chimaerothyris dombrowiensis* Zone (*Polygnathus partitus* Zone) of Zbrza; set VIII of the Grzegorzowice Beds at Grzegorzowice, Holy Cross Mountains. Equivalent of *Ch. dombrowiensis* Zone in borehole Ogrodzieniec IG2 (1269.4 m, 1119.7 m), Cracow Upland, Poland.

Genus *Mercedescaudina* Schallreuter, 1975

Type species: *Protocaudina triperforata* Schallreuter, 1968.

Species included. — *Mercedescaudina triperforata* (Schallreuter, 1968), Schallreuter (1968) but not *sensu* Mostler (1972) and Langer (1991; see Boczarowski 1997b); *Mercedescaudina mostleri* Schallreuter, 1975, Schallreuter (1975), *Mercedescaudina langeri* sp. n.

Mercedescaudina langeri sp. n.
(Pl. 18: 19–21; Text-figs 51A–G, 52A–X, 53A–T)

1980. *Eocaudina septaforminalis* Martin; Ebner and Fenninger, pp. 6–7, Taf. IV: 2.
1980. *Protocaudina hexagonaria* Martin; Ebner and Fenninger, pp. 6–7, Taf. IV: 4.
1991. *Protocaudina triperforata* Schallreuter; Langer, p. 46, Taf. 8: 1–4.

Holotype: GIUS 4-584 Mrz./217/26, Text-fig. 51A.

Type horizon: Late Givetian, Early *Mesotaxis falsiovalis* Zone.

Type locality: Trench II, layer 13 at Marzysz, Holy Cross Mountains.

Derivation of the name: From Latin *langeri* – in honour of Wolfhart Langer, the German student who first illustrated these specimens in 1991.

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Sclerites: > 100000	Diameter	360	200	355	430
	Number of pores	12	6	12	27

Diagnosis. — Shield-shaped plates usually with three pores in triangular arrangement in their centre, and with nine smaller pores in the marginal zone.

Description. — Among thousands of specimens studied about 85% show the features listed in the diagnosis. Sclerites are shield-shaped, perforate plates mostly oval or circular in shape. The arrangement of central pores is caused by geometrical construction within the limited space of a hemisphere. The pores are bordered by a delicate network with an outlined margin, typical for this type of sclerite (Text-fig. 51A). The marginal girdle forms a thickening, occasionally provided with residual spaghetti-like outgrowths (Pl. 18: 21; Text-fig. 51G); its duplication may occur.

Sclerites with abnormal development are quite common (Pl. 18: 19–21; Text-figs 51C–F, 52A–X, 53A–T); structures resulting from sediment compaction are not included. A whole assemblage has been formed of undifferentiated plates, demonstrating growth phases from specimens with two central or/and few additional pores. Some poorly developed specimens with stirrups and other additional processes may represent either individual variability or pathological phenomena (Text-fig. 51C–F).

Remarks. — Some of the sclerites have four central pores suggesting some affinity with *Palaeocaudina* gen. n. In fact *Palaeocaudina* sclerites may occasionally display three central openings. The marginal girdle of *Mercedescaudina langeri* may have fine pores, as in *Staurocaudina dombrowiana* sp. n., but such specimens are very rare (Text-fig. 51C). Occasionally this sclerites occur in enormous frequency – in some samples from Marzysz it is up to 350 thousand plates per 1 kg of rock. Among the specimens studied one aggregate of *Mercedescaudina* and *Achistrum* wheels has been found; as it lacked

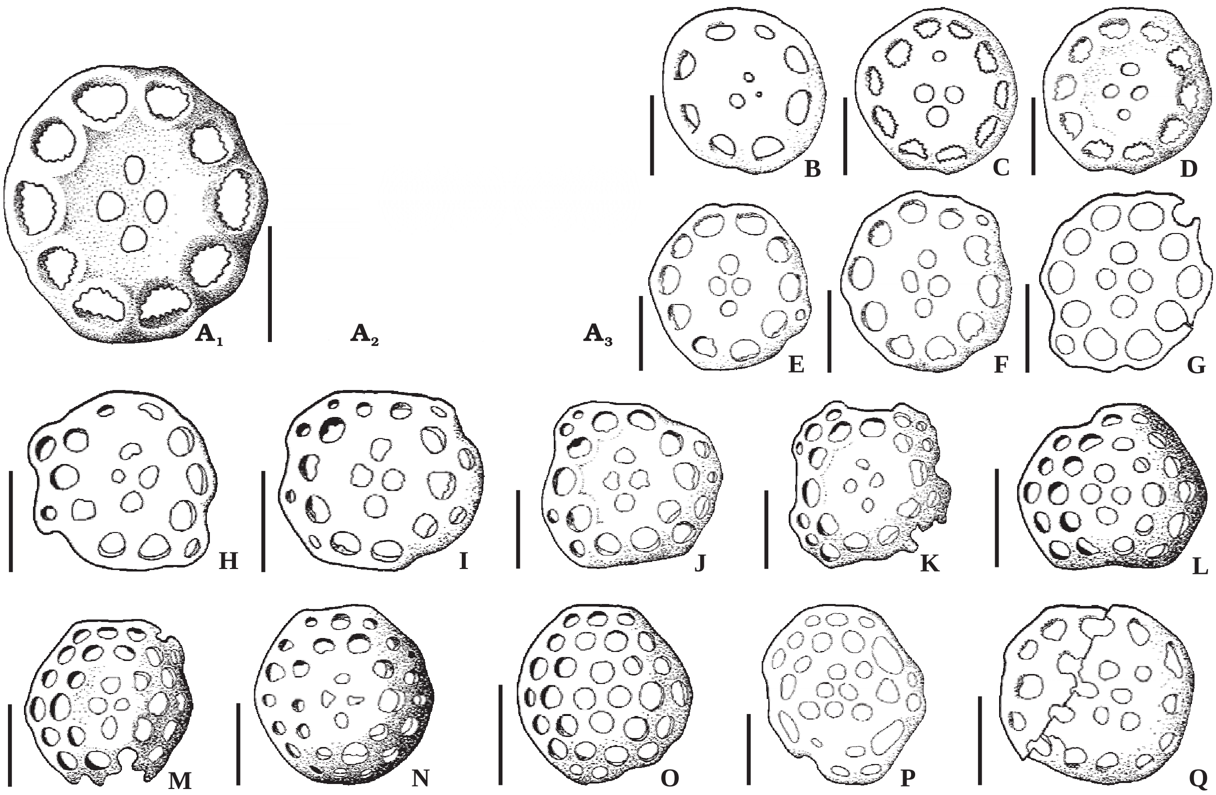


Fig. 54. Sclerites of *Staurocaudina canina* sp. n. from the Late Frasnian set G1 of Psie Górki, Holy Cross Mountains. **A**. Holotype GIUS 4-601 Psi./518/2; A_1 outer view, A_2 lateral view, A_3 inner view. **B**–**Q**. Outer views. **B**. Circular specimen with three central and eight marginal pores GIUS 4-601 Psi./537/5. **C**. GIUS 4-601 Psi./537/2. **D**. GIUS 4-601 Psi./518/1. **E**. GIUS 4-601 Psi./517/1. **F**. GIUS 4-601 Psi./517/2. **G**. GIUS 4-601 Psi./517/3. **H**. GIUS 4-601 Psi./517/4. **I**. GIUS 4-601 Psi./517/6. **J**. GIUS 4-601 Psi./517/5. **K**. GIUS 4-601 Psi./517/7. **L**. GIUS 4-601 Psi./517/8. **M**. GIUS 4-601 Psi./517/10. **N**. GIUS 4-601 Psi./517/9. **O**. GIUS 4-601 Psi./517/11. **P**. GIUS 4-601 Psi./537/1. **Q**. GIUS 4-601 Psi./537/3. Scale bar 200 µm.

the characteristic calcitic cement typical of sclerites preserved in roting body wall, the aggregate is considered accidental, of no biological value (Text-fig. 51B). Specimens of Langer (1991) are identical with the average forms from Poland.

Occurrence. — Devonian: pieces of limestones in Carboniferous molasse (Westphalian D) at Falcovec, Bulgaria. Early Givetian: Loogh Formation, Wotan Member, Wotan quarry near Üxheim; Loogh Formation, Hustley-Barley Members, Daasberg near Gerolstein, Rhenish Slate Mountains, Germany. Late Givetian: outcrop I, trench II at Marzysz; set B of Posłowice; set C of Sowie Górki; set C of Stokówka; set A of Wietrznia Ia, Kielce; set A of Wietrznia II, Kielce; set B of Czarnów; Wola Jachowa; set B of Zbrza; set A of Góra Zamkowa, Chęciny, Holy Cross Mountains, Poland.

Family **Calclamnidae** Frizzell *et* Exline, 1955 *partim*

Remarks. — The early evolution of the calclamnid lineage is only poorly known due to the scarcity of fossils in the Early Palaeozoic. The oldest sclerites of *Eocaudina* (= *Thuroholia croneisi*) are Caradoc in age. As for the younger, post-Palaeozoic forms it is not easy to distinguish the eocaudinids from the other forms: *Elgerius* Defladre-Rigaud, 1952; *Paracucumarites* Defladre-Rigaud, 1961; skeleton of larvae or perforate plates from the ophiuroid's central disc (e.g. *E. cassianensis* Frizzell *et* Exline, 1955 in Mostler and Parwin 1973; *E. acanthocaudinoides* Mostler, 1970). On the other hand *E. crassa* Mostler, 1972 or *E. subquadrata* Mostler, 1971 (cf. Mostler 1970, 1971a, 1972a) might be assigned to Calclamninae. In the Devonian, radial plates from the calcareous rings have been found. Two main lineages can be observed: the main with broad elements, the other one with narrow sclerites. Haude (1992) identified tentacles of these holothuroids, but did not find skeletal elements of the tube feet.

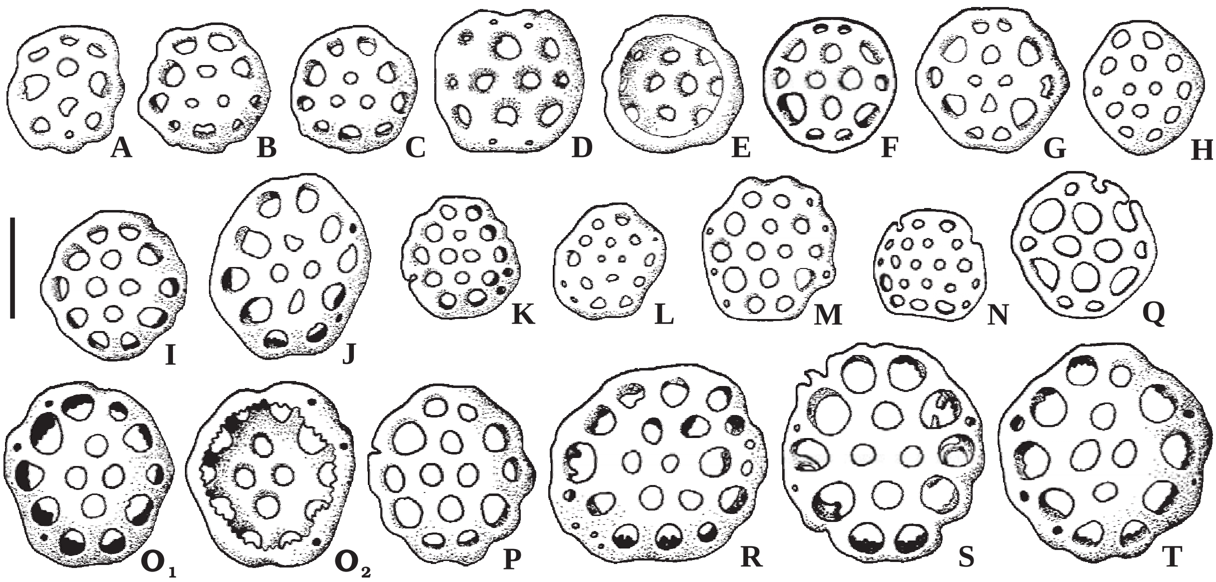


Fig. 55. Sclerites of *Staurocaudina dombrowiana* sp. n. from the earliest Eifelian *Chimaerothyris dombrowiensis* horizon, set VIII of Grzegorzowice (A–N) and Zbrza (O–T), Holy Cross Mountains. **A**. Specimen with two pores in the central zone, GIUS 4-615 Grz./372/2. **B**. Irregular specimen GIUS 4-615 Grz./372/4. **C**. Regular specimen GIUS 4-615 Grz./372/12. **D**. Flat specimen GIUS 4-615 Grz./372/14. **E**. Sclerite GIUS 4-615 Grz./372/13, inner view. **F**. Circular specimen GIUS 4-615 Grz./372/7. **G**. Hexagonal specimen GIUS 4-615 Grz./372/5. **H**. Semihexagonal specimen GIUS 4-615 Grz./372/6. **I**. GIUS 4-615 Grz./372/8. **J**. GIUS 4-615 Grz./372/3. **K**. GIUS 4-615 Grz./372/1. **L**. GIUS 4-615 Grz./372/10. **M**. GIUS 4-615 Grz./372/9. **N**. GIUS 4-615 Grz./372/11. **O**. Holotype sclerite with four pores in the central zone, three additional pores, and crenulation, GIUS 4-779 Zba./358/1; O_1 outer view, O_2 inner view. **P**. GIUS 4-779 Zba./358/2. **Q**. Flat specimen GIUS 4-779 Zba./358/3. **R**. Rounded-lobate specimen with crenulation, GIUS 4-779 Zba./358/4. **S**. Irregular-lobate specimen with stirrups and crenulation, GIUS 4-779 Zba./358/5. **T**. GIUS 4-779 Zba./358/6. Scale bar 200 μm.

Subfamily **Eocaudiniinae** subfam. n.

Diagnosis. — Sclerites in the shape of rounded or hexagonal sieve plates.

Remarks. — The Calclamninae differ from this new subfamily by having sclerites with elongate pores at their centre and by their cross-like arrangement of pores.

Genera included. — *Elgerius* Deflandre-Rigaud, 1959; *Eocaudina* Martin, 1952.

Genus *Eocaudina* Martin, 1952

Type species: *Eocaudina septaforaminalis* Martin, 1952.

Remarks. — Classification of *Eocaudina* within the holothurians should no longer be put in doubt, especially after the research done by Haude (1983, 1992), who discovered more or less complete scleritomes of these animals containing both sclerites and the elements of calcareous rings. The lack of any spaghetti-like outgrowths precludes classification of these sclerites in other groups of echinoderms. Hui Ding (1985) mistakenly identified some echinoid thecae plates (with mamelons) as species of *Eocaudina* and *Mortensenites*. Distinction of species within the genus may be problematic, as their body wall sclerites are practically identical. This is accompanied by enormous individual variability. Consequently they can be defined only in terms of sclerite assemblages, which requires numerous sclerites and elements of the calcareous rings; only the latter allow for unequivocal identification.

Eocaudina? *concentrica* Langer, 1991
(Text-fig. 66A–B)

1991. *Eocaudina concentrica* n. sp.; Langer, p. 45, Taf. 7: 6.

Holotype: Langer 1991: pl. 7: 6.

Type horizon: Early Givetian, Loogh Formation, Wotan Member.

Type locality: Wotan quarry near Üxheim, Eifel, Germany.

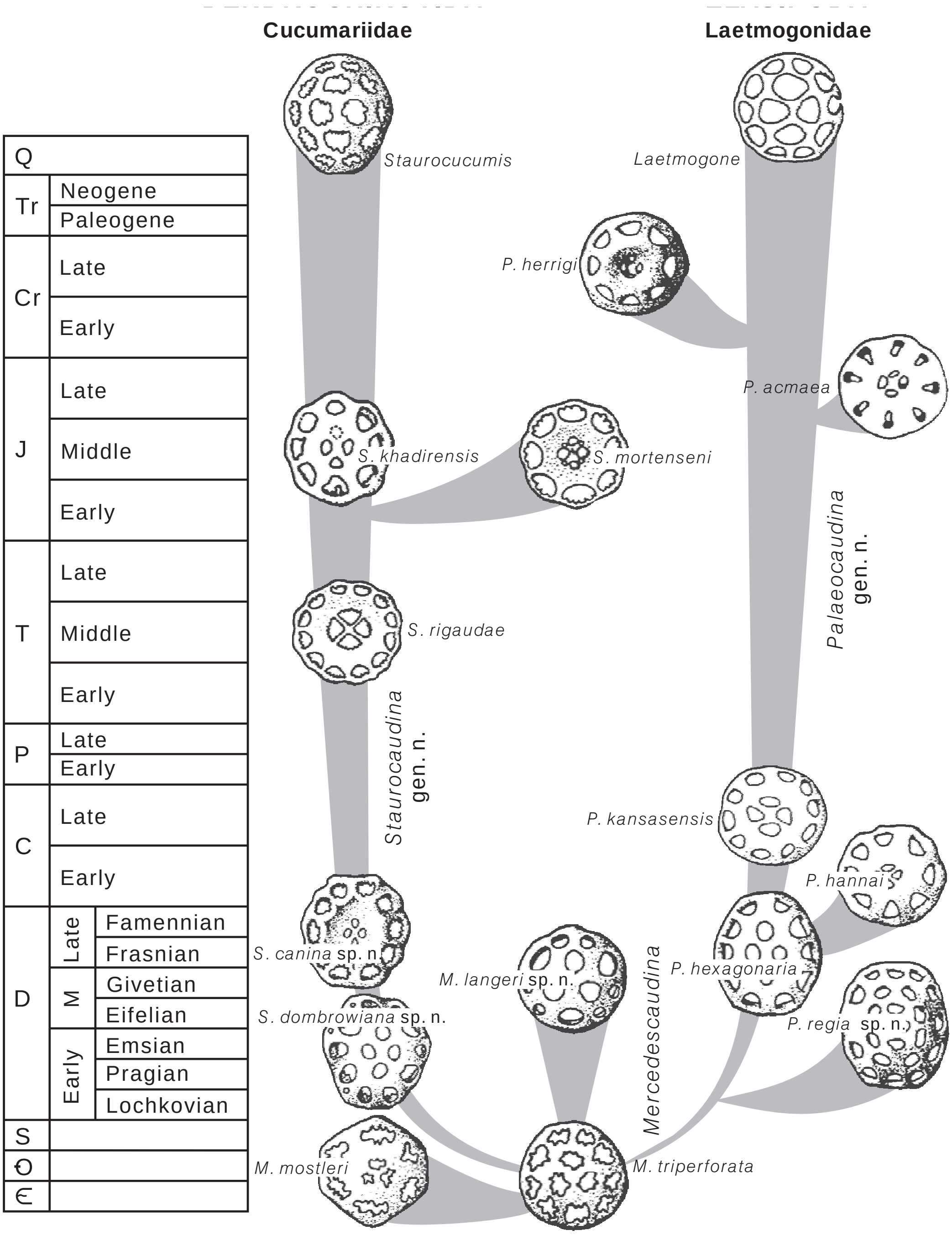


Fig. 56. Proposed phylogeny of the families Cucumariidae and Laetmogonidae (after Boczarowski 1997b). Figures of *Mercedescaudina mostleri* after Schallreuter (1975), *Mercedescaudina triperforata* after Schallreuter (1968), *Staurocaudina rigaudae* after Mostler (1970), *Staurocaudina mortenseni* after Deflandre-Rigaud (1946, 1962), *Staurocaudina khadirensis* after Soodan (1977), *Staurocucumis* after Ekman (1927), *Palaeocaudina hexagonaria* after Gutschick and Canis (1971), *Palaeocaudina hannai* after Croneis and Mc Cormack (1932), *Palaeocaudina herrigi* after Reich (1995), *Palaeocaudina kansasensis* after Hanna (1930), Frizzell and Exline (1966), *Palaeocaudina acmaea* after Matyja (1972), and *Laetmogone* after Mitsukuri (1912). Not to scale.

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)		
Number of specimens	Features	Minimum	Mean	Maximum
Sieve plates: 75	Diameter	625	940	1694
	Number of pores	80	150	170 (?)

Remarks. — Specimens from the Holy Cross Mountains. are mostly incomplete, generally they are very large. They have no spaghetti-like processes on their surfaces, but occasionally, at rod intersections, fragments of a multilayered calcitic network (like in echinoid's sclerites) occur. Their assignment to holothurioids is thus doubtful.

Occurrence. — Early Givetian: Loogh Formation, Wotan Member, Wotan quarry near Üxheim, Eifel, Rhenish Slate Mountains, Germany. Late Frasnian: set H of Kostomłoty IV, Holy Cross Mountains, Poland.

Eocaudina ovalis Matyja, Matyja, *et* Szulczewski, 1973
(Pl. 18: 1–12; Text-figs 57H, 58A–AJ, 66G–L)

1973. *Eocaudina ovalis* sp. n.; Matyja *et al*., pp. 140–141, pl. 2: 1–3, 7.

1973. *Eocaudina gornensis* sp. n.; Matyja *et al*., p. 139, pl. 1: 12, 14.

1973. *Eocaudina mccormacki* Frizzell *et* Exline; Matyja *et al*., pp. 139–140 (partim), pl. 1: 1–6, 8, 10, 21, 23 (non figs 7, 9, 16); pl. 2: 5, 16, 17.

1973. *Eocaudina marginata* (Langenheim *et* Epis); Matyja *et al*., p. 140 (partim), pl. 2: 6 (non figs 8–10, 15).

?1974. *Eocaudina gornensis* sp. n.; Garcia-Lopez and Truyols, p. 18, text-fig. 1C.

Holotype: Matyja *et al*. 1973: pl. 2: 2.

Type horizon: Mid Frasnian, set C, *Palmatolepis punctata* (Mid *P. asymmetricus* in older zonation) Zones.

Type locality: Józefka Hill, Górno, Holy Cross Mountains.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)		
Number of specimens	Features	Minimum	Mean	Maximum
Radial plates: 5	Height	860	900	1000
	Width	940	1060	1185
Sieve plates: >1500	Diameter	130	315	500
	Number of pores	4	82	100

Description. — Calcareous ring. Radial plates of the calcareous ring are X-shaped with broadly expanded distal processes. The slit between the proximal processes is broad. Symmetrically arranged processes are built differently: one of them is slightly shorter, with a deep boat-like depression on its internal side; the other one, slightly larger, has the surface of its internal blade folded. Seen from the exterior, symmetrically disposed, cuneate depressions border proximal processes from the top, and from the bottom processes of the distal part, and from the ventral side ventral lamella (at this location quite smooth and unfolded; Text-fig. 57H). The angle between adjoining plates (45–60°) suggests that the interradial elements must have been very narrow, even if only five radials were originally present. As reconstructed by Haude (1992) most probably there were ten interradials, each of them would then occupy a sector of 6–13°.

Sclerites. The sclerites represent all the growth stages. Large ones typically have fine pores (on average 90 in number). About 60% elements in the collection have an elliptical outline, remaining specimens being very variable (Pl. 18: 1–12; Text-figs 58A–AJ, 66G–L). Sclerites vary in size. Pores are disposed along lines intersecting at angle of 110°. Such a pattern allows for a dense distribution of pores over the spherical surface. *Eocaudina gornensis* is only a hexagonal variety of these sclerites, known also in other species (cf. Matyja *et al*. 1973).

Remarks. — The species differs others in this genus by its widely expanded distal processes on radial plates, wedge-shaped depressions of the exterior and broad slit between proximal processes. Sclerites are predominantly elliptical or even elongate in outline; generally small elements predominate and the pores (up to about 100 in number) are relatively densely packed.

Occurrence. — Frasnian: Portilla Formation, Cantabrian Mountains, Spain. Frasnian: uppermost part of the coral limestone in borehole Korczmin IG–1 (1932.7 m), Lublin Upland, Poland. Mid Frasnian: set C of Górno. Mid (Late?) Frasnian: Tudorów. Late Frasnian: set C, *Manticoceras* limestones of Kadzielnia; set G.1. of Psie Górki, Holy Cross Mountains, Poland.

Eocaudina patella sp. n.
(Pl. 18: 14; Text-fig. 66O–U)

Holotype: GIUS 4-747 Sow./696/2, Text-fig. 66Q.

Type horizon: Late Givetian, Early *Mesotaxis falsiovalis* Zone.

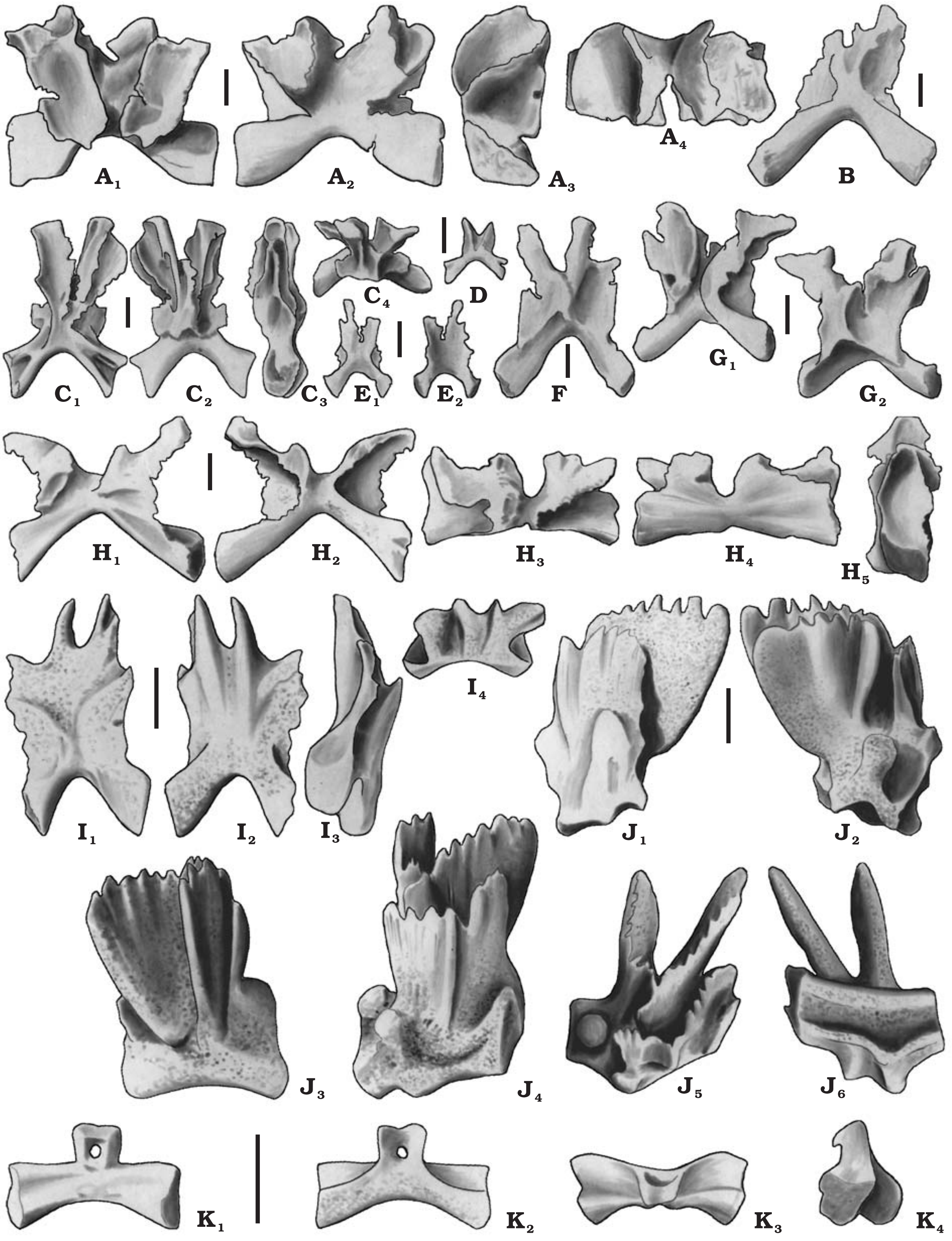


Fig. 57. Elements of calcareous rings of holothurians from the Devonian of the Holy Cross Mountains. **A**–**B**. *Eocaudina plaga* sp. n. from the earliest Eifelian *Chimaerothyris dombrowiensis* horizon, set VIII of Grzegorzowice. **A**. Holotype GIUS 4-618 Grz./376/1; A_1 inner view, A_2 outer view, A_3 lateral view, A_4 proximal view. **B**. GIUS 4-618 Grz./376/2, outer view. **C**–**G**. *Eocaudina septaforminalis* Martin, 1952 radial plates from the Late Givetian of Marzysz, samples Marzysz II/W/2 (C), Marzysz II/W/0 (D, G), Marzysz II/W/2 (E), Marzysz II/W/6 (F). **C**. GIUS 4-564 Mrz./487/1; C_1 inner view, C_2 outer view, C_3 lateral view, C_4 proximal view. **D**. Juvenile specimen GIUS 4-562 Mrz./128/2, inner view. **E**. Juvenile specimen GIUS 4-564 ➛

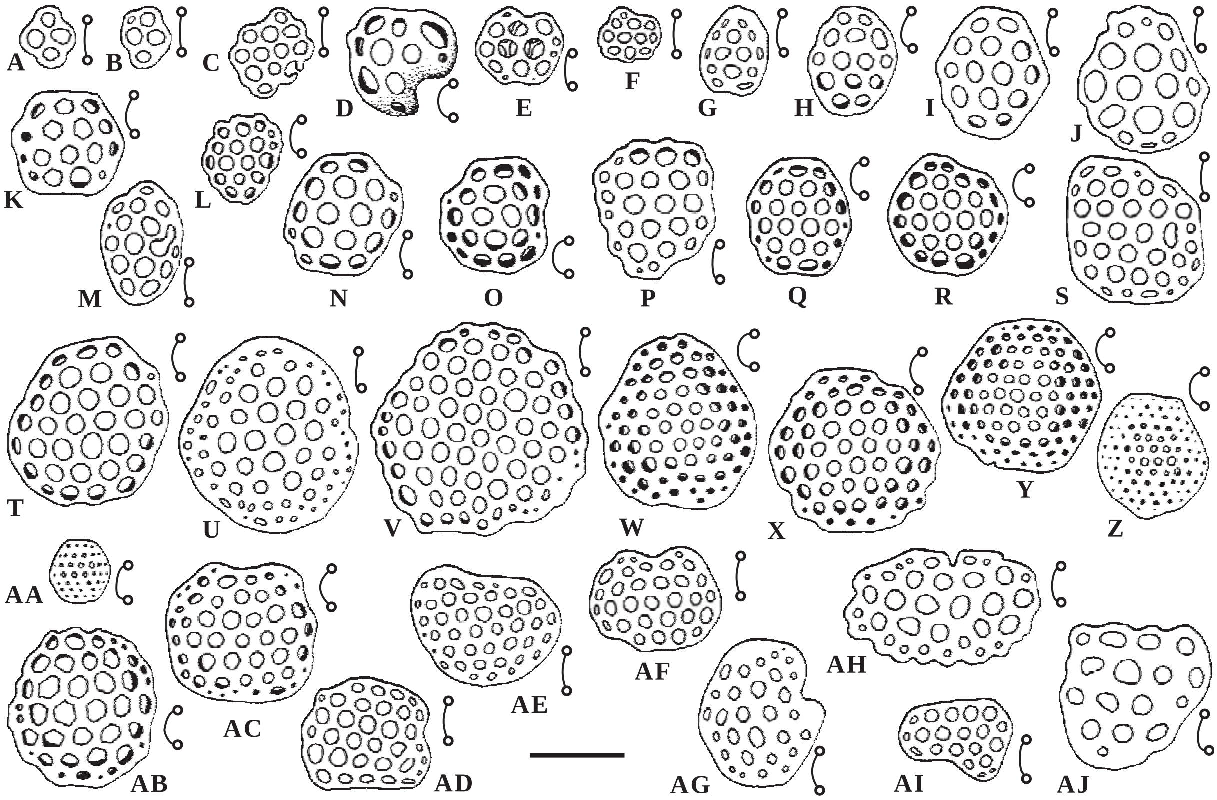


Fig. 58. Sclerites of *Eocaudina ovalis* Matyja *et al.*, 1973 from the Mid (Late?) Frasnian of Tudorów, Holy Cross Mountains, outer views. **A**. Specimen GIUS 4-791 Tud./501/3. **B**. GIUS 4-791 Tud./501/4. **C**. GIUS 4-791 Tud./501/5. **D**. GIUS 4-791 Tud./501/6. **E**. Specimen with stirrups, GIUS 4-791 Tud./501/7. **F**. GIUS 4-791 Tud./501/8. **G**. GIUS 4-791 Tud./501/9. **H**. GIUS 4-791 Tud./501/10. **I**. GIUS 4-791 Tud./501/11. **J**. GIUS 4-791 Tud./501/12. **K**. GIUS 4-791 Tud./501/13. **L**. GIUS 4-791 Tud./501/14. **M**. GIUS 4-791 Tud./501/15. **N**. GIUS 4-791 Tud./501/16. **O**. GIUS 4-791 Tud./501/17. **P**. GIUS 4-791 Tud./501/18. **Q**. GIUS 4-791 Tud./501/19. **R**. GIUS 4-791 Tud./501/20. **S**. GIUS 4-791 Tud./501/21. **T**. GIUS 4-791 Tud./501/22. **U**. GIUS 4-791 Tud./501/23. **V**. GIUS 4-791 Tud./501/24. **W**. GIUS 4-791 Tud./501/25. **X**. GIUS 4-791 Tud./501/26. **Y**. GIUS 4-791 Tud./501/27. **Z**. GIUS 4-791 Tud./501/28. **AA**. GIUS 4-791 Tud./501/29. **AB**. GIUS 4-791 Tud./501/30. **AC**. GIUS 4-791 Tud./501/31. **AD**. GIUS 4-791 Tud./501/32. **AE**. GIUS 4-791 Tud./501/33. **AF**. GIUS 4-791 Tud./501/34. **AG**. GIUS 4-791 Tud./501/35. **AH**. GIUS 4-791 Tud./501/36. **AI**. GIUS 4-791 Tud./501/37. **AJ**. GIUS 4-791 Tud./501/38. Scale bar 200 μm.

Type locality: Set C of Sowie Górki, Holy Cross Mountains.
Derivation of the name: From Latin *patella* – bowl.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Sieve plates: 45	Diameter	550	550	570	620
	Number of pores	54	36	55	62

Diagnosis. — Sclerites oval in outline, hat-shaped, with small pores in the centre.

Mrz./487/2; E_1 inner view, E_2 outer view. **F**. GIUS 4-568 Mrz./113/1, outer view. **G**. GIUS 4-562 Mrz./128/1; G_1 inner view, G_2 outer view. **H**. Radial plate of *Eocaudina ovalis* Matyja *et al.*, 1973 from the Mid (Late?) Frasnian of Tudorów, GIUS 4-790 Tud./496/1; H_1 outer view, H_2 inner view, H_3 proximal view, H_4 distal view, H_5 lateral view. **I**. Holotype radial plate GIUS 4-564 Mrz./487/4 of *Palaeohemioedema cognata* sp. n. from the Late Givetian of Marzysz II/W/2; I_1 inner view, I_2 outer view, I_3 lateral view, I_4 proximal view. **J**. Indeterminate radial plate GIUS 4-564 Mrz./1002/1 from the same sample; J_1 lateral view, J_2 opposite lateral view, J_3 outer view, J_4 inner view, J_5 proximal view, J_6 distal view. **K**. Radial plate of *Gagesiniotrochus billetti* sp. n. from the Early Givetian of outcrop III at Śniadka, GIUS 4-439 Śni./957/2; K_1 inner view, K_2 outer view, K_3 proximal view, K_4 lateral view. Scale bar 200 μm.

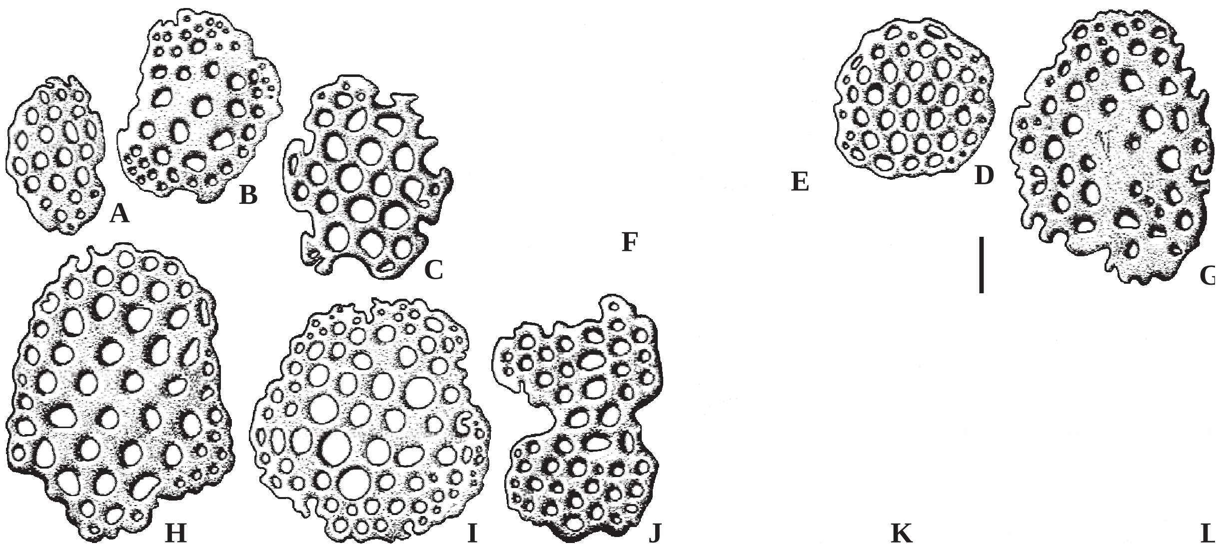


Fig. 59. Sclerites of *Eocaudina plaga* sp. n. from the earliest Eifelian *Chimaerothyris dombrowiensis* horizon, set VIII of Grzegorzowice, Holy Cross Mountains, outer views. **A**. Specimen GIUS 4-618 Grz./369/1. **B**. GIUS 4-618 Grz./369/2. **C**. GIUS 4-618 Grz./369/3. **D**. GIUS 4-618 Grz./369/4. **E**. GIUS 4-618 Grz./369/5. **F**. GIUS 4-618 Grz./369/6. **G**. GIUS 4-618 Grz./369/7. **H**. GIUS 4-618 Grz./369/8. **I**. GIUS 4-618 Grz./369/9. **J**. GIUS 4-618 Grz./369/10. **K**. GIUS 4-618 Grz./369/11. **L**. GIUS 4-618 Grz./369/12. Scale bar 200 µm.

Description. — Sclerites are oval, with uneven margins. Quite flat specimens occasionally occur (ca. 5% of the collection), possibly simply crushed elements.

Remarks. — From the other species this one differs by its hat-shaped form and oval outline. *Eocaudina croneisi* (Gutschick, 1954) from the Ordovician of Illinois, although with similar outline, is more elongate in shape (Gutschick 1954).

Occurrence. — Only known from the type locality.

Eocaudina plaga sp. n.
(Pl. 17: 1–4; Text-figs 57A–B, 59A–L)

1973. *Eocaudina mccormacki* Frizzell and Exline; Matyja *et al*., pp. 139–140 (partim), pl. 1: 9 (non pl. 1: 1–8, 10, 16, 21, 23; non pl. 2: 5, 16, 17).

Holotype: GIUS 4-618 Grz./376/1, Text-fig. 57A.

Type horizon: Early Eifelian, set VIII of the Grzegorzowice Beds, *Polygnathus partitus* Zone.

Type locality: Grzegorzowice, Holy Cross Mountains.

Derivation of the name: From Latin *plaga* – net.

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Radial plates: 3	Height	950	900	1055	1320
	Width	1170	1070	1165	1255
Sieve plates: > 1000	Length	–	560	845	1270
	Number of pores	–	23	87	w103

Diagnosis. — The sclerites completely flat and irregular in shape; pores separated by thick rods and not aligned. A radial plate with rectangular blades on the ventral side of two proximal processes with caverns occurring over almost their entire surface.

Description. — Calcareous ring. Radial plates from the calcareous ring are X-shaped with widely expanded distal processes. The slit between the proximal processes is narrow. Outgrowths, symmetrically arranged, are of a uniform structure. Depressions acting as a muscle attachment proximally display a deflection but still can be traced farther proximally. In the external wedge-shaped part, symmetrically arranged depressions occur, bordered on their upper side by the proximal processes, on their lower side by the processes of distal part, and ventrally by the inner lamella, which are quite smooth and arched (Text-fig. 57A). The angle

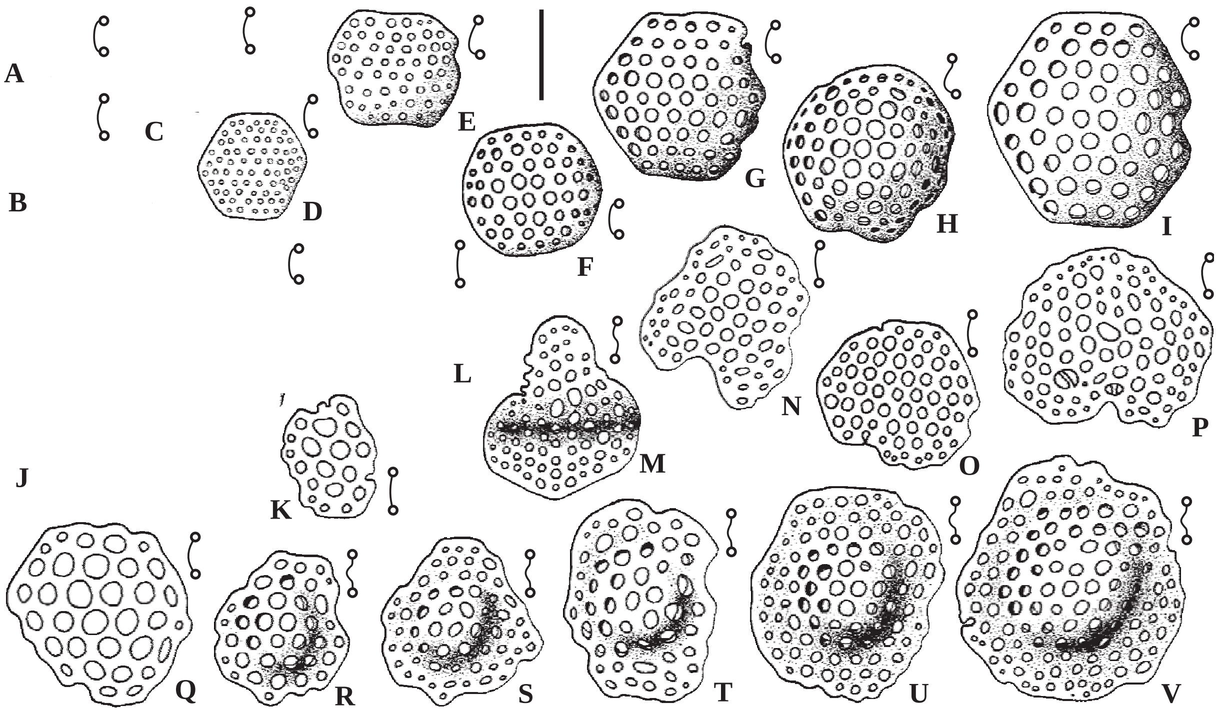


Fig. 60. Sclerites of *Eocaudina rimosa* sp. n. from the Early Givetian of outcrop III at Śniadka, Holy Cross Mountains, outer views. **A**. Specimen GIUS 4-439 Śni./960/11. **B**. GIUS 4-439 Śni./960/9. **C**. GIUS 4-439 Śni./960/6. **D**. GIUS 4-439 Śni./960/10. **E**. GIUS 4-439 Śni./960/4. **F**. GIUS 4-439 Śni./960/8. **G**. GIUS 4-439 Śni./960/7. **H**. GIUS 4-439 Śni./960/2. **I**. GIUS 4-439 Śni./960/1. **J**. GIUS 4-439 Śni./960/5. **K**. GIUS 4-439 Śni./960/14. **L**. GIUS 4-439 Śni./960/18. **M**. GIUS 4-439 Śni./960/12. **N**. GIUS 4-439 Śni./960/20. **O**. GIUS 4-439 Śni./960/21. **P**. GIUS 4-439 Śni./960/22. **Q**. GIUS 4-439 Śni./960/15. **R**. GIUS 4-439 Śni./960/16. **S–V**. Tube foot endplates (?). **S**. GIUS 4-439 Śni./960/19. **T**. GIUS 4-439 Śni./960/13. **U**. GIUS 4-439 Śni./960/17. **V**. Holotype GIUS 4-439 Śni./960/3. Scale bar 200 µm.

formed between the contacting plates (40–50°) suggests that the interradial elements must have been narrow; if the number of radials exceeded five they must have been still narrower. Each of them must have occupied angular space of 11–16°. Juvenile radial plates also have long distal processes (Text-fig. 57B).

Sclerites from the body wall. These elements represent various growth stages (Pl. 17: 1–4; Text-fig. 59A–L). Large sclerites have up to 104 pores. All the sclerites have various pores within a single plate. Fine pores occur mostly at the plate margin, and their size increases towards the plate centre.

Remarks. — This sclerites differ from those of other species by their flat blade, pore arrangement and the thickness of rods separating the pores. Also the pores are without smooth flanks. Radial plates have a unique development of proximal processes.

Occurrence. — Late Emsian: set V of the Grzegorzowice Beds at Grzegorzowice. Early Eifelian: brachiopod *Chimaerothyris dombrowiensis* Zone (*Polygnathus partitus* Zone), set VIII of the Grzegorzowice Beds at Grzegorzowice, Holy Cross Mountains, Poland.

Eocaudina rimosa sp. n.
(Text-fig. 60A–V)

Holotype: GIUS 4-439 Śni./960/3, Text-fig. 60V.
Type horizon: Early Givetian, *Polygnathus hemiansatus* Zone.
Type locality: Outcrop III at Śniadka, Holy Cross Mountains.
Derivation of the name: From Latin *rimosus* – full of slits, leaky.

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Sieve plates: > 500	Length	560	155	405	675
	Number of pores	123	18	70	123

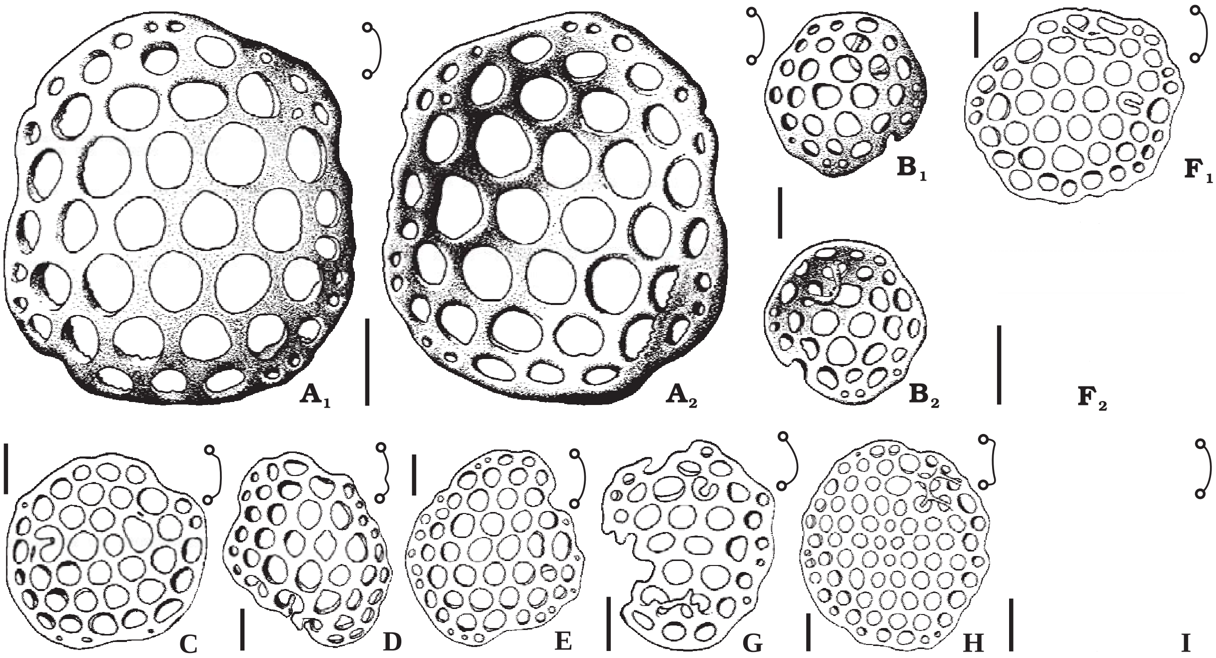


Fig. 61. Sclerites of *Eocaudina septaforminalis* Martin, 1952 from the Late Givetian of Marzysz II/13, Holy Cross Mountains. **A**. The most common morphology, specimen GIUS 4-584 Mrz./1/B-1; A_1 outer view, A_2 inner view. **B**. Specimen with stirrup, GIUS 4-584 Mrz./1/D-4; B_1 outer view, B_2 inner view. **C**. Specimen with a process in the inner zone, GIUS 4-584 Mrz./1/G-6, outer view. **D**. Specimen with a process in the marginal zone, GIUS 4-584 Mrz./1/B-2a, outer view. **E**. Specimen with the stirrup, GIUS 4-584 Mrz./1/D-3, outer view. **F**. Specimen with process and stirrup, GIUS 4-584 Mrz./1/D-1; F_1 whole specimen, F_2 details of F_1. **G**. Incomplete specimen with process and stirrup, GIUS 4-584 Mrz./1/D-7, inner view. **H**. Specimen with double stirrup, GIUS 4-584 Mrz./1/D-6, inner view. **I**. Specimen with numerous processes, GIUS 4-584 Mrz./1/D-5, outer view. Scale bar 200 μm.

Diagnosis. — Typical sclerites from the body wall of irregular outline, hat-shaped. No flat bordering of pores present.

Description. — Besides the typical hat-shaped forms (52%), hexagonal or subhexagonal shapes (32%), similar to those in other species of *Eocaudina* are represented. Remaining sclerites are irregular (16%). Perforating pores are very densely packed; there can be as many as 18–120 of them.

Remarks. — The most important diagnostic feature of this species is the lack of smooth, flat borders to the pores. Also high proportion of hat-shaped sclerites is to be noted. The closest species is *Eocaudina septaforminalis*, which differs in having flat bordering around the pores.

Occurrence. — Early Givetian: outcrop III at Śniadka, Holy Cross Mountains, Poland.

Eocaudina septaforminalis Martin, 1952 emend. Gutschick *et* Canis, 1971
(Pl. 17: 5–13; Text-figs 57C–G, 61A–I, 62A–P, 63A–P, 64A–S, 65A–R, 66M–N)

1952. *Eocaudina septaforminalis* Martin, n. sp.; Martin, pp. 728–729, text-fig. 2.

1952. *Protocaudina hexagonaria* Martin, n. sp.; Martin, p. 728, text-fig. 1.

1955. *Protocaudina hexagonaria* Martin; Frizzell and Exline, p. 137, pl. 8: 12.

1955. *Eocaudina septaforminalis* Martin; Frizzell and Exline, pp. 89–90, pl. 3: 13–14.

1965. *Eocaudina gutschicki* Frizzell *et* Exline; Beckmann, pp. 202–203, Taf. 1: 4, 5; text-figs 3–7.

1971. *Eocaudina septaforminalis* Martin; Gutschick and Canis, pp. 334–335, pls 47: 1, 4, 5, 14–20, 27; 48: 15, 16, 31–55; text-figs 1–3.

1971. *Eocaudina mccormacki* Frizzell *et* Exline; Gutschick and Canis, p. 334, pls 47: 26–28; 48: 17–30.

non 1971d. *Eocaudina septaforminalis* Martin; Mostler, p. 8, pl. 1: 8–13.

1973. *Eocaudina mccormacki* Frizzell *et* Exline; Matyja *et al*., pp. 139–140 (partim), pl. 1: 1–8, 10, 21, 23 (non fig. 9); pl. 2: 5, 16, 17.

non 1980. *Eocaudina septaforminalis* Martin; Ebner and Fenninger, pp. 6–7, Taf. IV: 2.

1991. *Eocaudina mccormacki* Frizzell *et* Exline; Langer, pp. 44–45, Taf. 7: 1, 4, 7; 8: 5.

1991. *Eocaudina* n. sp. A; Langer, p. 45, Taf. 8: 6, 7.

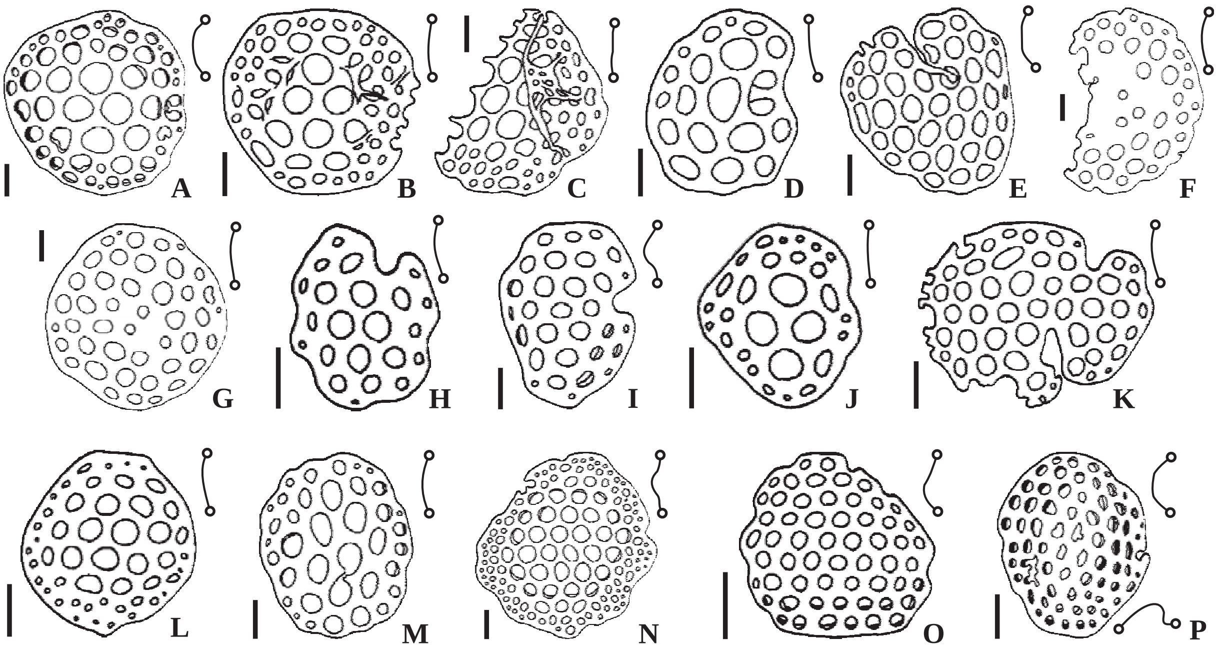


Fig. 62. Sclerites of *Eocaudina septaforminalis* Martin, 1952 from the Late Givetian of Marzysz, Holy Cross Mountains, samples Marzysz II/4 (A–D, F–G), Marzysz II/W/6 (E), and Marzysz II/13 (H–P). **A**. GIUS 4-575 Mrz./317/50. **B**. Specimen with five stirrups, GIUS 4-575 Mrz./317/51. **C**. Specimen with the additional grid, GIUS 4-575 Mrz./317/53. **D**. Specimen GIUS 4-575 Mrz./317/52. **E**. GIUS 4-568 Mrz./104/39. **F**. GIUS 4-575 Mrz./317/30. **G**. GIUS 4-575 Mrz./317/14. **H**. GIUS 4-584 Mrz./2/E-7. **I**. Irregular form GIUS 4-584 Mrz./2/F-7. **J**. GIUS 4-584 Mrz./2/G-9. **K**. GIUS 4-584 Mrz./1/G-1. **L**. GIUS 4-584 Mrz./2/G-8. **M**. GIUS 4-584 Mrz./1/G-2. **N**. GIUS 4-584 Mrz./1/F-1. **O**. GIUS 4-584 Mrz./1/A-2. **P**. Atypical distorted specimen GIUS 4-584 Mrz./1/G-3. Scale bar 200 μm.

1991. *Eocaudina* aff. *septaforminalis* Martin; Langer, p. 45, Taf. 8: 8, 9.

Neotype: UND 483, Gutschick and Canis 1971: pl. 48: 45.

Type horizon: Givetian (Taghanic stage), Solon member of the Cedar Valley Formation.

Type locality: Shellsburg quarry at Urbana Bridge, near Urbana, Iowa.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)		
Number of specimens	Features	Minimum	Mean	Maximum
Radial plates: 64	Height	370	980	1185
	Width	355	815	845
Sieve plates: >100 000	Diameter	320	660	1150
	Number of pores	19	48	126

Description. — Calcareous ring. Radial plates are very narrow and high, X-shaped (Pl. 17: 12–13; Text-fig. 57C–G). Two high proximal processes, with wedge-shaped slits served as muscle attachment platform. These processes are folded to a various degree; the slit separating the processes is narrow. On their internal side distal processes display wedge-shaped slits, which extend up to half of the process and open towards the exterior. In this direction the plates are strongly folded. The angle between adjoining plates is 45°; in this species the interradial plates must have been extremely narrow.

Sclerites. Morphological variation of the sclerites is enormous (Pl. 17: 5–11; Text-figs 61A–I, 62A–P, 63A–P, 64A–S, 65A–R, 66M–N). Circular, oval, subhexagonal, hexagonal and irregular plates can be observed. The greatest number of pores is 126 per sclerite. In some samples (Marzysz II/4, II/13) the proportion of atypical forms is high (ca. 1%). Such forms were provided, generally on their concave side, with processes, rods, stirrups of various sort, attached networks and slits (Pl. 17: 8, 9; Text-figs 61B–I, 62A–K). Among the found natural aggregates, various morphological types were recorded, until now regarded as separate species (cf. Haude 1992).

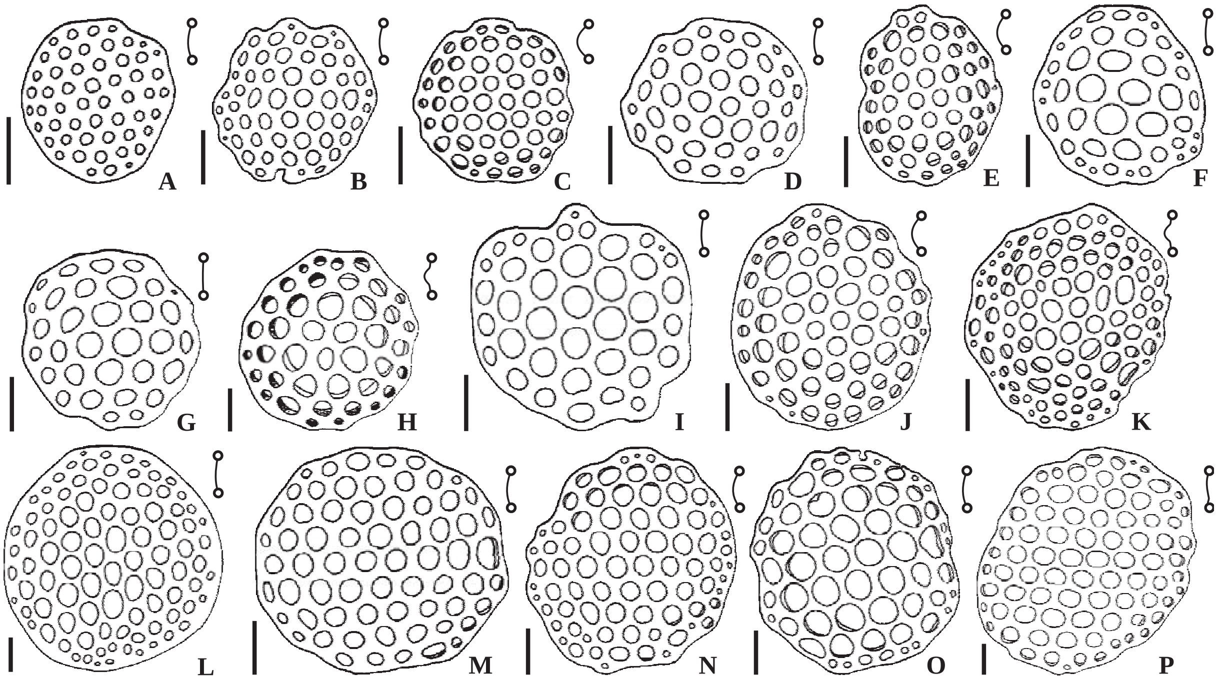


Fig. 63. Sclerites of *Eocaudina septaforminalis* Martin, 1952 from the Late Givetian of Marzysz, Holy Cross Mountains samples Marzysz II/13 (A–H, J–K, M–P), Marzysz II/4 (I), and Marzysz II/W/6 (L); outer views. **A**. GIUS 4-584 Mrz./2/A-7. **B**. GIUS 4-584 Mrz./2/A-1. **C**. GIUS 4-584 Mrz./1/E-1. **D**. GIUS 4-584 Mrz./2/A-2. **E**. GIUS 4-584 Mrz./1/B-6. **F**. GIUS 4-584 Mrz./2/A-4. **G**. GIUS 4-584 Mrz./2/A-3. **H**. GIUS 4-584 Mrz./1/A-5. **I**. GIUS 4-575 Mrz./317/43. **J**. GIUS 4-584 Mrz./1/G-7. **K**. GIUS 4-584 Mrz./1/F-7. **L**. GIUS 4-568 Mrz./99/2. **M**. GIUS 4-584 Mrz./1/F-6. **N**. GIUS 4-584 Mrz./1/B-2b. **O**. GIUS 4-584 Mrz./1/G-4. **P**. GIUS 4-584 Mrz./1/E-7. Scale bar 200 µm.

Remarks. — The slit between the proximal processes of the radials is the narrowest among all the species described so far. Well preserved specimens display a smooth border around the pores of their sclerites. Most of the growth stages could be observed, though 78% of the collection are specimens similar to the material of Gutschick *et al*. (1971), namely oval sclerites, with large pores strictly following a linear arrangement and smaller ones at the plate margin. Single isolated sclerites cannot be used to identify the species or distinguish it from *Eocaudina ovalis. Eocaudina septaforminalis* from the Carboniferous of Afghanistan (Mostler 1971d) has much larger central pores on its sclerite.

Occurrence. — Givetian (Taghanic stage): Solon Member of Cedar Valley Formation, Shellsburg quarry of Urbana Bridge, Iowa. Mid (Late?) Givetian: set B of Jaźwica, Holy Cross Mountains, Poland. Late Givetian: trench II at Marzysz; set B of Posłowice; set C of Sowie Górki; set C of Stokówka; set A of Wietrznia Ia, Kielce; set A of Wietrznia II, Kielce; set B of Czarnów; Wola Jachowa; set B of Zbrza; set A of Góra Zamkowa, Chęciny, Holy Cross Mountains, Poland. Late Givetian: *Scutellum* bed in the Massenkalk at Rothe quarry, Schladetal near Bergisch-Gladbach, Rhenish Slate Mountains, Germany.

Eocaudina? *subhexagona* Gutschick, Canis, *et* Brill, 1967
(Text-fig. 66C–F)

1967. *Eocaudina subhexagona* Gutschick, Canis *et* Brill n. sp.; Gutschick *et al*., p. 1469, pls 186: 16–21; 187: 18.
non 1968a. *Eocaudina subhexagona* Gutschick, Canis *et* Brill; Mostler, p. 55, Taf. 2: 1–4.
non 1971. *Eocaudina subhexagona* Gutschick, Canis *et* Brill; Zawidzka, p. 433, pl. I: 8–11.
1973. *Eocaudina subhexagona* Gutschick, Canis *et* Brill; Matyja *et al*., pp. 141–142 (partim), pl. 1: 22, (non figs 24–29); 2: 4.
?1980. *Eocaudina subhexagona* Gutschick, Canis *et* Brill; Ebner and Fenninger, pp. 6–7, Taf. IV: 3.

Holotype: UND 102, Gutschick *et al*. 1967: text-fig. 16.
Type horizon: Tournaisian, Lodgepole Limestone
Type locality: Not specified, Montana.

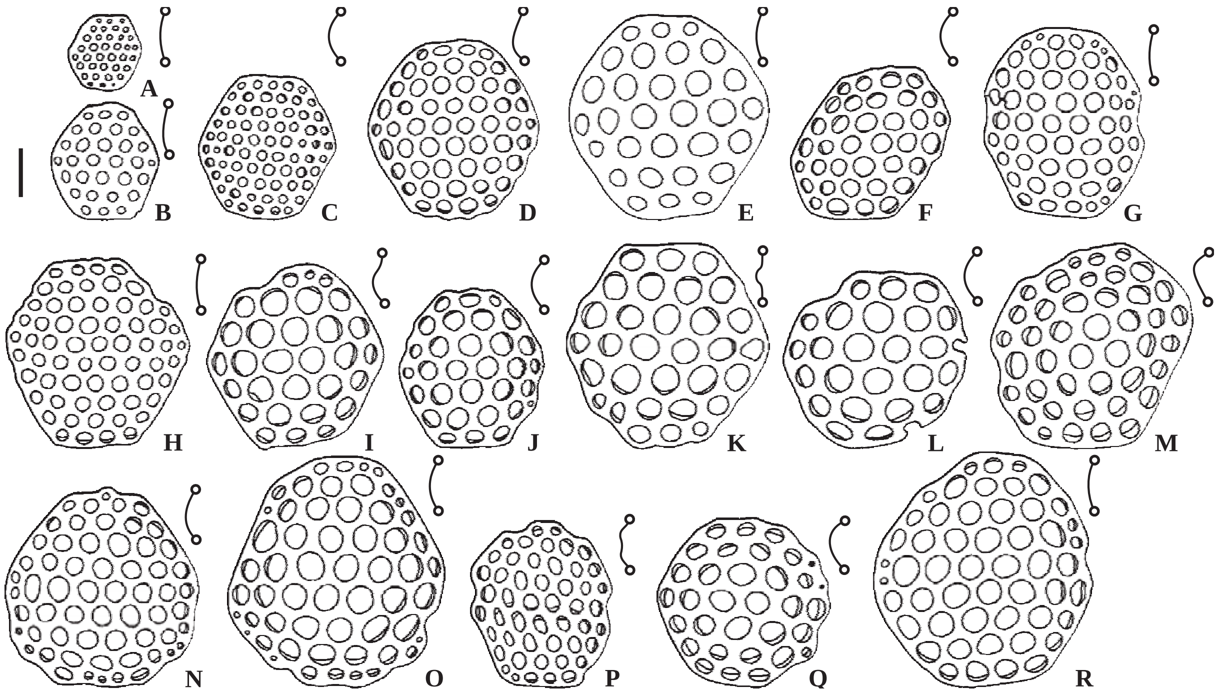


Fig. 64. Sclerites of *Eocaudina septaforminalis* Martin, 1952 from the Late Givetian of Marzysz, Holy Cross Mountains, samples Marzysz II/13 (A–D, F–S) and Marzysz II/4 (E); hexagonal form, outer views. **A**. Specimen GIUS 4-584 Mrz./2/D-1. **B**. GIUS 4-584 Mrz./2/B-4. **C**. GIUS 4-584 Mrz./1/C-6. **D**. GIUS 4-584 Mrz./1/C-1. **E**. GIUS 4-575 Mrz./317/49. **F**. GIUS 4-584 Mrz./1/C-7. **G**. GIUS 4-584 Mrz./1/F-2. **H**. GIUS 4-584 Mrz./1/C-5. **I**. GIUS 4-584 Mrz./1/C-2. **J**. GIUS 4-584 Mrz./1/C-3. **K**. GIUS 4-584 Mrz./1/C-4. **L**. GIUS 4-584 Mrz./1/A-3. **M**. GIUS 4-584 Mrz./1/A-4. **N**. GIUS 4-584 Mrz./1/D-2. **O**. GIUS 4-584 Mrz./1/B-4. **P**. GIUS 4-584 Mrz./1/B-7. **R**. GIUS 4-584 Mrz./1/E-2. **S**. GIUS 4-584 Mrz./1/A-6. Scale bar 200 µm.

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)		
Number of specimens	Features	Minimum	Mean	Maximum
Sieve plates: 56	Diameter	220	?	400 (?)
	Number of pores	10	?	30 (?)

Remarks. — Juvenile and more numerous but fragmentarily preserved mature specimens are very fragile due to the delicacy of their skeletal rods. Smaller specimens of the type series (see Gutschick *et al*. 1967) are very well preserved, but bigger fragments are mostly crushed fragments. These sclerites are possibly partially non-holothurian in origin (Pl. 7: 8–11, 13–16). In material from the Devonian of the Holy Cross Mountains stronger etching may expose multilayered structures of hexagonal pores forming aggregates linked by a few connected blades. Possibly these are the elements of the central disc of ophiuroids or of the thecal plates of echinoids (Pl. 7: 13–17). Also specimens of *Eocaudina marginata* and *Eocaudina subhexagona* (Matyja *et al*. 1973; Zawidzka 1971), and those from the Triassic of the Alps and the Tatra Mountains (Mostler 1968a, b; Zawidzka 1971) surely do not belong to the present species.

Occurrence. — Devonian?: pieces of limestones in Carboniferous molasse (Westphalian D) at Falcovec, Bulgaria. Late Frasnian: set G1 of Psie Górki, Holy Cross Mountains, Poland. Famennian *P. marginifera* Zone: borehole Chojnice 2 (3123.7–3129.9 m), Pomerania, Poland. Tournaisian: Lodgepole Limestone, Allan Mountain Limestone, Madison County, Montana; Chouteau, Missouri; Compton Limestone, Cedar County, Missouri, and Chappel Limestone, Central Texas.

Subfamily **Calclamninae** subfam. n.

Diagnosis. — Sclerites with elongate pores at their centres, in cross-like arrangement.

Remarks. — These forms evolved during the Devonian from a common stem with *Propinquoohshimella*, the latter a derivative from *Eocaudina*. After the Carboniferous they are known only from the Triassic and Jurassic. *Fissobractites* is derived rather from *Calclamna norica* than from *Calclamna permotriassica* Mostler *et*

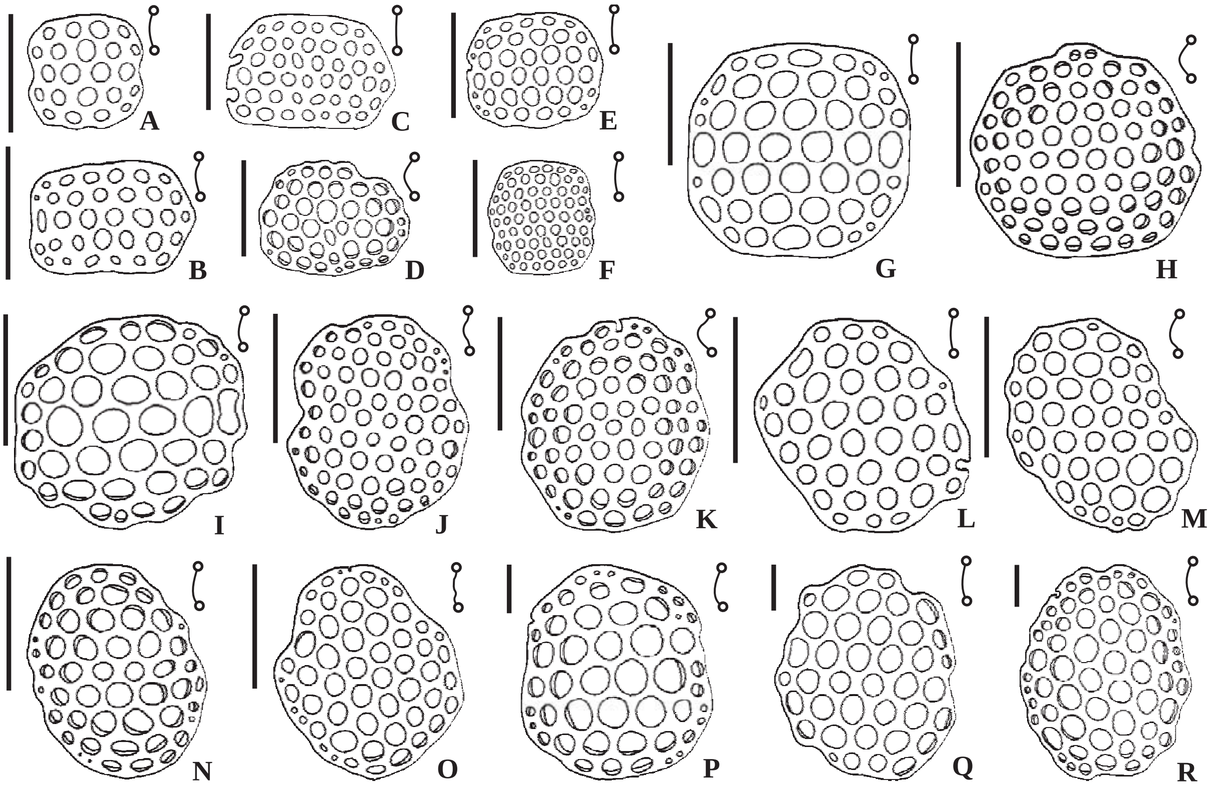


Fig. 65. Sclerites of *Eocaudina septaforminalis* Martin, 1952 from the Late Givetian of Marzysz, Holy Cross Mountains, samples Marzysz II/13 (A–F, H–R) and Marzysz II/4 (G). Transition from square form, through rectangular, to elliptical, outer views. **A**. Specimen GIUS 4-584 Mrz./2/E-2. **B**. GIUS 4-584 Mrz./2/B-3. **C**. GIUS 4-584 Mrz./2/E-1. **D**. GIUS 4-584 Mrz./1/G-5. **E**. GIUS 4-584 Mrz./2/B-2. **F**. GIUS 4-584 Mrz./1/A-1. **G**. GIUS 4-575 Mrz./317/38. **H**. GIUS 4-584 Mrz./1/B-3. **I**. GIUS 4-584 Mrz./1/F-5. **J**. GIUS 4-584 Mrz./1/B-5. **K**. GIUS 4-584 Mrz./1/A-7. **L**. GIUS 4-584 Mrz./1/E-5. **M**. GIUS 4-584 Mrz./1/E-4. **N**. GIUS 4-584 Mrz./1/E-6. **O**. GIUS 4-584 Mrz./1/F-3. **P**. GIUS 4-584 Mrz./1/B-1. **Q**. GIUS 4-584 Mrz./1/F-4. **R**. GIUS 4-584 Mrz./1/E-3. Scale bar 200 µm.

Rahimi-Yazd, 1976 (cf. Gilliland 1993; see Bartenstein 1936; Bartenstein and Brand 1937; Blake in Tate and Blake 1876; Croneis and Mc Cormack 1932; Frentzen 1964; Frizzell and Exline 1955, 1966; Issler 1908; Kozur and Mock 1972, 1974; Kristan-Tollmann 1963, 1964; Mortensen 1937; Mostler 1967, 1968a; Tandon and Saxena 1977). Proposed relationships are presented in Text-fig. 76.

Included genera. — *Calclamna* Frizzell *et* Exline, 1955; *Fissobractites* Kristan-Tollmann, 1963; *Priscocaudina* gen. n.

Genus *Priscocaudina* gen. n.

Type species: *Priscocaudina crucensis* sp. n.

Derivation of the name: From Latin *priscus* – primary, the name is after the genera *Eocaudina* and *Priscopedatus*.

Diagnosis. — Tear-shaped or polygonal pores arranged in form of a cross in the sclerite centre.

Remarks. — *Priscocaudina* differs from *Fissobractites* by development of the central pores – *Fissobractites* has elongated pores up to sclerite periphery. *Priscocaudina* has polygonal pores but *Fissobractites* has rounded pores (cf. Frizzell and Exline 1955, 1966; Kristan-Tollmann 1963, 1964; Mostler 1967, 1968a).

Species included. — *Priscocaudina crucensis* sp. n., *Priscocaudina marginata* (Langenheim *et* Epis, 1957) of Gutschick (1959), Gutschick *et al*. (1967), Langenheim and Epis (1957) but not *sensu* Ding (1985), Matyja *et al.* (1973) and Mostler (1968b); *Priscocaudina scotica* (Frizzell *et* Exline, 1955) = *Achistrum nicholsoni* Etheridge, 1881, of Croneis and McCormack (1932) and Frizzell and Exline (1955).

Priscocaudina crucensis sp. n.
(Pl. 18: 13; Text-fig. 67A–S)

Holotype: GIUS 4-791 Tud./502/17. Text-fig. 67B.

Type horizon. Mid (Late?) Frasnian, Early *Palmatolepis hassi* to Late *Palmatolepis rhenana* Zones.

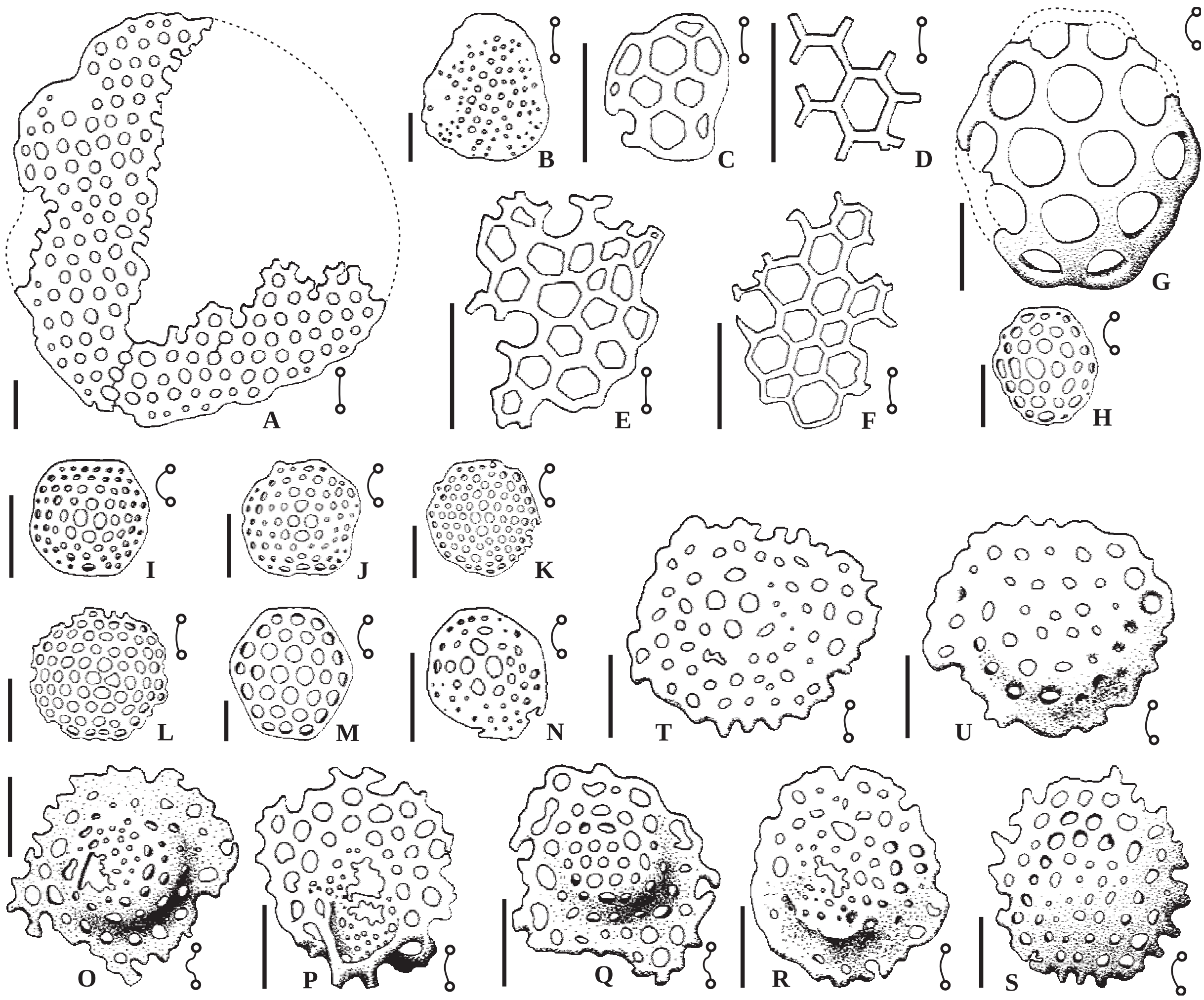


Fig. 66. Holothurian sclerites from the Devonian of the Holy Cross Mountains. **A**–**B**. *Eocaudina concentrica* Langer, 1991 from the Late Frasnian set H of Kostomłoty IV, outer views. **A**. Specimen GIUS 4-755 Kos./531/1. **B**. GIUS 4-755 Kos./531/2. **C**–**F**. ?*Eocaudina subhexagona* Gutschick, Canis *et* Brill, 1967 from the Late Frasnian set G1 of Psie Górki. **C**. Small specimen GIUS 4-601 Psi./513/4. **D**. Fragmentary sclerite GIUS 4-601 Psi./513/2. **E**. Sclerite GIUS 4-601 Psi./513/1. **F**. Sclerite GIUS 4-601 Psi./513/3. **G**–**L**. *Eocaudina ovalis* Matyja *et al.*, 1973 from the Late Frasnian set G1 of Psie Górki (G–H, J–L) and the Mid (Late?) Frasnian, Tudorów (I). **G**. GIUS 4-601 Psi./1100/1. **H**. GIUS 4-601 Psi./515/1. **I**–**L**. Tube foot endplates(?). **I**. GIUS 4-790 Tud./1119/1. **J**. GIUS 4-601 Psi./514/1. **K**. GIUS 4-601 Psi./514/2. **L**. GIUS 4-601 Psi./514/3. **M**–**N**. *Eocaudina septaforminalis* Martin, 1952. **M**. Specimen GIUS 4-607 Grn./528/1 similar to *Eocaudina gornensis* of Matyja *et al.* (1973) from the Mid Frasnian set C of Górno. **N**. Tube foot endplate(?) GIUS 4-575 Mrz./1118/1, Late Givetian of Marzysz II/4. **O**–**U**. *Eocaudina patella* sp. n. from the Late Givetian set C of Sowie Górki. **O**. GIUS 4-746 Sow./688/1. **P**. GIUS 4-747 Sow./696/1. **Q**. Holotype GIUS 4-747 Sow./696/2. **R**. GIUS 4-747 Sow./696/3. **S**. GIUS 4-747 Sow./696/4. **T**. GIUS 4-747 Sow./696/6. **U**. GIUS 4-747 Sow./696/5. Scale bar 200 µm.

Type locality: Tudorów, Holy Cross Mountains.

Derivation of the name: From Latin *crucensis* – referring to the Holy Cross Mountains, the type area and to the cross in the centre of sclerites.

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Sieve plates: 250	Length	400	210	355	400
	Number of pores	31	5	18	31

Diagnosis. — As for the genus.

Description. — Sclerites most commonly of an oval shape (84% of the collection), with a flat marginal ring. Additional pores tear-shaped, polygonal or oval in outline, arranged around the central cross; towards

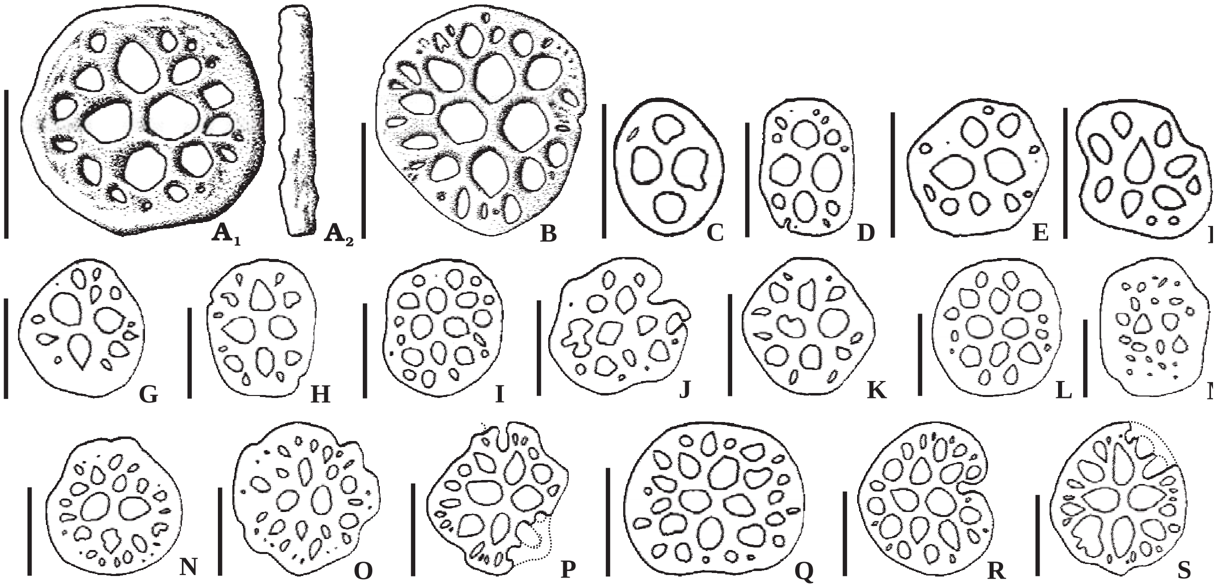


Fig. 67. Sclerites of *Priscocaudina crucensis* sp. n. from the Mid (Late?) Frasnian of Tudorów, Holy Cross Mountains. Transition from elliptical small specimens, through circular, to heart-shaped larg specimens. **A**. GIUS 4-791 Tud./502/18; A_1 side view, A_2 lateral view. **B**. Holotype GIUS 4-791 Tud./502/17. **C**. Juvenile form GIUS 4-791 Tud./502/1. **D**. GIUS 4-791 Tud./502/2. **E**. GIUS 4-791 Tud./502/3. **F**. GIUS 4-791 Tud./502/4. **G**. GIUS 4-791 Tud./502/7. **H**. GIUS 4-791 Tud./502/6. **I**. GIUS 4-791 Tud./502/5. **J**. GIUS 4-791 Tud./502/12. **K**. GIUS 4-791 Tud./502/14. **L**. GIUS 4-791 Tud./502/8. **M**. GIUS 4-791 Tud./502/9. **N**. GIUS 4-791 Tud./502/10. **O**. GIUS 4-791 Tud./502/11. **P**. GIUS 4-791 Tud./502/16. **Q**. GIUS 4-791 Tud./502/19. **R**. GIUS 4-791 Tud./502/13. **S**. GIUS 4-791 Tud./502/15. Scale bar 200 μm.

the periphery their size reduces, as is typical of the subfamily (Pl. 18: 13; Text-fig. 67A–S). Some sclerites have a slit at the periphery, making them heart-like in shape (Text-fig. 67J, R).

Remarks. — They differ from the typical sclerites of *Calclamna* by their rounded, regular shape and by heaving tear-shaped pores, whose arrangement resembles that in other species of *Priscocaudina* gen. n. in having of smaller pores located near the sclerite margin.

Occurrence. — Only known from the type locality.

Family **Phyllophoridae** Oestergren, 1907 emend. Pawson *et* Fell, 1965
Subfamily **Propinquoohshimellinae** subfam. n.

Diagnosis. — Only central pores are in a cross-like arrangement, the remainder being arranged irregularly.

Genus *Propinquoohshimella* gen. n.

Type species: *Propinquoohshimella remigia* sp. n.

Derivation of the name: From Latin *propinquus* – close, related, the name reflects the morphological similarity of the sclerites with the modern genus *Ohshimella* Heding *et* Panning, 1954.

Diagnosis. — Rods in the form of a smooth, arched blade, with both its ends paddle-shaped, flat expansions penetrated by a few pores, or bifurcating. The sclerites from the body wall are the blades pierced by a very large number of pores; the central ones are the largest and form the characteristic cross.

Remarks. — Sklerotome contains rods and sieve plates. Networks seem to be directly inherited from *Eocaudina*. As suggested by Haude (1992) *Eocaudina* also had locally perforate and irregularly branched rods in its tentacles. This indicates *Propinquoohshimella remigia* sp. n. may have evolved from this lineage. The same aggregates of sclerites can be found also in the living phyllophorids *Ohshimella* Heding *et* Panning, 1954 and also e.g. by *Pseudothyone sculponea* Cherbonnier, 1958 (cf. Cherbonnier 1958b, 1988). Proposed phylogenetic relationships are presented in Text-fig. 76.

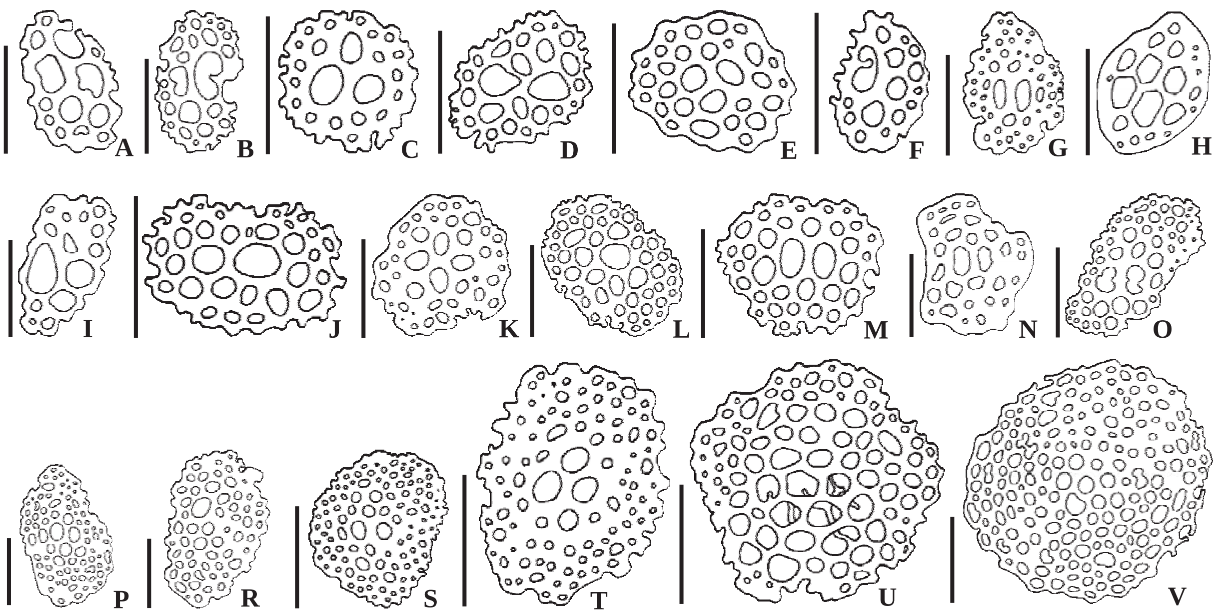


Fig. 68. Sclerites from body wall of *Propinquoohshimella remigia* sp. n. from the Early Givetian outcrop III at Śniadka, Holy Cross Mountain, side views. **A**. Specimen GIUS 4-439 Śni./957/11. **B**. GIUS 4-439 Śni./957/20. **C**. GIUS 4-439 Śni./957/16. **D**. GIUS 4-439 Śni./957/10. **E**. GIUS 4-439 Śni./957/18. **F**. GIUS 4-439 Śni./957/27. **G**. GIUS 4-439 Śni./957/23. **H**. GIUS 4-439 Śni./957/31. **I**. GIUS 4-439 Śni./957/28. **J**. GIUS 4-439 Śni./957/21. **K**. GIUS 4-439 Śni./957/25. **L**. GIUS 4-439 Śni./957/13. **M**. GIUS 4-439 Śni./957/30. **N**. GIUS 4-439 Śni./957/14. **O**. GIUS 4-439 Śni./957/26. **P**. GIUS 4-439 Śni./957/24. **R**. GIUS 4-439 Śni./957/17. **S**. GIUS 4-439 Śni./957/12. **T**. GIUS 4-439 Śni./957/29. **U**. Tube foot endplate(?) GIUS 4-439 Śni./957/19. **V**. Tube foot endplate (?) GIUS 4-439 Śni./957/15. Scale bar 200 µm.

Propinquoohshimella remigia sp. n.
(Pls 16: 16; 17: 14–16; Text-figs 68A–V, 69E–J)

Holotype: GIUS 4-439 Śni./950/1, Text-fig. 69E.

Type horizon: Early Givetian, *Polygnathus hemiansatus* Zone.

Type locality: Outcrop III, Śniadka, Holy Cross Mountains.

Derivation of the name: From Latin *remigius* – paddle.

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Rods: 113	Length	670	405	570	695
	Number of pores	11	0	8	14
Sieve plates: 1897	Diameter	–	200	270	460
	Number of pores	–	13	75	167

Diagnosis. — As for the genus.

Description. — Central pores of the sclerites from the body wall are always the largest, and they are circular, oval or polygonal in outline. The smallest pores are at the periphery of sclerites. The plates are unusually thin and fragile. The tube feet endplates are the largest sclerites and are circular in outline. Others, from the body wall are elliptically oval or irregular (Pl. 17: 14–16; Text-fig. 68A–V).

Rods from the tentacles have bars of variable length. Maximally ten pores may pierce the side bars. Bifurcation may occur in numerous planes, but the subsequent planes are gradually smaller and smaller (Pl. 16: 16; Text-fig. 69E–J).

Remarks. — Sclerites of this species do not resemble any other known form. However, the shape of processes of the radial plate is similar to *Andenothyone gondwanenesis* Haude, 1995 from the Late Devonian of Argentina (Haude 1995a, b and in press).

Occurrence. — Only known from the type locality.

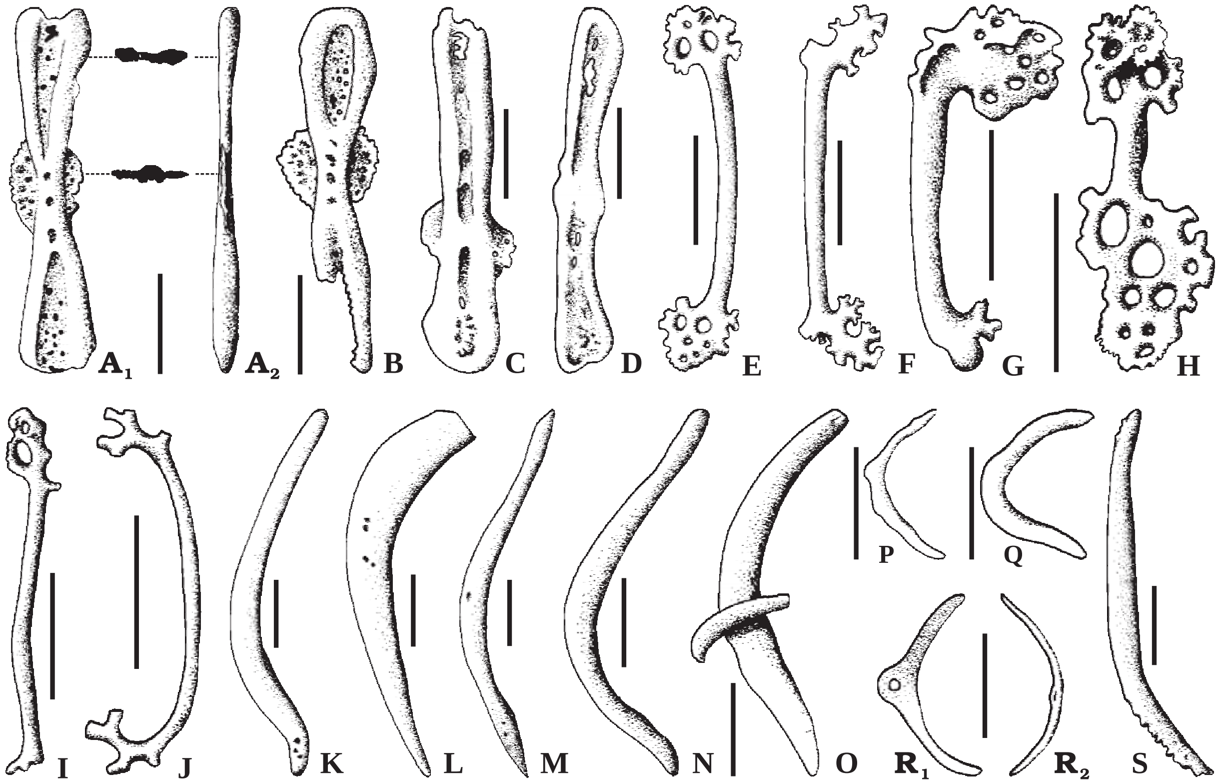


Fig. 69. Holothurian sclerites from the Devonian of the Holy Cross Mountains. **A**–**D**. *Ocellothuria binoculata* sp. n. **A**. Holotype GIUS 4-584 Mrz./221/1, Late Givetian, Marzysz II/13; A_1 side view, A_2 lateral view. **B**. GIUS 4-584 Mrz./221/2, same sample. **C**. GIUS 4-605 Las./527/1, Mid Givetian set B of Laskowa Góra. **D**. GIUS 4-605 Las./527/2, same sample. **E**–**J**. *Propinquoohshimella remigia* gen. et. sp. n. from the Early Givetian of outcrop III at Śniadka, side views. **E**. Holotype GIUS 4-439 Śni./950/1. **F**. GIUS 4-439 Śni./950/2. **G**. GIUS 4-439 Śni./950/3. **H**. GIUS 4-439 Śni./950/4. **I**. GIUS 4-439 Śni./950/5. **J**. GIUS 4-439 Śni./950/6. **K**–**S**. *Palaeocucumaria delicata* sp. n. from the Late Givetian of Marzysz, samples Marzysz II/W/6 (K–R) and Marzysz II/13 (S). **K**. GIUS 4-568 Mrz./94/1. **L**. GIUS 4-568 Mrz./94/2. **M**. Holotype GIUS 4-568 Mrz./94/3. **N**. GIUS 4-568 Mrz./94/4. **O**. GIUS 4-568 Mrz./94/5. **P**. GIUS 4-568 Mrz./94/6. **Q**. GIUS 4-568 Mrz./94/7. **R**. GIUS 4-568 Mrz./94/8;R_1 side view, R_2 lateral view. **S**. GIUS 4-584 Mrz./230/1. Scale bar 200 μm.

Order **Elasipodida** Théel, 1882

Family **Palaeocaudinidae** fam. n.

Diagnosis. — Sclerites with four central pores arranged in the shape of a cross; marginal edge of the girdle without fine toothlets or other projections.

Remarks. — Palaeocaudinidae fam. n. probably derived from *Mercedescaudina* (Text-figs 56, 76). The majority of its species belong to an lineage leading up to the extant Elasipodida. *Palaeocaudina regia* sp. n., may form a connecting link with the early *Eocaudina* as suggested by the high number of rings of marginal pores. Although *Eocaudina* had morphologically distinct tentacle sclerites, no such elements can be connected with body wall sclerites of *Palaeocaudina* gen. n. Sclerites similar to those of *Palaeocaudina* gen. n. can be found among Elasipodida in the family Laetmogonidae, e.g. *Bathygone* Pawson, 1965; *Laetmogone* Théel, 1882 or Deimatidae (cf. Ludwig 1894; Mitsukuri 1912; Pawson 1965).

Genus *Palaeocaudina* Boczarowski, 1997

Type species: *Protocaudina hexagonaria* Martin, 1952 emend. Gutschick *et* Canis, 1971.

Remarks. — The type species of *Protocaudina* Croneis, 1932, *Cheirodota* (?) *traquairii* Etheridge, 1881, is an element of an ophiocistioid sklerotome (Boczarowski 1997b). Therefore a new generic name has been proposed for holothurian sclerites earlier classified in *Protocaudina.*

Species included. — *Palaeocaudina acmaea* (Matyja, 1972) of Matyja (1972); *Palaeocaudina hannai* (Croneis, 1932) of Croneis and McCormack (1932), Deflandre-Rigaud (1952), and Frizzell and Exline

(1955); *Palaeocaudina herrigi* (Reich, 1995) of Reich (1995); *Palaeocaudina hexagonaria* (Martin, 1952 emend. Gutschick *et* Canis, 1971) of Gutschick and Canis (1971) but not *sensu* Frizzell and Exline (1955, 1966), Kozur *et al.* (1976) and Martin (1952); *Palaeocaudina kansasensis* (Hanna, 1930) of Bailey (1935), Croneis and McCormack (1932), Deflandre-Rigaud (1952), Frizzell and Exline (1955, 1966) and Hanna (1930) but not *sensu* Alexandrowicz (1971).

Palaeocaudina regia sp. n.
(Pl. 18: 18)

Holotype: GIUS 4-671 Ska./801/1, Pl. 18: 18.

Type horizon: Late Eifelian, set XVIII of the Skały Beds, Late *Tortodus kockelianus* Zone.

Type locality: Skały, Holy Cross Mountains.

Derivation of the name: From Latin *regius* – royal.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Sieve plates: 4	Diameter	325	300	330	360
	Number of pores	24	24	25	26

Diagnosis. — The sclerite pore cross is composed of two larger and two smaller alternating pores, and surrounded by two concentric rings of marginal pores.

Description. — Sclerites are almost rectangular, with rounded angles, or elliptical in outline. They are almost hemispherical. The marginal external ring with twelve, the internal one with eight pores. Pores of the neighbouring rings alternate. The marginal girdle forms an undoubled roll. flanking the sclerite.

Remarks. — Pores are not in a linear arrangement, a feature that distinguishes this species from the eocaudinids. Its structure is quite different from all the other species of the genus. Although it is in many ways transitional to *Eocaudina,* the pore cross concentric arrangement of marginal pores, and the presence of flank, are typical of *Palaeocaudina* gen. n.

Occurrence. — Late Eifelian: sets XVII, XVIII of the Skały Beds at Skały, Holy Cross Mountains, Poland.

Order **Aspidochirotida** Grube, 1840

Family **Synallactidae** Ludwig, 1894

Remarks. — Sclerites in a few other orders of Holothurioidea are close morphologically to the fossils here attributed to *Bracchiothuria* gen. n. These are to be briefly reviewed here.

Dendrochirotida. In the Cucumariidae *Abyssocucumis* Heding, 1942 and *Cucumaria* Blainville, 1834 (e.g. *Cucumaria abyssorum* Théel, 1885 and *Cucumaria albatrossi* Cherbonnier, 1941) have flat, perforated tips of the crosses and spiny processes at their centres but otherwise they are quite distinct from the fossil synallactid *Bracchiothuria* gen. n. (cf. Cherbonnier 1941a, 1947).

Elasipodida. The Psychropotidae (e.g. *Benthodytes* Théel, 1882 and *Psychropotes* Théel, 1882) have some sclerites with four-armed crosses and hook-like vertical process in the middle, however they are without perforation on the tips. *Euphronides* Théel, 1882 and *Psychropotes* Théel, 1882 have additional vertical processes in the centre and on the "feet". *Psychropotes scotiae* (Vaney, 1908) shows very similar anchor-like processes in the centre of the cross, but its sclerites have those processes covering the entire sclerite, as in *Nectothuria* Belyaev *et* Vinogradov, 1969. Representatives of the Deimatidae, e.g. *Oneirophanta* Théel, 1882 have perforated terminations of a cross but lack the vertical processes. In Elpidiidae such a perforation and the central process are both lacking. *Scotonassa* Théel, 1882 has perforated tips of the crosses but the single central process is vertical, very long and perforated on tip of its arm. *Peniagone* Théel, 1882 has a few vertical processes but not at the centre of a sclerite (cf. Belyaev and Vinogradov 1969; Billett *et al.* 1985; Ludwig 1894; Massin and Sibuet 1983; Pawson 1985).

Aspidochirotida. Sclerites of the Synallactidae *Mesothuria* Ludwig, 1894 have a spine in the cross centre and terminal perforations. *Synallactes* also has terminations perforate and a central process. The most complex form is that seen in *Paelopatides quadridens* Heding, 1940, which, at first glance, is difficult to tell

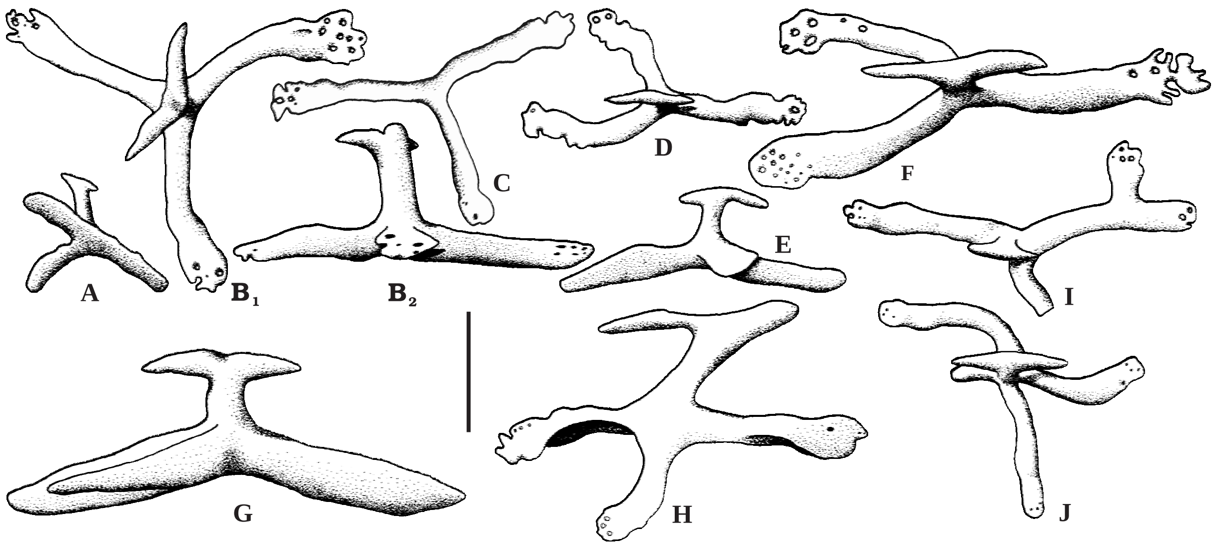


Fig. 70. Sclerites of *Bracchiothuria ancora* gen. et. sp. n. from the Late Givetian of Marzysz, Holy Cross Mountains, samples Marzysz II/W/6 (A–E), Marzysz II/13 (F–H), and Marzysz Ic/5 (I–J). **A**. GIUS 4-568 Mrz./8/5, oblique view. **B**. Holotype GIUS 4-568 Mrz./8/1; B_1 outer view, B_2 lateral view. **C**. GIUS 4-568 Mrz./8/2, inner view. **D**. GIUS 4-568 Mrz./8/3. outer view. **E**. GIUS 4-568 Mrz./8/4, lateral view. **F**. GIUS 4-584 Mrz./208/1, outer view. **G**. GIUS 4-584 Mrz./208/3, lateral view. **H**. GIUS 4-584 Mrz./208/2, lateral view. **I**. GIUS 4-561 Mrz./320/2, outer view. **J**. GIUS 4-561 Mrz./321/11, outer view. Scale bar 200 μm.

apart from the fossil material. There are three-armed sclerites with perforated tips, and anchor like process at arm intersections (cf. Cherbonnier and Féral 1976; Ludwig 1894; Sibuet 1978).

Bracchiothuria gen. n. is thus probably related to the ancestor of Synallactidae. Among the genera introduced by Mostler (1968c, 1969) only *Stichopitella* Mostler, 1969 (cf. Mostler 1969, 1972a) shows some similarities to the Synallactidae.

Genus *Bracchiothuria* gen. n.

Type species: *Bracchiothuria ancora* sp. n.

Derivation of the name: From Latin *bracchium* – arm.

Diagnosis. — Sclerites chiefly three-armed elements, with vertical processes bearing a small anchor at the point of intersection. The tips are flat and perforated.

Bracchiothuria ancora sp. n.
(Pl. 16: 21–24; Text-fig. 70A–J)

Holotype: GIUS 4-568 Mrz./8/1, Text-fig. 70B.

Type horizon: Late Givetian, Early *Mesotaxis falsiovalis* Zone.

Type locality: Trench II, layer W/6, Marzysz, Holy Cross Mountains.

Derivation of the name: From Latin *ancora* – anchor.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Crosses: 80	Length	565	270	460	745
	Height	220	80	190	215

Diagnosis. — As for the genus.

Description. — On flattened arms of the sclerite there mostly only a few pores but occasionally there may be as many as 14. The angle between the arms is variable and the anchor neck is not always perpendicular to the main body of the sclerite (Pl. 16: 21–24; Text-fig. 70A–J). Some specimens occur with four arms; in such a case always twisted. Arms of the sclerite are usually elliptical in section, what gives a somewhat flattened appearance to them.

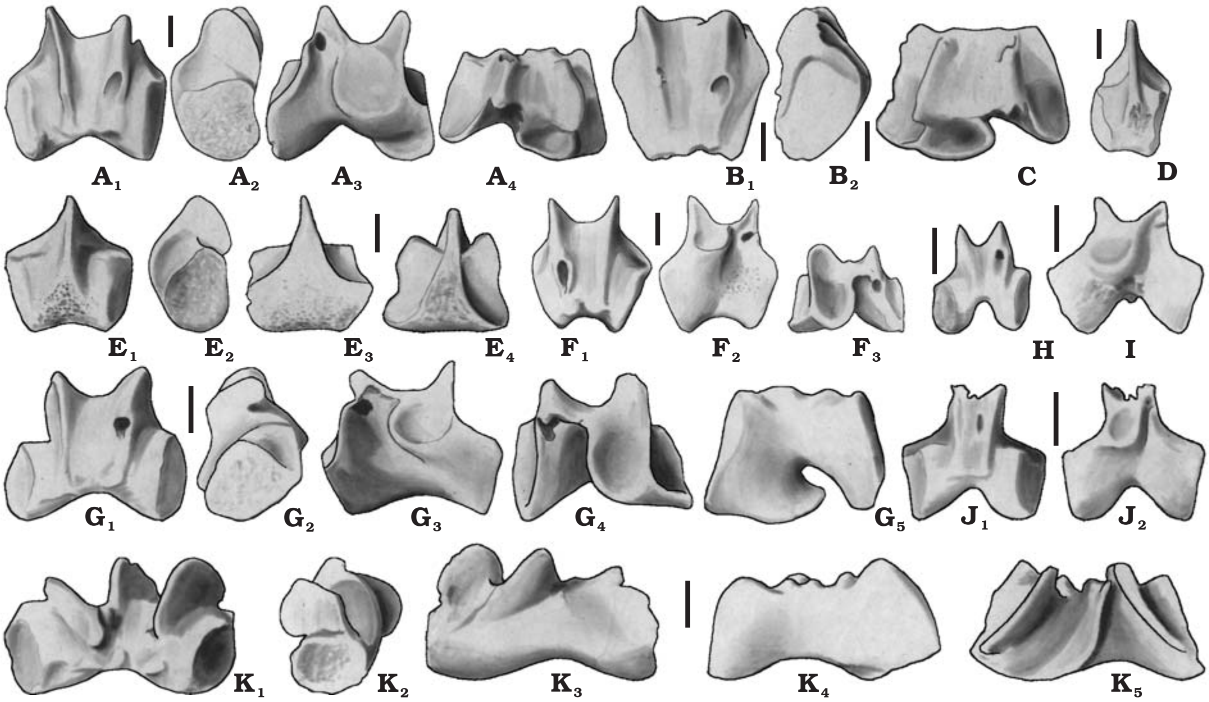


Fig. 71. Elements of the calcareous ring of *Achistrum tuto* sp. n. from the earliest Eifelian *Chimaerothyris dombrowiensis* horizon of Zbrza (A–E) and set VIII of Grzegorzowice (F–K), Holy Cross Mountains. **A**. Right radial plate GIUS 4-779 Zba./359/4; A_1 inner view, A_2 lateral view, A_3 outer view, A_4 proximal view. **B**. Narrow right radial plate GIUS 4-779 Zba./359/1; B_1 inner view, B_2 lateral view. **C**. Rright radial plate GIUS 4-779 Zba./359/5, proximal view. **D**. Interradial narrow plate GIUS 4-779 Zba./359/2, inner view. **E**. Interradial plate GIUS 4-779 Zba./359/3; E_1 inner view, E_2 lateral view, E_3 outer view, E_4 proximal view. **F**. Narrow left radial plate GIUS 4-615 Grz./427/4; F_1 inner view, F_2 outer view, F_3 proximal view. **G**. Holotype, radial plate GIUS 4-615 Grz./427/5; G_1 inner view, G_2 lateral view, G_3 outer view, G_4 proximal view, G_5 distal view. **H**. Juvenile right radial plate GIUS 4-615 Grz./427/6, inner view. **I**. Juvenile left radial plate GIUS 4-615 Grz./427/7, outer view. **J**. Juvenile right radial plate GIUS 4-615 Grz./428/8; J_1 inner view, J_2 outer view. **K**. Ventral radial plate with three anterior processes, GIUS 4-615 Grz./432/4; K_1 inner view, K_2 lateral view, K_3 outer view, K_4 distal view, K_5 proximal view. Scale bar 200 μm.

Remarks. — From the living *Paelopatides quadridens* the present species differs by lower proportion of sclerites with perforated terminations in relation to the ones without perforation; in the Devonian material the opposite proportions were observed. Also the extant forms have a slightly different shape of anchor, and, still more important, the ends of the arms are usually provided with a few spines in various orientation.

Occurrence. — Early Givetian: outcrop III at Śniadka. Late Givetian: outcrops I, II at Marzysz, Holy Cross Mountains, Poland.

Order **Apodida** Brandt, 1835

Family **Achistridae** Frizzell *et* Exline, 1955

Remarks. — Classification of the extinct Achistridae among the Apodida seems well established, being confirmed by hundreds of complete specimens (Sroka 1988) with well preserved sclerites and other anatomical details. The problem remains however, whether each of the species had only one kind of sclerite, either hooks or wheels, or perhaps wheels and hooks together. Haude (1992) was of the opinion that *Eocaudina spicata* (Gutschick, 1959) was an intermediate form between those with networks and those with hooks. The oldest specimens of this type is known from the Early Carboniferous of Indiana. Achistridae are very close to Myriotrochidae, mostly in details of their calcareous ring (cf. Belyaev 1980; Belyaev and Mironov 1978, 1981a, b; Gage and Billett 1986; Gilliland 1992a, b, 1993), but the presence of hooks make them similar also to the Chiridotidae (cf. Cherbonnier 1988; Pawson 1971).

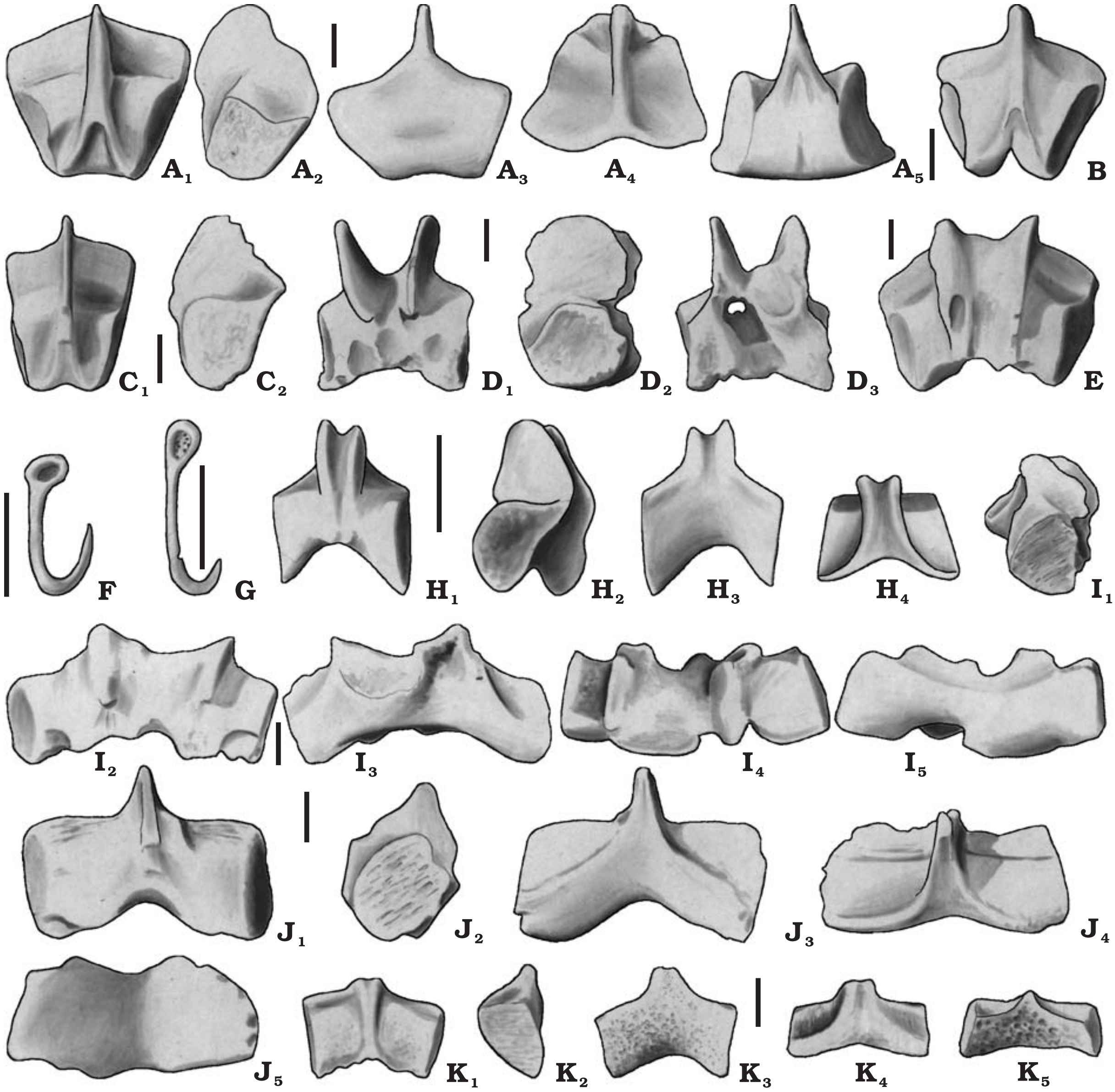


Fig. 72. Elements of the calcareous ring and body wall sclerites of *Achistrum* from the Devonian of the Holy Cross Mountains. **A**–**E**. *Achistrum tuto* sp. n. from the earliest Eifelian *Chimaerothyris dombrowiensis* horizon, set VIII of Grzegorzowice. **A**. Interradial plate GIUS 4-615 Grz./374/4; A_1 inner view, A_2 lateral view, A_3 outer-oblique view, A_4 proximal view, A_5 distal view. **B**. Juvenile interradial plate GIUS 4-615 Grz./374/6. **C**. Narrow interradial plate GIUS 4-615 Grz./374/5; C_1 inner view, C_2 lateral view. **D**. Radial wide plate with the big anterior processes, GIUS 4-615 Grz./427/9; D_1 inner view, D_2 lateral view, D_3 outer view. **E**. Wide radial plate, inner view, GIUS 4-615 Grz./427/10. **F**–**H**. *Achistrum* sp. A from the Early Givetian of outcrop III at Śniadka. **F**. Hook GIUS 4-439 Śni./951/1. **G**. Hook GIUS 4-439 Śni./951/2. **H**. Juvenile radial plate GIUS 4-439 Śni./1108/1; H_1 inner view, H_2 lateral view, H_3 outer view, H_4 proximal view. **I**–**K**. *Achistrum varicum* sp. n. from the Late Givetian set C of Sowie Górki. **I**. Holotype left radial plate GIUS 4-747 Sow./683/1; I_1 lateral view, I_2 inner view, I_3 outer view, I_4 proximal view, I_5 distal view. **J**. Interradial plate GIUS 4-747 Sow./683/2; J_1 inner view, J_2 lateral view, J_3 outer view, J_4 proximal view, J_5 distal view. **K**. Juvenile radial plate GIUS 4-747 Sow./683/3; K_1 inner view, K_2 lateral view, K_3 outer view, K_4 proximal view, K_5 distal view. Scale bar 200 μm.

The Myriotrochidae have both wheels and C-shaped rods. In the Chiridotidae particular genera have either wheels, C rods and hooks (*Taeniogyrus* Semper, 1868; *Trochodota* Ludwig, 1892), wheels and C rods (*Chiridota* Eschscholtz, 1829) or rods and hooks (*Toxodora* Verrill, 1867). The Achistridae, with hooks only and Myriotrochidae with wheels and C rods may be derived from the Chiridotidae (cf. Gilliland 1993), probably the earliest group with representatives in the Devonian (or possibly earlier).

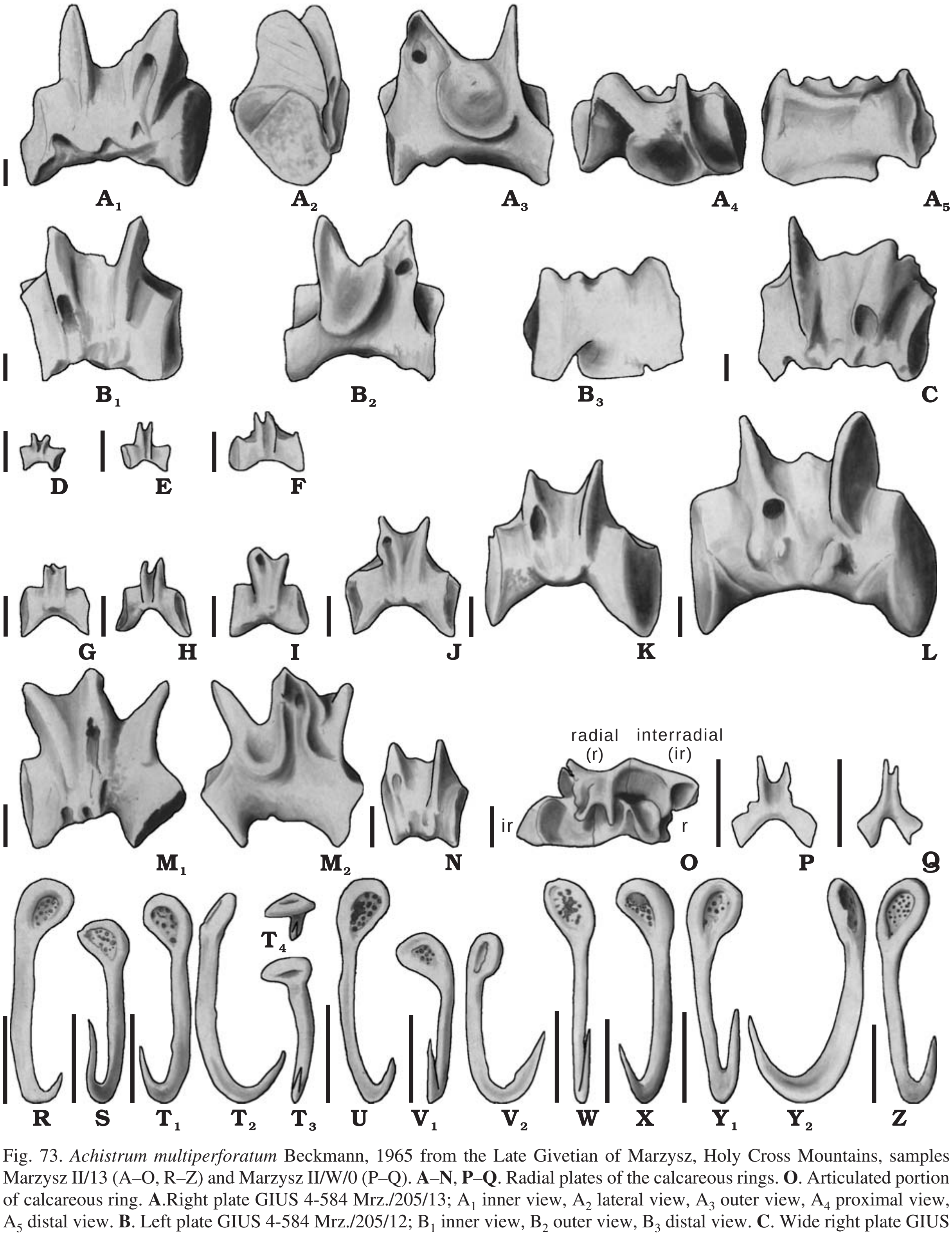


Fig. 73. *Achistrum multiperforatum* Beckmann, 1965 from the Late Givetian of Marzysz, Holy Cross Mountains, samples Marzysz II/13 (A–O, R–Z) and Marzysz II/W/0 (P–Q). **A**–**N**, **P**–**Q**. Radial plates of the calcareous rings. **O**. Articulated portion of calcareous ring. **A**.Right plate GIUS 4-584 Mrz./205/13; A_1 inner view, A_2 lateral view, A_3 outer view, A_4 proximal view, A_5 distal view. **B**. Left plate GIUS 4-584 Mrz./205/12; B_1 inner view, B_2 outer view, B_3 distal view. **C**. Wide right plate GIUS 4-584 Mrz./205/23, inner view. **D**–**L**. Ontogenetic series of left radial plates, inner views. **D**. GIUS 4-584 Mrz./205/3. **E**. GIUS 4-584 Mrz./205/4. **F**. GIUS 4-584 Mrz./205/5. **G**. GIUS 4-584 Mrz./205/6. **H**. GIUS 4-584 Mrz./205/7. **I**. GIUS 4-584 Mrz./205/8. **J**. GIUS 4-584 Mrz./205/9. **K**. GIUS 4-584 Mrz./205/10. **L**. GIUS 4-584 Mrz./205/1. **M**. Ventral radial plate with three anterior processes, GIUS 4-584 Mrz./205/11; M_1 inner view, M_2 outer view. **N**. Narrow, left radial plate GIUS 4-584 Mrz./205/2, inner view. **O**. GIUS 4-584 Mrz./206/1. **P**. Juvenile plate GIUS 4-562 Mrz./129/1, outer view. **Q**. Juvenile plate GIUS 4-562 Mrz./129/2, inner view. **R**–**Z**. Hooks from body wall. **R**. GIUS 4-584 Mrz./214/1. **S**. GIUS 4-584 Mrz./214/2. **T**. GIUS 4-584 Mrz./214/3. **U**. GIUS 4-584 Mrz./214/4. **V**. GIUS 4-584 Mrz./214/5. **W**. GIUS 4-584 Mrz./214/6. **X**. GIUS 4-584 Mrz./214/7. **Y**. GIUS 4-584 Mrz./214/8. **Z**. GIUS 4-584 Mrz./214/9. Scale bar 200 μm.

Becker and Weigelt (1975) in their paper on ophiuroids described and illustrated for the first time the calcareous ring elements of a holothurioid from the Devonian of Germany. The radial element of *Achistrum* illustrated by Haude (1983) is very similar to some plates from the Holy Cross Mountains. In 1993 Prokop published photographs of the calcareous ring elements from the Early Devonian (Pragian – Lodenice limestone, "Červeny lom", Prague-Klukowice, Bohemia). Prokop's radial element has three prominent proximal processes, more or less of the same height. On the inner side at the basis of each arm there occurs a knob. This is in good agreement with the reconstruction, given in this paper, prepared on the basis of partially articulated calcareous rings (Text-fig. 74). The Bohemian species is the oldest member of the *Achistrum* lineage. Younger species show a trend toward reduction of the central proximal process or its fusion with one or two lateral processes (Text-figs 71, 72, 73A–O). Haude (1995a) illustrated the calcareous ring of a holothurian from the Givetian of the Rhenish Slate Mountains which had the radials and interradials similar in general appearance to *Achistrum* but with another type of symmetry and another arrangement of elements within the ring (*Nudicorona seilacheri* Haude, 1995; Haude 1995a, in press). The ventral radial plate in this holothurian has only two proximal processes, and the channel penetrates directly through the right process. The arrangement of pores is asymmetrical. Numerous groups of holothurians have a similar plan of plates of the calcareous ring.

Genus *Achistrum* Etheridge, 1881

Type species: *Achistrum nicholsoni* Etheridge, 1881.

Remarks. — Reconstructed calcareous ring of *Achistrum* (Text-fig. 74M) is based on the data of H.L. Clark (1907), Cuénot (1966), Gage and Billett (1986), Hyman (1955), and Pawson (1982).

Achistrum multiperforatum Beckmann, 1965
(Pl. 19: 4–18; Text-figs 73A–Z, 74A–F, I, J)

1965. *Achistrum* (*Porachistrum*) *multiperforatum* n. sp.; Beckmann, pp. 204–205, Taf. 1: 6–8; text-figs 8–10.
1991. *Achistrum* (*Porachistrum*) cf. *multiperforatum* Beckmann; Langer, p. 44, Taf. 7: 5.

Holotype: Nr 10 (De 58), Beckmann 1965: text-fig. 9.

Type horizon: Givetian, *Scutellum* bed in the Massenkalk.

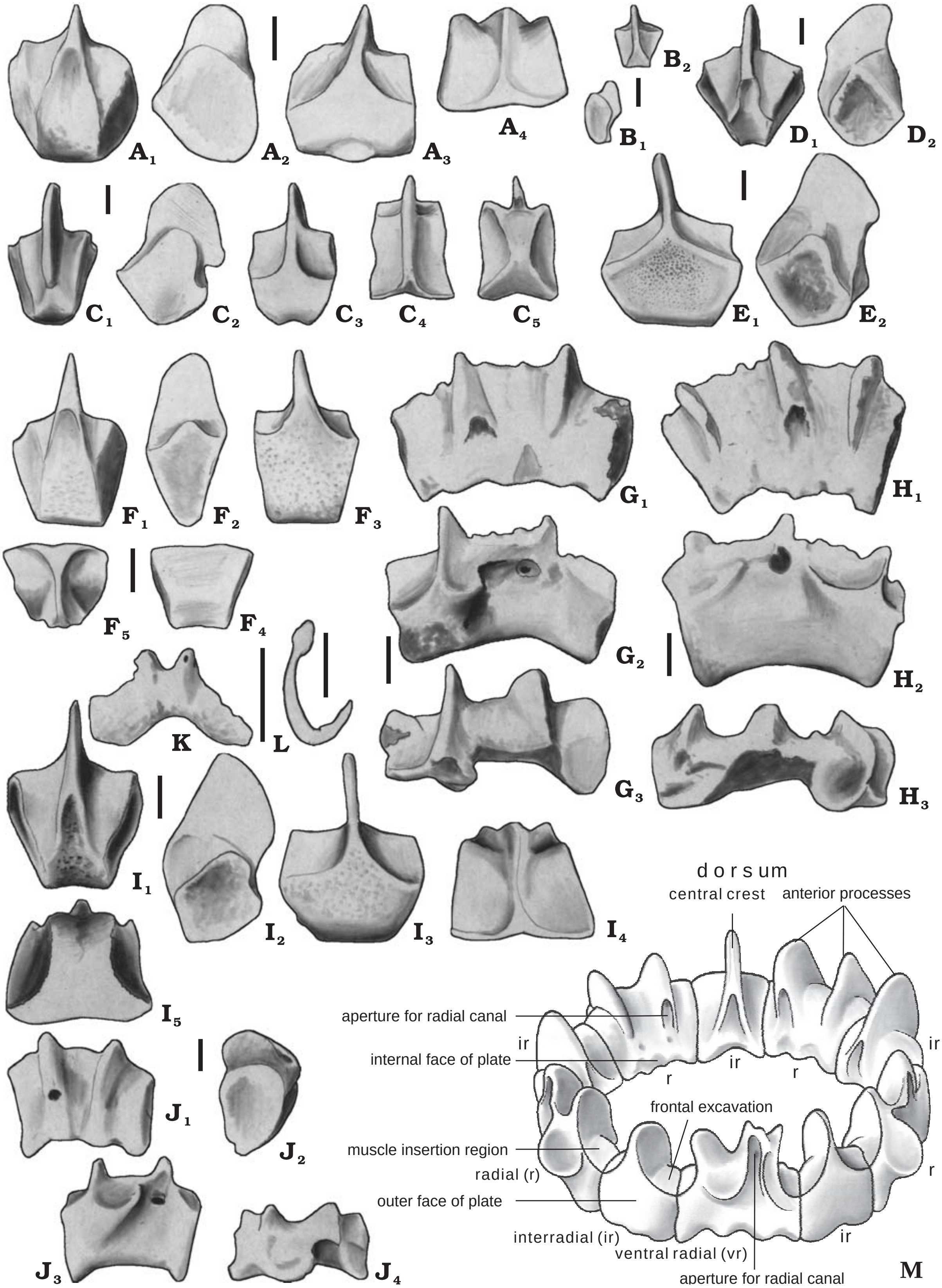
Type locality: Rothe quarry, Schladetal near Bergisch-Gladbach, Rhenish Slate Mountains, Germany.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)		
Number of specimens	Features	Minimum	Mean	Maximum
Radial plates: > 500	Height	180	865	1285
	Width	215	880	1420
Ventral radial plates: 5	Height	595	715	820
	Width	580	680	790
Interradial plates: > 500	Height	445	1090	1200
	Width	345	865	975
Hooks: > 5000	Length	385	470	580
	Number of pores in eye	10	15	19

Emended diagnosis. — Radial elements of the calcareous ring with a large, but not protruding, concavity for muscle insertion. On the inner edge of the distal part of the radials there are four distinct knobs, each pair

Fig. 74. Elements of the calcareous rings of *Achistrum* from the Devonian of the Holy Cross Mountains. **A–F**. Interradial plates of *Achistrum multiperforatum* Beckmann, 1965 from the Late Givetian sample Marzysz II/13. **A**. GIUS 4-584 Mrz./207b/6; A_1 inner view, A_2 lateral view, A_3 outer view, A_4 proximal view. **B**. Juvenile plate GIUS 4-584 Mrz./207/1; B_1 lateral view, B_2 inner view. **C**. Narrow form with short anterior process, GIUS 4-584 Mrz./207b/2; C_1 inner view, C_2 lateral view, C_3 outer view, C_4 proximal view, C_5 distal view. **D**. Narrow form with long anterior process, GIUS 4-584 Mrz./207b/3; D_1 inner views, D_2 lateral view. **E**. Wide form with long anterior process, GIUS 4-584 Mrz./207b/5; E_1 outer view. E_2 lateral view. **F**. Narrow form with abnormal anterior process, GIUS 4-584 Mrz./207b/14; F_1 inner view, F_2 lateral view, F_3 outer view, F_4 proximal view, F_5 distal view. **G–H**. Elements of calcareous rings of *Achistrum varicum* sp. n. from the Late Givetian, Marzysz Ic/5. **G**. Left radial plate GIUS 4-561 Mrz./321/1; G_1 inner view, G_2 outer view, $\mathbf{G_3}$ proximal view. **H**. Ventral radial plate with three anterior process, GIUS 4-561 Mrz./321/2; H_1 inner view, H_2 outer view, H_3 proximal view. **I–J**. *Achistrum multiperforatum* Beckmann, 1965. **I**. Interradial plate ➛



from the Late Givetian Marzysz II/13, GIUS 4-584 Mrz./207b/4; I_1 inner view, I_2 lateral view, I_3 outer view, I_4 proximal view, I_5 distal view. **J**. Left radial plate from the Mid Frasnian set D of Wietrznia II in Kielce, GIUS 4-793 Wie./526/1; J_1 inner view, J_2 lateral view, J_3 outer view, J_4 proximal view. **K**. Right radial plate of *Achistrum* sp. C from the Late Frasnian set G1 of Psie Górki in Kielce, GIUS 4-601 Psi./538/1, inner view. **L**. Hook without eye of *Achistrum* sp. B from the Mid Frasnian set C of Górno, GIUS 4-607 Grn./519/1. Scale bar 200 μm. **M**. Reconstruction of the calcareous ring; not to scale.

separated by a concavity, giving the margin a wavy appearance. Sclerites are hooks with a perforated eye, its network is droplet-like in outline.

Description. — Calcareous ring. Right and left radial plates have two almost identical proximal processes each. The thicker one has a radial channel at it base, almost central or towards the proximal edge. On the outer side the radial canal aperture opens into a triangular pit, flanked from its axial part by a low bar or wall. From the internal side the aperture forms a local expansion of the margin of the proximal process. Its width is slightly larger than its height (Pl. 19: 4–10, 18; Text-figs 73A–N, 74J). The edges of the proximal processes reach up to half the height of the internal surface. Radial elements that are ventral in position have three virgate proximal processes, one of them separated from the proximal side by a deep slit, the two other by shallower ones (Text-fig. 73O). The radial channel is relatively high, situated near the middle part of the process. On the outer side the aperture of the radial channel opens into a tear-shaped and strongly elongate pit, surrounded on its three flanks by partitions; on the opposite side the aperture opens half way up the process toward the distal side of the channel where it is prolonged as a conduit. From the inner side it forms a local extension of the edge of proximal process.

Interradial plates have a single proximal process reaching up to half of the ventral side, where it bifurcates and quickly fades, expanding to the sides. The two main dimensions of the plates are similar, although some variations can be observed in this respect (Pl. 19: 11–14; Text-fig. 74A–F, I).

The lateral surface of both types of plates is characterised by all angles rounded (cf. Text-fig. 74M), with frontal and distal angles the most rounded. The inner and outer edges in large specimens can be slightly longer. Numerous elements found articulated allows reconstruction of the whole calcareous ring (Pl. 19: 15, 16; Text-figs 73O, 74M).

Sclerites. The hooks have blades which are to a various degree curved and flattened on their sides. Numerous aggregates together with elements of the calcareous rings were found (Pl. 19: 16, 18).

Remarks. — *A. multiperforatum* differs from the other species by the presence of fine knobs along the imaginative line connecting the proximal processes and by details of the lateral surface connecting the particular elements. The hooks, which are non-diagnostic for the species, are developed as in the original collection of Beckmann.

Occurrence. — Late Eifelian: Błonia Sierzawskie near Świętomarz, Holy Cross Mountains, Poland. Givetian: upper part of the Rodert-Formation, Mechernich-Keldernich, Rhenish Slate Mountains, Germany. Mid (Late?) Givetian: set B of Jaźwica, Holy Cross Mountains, Poland. Late Givetian: *Scutellum* bed in the Massenkalk, Rothe quarry, Schladetal near Bergisch-Gladbach, Rhenish Slate Mountains, Germany. Outcrop I, trench II at Marzysz; set B of Posłowice; set C of Stokówka. Mid Frasnian: set D (?) of Wietrznia II quarry, Kielce, Holy Cross Mountains, Poland.

Achistrum tuto sp. n.
(Pl. 19: 1–3; Text-figs 71A–K, 72A–E)

Holotype: GIUS 4-615 Grz./427/5, Text-fig. 71G.

Type horizon: Early Eifelian, set VIII of the Grzegorzowice Beds, *Polygnathus partitus* Zone.

Type locality: Grzegorzowice, Holy Cross Mountains.

Derivation of the name: From Latin *tuto* – sure.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Radial plates: > 500	Height	805	475	865	910
	Width	805	430	745	955
Ventral radial plates: 7	Height	–	420	540	580
	Width	–	880	925	1014
Interradial plates: > 500	Height	–	715	770	805
	Width	–	565	780	880

Diagnosis. — Interradial and radial elements of the calcareous ring with a ruff on their outer proximal edges, adjoining and surrounding the proximal processes.

Description. — Calcareous ring. Right and left radials have two different proximal processes. The right proximal process has a radial channel at its base which is placed very low and occasionally penetrates the main part of the plate (Pl. 19: 1–2; Text-figs 71A–C, F–K, 72D). On the outer side the aperture of the radial channel opens into a rectangular or triangular pit, bordered on all sides by low partitions. The aperture on the inner side forms a local extension of the edge of the proximal process. Spherical processes of the inner-distal side are hardly developed. The edges of the proximal processes reach up to the inner-distal edge. The muscle attachment cavity on the external surface is large and protruding, as seen distally (Text-fig. 71G_4). Radial elements that lay ventral in position have three proximal processes, one is separate, the two others intergrown from the back-side. The radial channel is within the median process.

Interradials have only one proximal process reaching up to their inner-distal edge where it bifurcates and fades, broadening to the sides. Plates vary in proportions (Pl. 19: 3; Text-figs 71D–E, 72A–C).

Lateral surfaces in both plate types have rounded angles (cf. Text-fig. 74M) except in the case of the outer angle, where there is an outer ruff. The proximal edge is longer than the distal one, the inner and the outer edges are of similar length.

Remarks. — *A. tuto* sp. n. differs from other species by the presence of a high ruff, the edges of proximal processes passing over the inner surface and by details of the lateral surface connecting particular calcareous ring elements.

Occurrence. — Early Eifelian: brachiopod *Chimaerothyris dombrowiensis* Zone (*Polygnathus partitus* Zone) of Zbrza; set VIIIof the Grzegorzowice Beds at Grzegorzowice, Holy Cross Mountains, Poland.

Achistrum varicum sp. n.
(Text-figs 72I–K, 74G, H)

Holotype: GIUS 4-747 Sow./683/1, Text-fig. 72I.
Type horizon: Late Givetian, Early *Mesotaxis falsiovalis* Zone.
Type locality: Set C of Sowie Górki, Holy Cross Mountains.
Derivation of the name: From Latin *varicum* – straddled.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Radial plates: 30	Height	565	565	590	670
	Width	1255	1090	1110	1255
Ventral radial plates: 2	Height	–	775	790	805
	Width	–	1100	1130	1165
Interradial plates: 13	Height	–	315	490	730
	Width	–	610	840	1150

Diagnosis. — Elements of the calcareous ring twice as long as high.

Description. — Calcareous ring. Right and left radial plates have two low proximal processes, of equal height. The thicker of the two has the radial channel at its base, situated half-way up the plate (Text-fig. 74G). On the outer side the channel opens into a rectangular pit, while on the inner side no local extension of the edge of the proximal process can be observed. Spherical protuberances of the inner-distal faces are absent, instead of them there are frilled lobes. The edges of the proximal processes reach up to half the height of the inner surface. The muscle insertion basin is placed on the outer surface and it is small and shallow. Radial elements in ventral position have three distinctly separate proximal processes with the radial channel proceeding through the middle process (Text-figs 72I, 74H).

Interradial plates have a single, undivided proximal process reaching up to half the height of the inner side (Text-fig. 72J). On the outer side the process has a shallow conduit. All angles of the lateral surface are rounded (comp. Text-fig. 74M), or occasionally may even be oval or triangular in outline, in which case the outer edge is very short. Most commonly all the margins are of equal length. Both the radials and the interradials have a low ruff.

Remarks. — Characteristic of this species is the low ruff and the edges of the proximal processes, which are up to half the length of plates, and the details of the lateral surface uniting the calcareous ring elements.

Occurrence. — Late Givetian: set C of Sowie Górki; outcrop I at Marzysz, Holy Cross Mountains, Poland.

Achistrum sp. A
(Text-fig. 72F–H)

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)		
Number of specimens	Features	Minimum	Mean	Maximum
Plates from calcareous ring: 2	Height	215	285	360
	Width	200	245	290
Hooks: 7	Length	275	300	345
	Number of pores in eye	7	8	9

Description. — Recognised plates of the calcareous ring have two identical and parallel proximal processes. At their prolongation, along the inner-distal edge, there are two knobs. Plates have no radial channel. Sclerites typically have a flat blade and elliptical, perforated eye.

Remarks. — Although the plates are devoid of any radial channel, most probably they represent a juvenile radial plates of *Achistrum multiperforatum* (cf. Text-figs 72H and 73D–H). Sclerites differ from the other species in the an elliptical shape of their eye.

Occurrence. — Early Givetian: outcrop III at Śniadka, Holy Cross Mountains, Poland.

Achistrum sp. B
(Text-fig. 74L)

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)		
Number of specimens	Features	Minimum	Mean	Maximum
Hooks: 5	Length	345	370	385

Description. — Hooks with a spherical termination in place of a typical eye.

Remarks. — Such a morphology of sclerites possibly reflects their poor preservation.

Occurrence. — Mid Frasnian: set C of Górno, Holy Cross Mountains, Poland.

Achistrum sp. C
(Text-fig. 74K)

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)		
Number of specimens	Features	Minimum	Mean	Maximum
Radial plates: 1	Height	200	–	–
	Width	360	–	–

Description. — Asymmetrical radial plates have two identical proximal processes, a radial channel penetrates one of them. The distal surface the radial plate is arched.

Remarks. — The plate is not typical for any of the species described; as it is a single and poorly preserved element it cannot be easily classified.

Occurrence. — Late Frasnian: set G1 of Psie Górki, Holy Cross Mountains, Poland.

Family **Myriotrochidae** Théel, 1877

Remarks. — Gilliland (1993) presented a hypothesis that the primitive Myriotrochidae is derived from the Late Carboniferous *Thallatocanthus* Carini, 1962 via such intermediate forms as *Semperites* Mostler, 1971 (cf. Mostler 1971a). The material illustrated herein demonstrates that the typical representatives of the lineage were present already in the Devonian. *Gagesiniotrochus* gen. n. displays not only the sclerites typical for the family but also the radial plates, only slightly different those of living myriotrochids e.g. *Lepidotrochus kermadecensis* (Belyaev, 1970), *L. novaguienensis* Belyaev, 1980 or by other living Myriotrochidae (cf. Belyaev 1970, 1978, 1980, 1981a, b). Garcia-Lóppez and Truyols (1974) presented the first paper illustrating a Frasnian myriotrochid (*Microantyx*).

Genus *Gagesiniotrochus* gen. n.

Type species: *Gagesiniotrochus billetti* sp. n.

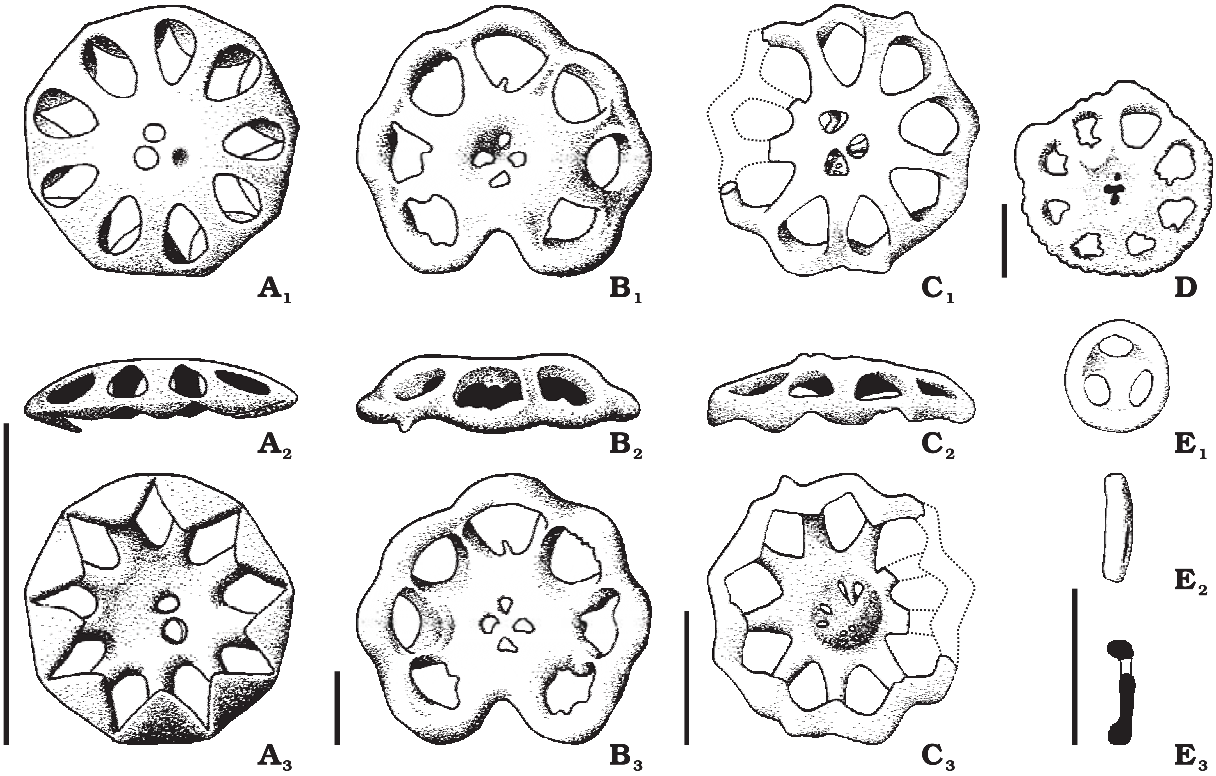


Fig. 75. Sclerites of holothurians from the Devonian of the Holy Cross Mountains. **A**. *Gagesiniotrochus billetti* sp. n. from the Early Givetian of outcrop III at Śniadka, holotype GIUS 4-439 Śni./971/1; A_1 outer view, A_2 lateral view, A_3 inner view. **B**–**D**. *Gagesiniotrochus astralis* sp. n. from the Late Givetian set C of Sowie Górki. **B**. Specimen with one underdeveloped pore, GIUS 4-746 Sow./690/1; B_1 outer view, B_2 lateral view, B_3 inner view. **C**. GIUS 4-746 Sow./689/1; C_1 outer view, C_2 lateral view, C_3 inner view. **D**. GIUS 4-746 Sow./700/1, outer view. **E**. *Palaeohemioedema cognata* sp. n. from the Late Givetian, sample Marzysz II/W/6 GIUS 4-568 Mrz./93/1; E_1 side view, E_2 lateral view, E_3 cross-section. Scale bar 200 µm.

Derivation of the name: From the name of J.D. Gage, who, jointly with D.S.M. Billett investigated the Myriotrochidae of the North Atlantic Ocean.

Diagnosis. — The wheels with a wavy or polygonal margin, with pores at the centre; marginal girdle with duplication, forming a triangular flap under each spoke.

Remarks. — Sclerites differ from the genus *Thallatocanthus* in having central pores, by the lack of fine indentation at the border of the doubled marginalium, and by the presence of a triangular flap under every spoke.

Gagesiniotrochus astralis sp. n.
(Text-fig. 75B–D)

Holotype: GIUS 4-746 Sow./700/1, Text-fig. 75D.

Type horizon: Late Givetian, *Mesotaxis falsiovalis* Zone.

Type locality: Set C of Sowie Górki, Holy Cross Mountains.

Derivation of the name: From Latin *astrum* – star.

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Wheels: 4	Diameter	500	360	500	715
	Number of marginal pores	8	7	8	9

Diagnosis. — The wheels have a wavy periphery and three or four pores at the centre.

Description. — At the centre of a concave-convex sclerite there are three or four tear-shaped pores and in the marginal zone there are eight or nine tear-shaped and/or oval pores. Under each spoke more or less vestigial triangular flaps can be observed. The marginal girdle is thick, of zigzag shape. Along the internal

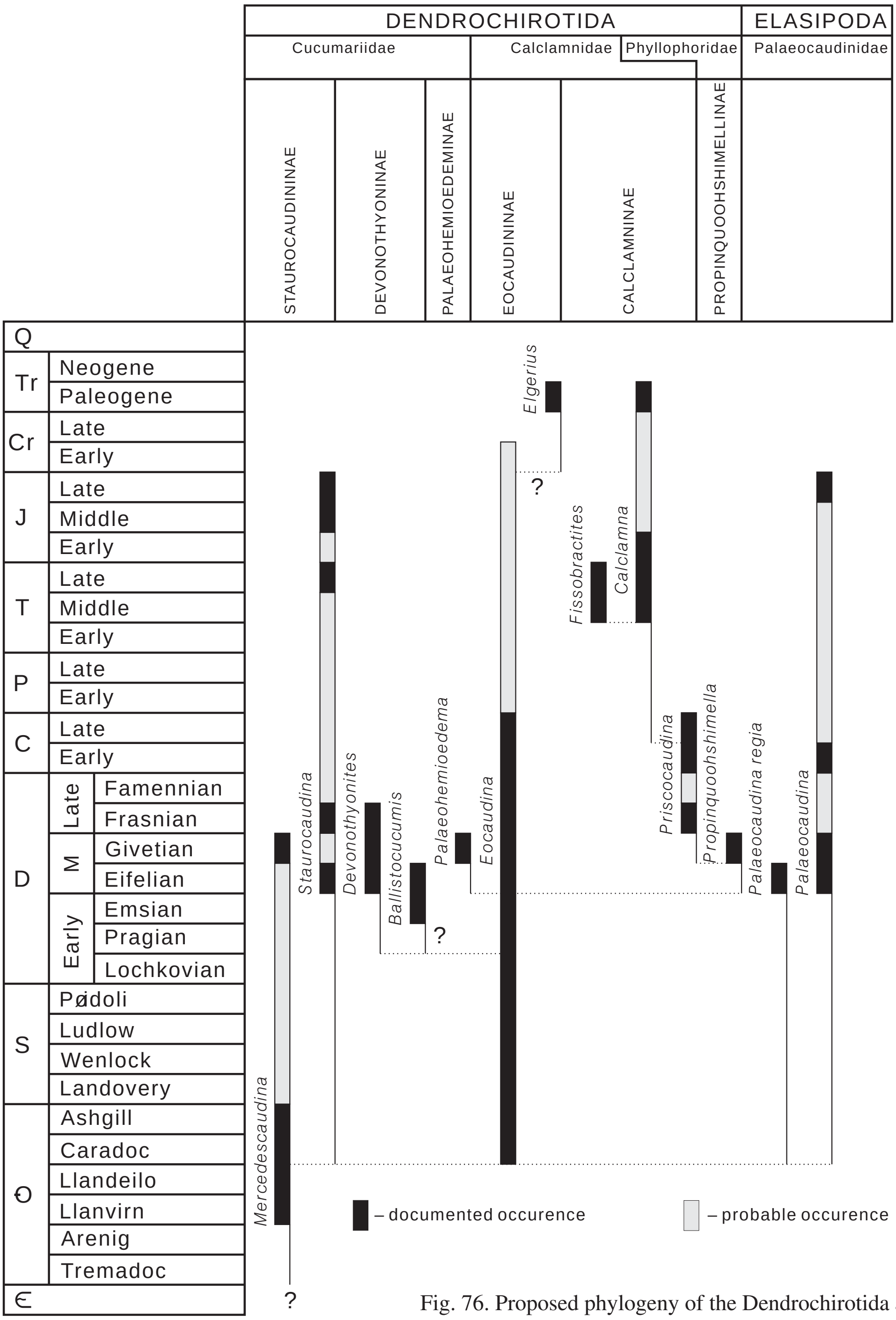


Fig. 76. Proposed phylogeny of the Dendrochirotida and Elasipodida.

side a thin button-shaped membrane may occur, irregularly and zonally perforate (Text-fig. 75C). Spokes are flat.

Remarks. — From *Gagesiniotrochus billetti* sp. n. the present species differs by its greater number of pores and by button-shaped hub, narrower marginal girdle and wavy outline of the sclerite.

Occurrence. — Only known from the type locality.

Gagesiniotrochus billetti sp. n.
(Text-figs 57K, 75A)

Holotype: GIUS 4-439 Śni./971/1, Text-fig. 75A.

Type horizon: Early Givetian, *Polygnathus hemiansatus* Zone.

Type locality: Outcrop III at Śniadka, Holy Cross Mountains.

Derivation of the name: From the name of D.S.M. Billett, the second author of the study on the Myriotrochidae.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Radial plates: 1	Height	250	250	–	–
	Width	405	405	–	–
Wheels: 2	Diameter	160	135	150	160
	Number of marginal pores	9	9	9	9

Diagnosis. — A single square-shaped proximal process on radial plates; radial channel central. Multiangular wheels with spokes with two or three pores in the centre.

Description. — Calcareous ring. Radial plates (Text-fig. 57K) with a cubiform proximal process. The circular radial aperture from the internal part opens within the square depression, on the opposite side it is oval. Convexity of the distal surface is only slight. From the interior there is a low ruff on the proximal edge. The side of the proximal process is arched, with a characteristic "nose". The lateral surface of the area of the anatomical contact with the neighbouring plate is triangular.

Sclerites. At the centre of the concave-convex sclerite there are two or three circular pores, in the marginal zone there are nine tear-shaped pores in the angles of the polygonal plate. The marginal girdle is duplicated and forms a triangular flap under every one of flat the spokes.

Remarks. — This species is very close to Recent *Lepidotrochus novaguienensis* in the structure of both its sclerites and its radial plates, the principal difference being the presence of a "nose" at the proximal process. Other Devonian sclerites have fewer spokes and larger marginal flaps under their sclerites. The latter character differentiates this species from *Gagesiniotrochus astralis* sp. n.

Occurrence. — Only known from the type locality.

Holothurioidea *incertae sedis*

Genus *Ocellothuria* gen. n.

Type species: *Ocellothuria binoculata* sp. n.

Derivation of the name: From Latin *ocellus* – eye.

Diagnosis. — Flat, spindle-shaped plates, with perforate eyes at opposite ends of the spindle, where it narrows; in its middle part, there occurs a thin, perforate, protruding lamella.

Ocellothuria binoculata sp. n.
(Pl. 16: 15; Text-fig. 69A–D)

Holotype: GIUS 4-584 Mrz./221/1, Text-fig. 69A.

Type horizon: Late Givetian, Early *Mesotaxis falsiovalis* Zone.

Type locality: Trench II, layer 13 at Marzysz, Holy Cross Mountains.

Derivation of the name: From Latin *bini* – double, *oculus* – eye, due to shape.

Material. — Number of specimens and dimensions:

Material		Dimensions (μm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Sclerites: 34	Length	735	735	775	815
	Width	145	110	140	205

Diagnosis. — As for the genus.

Description. — Ends of the sclerites may be open and V-shaped or may form a loop; in any case the structures flank the perforate network. A circular perforate blade surrounds the thinnest part of a sclerite, which can be placed somewhat asymmetrically (Pl. 16: 15; Text-fig. 69A–D).

Remarks. — This shape is similar that represented in sclerites of *Binoculites* Deflandre-Rigaud, 1952. The difference is that they have perforate oculi, rather like *Achistrum* (*Porachistrum*) *multiperforatum* Beckmann, 1965. The most similar are the anal teeth which though they lack hooked processes on their lateral sides, have a perforate ruff. Similar, imperforate ruffs are known from the plates of *Devonothyonites*. Further similarity can be observed in that both taxa occasionally have parallel marginal rods.

Occurrence. — Mid Givetian: set B of Laskowa Góra; Late Givetian: trench II at Marzysz, Holy Cross Mountains, Poland.

Undetermined radial plate
(Text-fig. 57J)

Material. — Number of specimens and dimensions:

Material		Dimensions (µm)			
Number of specimens	Features	Holotype	Minimum	Mean	Maximum
Radial plates: 1	Height	960	960	–	–
	Width	600	600	–	–

Description. — From the interior only two fan-shaped proximal processes are visible, in typical arrangement. From their ends the high blades of these processes are fused. From the exterior these processes are hidden behind the third one, obliquely arranged in respect to the former. Proximal edges of the processes are denticulate. Proximally, there is a clavate process on one side. Its distal surface has a groove (Text-fig. 57J).

Remarks. — The plate is quite unlike any known type of radial plate from the calcareous ring.

Occurrence. — Late Givetian Early *Mesotaxis falsiovalis* Zone: Trench II, layer W/2 at Marzysz, Holy Cross Mountains.

REFERENCES

Alexandrowicz, Z. 1971. Carboniferous Holothuroidea sclerites in the Upper Silesia Coal Basin (Southern Poland). *Rocznik Polskiego Towarzystwa Geologicznego* **41**, 281–291.

Bailey, W.F. 1935. Micropaleontology and stratigraphy of the Lower Pennsylvanian of central Missouri. *Journal of Paleontology* **9**, 483–502.

Baker, A.N. 1974. New species of brittle-stars from New Zealand (Echinodermata: Ophiuroidea). *Records of the Dominion Museum* **8**, 15, 247–266.

Baker, A.N. and Rowe, F.W.E. 1990. Atelostomatid sea urchins from Australian and New Zealand Waters (Echinoidea: Cassiduloida, Holasteroida, Spatangoida, Neolampadoida). *Invertebrate Taxononomy* **4**, 281–316.

Baker, A.N., Rowe, F.W.E., and Clark, H.E.S. 1986. A new class of Echinodermata from New Zealand. *Nature* **321**, 862–864.

Bartenstein, H. 1936. Kalk-Körper von Holothurien in norddeutschen Lias-Schichten. *Senckenbergiana* **18**, 1–10.

Bartenstein, H. and Brand, E. 1937. Mikro-paläontologische Untersuchungen zur Stratigraphie des nordwest-deutschen Lias und Doggers. *Abhandlungen der Senckenbergischen naturforschenden Gesellschaft* **439**, 1–224.

Bassler, R.S. and Kellett, B. 1934. Bibliographic index of Palaeozoic Ostracoda. *Geological Society of America, Special Paper* **1**, 1–500.

Becker, G. and Weigelt, H. 1975. Neue Nachweise von Ophiuroidea im Rheinischen Schiefergebirge. *Notizblatt des Hessischen Landesamtes für Bodenforschung* **103**, 5–36.

Beckmann, H. 1965. Holothuriensklerite aus dem Givet der Paffrather Mulde (Rheinisches Schiefergebirge). *Fortschritte in der Geologie von Rheinland und Westfalen* **9**, 195–208.

Belyaev, G.M. 1969. A new pelagic holothurian (Elasipoda, Psychropotidae) from the abyssal of the Kurilo-Kamchatka Trench [in Russian]. *Zoologitcheskij zhurnal* **48**, 709–716.

Belyaev, G.M. 19806. A new genus *Lepidotrochus* and new species of deep-sea holothurians (Apoda, Myriotrochidae)[in Russian]. *Zoologitcheskij zhurnal* **59**, 12, 1810–1819.

Belyaev, G.M. and Mironov, A.N. 1978. Holothurians of the genus *Myriotrochus* from the southern part of the Atlantic Ocean [in Russian]. *Trudy Instituta Okeanologii AN SSSR* **113**, 198–207.

Belyaev, G.M. and Mironov, A.N. 1981a. New species of the genus *Acanthotrochus* (Apoda, Myriotrochidae) [in Russian]. *Zoologitcheskij zhurnal* **60**, 520–529.

Belyaev, G.M. and Mironov, A.N. 1981b. Some new deep-sea species of the Myriotrochidae (Holothuroidea) from the northern and south-western parts of the Pacific Ocean [in Russian]. *Trudy Instituta Okeanologii AN SSSR* **115**, 165–173.

Bengtson, S. 1985. Taxonomy of disarticulated fossils. *Journal of Paleontology* **59**, 1350–1358.

Benson, R.H. Berdan, J.M., van den Bold, W.A., Hanai, T. Hessland, I.,Howe, H.V., Kesling, R.V., Levinson, S.A., Reyment, R.A., Moore, R.C., Scott, H.W., Shaver, R.H., Sohn, I.G., Stover, L.E., Swain F.M., and Sylvester-Bradley, P.C. 1961. Ostracoda. Systematic Descriptions. *In:* R.C. Moore and C.W. Pitrat (eds), *Treatise on Invertebrate Paleontology, Part Q, Arthropoda 3, Crustacea, Ostracoda*, Q99–Q421. University of Kansas Press, Boulder.

Beyrich, E. 1857. Über ein zu den Palechiniden gehöriges Petrefakt. *Zeitschrift der Deutschen geologischen Gesellschaft* **9**, 4.

Billett, D.S.M., Hansen, B., and Huggett, Q.J. 1985. Pelagic Holothurioidea (Echinodermata) of the northeast Atlantic. *In:* B.F. Keegan and B.D.S. O'Connor (eds), *Echinodermata, Proceedings of the Fifth International Echinoderm Conference*, Galway, 24–29 Sept. 1984, 399–411. A.A. Balkema, Rotterdam.

Bindemann, W. 1938. Ein Echinid mit Laterne aus dem Kulm von Herborn. *Meekechinus ?herbornensis* n. sp. *Senckenbergiana* **20**, 203–220.

Blake, D.B. 1968. Pedicellariae of two Silurian echinoids from Western England. *Palaeontology* **11**, 576–579.

Blake, J.F. 1876. Class Echinodermata; Incertae sedis. *In:* R. Tate and J.F. Blake (eds), *The Yorkshire Lias*, 439–446. John Van Voost, London.

Boczarowski, A. 1992. Drobne szkarłupnie bezłodyżkowe z dewonu Gór Świętokrzyskich, Paleontologiczny zapis zdarzeń późnego dewonu i karbonu, XV Konferencja Paleontologów. *Przegląd Geologiczny* **10**, 604.

Boczarowski, A. 1997a. *Achistrum antiquus* a new species of apodid holothurian from the Late Permian of the Holy Cross Mountains. *Prace Państwowego Instytutu Geologicznego* **157**, 93–103.

Boczarowski, A. 1997b. Mistaken identity of wheel-shaped sclerites of Ophiocistioidea and Holothurioidea. *Slovak Geological Magazine* **3**, 331–340.

Campbell, A.C. 1973. Observations on the activity of echinoid pedicellariae. I. Stem responses and their significance. *Marine Behavior Physiology* **2**, 33–61.

Campbell, A.C. 1974. Observations on the activity of echinoid pedicellariae. II. Jaw responses of tridentate and ophiocephalous pedicellariae. *Marine Behavior Physiology* **3**, 17–34.

Campbell, A.C. 1976. Observations on the activity of echinoid pedicellariae. III. Jaw responses of globiferous pedicellariae and their significance. *Marine Behavior Physiology* **4**, 25–39.

Campbell, A.C. 1983. Form and function of pedicellariae. *Echinoderm Studies* **1**, 139–167.

Cannon, L.R.G. and Silver, H. 1986. *Sea Cucumbers of Northern Australia*. 60 pp. Queensland Museum, Brisbane.

Cherbonnier, G. 1941a. Etude anatomique et biogéographique sur deux *Cucumaria abyssaux: C. abyssorum* Théel et *C. albatrossi* n. sp. *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **13**, 93–103.

Cherbonnier, G. 1941b. Note sur *Cucumaria spatha* n. nom. (= *C. grandis* Vaney), et *Cucumaria turqueti* Vaney, (Holothuries). *Bulletin du Muséum National d'Histoire Naturelle*, 2e série **13**, 6, 571–574.

Cherbonnier, G. 1947. Note sur une Holothurie abyssale: *Abyssocucumis ingolfi* (Deichman). *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **9**, 459–463.

Cherbonnier, G. 1950. Note sur une Holothurie dendrochirote de Dakar: *Cladodactyla senegalensis* Panning. *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **22**, 476–479.

Cherbonnier, G. 1951. Les Holothuries de Lesson, 1re Note. *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **23**, 295–301.

Cherbonnier, G. 1953. Recherches sur les synaptes (Holothuries apodes) de Roscoff. *Archives de Zoologie Expérimentale et Générale* **90**, 163–186.

Cherbonnier, G. 1955. Holothuries récoltées en Océanie française par G. Ranson, en 1952. (5e et dermiére note). *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **27**, 380–386.

Cherbonnier, G. 1957. Holothuries des côtes de Sierra-Leone. *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **29**, 485–492.

Cherbonnier, G. 1958a. Holothuries des côtes de Sierra-Leone. (2e note). *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **30**, 101–108.

Cherbonnier, G. 1958b. Note sur *Pseudothyone sculponea* nouvelle espéce d'Holothurie dendrochirote de Méditerranée. *Vie et Milieu* **9**, 62–66.

Cherbonnier, G. 1959. Échinodermes de la Guyane Française (Crinoides, Astérides, Ophiurides, Échinides, Holothurides). *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **31**, 367–372.

Cherbonnier, G. 1961. Deux nouvelles espéces d'Holothuries dendrochirotes des Côtes Brésiliennes. *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **33**, 611–615.

Cherbonnier, G. 1965. Holothurides. Resultats scientifiques. Expédition Océanographique Belge, Eaux Côtiéres Africaines de l'Atlantique Sud (1948–1949). *Résultats Scientifiques, Institut Royal des Sciences Naturelles de Belgique* **3**, 37–59.

Cherbonnier, G. 1968. Les pédicellaires globiféres de l'oursin régulier *Paracentrotus lividus* (Lamarck). *Bulletin du Muséum National d'Histoire Naturelle, 2e série* **39**, 1211–1213.

Cherbonnier, G. 1973. Sur une nouvelle espéce d'Holothurie dendrochirote du golfe de Guinée: *Hemioedema multipodia* n. sp. *Bulletin du Muséum National d'Histoire Naturelle, 3e série Zoologie* **115**, 1161–1165.

Cherbonnier, G. 1988. Faune de Madagascar. Echinodermes: Holothurides. *Institut Francais de Recherche Scientifique pour le Development en Cooperation, Editions de l'ORSTOM* **70**, 1–292.

Cherbonnier, G. and Féral, J.P. 1976. Echinodermes: Holothuries. *Résultats des Campagnes Musorstom. I – Philippines, (18–28 Mars 1976)* **17**, 357–412.

Cherbonnier, G. and Guille, A. 1978. Faune de Madagascar. Echinodermes: Ophiurides. *Editions du Centre National de la Recherche Scientifique* **40**, 1–272.

Clark, H.L. 1907. The apodus holothurians. *Smithsonian Contribution to Knowledge* **35**, 1–231.

Clausen, C.-D., Weddige, K., and Ziegler, W. 1993. Devonian of the Rhenish Massif. Table. *In:* E. Crick (ed.), *SDS, International Union of Geological Sciences, Commission on Stratigraphy, Subcommission on Devonian Stratigraphy, Newsletter* **10**, 18–19.

Croneis, C. and Mc Cormack, J. 1932. Fossil Holothuroidea. *Journal of Paleontology* **6**, 111–148.

Cuénot, L. 1948. Anatomie, éthologie et systématique des Échinodermes. *In:* P.P. Grassé (ed.), *Échinodermes, Stomocordés, Procordes. Traité de Zoologie. Anatomie, Systématique, Biologie. Tome XI.* 312 pp. Masson et C[ie] Éditeurs, Paris.

Deflandre-Rigaud, M. 1946. Sur les divers types de sclérites d'Holothurides Oxfordiens des marnes de Villersur-Mer. *Comptes rendus de l'Académie des Sciences, Paris* **223**, 513–515.

Deflandre-Rigaud, M. 1952. Contribution a la systématique des sclérites d'Holothurides fossiles. *Bulletin de l'Institut Océanographique (Monaco)* **946**, 1–11.

Deflandre-Rigaud, M. 1953. Classe des Holothurides. *In:* J. Piveteau (ed.), *Traité de Paléontologie 3*, 948–957. Masson et C[ie], Paris.

Deflandre-Rigaud, M. 1962. Contribution a la connaissance des sclérites d'Holothurides fossiles. *Mémoires du Muséum National d'Histoire Naturelle, Nouvelle série* **11**, 1–123.

Dehm, R. 1952. *Rhenechinus hopstätteri* nov. gen. nov. sp., ein Seeigel aus dem rheinischen Unter Devon. *Notizblat des Hessischen Landesamtes für Bodenforschung zu Wiesbaden* **81**, 88–95.

Dehm, R. 1961. Ein Zweiter Seeigel, *Porechinus porosus* nov. gen. nov. sp. aus dem rheinischen Unter Devon. *Mitteilungen der Bayerische Staatssammlung für Paläontologie und historische Geologie* **1**, 1–8.

Ding, H. 1985. Discovery of holothurian sclerites from the Taiyuan Formation (Upper Carboniferous), Henan, China. *Acta Micropaleontologica Sinica* **2**, 339–348.

Durham, J.W. 1966a. Echinoidea – phylogeny and evolution. *In:* R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata* 3 (1), U266–U269. University of Kansas Press, Lawrence.

Durham, J.W. 1966b. Echinoidea – Classification. *In:* R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata* 3 (1), U270–U295. University of Kansas Press, Lawrence.

Durham, J.W. 1966c. Clypeasteroids. *In:* R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata* 3 (2), U450–U491. University of Kansas Press, Lawrence.

Durham, J.W. 1966d. Evolution among the Echinoidea. *Biological Review* **41**, 368–391.

Durham, J.W., Fell, H.B., Fischer, A.G, Kier, P.M., Melville, R.V., Pawson, D.L., and Wagner, C.D. 1966. Echinoidea – systematic description. *In:* R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata* 3 (1), U297. University of Kansas Press, Lawrence.

Durham, J.W. and Melville, R.V. 1957. A classification of echinoids. *Journal of Paleontology* **31**, 242–272.

Ebner, F. and Fenninger, A. 1980. Mikrofazies und Biostratigraphie der Kalkgerölle von Falcovec (NW Bulgarien). *Paleontology, Stratigraphy and Lithology* **12**, 3–12.

Ekman, S. 1927. Holothurien der Deutschen Südpolar-Expedition 1901–1903 aus der Ostantarktis und vin den Kerguelen. – XIX. *Zoologie* **11**, 361–419.

Etheridge, R., Jr. 1881. On the presence of the scattered skeletal remains of Holothuroidea in the Carboniferous Limestone series of Scotland. *Proceedings of the Royal Philosophical Society of Edinburgh* **6**, 183–198.

Fedotov, D.M. 1926. The plan of structure and systematic status of the Ophiocistia (Echinoderma). *Proceedings of the Zoological Society London 4*, 1147–1157.

Fischer, A. G. 1966. Spatangoids. *In:* R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata* 3 (2), U543–U628. University of Kansas Press, Lawrence.

Fluegeman, R.H. and Orr, R.W. 1990. Occurrence of *Sievertsia* (Echinodermata: Cyclocystoidea) from the Middle Devonian of Northern Indiana. *Journal of Paleontology* **64**, 480–482.

Frentzen, K. 1964. Funde von Holothurien-Kalkkörperchen im Jura des Oberrheingebietes. *Beitrage zur naturkundlichen Forschung Südwest-deutschland* **23**, 31–51.

Frizzell, D.L. and Exline, H. 1955. Monograph of Fossil Holothurian Sclerites. *Bulletin, University of Missouri, School of Mines and Metallurgy, Technical series* **89**, 1–204.

Frizzell, D.L. and Exline, H. 1966. Holothuroidea-Fossil Record. *In:* R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata* 3 (2), U646–U672. University of Kansas Press, Lawrence.

Gage, J.D. and Billett, D.S.M. 1986. The family Myriotrochidae Théel (Echinodermata: Holothurioidea) in the deep northeast Atlantic Ocean. *Zoological Journal of the Linnean Society* **88**, 229–276.

Garcia-López, S. and Truyols, J. 1974. Presencia de escleritos de holothuroideos enlas calizas devonicas de la Cordillera Cantabrica. *Breviora Geologica Astúrica* **18**, 17–20.

Geis, H.L. 1936. Recent and fossil pedicellariae. *Journal of Paleontology* **10**, 427–448.

Gekker [Hecker], R.F. 1938. A new member of the class Ophiocistia Sollas (*Volchovia* n. g.) from the Ordovician of Leningrad province and changes in the diagnosis of this class. *Doklady Akademii SSSR* **19**, 425–427.

Gekker [Hecker], R.F. 1940. Carpoidea, Eocrinoidea und Ophiocistia des Ordovizium des Leningrader Gebietes und Estlands. *Travaux de l'Academie des Sciences URSS, Institute Paléontologie* **9**, 5–82.

Gilliland, P.M. 1992a. Holothurians in the Blue Lias of Southern Britain. *Palaeontology* **35**, 159–210.

Gilliland, P.M. 1992b. Holothurian faunal changes at the Triassic–Jurassic boundary. *Lethaia* **25**, 69–84.

Gilliland, P.M. 1993. The skeletal morphology, systematics and evolutionary history of holothurians. *Special Papers in Palaeontology* **47**, 1–147.

Grabert, G. and Grabert, H. 1956. *Encrinaster schmidti* (Schöndorf), ein Leitfossil aus der Herdorf-Gruppe (oberes Siegenium). *Paläontologische Zeitschrift* **30**, 190–198.

Grabert, G. and Grabert, H. 1965. Eine Protasteridae (Ophiuroidea) aus dem rheinischen Mitteldevon. *Fortschritte in der Geologie von Rheinland und Westfalen* **9**, 189–199.

Gramann, F., Lain, F., and Stoppel, D. 1972. Paleontological evidence of Triassic age for limestones from the southern Shan and Kayah slates of Burma. *Geologisches Jahrbuch, Series B* **1**, 1–33.

Gutschick, R.C. 1954. Holothurian sclerites from the Middle Ordovician of Northern Illinois. *Journal of Paleontology* **28**, 827–829.

Gutschick, R.C. 1959. Lower Mississippian holothurian sclerites from the Rockford Limestone of Northern Indiana. *Journal of Paleontology* **33**, 130–137.

Gutschick, R.C. and Canis, W.F. 1971. The holothurian sclerite genera *Cucumarites*, *Eocaudina* and *Thuroholia* – restudy of *Eocaudina* and *Protocaudina* from the Devonian of Iowa. *Journal of Paleontology* **45**, 327–337.

Gutschick, R.C., Canis W.F., and Brill, Jr., K.G. 1967. Kinderhook (Mississippian) Holothurian sclerites from Montana and Missouri. *Journal of Paleontology* **41**, 1461–1480.

Haffer, J. and Jentsch, S. 1962. Über die *Lepidocentrus*-Arten (Echinoidea) des rheinischen Mitteldevon. *Paläontologische Zeitschrift H. Schmidt-Festband*, 77–85.

Hahn, G. and Brauckmann, C. 1981. Ein neuer Ophiuren-Fund aus dem Kulm von Herborn (Asterozoa, Unter-Karbon IIIα, Hessen). *Geologisches Jahrbuch Hessen* **109**, 5–18.

Hall, J. 1851. Report of the geology of the Lake Superior Land District, Pt. II, The iron region. *In*: J.W. Foster and J.D. Whitney (eds), *United States 32nd Congress Special Session* **4**, 203–231.

Hanna, G.D. 1930. Remains of Holothuroidea from the Carboniferous of Kansas. *Journal of Paleontology* **4**, 413–416.

Haude, R. 1982. Ophiuren (Echinodermata) aus dem Karbon des Rheinischen Schiefergebirges. *Geologisches Jahrbuch Hessen* **110**, 5–26.

Haude, R. 1983. Kaum bekannte und seltene Echinodermen aus dem Mitteldevon des rechtsrheinischen Schiefergebirges. *Aufschluss* **34**, 101–110.

Haude, R. 1992. Fossil holothurians: Sclerite aggregates as 'good' species. *In:* L. Scalera-Liaci and C. Canicatti (eds), *Echinoderm Research 1991, Proceedings of the Third European Conference on Echinoderms, Lecce, Italy, 9–12 September 1991*, 29–33. A.A. Balkema, Rotterdam.

Haude, R. 1994. Fossil holothurians: Constructional morphology of the sea cucumber, and the origin of the calcareous ring. *In:* B. David, A. Guille, J.-P. Féral, and M. Roux (eds), *Echinoderms through Time*, *Proceedings of the Eight International Conference Dijon/France/6–10 September 1993*, 517–522. A.A. Balkema, Rotterdam.

Haude, R. 1995a. Die Holothurien-Konstruktion: Evolutionsmodell und ältester Fossilbericht. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* **195**, 181–198.

Haude, R. 1995b. Echinodermen aus dem Unter-Devon der argentinischen Präkordillere (Sammlung Bodenbender). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* **197**, 37–86.

Haude, R. (in press). *Nudicorona*, eine neue paläozoische Holothurie mit unterskelettierter Körperwand. *Aufsschluß*.

Haude, R. and Langenstrassen, F. 1976a. Winkelzähne von Ophiocistioiden aus Silur, Devon und Karbon. *Lethaia* **9**, 179–184.

Haude, R. and Langenstrassen, F. 1976b. *Rotasaccus dentifer* n. g. n. sp. ein devonischer Ophiocistoide (Echinodermata) mit holothuroiden Wandskleriten und echinoidem Kauapparat. *Paläontologische Zeitschrift* **50**, 130–150.

Haude, R. and Thomas, E. 1983. Ophiuren (Echinodermata) des hohen Oberdevons im nördlichen Rheinischen Schiefergebirge. *Paläontologische Zeitschrift* **57**, 121–142.

Haude, R. and Thomas, E. 1994. Eleutherozoen (Echinodermata) aus dem Unter-Karbon von Aprath im Bergischen Land. *Archäologie im Ruhrgebiet Jahrgang, Geologie, Paläontologie und Vor- und Frühgeschichte zwischen Lippe und Wupper* **2**, 115–132.

Heaslip, W.G. 1969. A new cyclocystoid (Echinodermata) from Cortland, New York, extends class stratigraphic range to Upper Devonian. *Geological Society of America, Abstracts with Program* **1**, 96.

Hess, H. 1971. Über einige Echiniden aus Dogger und Malm des Schweizer Juras. *Eclogae geologicae Helvetiae* **64**, 611–633.

Hess, H. 1975. Die fossilen Echinodermen des Schweizer Juras. *Veröffentlichungen aus dem Naturhistorischen Museum Basel* **8**, 1–130.

Hoare, R.D. and Sturgeon, M.T. 1976. Echinoid remains from the Pennsylvanian Vanport Limestone (Allegheny Group), Ohio. *Journal of Paleontology* **50**, 13–24.

Hyman, L.H. 1955. *The Invertebrates: Echinodermata*, vii + 763. McGraw-Hill, New York, Toronto, London.

Irimura, S. 1988. Ossicles of the stomach wall of Ophiuroidea and their taxonomic significance. *In:* R.D. Burke, P.V. Mladenov, P. Lambert, and R.L. Parsley (eds), *Echinoderm Biology*, *Proceedings of the Sixth International Echinoderm Conference, Victoria 23–28 August 1987*, 315–322. A.A. Balkema, Rotterdam.

Issler, A. 1908. Beiträge zur Stratigraphie und Mikrofauna des Lias in Schwaben. *Palaeontographica*, **55**, 1–104.

Jackson, R.T. 1912. Phylogeny of the Echini, with a revision of Palaeozoic species. *Memoirs of the Boston Society of Natural History* **7**, 1–491.

Jaekel, O. 1901. Über Carpoideen, eine neue Klasse Pelmatozoen. *Zeitschrift der Deutschen Geologischen Gesellschaft* **52**, 66–667.

Jaekel, O. 1903. Asteriden und Ophiuriden aus dem Silur Böhmens. *Zeitschrift der Deutschen Geologischen Gesellschaft* **55**, 106–113.

Jaekel, O. 1918. Phylogenie und System der Pelmatozoa. *Paläontologische Zeitschrift* **3**, 1–128.

Jangoux, M. and Lambert, A. 1988. Comparative anatomy and classification of asteroid pedicellariae. *In:* R.D. Burke, P.V. Mladenov, P. Lambert, and R.L. Parsley (eds), *Echinoderm Biology, Proceedings of the Sixth International Echinoderm Conference, Victoria 23–28 August 1987*, 719–723. A.A. Balkema, Rotterdam.

Jell, P.A. 1983. Early Devonian echinoderms from Victoria (Rhombifera, Blastoidea and Ophiocistioidea). *Memoirs of the Association of Australasian Palaeontologists* **1**, 209–235.

Jensen, M. 1980. An alleged stirodont lantern in an irregular Echinoid. *In*: M. Jangoux (ed.), *Echinoderms: Present and Past, Proceedings of the European Colloquium on Echinoderms, Brussels, 3–8 Sept. 1979*, 31–35. A.A. Balkema, Rotterdam.

Jensen, M. 1981. Morphology and classification of Euechinoidea Bronn, a cladistic analysis. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening* **143**, 7–99.

Jensen, M. 1982. Pedicellariae in classification of echinoids. *In:* J.M. Lawrence (ed.), *Echinoderms: Proceedings of the International Conference, Tampa Bay, 14–17 Sept. 1981*, 111–115. A.A. Balkema, Rotterdam.

Jesionek-Szymańska, W. 1979. Morphology and microstructure of oligolamellar teeth in Paleozoic echinoids. Part I. Teeth of some early lepidocentrid echinoids. *Acta Palaeontologica Polonica* **24**, 265–274.

Jesionek-Szymańska, W. 1982. Morphology and microstructure of oligolamellar teeth in Paleozoic echinoids. Part 2. Givetian (Middle Devonian) stage of evolution of oligolamellar teeth. *Acta Palaeontologica Polonica* **27**, 195–211.

Jones, T.R. 1887. *Notes on Some Silurian Ostracoda From Gothland*, 1–8. P.A. Norsteadt & Söner, Stockholm.

Johnson, J.G. 1993. Comment and reply. Devonian conodont zones. *In*: E. Crick (ed.), *SDS, International Union of Geological Sciences, Commission on Stratigraphy, Subcommission on Devonian Stratigraphy, Newsletter* **10**, 45.

Kesling, R.V. 1963. Morphology and relationships of *Cyclocystoides*. *Contributions from the Museum of Paleontology, The University of Michigan* **18**, 157–176.

Kesling, R.V. 1966. Cyclocystoids. *In*: R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata* 3 (1), U188–U210. University of Kansas Press, Lawrence.

Kesling, R.V. 1968. A new brittle-star from the Middle Devonian Arkona shale of Ontario. *Contributions from the Museum of Paleontology, The University of Michigan* **23**, 37–51.

Kesling, R.V. 1970. *Drepanaster wrighti*, a new species of brittle-star from the Middle Devonian Arkona shale of Ontario. *Contributions from the Museum of Paleontology, The University of Michigan* **23**, 73–79.

Kesling, R.V. 1971. *Antiquaster magrumi*, a new unusual brittle-star from the Middle Devonian Silica Formation of northwestern Ohio. *Contributions from the Museum of Paleontology, The University of Michigan* **23**, 181–191.

Kesling, R.V. 1972. *Strataster devonicus*, a new brittle-star with unusual preservation from the Middle Devonian Silica Formation of Ohio. *Contributions from the Museum of Paleontology, The University of Michigan* **24**, 9–15.

Kesling, R.V. and Chilman, R.B. 1975. Strata and Megafossils of the Middle Devonian Silica Formation. *Papers on Paleontology* **8**, 1–408.

Kesling, R.V. and Chilman, R.B. 1978. Ostracods of the Middle Devonian Silica Formation. *Papers on Paleontology* **18**, (I) 1–169; (II) 1–266.

Kesling, R.V. and Le Vasseur, D. 1971. *Strataster ohioensis*, a new Early Mississippian brittle-star, and the paleoecology of its community. *Contributions from the Museum of Paleontology, The University of Michigan* **23**, 20, 305–341.

Kier, P.M. 1957. A New Upper Carboniferous Echinoid from Texas. *Geological Magazine* **94**, 326–328.

Kier, P.M. 1958. New American Paleozoic Echinoids. *Smithsonian Miscellaneous Collections* **135**, 1–26.

Kier, P. M. 1966. Noncidaroid Paleozoic Echinoids. *In*: R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata 3 (1)*, U298–U312. University of Kansas Press, Lawrence.

Kier, P.M. 1968. *Nortonechinus* and the ancestry of the cidarid echinoids. *Journal of Paleontology* **42**, 1163–1170.

Kier, P.M. 1974. Evolutionary trends and their functional significance in the post-Paleozoic Echinoids. *Journal of Paleontology* **48**, *Supplement to No. 3, part II of II*, 1–94.

Kolata, D.R. 1975. Middle Ordovician echinoderms from northern Illinois and southern Wisconsin. *Paleontological Society, Memoir* **7**, 1–62.

Kornicker, L.S. and Imbrie, J. 1958. Holothurian sclerites from the Florena shale (Permian) of Kansas. *Micropaleontology* **4**, 93–96.

Kozur, H. and Mock, R. 1972. Neue Holothurien-Sklerite aus der Trias der Slowakei. *Geologisch-Paläontologische Mitteilungen Innsbruck* **2**, 12, 1–47.

Kozur, H. and Mock, R. 1974. Holothurien-Sklerite aus der Trias der Slowakei und ihre stratigraphische bedeutung. *Geologicky Zbornik-Geologica Carpathica* **25**, 113–143.

Kozur, H., Mock, R., and Mostler, H. 1976. Stratigraphische Neueninstufung der Karbonatgesteine der „unteren Schichtenfolge” von Ochtiná (Slowakei) in das oberste Visé und Serpukhovian (Namur A). *Geologisch-Paläontologische Mitteilungen Innsbruck* **6**, 1, 1–29.

Kristan-Tollmann, E. 1963. Holothurien-Sklerite aus der Trias der Ostalpen. *Sitzungsberichte der Österreichische Akademie der Wissenschaften Wien, Mathematisch-Naturwissenschaftliche Klasse, Abteilung I* **172**, 351–380.

Kristan-Tollmann, E. 1964. Zur Charakteristik triadischer Mikrofaunen. *Paläontologische Zeitschrift* **38**, 66–73.

Langenheim, R.L., Jr. and Epis, R.C. 1957. Holothurian sclerites from the Mississippian Escabrosa limestone, Arizona. *Micropaleontology* **3**, 165–170.

Langer, W. 1991. Beiträge zur Mikropaleontologie des Devons im Rheinischen Schiefergebirge. *Geologisches Jahrbuch, Reihe A* **128**, 35–65.

Lawrence, J. 1987. *A Functional Biology of Echinoderms*, 1–340. Croom Helm, London.

Lehmann, W.M. 1957. Die Asterozoen in den Dachschiefern des rheinischen Unterdevons. *Abhandlungen des Hessischen Landesamtes für Bodenforschung* **21**, 1–160.

Lehmann, W.M. 1958. Eine Holothurie zusammen mit *Palaenectria devonica* und einem Brachiopoden in den unterdevonischen Dachschiefern des Hunsrücks durch Röntgenstrahlen entdect. *Notizblat des Hessischen Landesamtes für Bodenforschung* **86**, 81–86.

Levinson, S.A. 1961. Identification of Fossil Ostracodes in thin section. *In*: R.C. Moore and C.W. Pitrat (eds), *Treatise on Invertebrate Paleontology, Part Q, Arthropoda 3, Crustacea, Ostracoda*, Q70–Q73. The University of Kansas Press, Lawrence.

Lipiec, M. 1992. Some Jurassic holothurian sclerites from the High-Tatric Series of the Tatra Mts., Poland. *Geological Quarterly* **36**, 435–450.

Lovén, S. 1874. Études sur les Échinoidées. *Kongelige Svenska Vetenskaps-Akademiens Handlingar, n. ser.* **11**, 7, 1–91.

Ludwig, H. 1894. The Holothuroidea. *Memoirs of the Museum of Comparative Zoology, Harvard College* **17**, 3, 1–183.

MacBride, E.W. and Spencer, W.K. 1938. Two new Echinoidea, *Aulechinus* and *Ectinechinus* and an adult plated Holothurian, *Eothuria*, from the Upper Ordovician of Girvan. *Philosophical Transactions of the Royal Society, London B* **229**, 91–136.

Malec, J. 1984. Nowe dane o stratygrafii dewonu w profilu Grzegorzowice-Skały. *Kwartalnik Geologiczny* **23**, 782.

Malec, J. 1989. Lower Eifelian ostracods from the west Świętokrzyskie Mountains (Poland). *Acta Palaeontologica Polonica* **34**, 233–270.

Malec, J. 1991. Uwagi o stratygrafii utworów dewonu dolnego i środkowego w zachodniej części Gór Świętokrzyskich. *Kwartalnik Geologiczny* **35**, 525–526.

Märkel, K. 1970a. Morphologie der Seeigelzähne. III. Die Zähne der Diadematoida und Echinothuroida (Echinodermata, Echinoidea). *Zeitschrift für Morphologie der Tiere* **66**, 189–211.

Märkel, K. 1970b. Morphologie der Seeigelzähne. IV. Die Zähne von *Laganum* und *Clypeaster* (Echinodermata, Echinoidea). *Zeitschrift für Morphologie der Tiere* **68**, 370–389.

Märkel, K. 1976a. Struktur und Wachstum der Coronarskeletes von *Arbacia lixula* Linné (Echinodermata, Echinoidea). *Zoomorphologie* **84**, 279–299.

Märkel, K. 1976b. Das Wachstum der Laterne des Aristoteles und seine Anpassung an die Funktion der Laterne (Echinodermata, Echinoidea). *Zoomorphologie* **86**, 25–40.

Märkel, K. 1979. Structure and growth of the cidaroid socket-joint lanterns of Aristotle compared to the hinge-joint lanterns of non-cidaroid regular echinoids (Echinodermata, Echinoidea). *Zoomorphologie* **94**, 1–32.

Märkel, K., Gorny, P., and Abracham, K. 1977. Microarchitecture of sea urchin teeth. *Fortschritte der Zoologie* **24**, 103–114.

Märkel, K. and Titschack, H. 1969. Morphologie der Seeigelzähne. I. Der Zahn von *Stylocidaris affinis* (Phil.), (Echinodermata, Echinoidea). *Zeitschrift für Morphologie der Tiere* **64**, 179–200.

Martin, W.R. 1952. Holothuroidea from the Devonian of Iowa. *Journal of Paleontology* **26**, 728–729.

Massin, C. and Sibuet, M. 1983. Découverte dans le basin profond du Cap de l'espéce antarctique *Psychropotes scotiae* (Vaney, 1908) (Echinodermata Holothuroidea). *Bulletin du Muséum National d'Histoire Naturelle, 4ᵉ série* **5A**, 169–174.

Matyja, B.A. 1972. Holothurian sclerites from the Oxfordian limestones of the Holy Cross Mts. *Acta Geologica Polonica* **22**, 233–246.

Matyja, B.A., Matyja. H., and Szulczewski. M. 1973. The genus *Eocaudina* Martin (Holothuroidea) from the Devonian of Poland. *Acta Geologica Polonica* **23**, 135–147.

McNamara, K.J. and Henderson, R.A. 1984. A Redescription of the Rare Echinoid *Taimanawa mortenseni* Henderson and Fell (Spatangoida: Brissidae). *Records of the Western Australian Museum* **11**, 403–410.

McNamara, K.J. and Philip, G.M. 1980. Living Australian Schizasterid Echinoids. *Proceedings of the Linnean Society of New South Wales* **104**, 127–146.

Melville, R.V. and Durham, J.W. 1966. Skeletal Morphology. *In:* R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata 3 (1)*, U220–U257. University of Kansas Press, Lawrence.

Miller, S.A. and Gurley, W.F.E. 1895. Description of new species of Palaeozoic Echinodermata. *Illinois State Museum Natural History, Bulletin B*, 62.

Mitsukuri, K. 1912. Studies on actinopodus Holothurioidea. *Journal of the College of Science, Imperial University of Tokyo* **29**, 1–284.

Mooi, R. 1989. Living and Fossil Genera of the Clypeasteroida (Echinoidea: Echinodermata): An illustrated key and annotated checklist. *Smithsonian Contributions to Zoology* **488**, 1–51.

Mortensen, T. 1928. *A Monograph of the Echinoidea. I. Cidaroida*. 551 pp. C.A. Reitzel, København.

Mortensen, T. 1935. *A Monograph of the Echinoidea. II. Bothriocidaroida, Melonechinoidea, Lepidecentroida, Stirodonta*. 647 pp. C.A. Reitzel, København.

Mortensen, T. 1937. Some echinoderm remains from Jurassic of Würtemberg. *Biologiske Meddelelser Kongelige Danske Videnskabernes* **13** (10), 1–28.

Mortensen, T. 1940. *A Monograph of the Echinoidea. III. (1). Aulodonta with additions to vol. II (Lepidocentroidea and Stirodonta)*. 370 pp. C.A. Reitzel, København.

Mortensen, T. 1943a. *A Monograph of the Echinoidea. III. (2). Camarodonta I. Orthopsidae, Glyphocyphidae, Temnopleuridae, Toxopneustidae*. 533 pp.. C.A. Reitzel, København.

Mortensen, T. 1943b. *A Monograph of the Echinoidea. III. (3). Camarodonta II. Echinidae, Strongylocentrotidae, Parasalenidae, Echinometridae*. 446 pp. C.A. Reitzel, København.

Mortensen, T. 1948a. *A Monograph of the Echinoidea. IV. (1). Holectypoidea, Cassiduloidea*. 378 pp. C.A. Reitzel, København.

Mortensen, T. 1948b. *A Monograph of the Echinoidea. IV. (2). Clypeasteroidea.: Clypeasteridae, Arachnoididae, Fibulariidae, Laganidae and Scutellidae* 471 pp. C.A. Reitzel, København.

Mortensen, T. 1950. *A Monograph of the Echinoidea. V. (1). Spatangoida. I. Protosternata, Meridosternata, Amphisternata I, Palaeopneustidae, Palaeostomatidae, Aeropsidae, Toxasteridae, Micrasteridae, Hemiasteridae*. 432 pp. C.A. Reitzel, København.

Mortensen, T. 1951. *A Monograph of the Echinoidea. V. (2). Spatangoida II. Amphisternata I. Spatangidae, Loveniidae, Pericosmidae, Schizasteridae, Brissidae*. 593 pp. C.A. Reitzel, København.

Mostler, H. 1967. Conodonten und Holothurien sklerite aus den norischen Hallstätter-Kalken von Hernstein (Niederösterreich). *Verhandlungen der Geologischen Bundesanstalt* **1967**, 177–188.

Mostler, H. 1968a. Holothurien-Sklerite und Conodonten aus dem Schreyeralmkalk (Anisium) der Nördlichen Kalkalpen (Oberösterreich). *Verhandlungen der Geologischen Bundesanstalt* **1968**, 54–65.
Mostler, H. 1968b. Holothurien-Sklerite aus oberanisischen Hallstätterkalken (Ostalpen, Bosnien, Türkei). *Veröffentlichungen der Universität Innsbruck* **2**, 5–45.
Mostler, H. 1968c. Neue Holothurien-Sklerite aus norischen Hallstätter Kalken (Nördliche Kalkalpen). *Bericht des Naturwissenschaftlichen-Medizinischen Vereins in Innsbruck* **56**, 427–441.
Mostler, H. 1969. Entwicklungsreihen triassischer Holothurien-Sklerite. *Veröffentlichungen der Universität Innsbruck* **18**, 5–51.
Mostler, H. 1970. Über einige Holothurien-Sklerite aus der Süd- und Nordalpinen Trias. *Festband der Geologische Institut 300-Jahr-Feier Universität Innsbruck*, 339–360.
Mostler, H. 1971a. Holothuriensklerite aus anisichen, karnischen und norishen Hallstätterkalken. *Geologisch-Paläontologische Mitteilungen Innsbruck* **1** (1), 1–30.
Mostler, H. 1971b. Ophiurenskelettelemente (äussere Skelettanhänge) aus der alpinen Trias. *Geologisch-Paläontologische Mitteilungen Innsbruck* **1** (9), 1–35.
Mostler, H. 1971c. Häufigkeit und Bedeutung von Schwammspiculae in triassischen Mikrofaunen. *Geologisch-Paläontologische Mitteilungen Innsbruck* **1** (11), 1–19.
Mostler, H. 1971d. Mikrofaunen aus dem Unter-Karbon vom Hindukusch. *Geologisch-Paläontologische Mitteilungen Innsbruck* **1** (12), 1–19.
Mostler, H. 1972a. Neue Holothurien-Sklerite aus der Trias der Nördlichen Kalkalpen. *Geologisch-Paläontologische Mitteilungen Innsbruck* **2** (7), 1–32.
Mostler, H. 1972b. Die stratigraphische Bedeutung von Crinoiden-, Echiniden- und Ophiurenskelettelementen aus triassischen Karbonatgesteinen. *Mitteilungen der Geselschaft der Geologische Bergbaustudien* **21**, 711–728.
Mostler, H. and Parwin P. 1973. Ein Beitrag zur Feinstratigraphie der Hallstätter Kalke am Sirius Kogel (Bad Ischl, Oberösterreich). *Geologisch-Paläontologische Mitteilungen Innsbruck* **3** (7), 1–47.
Mostler, H. and Rahimi-Yazd, A. 1976. Neue Holothuriensklerite aus dem Oberperm von Julfa in Nordiran. *Geologisch-Paläontologische Mitteilungen Innsbruck* **5** (7), 1–35.
Müller, J. 1857. Über neue Echinodermen des Eifeler Kalkes. *Abhandlungen der Königlich Akademie der Wissenschaften* 243–268.
Nestler, H. 1966. Echiniden aus dem Unter-Maastricht der insel Rügen. II. Pedicellarien. *Geologie* **15**, 340–365.
Nestler, H. 1982. Die Fossilien der Rügener Schreibkreide. *Die Neue Brehm-Bücherei* **486**, 3–108.
Nichols, D. 1972. The water-vascular system in living and fossil echinoderms. *Palaeontology* **15**, 519–538.
Nichols, D. 1986. A new class of echinoderms. *Nature* **321**, 808.
Pajchlowa, M. 1957. Dewon w profilu Grzegorzowice-Skały. *Biuletyn Instytutu Geologicznego* **122**, 145–254.
Paul, H. 1939. Die Etroeungt-Schichten des Bergischen Landes. *Jahrbuch von der Preußischen geologischen Landesanstatt* **59**, 647–726.
Pawson, D.L. 1965. New sea-cucumbers (Echinodermata: Holothuroidea) from New Zealand Waters. *Records of the Dominion Museum* **5**, 11, 75–82.
Pawson, D.L. 1966. Phylogeny and Evolution of Holothuroids. *In*: R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata 3 (2)*, U641–U646. University of Kansas Press, Lawrence.
Pawson, D.L. 1971. Holothuroidea. *In*: E.M. van Zinderen, J.M. Winterbottom, and R.A. Dyer (eds), *Marion and Prince Edwards Islands*, 288–290. A.A. Balkema, Cape Town.
Pawson, D.L. 1980. Holothuroidea. *In*: T.W. Broadhead and J.A. Waters (eds), Echinoderms. Notes for a short course. *University of Tennessee Department of Geological Sciences, Studies in Geology* **3**, 175–192.
Pawson, D.L. 1982. Holothuroidea. *In*: S.P. Parker (ed.), *Synopsis and classification of living organisms*, 791–792, 814–818. McGraw-Hill, New York.
Pawson, D.L. 1985. *Psychropotes hyalinus*, a new species, a swimming elasipod sea cucumber (Echinodermata: Holothuroidea) from the north central Pacific Ocean. *Proceedings of the Biological Society of Washington* **98**, 523–525.
Philip, G.M. 1963. Silurian echinoid pedicellariae from New South Wales. *Nature* **200**, 1334.
Prokop, R.J. 1980. Cyclocystoidea Miller and Gurley, 1895 (Echinodermata) from the Bohemian Lower Devonian. *Věstnik ústředniho Ústavu geologickego* **55**, 19–26.
Prokop, R.J. 1993. First find of the undoubted skeletal elements of holothurians in the Devonian of Czech Republic. *Časopis Narodniho Muzea, Rada přirodovědna* **161**, 45–46.
Prokop, R.J. and Petr, V. 1987. First find of ophiocistioids (Echinodermata) in the Bohemian Lower Devonian. *Časopis pro mineralogii a geologii* **32**, 161–163.
Racki, G. 1992. Evolution of the bank to reef complex in the Devonian of the Holy Cross Mountains. *Acta Palaeontologica Polonica* **37**, 87–182.
Racki, G. and Bultynck, P. 1993. Conodont biostratigraphy of the Middle to Upper Devonian boundary beds in the Kielce area of the Holy Cross Mts. *Acta Geologica Polonica* **43**, 1–25.
Racki, G., Makowski, I., Mikłas, J., and Gawlik, S. 1993. Brachiopod biofacies in the Frasnian reef-complexes: an example from the Holy Cross Mts Poland. *Geologia* **12/13**, 64–109.
Raymond, P.E. 1913. Notes on Cyclocystoides. *Geological Survey of Canada Department of Mines, Victoria Memorial Museum Bulletin* **1**, 23–32.
Regnéll, G. 1945. Non-crinoid Pelmatozoa from the Paleozoic of Sweden. A taxonomic study. *Meddelanden fran Lunds Geologisk-Mineralogiska Institution* **108**, viii + 1–255.

Regnéll, G. 1948. Echinoderms (Hydroporidea, Ophiocistia) from the Ordovician (Upper Skiddavian, 3cβ) of the Oslo Region. *Norsk Geologisk Tidsskrift* **27**, 14–58.
Regnéll, G. 1956. Silurian Echinoids from Gotland. *Arkiv för Mineralogi och Geologi* **2**, 155–178.
Regnéll, G. 1960. Intermediate forms in early Palaeozoic echinoderms. *Report of the International Geological Congress, XXI Session, Norden*, 1960, *Part XXII, International Paleontological Union*, 71–80.
Regnéll, G. 1973. Tidiga tagghudingar. *Fauna och flora* **4**, 121–176.
Reich, M. 1995. Erster sicherer Nachweis der Elasipoda (Holothuroidea, Echinodermata) aus der Kreide, sowie Bemerkungen zu den Holothurienresten der Oberkreide. *Archiv für Geschiebekunde* **1**, 681–688.
Richter, R. 1930. Schuppenröhren als Anzeiger von zwei im deutschen Devon neuen echinodermen-Gruppen (Edrioasteroidea Billings und Ophiocistia Sollas?). *Senckenbergiana* **12**, 279–304.
Roberts, M.P. and Campbell, A.C. 1988. Functional anatomy of pedicellariae from *Asterias rubens* L. *In:* R.D. Burke, P.V. Mladenov, P. Lambert, and R.L. Parsley (eds), *Echinoderm Biology, Proceedings of the Sixth International Echinoderm Conference, Victoria 23–28 August 1987*, 725–733. A.A. Balkema, Rotterdam.
Romanek, A. 1984. Ophiocistioidea (Echinodermata) z dewonu środkowego Gór Świętokrzyskich. *Kwartalnik Geologiczny* **28**, 547–544.
Rowe, F.W.E. 1988. Review of the extant class Concentricocycloidea and reinterpretation of the fossil class Cyclocystoidea. *In*: R.D. Burke, P.V. Mladenov, P. Lambert, and R.L. Parsley (eds), *Echinoderm Biology, Proceedings of the Sixth International Echinoderm Conference, Victoria 23–28 August 1987*, 3–15. A.A. Balkema, Rotterdam.
Rowe, F.W.E., Baker A.N., and Clark, H.E.S. 1988. The morphology, development and taxonomic status of *Xyloplax* Baker, Rowe and Clark (1986) (Echinodermata: Concentricocycloidea), with the description of a new species. *Proceedings of the Royal Society of London B* **233**, 431–459.
Sandberg, C.A. and Gutschick, R.C. 1984. Distribution, microfauna and source-rock potential of Mississippian Delle Phosphatic Member of Woodman Formation and equivalents, Utah and adjacent states. *In*: J. Woodward, F.F. Meissner, and J.L. Clayton (eds), *Hydrocarbon Source Rocks of the Greater Rocky Mountain Region*, 135–178. Denver, Colorado, Rocky Mountain Association of Geologists.
Salter, J.W. and Billings, E. 1858. On *Cyclocystoides*, a new genus of Echinodermata from the Lower and Middle Silurian Rocks. *Canada Geological Survey, Figures and Descriptions of Canadian Organic Remains, Decade* **3**, 86–90.
Schallreuter, R. 1968. Die ältesten sicheren Holothuroideenreste (Ordoviz). *Neues Jahrbuch für Geologie und Paläontologie Monatshefte* **1968**, 522–529.
Schallreuter, R. 1975. Ein neuer ordovizischer Holothuriensklerite aus öjemyrgescheiben der Insel Gotland. *Neues Jahrbuch für Geologie und Paläontologie Monatshefte* **1975**, 727–733.
Schmidt, W.E. 1944. *Ophiaulax decheni* (Dewalque), ein Schlangenstern in den Angertal-Schichten des Blattes Kettwig (Ruhrgebiet). *Zeitschrift der deutschen geologischen Gesellschaft* **96**, 170–175.
Schöndorf, F. 1911. Palaeozoische Seesterne Deutschlands. II. Die Aspidosomatiden des deutschen Unterdevon. *Palaeontographica* **57**, 1–66.
Schuchert, C. 1914. *Fossilium Catalogus, I: Animalia, pars 3, Stelleroidea Palaeozoica*. 53 pp. W. Junk, Berlin.
Schuchert, C. 1915. Revision of Paleozoic Stelleroidea with special reference to North American Asterozoa. *United States National Museum Bulletin* **88**, 1–311.
Schwarzbach, M. and Zimmermann, F. 1936. Ophiuren aus dem Waldenburger Kulm (*Silesiaster longivertebralis* n. g., n. sp.). *Zentralblatt für Mineralogie, Geologie und Paläontologie B* **1936**, 438–444.
Scott, H.W. 1961a. Shell Morphology of Ostracoda. *In:* R.C. Moore and C.W. Pitrat (eds), *Treatise on Invertebrate Paleontology, Part Q, Arthropoda* 3, *Crustacea, Ostracoda*, Q21–Q37. University of Kansas Press, Lawrence.
Scott, H.W. 1961b. Orientation of Ostracode Shells. *In:* R.C. Moore and C.W. Pitrat (eds), *Treatise on Invertebrate Paleontology, Part Q, Arthropoda* 3, *Crustacea, Ostracoda*, Q44–Q47. University of Kansas Press, Lawrence.
Scott, H.W. 1961c. Classification of Ostracoda. *In:* R.C. Moore and C.W. Pitrat (eds), *Treatise on Invertebrate Paleontology, Part Q, Arthropoda* 3, *Crustacea, Ostracoda*, Q74–Q92. University of Kansas Press, Lawrence.
Seilacher, A. 1961. Holothurien im Hunsrückschiefer (Unter Devon). *Notizblatt des Hessischen Landesamtes für Bodenforschung zu Wiesbaden* **89**, 66–72.
Sibuet, M. 1974. *Cherbonniera utriculus* gen. nov., sp. nov., petite Holothurie (Molpadonia, Molpadiidae) des vases abyssales du Nord-Est Atlantique. *Comptes rendus de l'Académie des Sciences, Paris, Série D* **279**, 1443–1445.
Sibuet, M. 1978. *Synallactes longipapillata* nov. sp., nouvelle espéce d'Holothurie d'un genre rarement représenté dans l'Océan Atlantique. *Bulletin du Muséum National d'Histoire Naturelle*, Par*is, 3e série* **515**, 311–318.
Sieverts-Doreck, H. 1951. Über *Cyclocystoides* Salter and Billings und eine neue Art aus dem belgischen und rheinischen Devon. *Senckenbergiana* **32**, 9–30.
Skwarek, B. 1990. Opracowanie mikropaleontologiczne wapieni dewońskich z kamieniołomu Wietrznia w Kielcach. *Unpublished MSc. thesis*, 1–39. University of Silesia, Department of Earth Sciences.
Smiley, S. 1988. The phylogenetic relationships of holothurians: a cladistic analysis of the extant echinoderm classes. *In*: C.R.C. Paul and A.B. Smith (eds), *Echinoderm Phylogeny and Evolutionary Biology*, 69–84. Clarendon Press, Oxford.
Smith, A.B. 1981. Implications of lantern morphology for the phylogeny of post-Palaeozoic echinoids. *Palaeontology* **24**, 779–801.
Smith, A.B. 1984. Ophiuroidea (Asterozoa) from the Lower Llanvirn of the Toledo Mountains (Central Spain). *Estudios geologicos* **40**, 440–443.

Smith, A.B. 1988a. To group or not to group: The taxonomic position of *Xyloplax*. *In*: R.D. Burke, P.V. Mladenov, P. Lambert, and R.L. Parsley (eds), *Echinoderm Biology*, *Proceedings of the Sixth International Echinoderm Conference, Victoria 23–28 August 1987*, 17–23. A.A. Balkema, Rotterdam.

Smith, A.B. 1988b. Fossil evidence for the relationships of extant echinoderm classes and their times of divergence. *In*: C.R.C. Paul and A.B. Smith (eds), *Echinoderm Phylogeny and Evolutionary Biology*, 85–97. Clarendon Press, Oxford.

Smith, A.B. and Paul, C.R.C. 1982. Revision of the class Cyclocystoidea (Echinodermata). *Philosophical Transactions of the Royal Society of London B* **296** (1981–82), 577–679.

Sollas, W.J. 1899. Fossils in the University Museum, Oxford: I. On Silurian Echinoidea and Ophiuroidea. *Geological Society of London*, *Quarterly Journal* **55**, 692–715.

Sollas, W.J. and Sollas, I.B.J. 1912. *Lapworthura*: a typical brittle star of the Silurian age Ophiuroidea. *Philosophical Transactions of the Royal Society of London B* **202**, 213–232.

Soodan, K.S. 1977. Fossil Holothuroidea from Kutch, India – part IV. *Geophytology* **7**, 179–182.

Spandel, E. 1898. Die Echinodermen des deutschen Zechsteins. *Naturhistorische Gesellschaft Nürnberg* **11**, 1–34.

Spencer, W.K. 1914–1940. *British Palaeozoic Asterozoa*, 1–540. Palaeontographical Society Monographs, London.

Spencer, W.K. and C.W. Wright, 1966. Asterozoans. *In*: R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata* 3 (1), U4–U107. University of Kansas Press, Lawrence.

Sroka. S.D. 1988. Preliminary studies on a complete fossil holothurian from the Middle Pennsylvanian Francis Creek Shale of Illinois. *In*: R.D. Burke, P.V. Mladenov, P. Lambert, and R.L. Parsley (eds), *Echinoderm Biology. Proceedings of the Sixth International Echinoderm Conference. Victoria 23–28 August 1987*, 159–160. A.A. Balkema, Rotterdam.

Stearn, C.W. 1956. A new Echinoid from the Upper Devonian of Alberta. *Journal of Paleontology* **30**, 741–746.

Straszak, G. 1986. Opracowanie mikropaleontologiczne wapieni żywetu okolic Siewierza. *Unpublished MSc. thesis*, 1–30. University of Silesia, Department of Earth Sciences.

Strauch, F. and Pockrandt, W. 1985. Ein *Encrinaster*-Vorkommen (Ophiuroidea) aus dem Unterdevon der Eifel. *Paläontologische Zeitschrift* **59**, 125–145.

Stricker, S.A. 1985. The ultrastructure and formation of the calcareous ossicles in the body wall of the sea cucumber *Leptosynapta clarki* (Echinodermata, Holothuroida). *Zoomorphology* **105**, 209–222.

Stricker, S.A. 1986. The Fine Structure and Development of Calcified Skeletal Elements in the Body Wall of Holothurian Echinoderms. *Journal of Morphology* **188**, 273–288.

Stürtz, B. 1886a. Beitrag zur Kenntnis palaeozoischer Seesterne. *Palaeontographica* **32**, 75–98.

Stürtz, B. 1886 b. Über palaeozoischer Seesterne. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie* **1886**, 142–154.

Stürtz, B. 1890. Neue beitrag zur Kenntnis palaeozoischer Seesterne. *Palaeontographica* **36**, 203–247.

Termier, H. and Termier, G. 1953. Classe des Echinides. *In*: J. Piveteau (ed), *Traité de Paléontologie 3*, 857–947. Masson et C[ie], Paris.

Tyler, P.A. and Gage, J.D. 1984. Seasonal reproduction of *Echinus affinis* (Echinodermata: Echinoidea) in the Rockall Trough, northeast Atlantic Ocean. *Deep-Sea Research* **31**, 387–402.

Ubaghs, G. 1941. Description de quelques ophiures du Famennian de la Belgique. *Musée Royal Histoire Naturelle Belgique*, *Bulletin* **17** (44), 1–31.

Ubaghs, G. 1942. *Bohemura constellata* (Thorent) et *Drepanaster* sp., Ophiurides du Devonien inférieur de la Belgique et du nord da la France. *Musée Royal Histoire Naturelle Belgique*, *Bulletin* **18** (7), 1–19.

Ubaghs, G. 1953. Classe des Ophiocistioides (Ophiocistioidea). *In*: J. Piveteau (ed.), *Traité de Paléontologie 3*, 843–856. Masson et C[ie], Paris.

Ubaghs, G. 1966. Ophiocystioids. *In*: R.C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part U, Echinodermata 3 (1)*, U174–U188. University of Kansas Press, Lawrence.

Witwicka, E., Bielecka, W., Styk O., and Sztejn, J. 1958. Metody opracowywania mikroskamieniałości. *Instytut Geologiczny*, *Biuletyn* **134**, 1–156.

Woodward, H. 1869. On *Eucladia* a new genus of Ophiuroidea from the Upper Silurian, Dudley. *Geological Magazine* **1**, 241–245.

Zankl, H. 1966. Holothurien-Sklerite aus dem Dachsteinkalk (Ober-Trias) der nördlichen Kalkalpen. *Paläontologische Zeitschrift* **40**, 70–88.

Zawidzka, K. 1971. Triassic holothurian sclerites from Tatra Mountains. *Acta Palaeontologica Polonica* **16**, 429–450.

Ziegler, W. and Sandberg, C. 1990. The Late Devonian Standard Conodont Zonation. *Courier Forschungs-Institut Senckenberg* **121**, 1–115.

Zhang, J. 1987. Early Carboniferous holothurian sclerites from South China and their stratigraphic significance. *11 International Congress of Carboniferous Stratigraphy and Geology, August 31 – September 4, 1987 Beijing, China*. *Abstracts of Papers* (I), *Sections 1–8*, 109.

Table 2

Stratigraphic register of localities. Biostratigraphy after Pajchlowa (1957), Malec (1984, 1989, 1991), Racki (1992 and personal communication), Racki and Bultynck (1993). Conodont zonation scheme after Ziegler and Sandberg (1990), Clausen, Weddige and Ziegler (1993), and Johnson (1993).

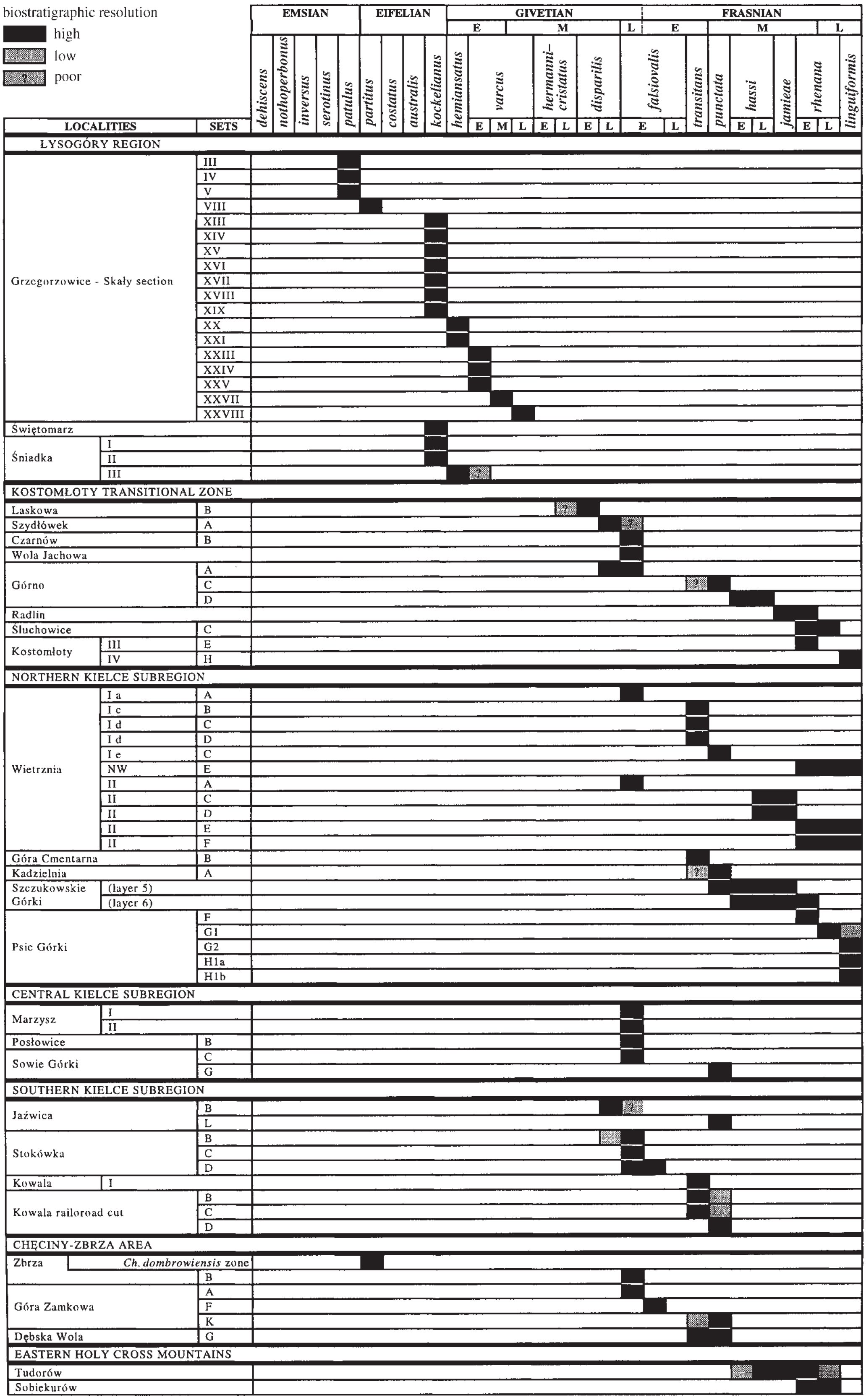


Table 3
Sources of material.

LOCALITIES		SET	Samples: Number of samples	Samples: Total weight (kg)	Exposures: Outcrop	Exposures: Trench	Exposures: Quarry	Rocks: Limestones	Rocks: Marly limestones	Rocks: Bituminous limestones	Rocks: Shales
Grzegorzowice - Skały secti		III	1	2.5		✠		✠			
		IV	1	1		✠		✠			
		V	2	2		✠				✠	
		VIII	14	25		✠				✠	
		XIII	2	2		✠		✠			✠
		XIV	25	88		✠		✠		✠	✠
		XV	20	20		✠		✠			✠
		XVI	3	17	✠						✠
		XVII	23	33		✠		✠		✠	✠
		XVIII	16	44		✠		✠		✠	✠
		XIX	3	2.5		✠				✠	✠
		XX	5	6.5	✠			✠			
		XXI	8	7.5	✠			✠			
		XXIII	20	20		✠		✠			
		XXIV	1	1		✠		✠			
		XXV	4	7		✠		✠			
		XXVII	1	1		✠		✠			
		XXVIII	2	2	✠			✠			
Świętomarz			13	16.5	✠			✠			✠
Śniadka	I		1	1	✠			✠			
	II		2	2.5	✠			✠			
	III		10	20	✠				✠	✠	✠
Laskowa		B	4	3			✠	✠			
Szydłówek		A	1	1.5		✠		✠			
Czarnów		B	2	2	✠			✠			
Wola Jachowa			1	1	✠			✠			
Górno		A	5	7.5	✠			✠			
		C	13	14.5	✠			✠			
		D	1	1.5			✠	✠			
Radlin			1	1.5			✠		✠		
Śluchowice		C	1	1			✠			✠	
Kostomłoty	III	E	8	8			✠	✠			
	IV	H	1	1	✠			✠			
Wietrznia	I a	A	2	2			✠	✠			
	I c	B	3	3			✠	✠			
	I d	C	5	5			✠	✠			
	I e	C	2	2			✠	✠			
	I d	D	2	2			✠	✠			
	NW	E	2	2			✠	✠			
	II	A	6	6			✠	✠			
	II	C	3	2			✠	✠			
	II	D	3	2			✠	✠			
	II	E	5	4			✠	✠			
	II	F	3	2			✠	✠			
Góra Cmentarna		B	1	1	✠			✠			
Kadzielnia		A	2	5			✠	✠			
Szczukowskie Górki	(layer 5)		2	3			✠	✠			
	(layer 6)		2	11			✠	✠			
Psie Górki		F	2	1.5			✠	✠			
		G1	3	3			✠	✠			
		G2	3	2.5			✠	✠			
		H1a	2	3			✠	✠			
		H1b	4	8			✠	✠			
Marzysz	I		10	17.5	✠				✠		
	II		44	81.5		✠			✠		
Posłowice		B	9	9.5		✠		✠			
Sowie Górki		C	15	17			✠	✠			
		G	1	4			✠	✠			
Jaźwica		B	8	30			✠	✠			
		L	1	1			✠	✠			
Stokówka		B	2	2			✠	✠			
		C	1	2			✠	✠			
		D	1	1			✠	✠			
Kowala I			1	1			✠	✠			
Kowala railoroad cut		B	5	5	✠			✠			
		C	6	7.5	✠			✠			
		D	1	1	✠			✠			
Zbrza	*Ch.dombrowiensis* zone		3	2.5		✠		✠	✠		
		B	2	0.5		✠		✠			
Ch.dombrowiensis zone Góra Zamkowa		A	4	5			✠	✠			
		F	2	2			✠	✠			
		K	2	2			✠	✠			
Tudorów			5	5.5	✠			✠			
Sobiekurów			3	2			✠	✠			
		Total	408	634 kg	19	19	36	65	5	8	9

IZOLOWANE SKLERYTY DEWOŃSKICH SZKARŁUPNI BEZŁODYGOWYCH

ANDRZEJ BOCZAROWSKI

STRESZCZENIE

Podstawowym celem niniejszej pracy było dotarcie do biologicznych realiów przemian faun szkarłupni zasiedlających muliste dna w dewonie Gór Świętokrzyskich. Próbowano tego dokonać poprzez identyfikację poszczególnych gatunków bezłodygowych szkarłupni na podstawie zespołów izolowanych elementów. szkieletowych. Dzięki zastosowanym po raz pierwszy na tak szeroką skalę metodom wydobywania kalcytowych mikroskamieniałości ze skał wapiennych możliwe okazało się nie tylko zidentyfikowanie biologicznie pojmowanych gatunków w poszczególnych zespołach, ale i prześledzenie ich zmian w czasie geologicznym. Techniki badawcze, rezultaty badań taksonomicznych i dynamikę faun przedstawiono w kolejnych rozdziałach pracy.

W wyniku maceracji próbek skał węglanowych i ilastych uzyskano doskonale zachowane elementy sklerytomów szkarłupni. Najbogatsza kolekcja pochodzi z szurfu w Marzyszu i odsłonięcia w Śniadce. Próbki te stratygraficznie obejmują przedział od późnego emsu (zona konodontowa *Polygnathus patulus)* do późnego franu włącznie (zona konodontowa *Palmatolepis linguiformis).* Poszczególne próbki umiejscowione są w przedziałach czasowych odpowiadających podstawowym cyklom transgresywnym.

W środkowym i późnym dewonie na znacznej części obecnego terytorium Gór Świętokrzyskich osadzały się mniej lub bardziej wapniste iły i muły. Środowiska tak rafowe jak i pozarafowe były zamieszkiwane przez liczne gatunki szkarłupni, ale generalnie zespoły te były dość jednorodne na poszczególnych etapach rozwoju dewońskiego basenu sedymentacyjnego w Górach Świętokrzyskich. W środowiskach takich, podobnie jak dziś, masowo występowały bezłodygowe szkarłupnie: wężowidła, rozgwiazdy, jeżowce i strzykwy, a ponadto cyclocystoidy i ofiocystoidy. Wiele odmian skał jest do tego stopnia przepełniona szczątkami szkarłupni, że można mówić o ich skałotwórczym znaczeniu. Po kryzysie późnofrańskim zespół szkarłupni zubożał i zmienił się na tyle, że bliższy jest zespołom wczesnokarbońskim niż frańskim. Z tego powodu nie włączono zespołów fameńskich w zakres tej pracy.

Oprócz izolowanych elementów udało się wymacerować złożone fragmenty szkieletów Echinodermata, mimo iż za życia połączone były jedynie miękkimi tkankami. Pomogło to w skompletowaniu sklerytomów poszczególnych gatunków. Rekonstrukcji tych dokonano przede wszystkim przez porównanie kompletnie zachowanych okazów kopalnych spokrewnionych z badanymi oraz ze szkarłupniami dzisiejszymi. Asocjacje sklerytów szkarłupni zidentyfikowane w ten sposób reprezentują ich sklerytomy, tzn. zestaw typów elementów szkieletowych należących do jednego gatunku. Już dawno zwracano uwagę na dużą przydatność dla systematyki i znajomości anatomii naturalnych agregatów sklerytów. Sklerytomy odzwierciedlają bowiem ściśle organizację anatomicznie żywych organizmów. Jeżeli na podstawie izolowanych elementów wyznaczono wcześniej jakieś sztuczne jednostki systematyczne, ale nie określono ich *explicite* jako parataksony, to materiał ten jest też ważny w kategoriach systematyki naturalnej. Stosując tę zasadę w poniższym opracowaniu zrezygnowano ze stosowania parataksonomii wszędzie tam, gdzie było to możliwe.

Kierując się tymi kryteriami, na podstawie kolekcji izolowanych sklerytów szkarłupni wydobytych z prawie 400 próbek skał wapiennych i ilastych z dewonu Gór Świętokrzyskich zidentyfikowano 60 nowych i 10 wcześniej rozpoznanych biologicznie zdefiniowanych gatunków oraz 59 zespołów sklerytomów w otwartej taksonomii.

Wężowidła stanowią procentowo największą część kolekcji, ale występowanie gatunków w poszczególnych interwałach czasowych dowodzi, że ich zróżnicowanie taksonomiczne było stosunkowo niskie, a poszczególne gatunki tworzyły monotonne i szeroko rozpowszechnione (powtarzalne) zespoły. Bardzo często w próbkach występuje tylko jeden gatunek. Skleryty *Furcaster* stanowią aż 90% okazów, występując w skałach tak masowo, że można mówić o ich skałotwórczej roli. Opisano 3 nowe rodzaje wężowideł, 16 nowych gatunków oraz wyróżniono 35 sklerytomów kolców, tarczek i innych elementów.

Cyclocystoidy zostały w tej pracy po raz pierwszy odnotowane z obszaru Polski. Grupa ta jest w Górach Świętokrzyskich tak licznie reprezentowana w porównaniu do innych obszarów geograficznych i pięter

stratygraficznych, iż można mówić o dewońskim etapie ich ewolucji. Opisano 11 nowych gatunków zaliczonych do dziewięciu nowych rodzajów. Większość z nich wyewoluowało z rodzaju *Sievertsia.* Wszystkie dewońskie rodzaje zaliczono do nowej rodziny Apycnodiscidae. W rodzinie Cyclocystoididae pozostawiono jedynie rodzaje *Cyclocystoides* i *Actinodiscus.*

Szczątki ofiocystoidów są również częste w osadach dewońskich Gór Świętokrzyskich, lecz zespół ten jest taksonomicznie najuboższy. Do ośmiu rodzajów (w tym trzy nowe) zaliczono siedem nowych gatunków oraz trzy znane. Ponieważ szczątki tych zwierząt bardzo często mylono ze sklerytami Holothurioida (rodzaj *Microantyx*) dokonano rewizji tego rodzaju pozostawiając przy nim jeden znany i jeden nowy gatunek. Zrewidowano także pozycję systematyczną *Protocaudina,* której gatunek typowy okazał się oficystoidem, a nie strzykwą, zaliczając do tego rodzaju dwa znane gatunki i jeden nowy. Rodzaj *Linguaserra* różni się tak bardzo budową goniodontów od innych, że wydzielono go w oddzielną rodzinę.

Jeżowce to kolejna, bardzo powszechna i trudna do analizy grupa. Ich szczątki występują masowo lecz większość płytek jest niediagnostyczna. Zapewne zespół ten jest mocno zróżnicowany gatunkowo, ale słabe poznanie form dewońskich wyklucza najczęściej ścisłą identyfikację taksonomiczną. Spośród trzech gatunków jeden, *Albertechinus devonicus* sp. n., charakteryzuje się masowym występowaniem, doskonałym zachowaniem oraz monotonnością składu tak, że jego sklerytom jest łatwo identyfikowalny. Często spotykano skupienia jego szczątków, a czasem połączone elementy, co ułatwiło rekonstrukcję. Ważnym problemem rozwiązanym w trakcie badań jest ustalenie prawdziwej przynależności skamieniałości *Bursulella.* Dawniej zaliczano je do małżoraczków, jednakże są to bezspornie pedicellarie jeżowca (z dwoma lub trzema szczękami). Przeanalizowano bardzo bogate zespoły morfotypów pedicellarii i ustalono występowanie już w dewonie odmian globisferycznych, trójzębnych i oficefalicznych. Wyróżniono cztery morfotypy obejmujące dziewięć odmian. Nie udało się poza morfotypem I ustalić ich bliższej przynależności taksonomicznej.

Strzykwy reprezentują niewątpliwie najbardziej zróżnicowany systematycznie zespół. Dokonano rewizji systematyki 17 gatunków. Większość perforowanych płytek szkarłupni zalicza się tradycyjnie do strzykw, choć skleryty te są najczęściej juwenilnymi stadiami elementów szkieletowych innych szkarłupni. Zespół strzykw wykazywał w dewonie wyjątkowe zróżnicowanie, co dowodzi, że główne linie ewolucyjne tych zwierząt rozeszły się bardzo wcześnie (przed emsem). Opisano trzydzieści gatunków (w tym dwadzieścia pięć nowych) i dziewięć nowych rodzajów. Skompletowano nie tylko skleryty skórne, ale także bogaty i kompletny zestaw sklerytów pasów okołoprzełykowych. Często trafiano na naturalne agregaty, lub połączone jak za życia zestawy płytek, co ułatwiło rekonstrukcję. Na tej podstawie udało się odtworzyć anatomię przedniego odcinka ciała rodzaju *Achistrium.* Przeanalizowano i porównano pod względem różnorodności sklerytów wszystkie znane współcześnie i kopalne rodzaje i stwierdzono występowanie już w dewonie takich rodzin jak Palaeocucumariidae, Cucumariidae, Phyllophoridae, Synallactidae, Myriotrochidae. Odrzucono parataksonomię i włączono do naturalnej systematyki rodzinę Achistridae; po dokonaniu rewizji *Protocaudina* utworzono dla gatunków strzykw nową rodzinę Palaeocaudininidae. Utworzono pięć nowych podrodzin, w których obrąb zaliczono znane i nowe rodzaje.

Małe bezłodygowe szkarłupnie tworzą serię odrębnych zespołów od późnego emsu aż po późny fran. Ich następstwo było kontrolowane przez cykle eustatycznych zmian poziomu morza.

INDEX OF GENERIC AND SPECIFIC NAMES

Explanation to index: * text-fig., bold description