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Holothurian sclerites from the Korytnica Clays (Middle Miocene; Holy Cross Mountains, Poland)

ABSTRACT: The Korytnica Clays yield a rich assemblage of the holothurian sclerites which contain 32 forms belonging to 4 families: Stichopitidae, Calclamnidae, Theeliidae and Synaptitidae. Eleven species are established new: *Calclamna cruciformis* sp. n., *C. tricorniculata* sp. n., *Calclamnella clavata* sp. n., *C. deflandreae* sp. n., *C. korytnicensis* sp. n., *C. sanctacrucensis* sp. n., *C. trigonalis* sp. n., *Calclamnoidea tollmannae* sp. n., *Eocaudina lacrimaeformis* sp. n., *Mortensenites kielcensis* sp. n., and *M. multilaminaris* sp. n. The comparison of this assemblage with sclerites of Recent holothurians makes possible to assume that both burrowing and free moving (or seaweed clinging) species lived in the Korytnica basin.

INTRODUCTION

Holothurian sclerites of Miocene age in Europe are known only from a few localities. They were first recorded from the Burdigalian deposits of Saucats and Cestas in the Aquitanian Basin wherefrom Duvergier (1924) described 3 groups of sclerites corresponding to sclerites of the Recent holothurian genera *Psolus, Echinocucumis* and *Oneirophantaz* living in the Gironde Bay. Subsequently, holothurian sclerites were reported from the Tortonian deposits of Baden, Eisenstadt and Müllendorf in the Vienna Basin (Papp & Küpper 1953, Kristan-Tollmann 1964). In Poland, they were found in the "Sarmatian" deposits (borehole Żrecze) of the Holy Cross Mts wherefrom Górka & Łuszczewska (1969) identified representatives of the genera *Eocaudina* (assigned by them to *Cucumarites* and *Calclamna* — *cf.* synonymy) and *Croneisites.*

The investigated material from the Korytnica Clays comes from the samples taken near village Karsy (*vide* Text-fig. 1; and Bałuk &

Radwański 1977, Text-fig. 2). The specimens from other sampling places are the subject of further investigations.

The recognized holothurian sclerite assemblage from the Korytnica Clays is relatively rich and well preserved, the surface of all specimens being glossy. It comprises 32 forms belonging to 4 families (*cf.* Table 1): Stichopitidae, Calclamnidae, Theeliidae and Synaptitidae. Sclerites are accompanied by numerous foraminifers as well as some ostracodes, radiolarians of the genus *Cenosphaera*, fragments of bryozoan colonies, sponge spicules and echinoid spines. A redeposited Upper Cretaceous material is represented i.a. by some foraminifers, and holothurian sclerites *Achistrum* and *Eocaudina inaequiporus* (Müller).

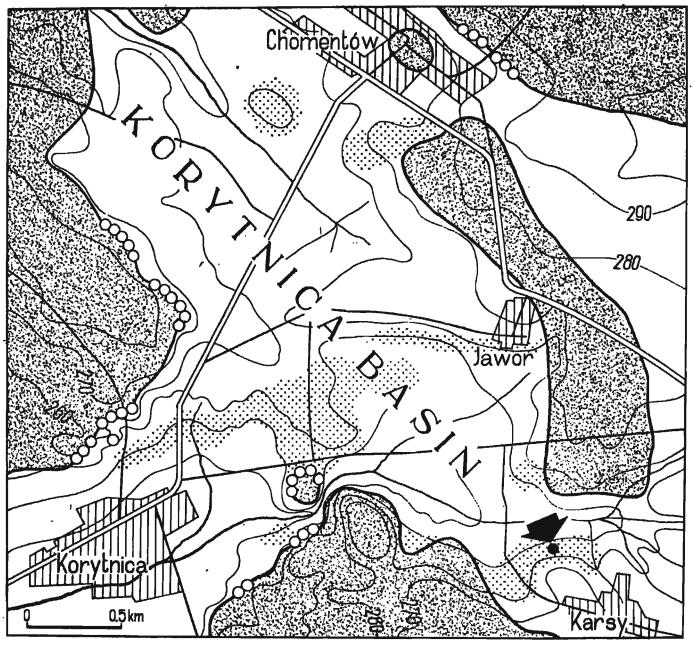

Fig. 1. Paleoenvironmental sketch of the Korytnica basin (*from*: Bałuk & Radwański 1977, Text-fig. 2)

Indicated are: marine area of the Korytnica basin during the Middle Miocene (Badenian) transgression (*blank*) and present-day outcrops of the Korytnica Clays (*stippled*); preserved fragments of littoral structures (*circled*); land or island areas along the seashore (*hachured*)

Arrowed is the sampling place for the investigated assemblage of holothurian sclerites

The taxonomy used in the present paper is that as offered by Frizzell & Exline (1966) in *Treatise on Invertebrate Paleontology* (Part U; Echinodermata *3*, vol. 2).

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Table 1

Holothurian sclerites from the Korytnica Clays

Cucumarites sp. *A* — Pl. 1, Fig. 13
Cucumarites sp. *B* — Pl. 3, Fig. 16
Calclamna cruciformis sp. n. — Pl. 1, Figs 5—7
C. tricorniculata sp. n. — Pl. 1, Fig. 4
Calclamnella aquitanica Rioult — Pl. 2, Figs 7—9
C. irregularis (Schlumberger) — Pl. 1, Fig. 11 and Pl. 2, Figs 2—3
C. sinuosa Rioult — Pl. 2, Fig. 1 and Pl. 4, Fig. 11
C. clavata sp. n. — Pl. 4, Fig. 10
C. deflandreae sp. n. — Pl. 2, Figs 5—6
C. korytnicensis sp. n. — Pl. 1, Figs 8—10 and Pl. 2, Fig. 4
C. sanctacrucensis sp. n. — Pl. 3, Figs 11—15
C. trigonalis sp. n. — Pl. 2, Figs 10—14
Calclamnella sp. — Pl. 2, Fig. 15
Calclamnoidea goniata Kristan-Tollmann — Pl. 4, Fig. 7
C. tollmannae sp. n. — Pl. 4, Figs 5—6
Calclamnoidea sp. — Pl. 4, Fig. 8
?*Calclamnoidea* sp. — Pl. 4, Fig. 9
Elgerius sp. — Pl. 4, Fig. 12
Eocaudina girondensis (Rioult) — Pl. 4, Fig. 4
E. kuepperi (Deflandre-Rigaud) — Pl. 3, Figs 2—7
E. robusta (Deflandre-Rigaud) — Pl. 3, Fig. 10
E. speciosa (Deflandre-Rigaud) — Pl. 1, Fig. 1 and Pl. 3, Fig. 1
E. subtrigonalis Kristan-Tollmann — Pl. 3, Fig. 9
E. aff. *variabilis* (Rioult) — Pl. 3, Fig. 8
E. lacrimaeformis sp. n. — Pl. 1, Fig. 3
Eocaudina sp. *A* — Pl. 2, Fig. 16
Eocaudina sp. *B* — Pl. 2, Fig. 17
Eocaudina sp. *C* — Pl. 1, Fig. 2
Mortensenites kielcensis sp. n. — Pl. 4, Fig. 15
M. multilaminaris sp. n. — Pl. 4, Figs 13—14
Theelia cf. *muellendorfensis* Kristan-Tollmann — Pl. 1, Fig. 12
Croneisites polonicus Górka & Łuszczewska — Pl. 4, Figs 1—3
Undetermined forms — Pl. 3, Figs 17—18

SYSTEMATIC DESCRIPTION

Family **Stichopitidae** Frizzell & Exline, 1956
Genus *CUCUMARITES* Deflandre-Rigaud, 1952
Cucumarites sp. *A*
(Pl. 1, Fig. 13)

Material: Two damaged specimens (Coll. No. H—1).
Dimensions: Arm length 375 μ, arm width 150 μ, hole diameter 12 μ.

Description. — Sclerite with three long, narrow arms ovate in cross section. Holes uniform in diameter, elliptical, elongated alongwith the longer axis of arm, arranged in parallel rows slightly shifted in relation to one another. Periphery straight, gently rounded.

Remarks. — This form differs from other species of the genus *Cucumarites* in long, narrow arms and the arrangement and shape of holes.

Cucumarites sp. *B*
(Pl. 3, Fig. 16)

Material: Two damaged specimens (Coll. No. *H—2*).
Dimensions: Arm length 750 μ, arm width 156 μ, hole diameter 25—35 μ.

Description. — Sclerite massive, with three wide thick arms; arms ovate, with strongly extended ends in cross section. Holes large, circular, facing one another or somewhat shifted; arranged in 4 parallel rows on wider thicker arms, and in two parallel rows on the third one, narrower arm. Periphery flattened, undulated.

Remarks. — The forms differ from representatives of other species of the genus *Cucumarites* in size, differences in number of rows of holes on arms, and in flattened periphery.

Family **Calclamnidae** Frizzell & Exline, 1956
Genus *CALCLAMNA* Frizzell & Exline, 1956
Calclamna cruciformis sp. n.
(Pl. 1, Figs 5—7)

Holotype: The specimen presented in Pl. 1, Fig. 5; housed in the Author's collection.
Paratypes: Specimens presented in Pl. 1, Figs 6—7.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).
Derivation of the name: Latin *crux* — cross; after a cross-like arrangement of the holes.
Diagnosis: Plate flat, spindle-shaped; 9 holes variable in size; hole pattern cruciform.
Material: Eight, well preserved specimens (Coll. No. *H*—3).
Dimensions: Length 275—400 μ, width 125—200 μ, hole diameter 15—40 μ, number of holes 6—10.

Description. — Sclerite perforated, flat, spindle-shaped, widest in the middle of its length; 9 holes arranged in the form of cross; longer cross axis composed of 7 holes (*a* in Text-fig. 2) and shorter cross axis (passing in the mid-length of the plate) made of 2 larger perforations (*b* in Text-fig. 2); holes loosely spaced (*c* in Text-fig. 2). Plate margin somewhat undulated.

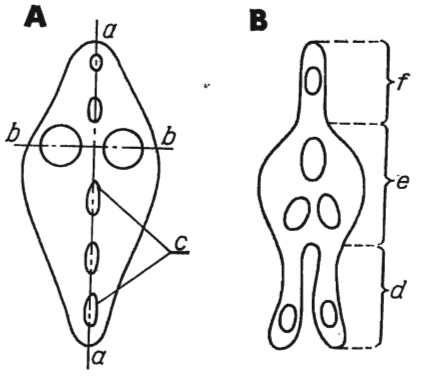

Fig. 2
Various shapes (*A*, *B*) of sclerites in the genus *Calclamna*
a long axis, *b* short axis, *c* loose holes, *d* lower projection, *e* central area, *f* upper projection

Variability. — Variability concerning position of shorter axis of the cross situated in the middle (Pl. 1, Fig. 7) or one-third of the plate length (Pl. 1, Fig. 6).

Remarks. — The new species differs from all the previously described species of the genus *Calclamna* in plate outline and arrangement of perforations.

Calclamna tricorniculata sp. n.
(Pl. 1, Fig. 4)

Holotype: The specimen presented in Pl. 1, Fig. 4; housed in the Author's collection.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.

Type horizon: Middle Miocene (Badenian).
Derivation of the name: Latin *corniculum* — tiny horn; after occurrence of three projections.
Diagnosis: Flat plate, with bilateral symmetry; central area with 3 holes; 3 projections of different length marked at opposite ends of the plate.
Material: Three, well preserved specimens (Coll. No. *H—4*).
Dimensions: Length 250—275 μ, width 150—200 μ, hole diameter 8—35 μ, number of holes 6.

Description. — Flat plate; three elliptic holes of different size arranged radially in the central area (*e* in Text-fig. 2). On one end of the plate the central area passes into short upper projection (*f* in Text-fig. 2), and on the opposite end — into 2 longer projections (*d* in Text-fig. 2); a single circular hole marked on each projection. Periphery finely undulated.

Remarks. — The new species differs from the remaining species of the genus *Calclamna* in the development of 3 projections and the arrangement of holes on the plate.

Genus *CALCLAMNELLA* Frizzell & Exline, 1956
Calclamnella aquitanica Rioult, 1965
(Pl. 2, Figs 7—9)

1965. *Calclamnella aquitanica* sp. n.; M. Rioult, pp. 168—170, Pl. 3, Figs 1, 9.
Material: Ten, well preserved specimens (Coll. No. *H—5*).
Dimensions: Length 375—600 μ, width 175—225 μ, hole diameter 15—50 μ, number of holes 8—18.

Remarks. — The investigated specimens differ from the holotype (*cf.* Rioult 1965) in somewhat larger dimensions of the plate. The sclerites are similar to those of Recent holothurians of the species *Holothuria vagabunda* Selenka reported by Erwe (1913, Pl. 6, Fig. 13 a) in plate outline and arrangement of holes, differing in larger size of the plate and more ovate holes. Holothurians of the species *Holothuria vagabunda* Selenka occur along the coasts of western South America, Mozambique, Zanzibar, as well as Red Sea, Gulf of Aden, Tahiti, and Hawaii (Erwe 1913).

Calclamnella irregularis (Schlumberger, 1890)
(Pl. 1, Fig. 11 and Pl. 2, Figs 2—3)

1890. *Priscopedatus irregularis* sp. n.; M. Schlumberger, pp. 199—200, Text-figs 20—21.
1932. *Priscopedatus irregularis* Schlumberger; C. Croneis & J. M. Cormack, Pl. 19, Figs 36—37.
1955. *Calclamnella irregularis* (Schlumberger); D. L. Frizzell & H. Exline, p. 78, Pl. 2, Figs 6—7.
1966. *Calclamnella irregularis* Schlumberger; D. L. Frizzell & H. Exline, Text-fig. 530, 4 a, b.
Material: Seven, well preserved specimens (Coll. No. *H—8*).
Dimensions: Length 250—370 μ, width 100—150 μ, hole diameter 17—25 μ, number of holes 15—18.

Remarks. — The investigated specimens do not differ from the holotype (*cf.* Schlumberger 1890). Sclerites of *Calclamnella irregularis* (Schlumberger) are similar to those of Recent *Holothuria polii* Delle Chiaje (*cf.* Cherbonnier 1951, Pl. 7, Fig. 19; Strenger 1963, Pl. 160) from the coasts of the Mediterranean and Adriatic Sea, differing in much larger size.

Calclamnella sinuosa Rioult, 1965
(Pl. 2, Fig. 1 and Pl. 4, Fig. 11)

1965. *Calclamnella sinuosa* sp. n., M. Rioult, p. 170, Pl. 3, Fig. 3.
Material: Ten, well preserved specimens (Coll. No. *H—11*).
Dimensions: Length 275—300 μ, width 175—185 μ, hole diameter 12—37 μ, number of holes 8—10.

Remarks. — The investigated specimens do not differ from the holotype.

Calclamnella clavata sp. n.
(Pl. 4, Fig. 10)

Holotype: The specimen presented in Pl. 4, Fig. 10, housed in the Author's collection.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).
Derivation of the name: Latin *clava* — club; after a club-like appearance of the sclerite.
Diagnosis: Sclerite massive, club-shaped; perforations arranged in two rows, one of which continues up to the middle, and another one throughout the whole sclerite.
Material: Four, well preserved specimens (Coll. No. *H—6*).
Dimensions: Length 425 μ, width 100 μ, hole diameter 10—20 μ, number of holes 11—12.

Description. — Sclerite massive, thick, club-shaped. Holes small, elliptical, elongated alongwith the longer axis of sclerite, arranged in 2 parallel rows of different length; one row continues up to the middle, and another throughout the sclerite; holes very loosely spaced. Periphery slightly undulated.

Remarks. — The new species differs from all the hitherto described species of the genus in massive, club-shaped appearance of the sclerite and in arrangement of holes.

Calclamnella deflandreae sp. n.
(Pl. 2, Figs 5—6)

Holotype: The specimen presented in Pl. 2, Fig. 5; housed in the Author's collection.
Paratype: The specimen presented in Pl. 2, Fig. 6.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).
Derivation of the name: In honour of Dr. Marthe Deflandre-Rigaud, an outstanding student of the holothurian sclerites.
Diagnosis: Plate flat, perforated, elongated; holes circular, loosely spaced, arranged in two rows shifted in relation to one another; 5 holes in the lower, and at least one hole in the upper row; periphery incised.
Material: Five, well preserved specimens (Coll. No. *H—7*).
Dimensions: Length 400—425 μ, width 175 μ, hole diameter 12—25 μ, number of holes 6—8.

Description is the same as diagnosis.

Variability. — Variability concerning the shape of holes changing from circular (Pl. 2, Fig. 5) to subtriangular (Pl. 2, Fig. 6), as well as the number of holes in the upper row, ranging from one (Pl. 2, Fig. 5) to two (Pl. 2, Fig. 6).

Remarks. — The new species differs from all the hitherto described species of the genus in having not numerous holes arranged in two rows of different length. The representatives of the new species are similar to sclerites of Recent holothurians *Holothuria pardalis* Selenka (*cf.* Cherbonnier 1951, Pl. 9, Figs 20—21) from the coasts of Hawaii Islands, differing in markedly larger size.

Calclamnella korytnicensis sp. n.
(Pl. 1, Figs 8—10 and Pl. 2, Fig. 4)

Holotype: The specimen presented in Pl. 1, Fig. 9; housed in the Author's collection.
Paratypes: Specimens presented in Pl. 1, Figs 8, 10.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).
Derivation of the name: From the Korytnica basin, in the deposits of which the holotype was found.
Diagnosis: Plate flat; central area with large holes arranged in 2 parallel rows; side area with fine holes developed at the extension of these rows.
Material: Fourteen, well preserved specimens (Coll. No. *H*—*8*).
Dimensions: Length 375—525 μ, width 175—200 μ, hole diameter 12—50 μ, number of holes 8—16.

Description. — Plate flat, spindle-shaped. Central area (*c* in Text-fig. 3) with 4 large, circular to elliptical holes arranged in 2 parallel rows markedly shifted in relation to one another. Side areas (*b* in Text-fig. 3) a half narrower than the central area, are developed on the extension of diagonal of the latter; the side areas display small, elliptical holes arranged in two parallel rows slightly shifted in relation to one another. Periphery undulated.

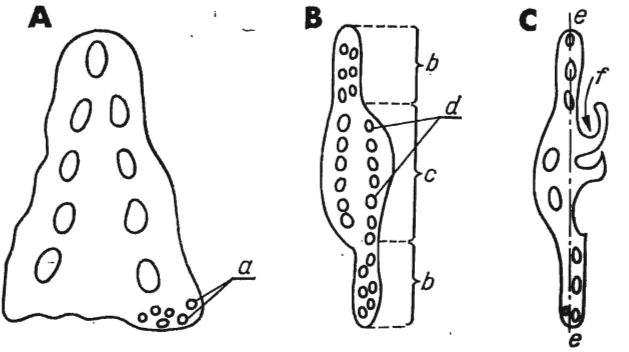

Fig. 3. Various shapes (*A*, *B*, *C*) of sclerites in the genus *Calclamnella*
a additional perforations, *b* side area, *c* central area, *d* dense holes, *e* longer axis, *f* notch

Variability. — Variability concerning (*1*) the appearance of side areas changing from elongate with numerous holes (Pl. 1, Fig. 9) to short, with less numerous holes (Pl. 1, Fig. 8), (*2*) the number of holes from the central area ranging from 4 (Pl. 1, Fig. 9) to 6 (Pl. 1, Fig. 10), and (*3*) a shift of side areas from sclerite margins towards the center.

Remarks. — The new species is similar to *C. fusiformis* Deflandre-Rigaud in sclerite outline and presence of central and side areas, differing in larger size and in the presence of holes on side areas.

Calclamnella sanctacrucensis sp. n.
(Pl. 3, Figs 11—15)

Holotype: The specimen presented in Pl. 3, Fig. 12; housed in the Author's collection.
Paratypes: Specimens presented in Pl. 3, Figs 11 and 13—15.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).
Derivation of the name: Latin *sanctacrucensis;* after the Holy Cross Mts, the region where the Korytnica basin is situated.

Diagnosis: Plate flat, elliptical in outline; holes arranged on both sides of longitudinal axis of the plate; periphery deeply incised.
Material: Twelve, well preserved specimens (Coll. No. *H—10*).
Dimensions: Length 325—425 μ, width 125—150 μ, hole diameter 12—25 μ, number of holes 3—10.

Description. — Plate flat, elongate elliptical in outline; 4 large, elliptical to subtriangular holes arranged in the row on one side, whilst 2 others on the opposite side of longitudinal axis of the plate; 5 holes of various size marked on both ends of the axis; notches in the periphery deeply incised (*f* in Text-fig. 3).

Variability. — Variability concerning depth of incision of the periphery; the incisions being either gentle (Pl. 3, Figs 13—14) or narrow and deep (Pl. 3, Figs 11, 15). Variable is also the number of holes which decreases when the number of incisions becomes greater.

Remarks. — The new species is similar to the species *Calclamnella transversa* Deflandre-Rigaud (*cf.* Deflandre-Rigaud 1962, Text-figs 14—15) known from the Oxfordian of France, in holes arranged on opposite sides of longitudinal axis of the plate and in deep incisions, differing in twice larger size of the plate and the occurrence of small holes on both ends of the longer axis. The representatives of *C. sanctacrucensis* sp. n. are similar to sclerites of Recent *Holothuria pervicax* Selenka (*cf.* Cherbonnier 1951, Pl. 13, Figs 8, 10) living along the coasts of Hawaii Islands, differing in markedly larger size, narrower axis and holes more ovate in outline.

Calclamnella trigonalis sp. n.
(Pl. 2, Figs 10—14)

Holotype: The specimen presented in Pl. 2, Fig. 11; housed in the Author's collection.
Paratypes: Specimens presented in Pl. 2, Figs 10 and 12—14.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).
Derivation of the name: Latin *trigon* — triangle; after triangular outline of the sclerite.
Diagnosis: Plate flat, triangular in outline; holes arranged in 2 rows converging in the apical part of the plate.
Material: Eleven, well preserved specimens (Coll. No. *H—12*).
Dimensions: Length 225—400 μ, width 150—200 μ, hole diameter 10—25 μ, number of holes 5—9.

Description. — Plate flat, subtriangular in outline. Holes circular to elliptical, displaced in relation to one another, arranged in 2 rows converging in the plate apex; largest close to the base of the plate, decreasing in diameter towards the apex, generally loosely spaced. Periphery gently undulated.

Variability. — Variability concerning the plate outline changing from low and broad (Pl. 2, Fig. 10) to high and slender (Pl. 2, Fig. 14). Supplementary perforations (*a* in Text-fig. 3) present (Pl. 2, Fig. 12) in the lower part of the plate or missing (Pl. 2, Figs 10—11 and 13—14).

Remarks. — The new species differs from all the hitherto described species of the genus *Calclamnella* in triangular outline and perforations arranged in 2 rows converging in the apical part of the plate.

Calclamnella sp.
(Pl. 2, Fig. 15)

Material: One, well preserved specimen (Coll. No. *H—13*).
Dimensions: Length 300 μ, width 175 μ, hole diameter 25—50 μ, number of holes 7.

Description. — Plate flat, semicircular in outline. Holes elliptical, variable in size, arranged in two rows; one of the rows is bent stronger and displaced for about one-hole distance in relation to another. Periphery straight.

Remarks. — The investigated specimen differs from the representatives of all the species *Calclamnella* hitherto described in small number of perforations and one row of perforation strongly bent.

Genus *CALCLAMNOIDEA* Frizzell & Exline, 1956

Calclamnoidea goniaia Kristan-Tollmann, 1964 (Pl. 4, Fig. 7)

1964. *Calclamnoidea goniaia* sp. n.; E. Kristan-Tollmann, p. 83, Pl. 4, Figs 7—8.
Material: Six, partly damaged specimens (Coll. No. *H—14*).
Dimensions: Width 120 μ, hole diameter 15—25 μ, number of holes 14—20.

Remarks. — The investigated specimens do not differ from the holotype.

Calclamnoidea tollmannae sp. n. (Pl. 4, Figs 5—6)

Holotype: The specimen presented in Pl. 4, Fig. 5; housed in the Author's collection.
Paratypes: The specimen presented in Pl. 4, Fig. 6.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).
Derivation of the name: In honour of Dr. Edith Kristan-Tollmann, an outstanding student of the holothurian sclerites.

Diagnosis: Plate flat, with three short and broad arms; holes arranged in rows.

Material: Six, well preserved specimens (Coll. No. *H—15*).
Dimensions: Arm width 125 μ, arm length 100—125 μ, hole diameter 12—25 μ, number of holes 12—14.

Description. — Plate flat, with ends passing into arms roughly of the same length. Holes small, circular to elliptical, arranged in two parallel rows, somewhat shifted in relation to one another. Periphery gently incised.

Remarks. — The new species differs from all the hitherto described species of the genus *Calclamnoidea* in the development of three arms and the arrangement of holes on the arms.

Calclamnoidea sp. (Pl. 4, Fig. 8)

Material: One, well preserved specimen (Coll. No. *H—16*).
Dimensions: Length 300 μ, width 125 μ, hole diameter 18—50 μ, number of holes 22.

Description. — Plate flat, reniform. Holes variable in diameter, circular to elliptical, arranged in 2—3 rows parallel to the plate periphery. Periphery broadly sinuated.

Remarks. — The specimen differs from the representatives of hitherto described species of *Calclamnoidea* in reniform holes and their arrangement.

?Calclamnoidea sp. (Pl. 4, Fig. 9)

Material: One, well preserved specimen (Coll. No. *H—17*).
Dimensions: Length 800 μ, width 300 μ, diameter of holes 20—80 μ, number of holes 24.

Description. — Plate massive, subrectangular in outline, with biconvex central part. Holes circular to elliptical, variable in diameter, arranged in 2 longer

and 2 shorter rows; longer rows arcuately bent, parallel to the plate periphery and continuing throughout the plate; shorter rows are oriented obliquely to the longer ones. Periphery incised.

Genus *ELGERIUS* Deflandre-Rigaud, 1959

Elgerius sp.

(Pl. 4, Fig. 12)

Material: One, somewhat damaged specimen (Coll. No. *H—18*).
Dimensions: Length 200 μ, diameter of perforations 10—15 μ.

Description. — Plate very fragile, concave—convex, circular in outline; with central part strongly convex, made of a single layer. Parforations large, circular to elliptical, loosely spaced. Peripheral zone double-layered, with small perforations arranged in 2 rows roughly parallel to the margin. Periphery finely undulated.

Remarks. — The specimen differs from the representatives of hitherto described species of the genus *Elgerius* in the plate outline and character and arrangement of perforations in central and peripheral parts of the plate.

Genus *EOCAUDINA* Martin, 1952

Eocaudina girondensis (Rioult, 1965)

(Pl. 4, Fig. 4)

1965. *Cucumarites girondensis* sp. n.; M. Rioult, pp. 172—174, Pl. 2, Fig. 8.
Material: Four damaged specimens (Coll. No. *H—19*).
Dimensions: Length 350 μ, width 150—275 μ, diameter of perforations 12—25 μ.

Remarks. — The specimens correspond exactly to the holotype.

Eocaudina kuepperi (Deflandre-Rigaud, 1961)

(Pl. 3, Figs 2—7)

1953. Kalkplättchen von Deimatidae; A. Papp & K. Küpper, pp. 50—51, Pl. 1, Figs 1—4.
1962. *Cucumarites kupperi* Deflandre-Rigaud; M. Deflandre-Rigaud, p. 110.
1964. *Calclamnoidea kupperi* (Deflandre-Rigaud); E. Kristan-Tollmann, p. 82, Pl. 4, Figs 1—6.
1966. *Eocaudina kupperi* (Deflandre-Rigaud); D. Frizzell & H. Exline, p. U661.
1969. *Calclamna* sp.; H. Górka & L. Łuszczewska, pp. 375—376, Pl. 76, Figs 8—9.
Material: Twenty, well preserved specimens (Coll. No. *H—21*).
Dimensions: Length 300—375 μ, width 150—250 μ, diameter of perforations 12—30 μ, number of perforations 15—27.

Variability. — Variability mainly concerning the plate outline changing from rectangular (Pl. 3, Fig. 4) to almost square (Pl. 3, Fig. 7), and the number of perforations in rows ranging from three (Pl. 3, Fig. 4) to five (Pl. 3, Fig. 7).

Remarks. — The investigated specimens do not differ from those described by Papp & Küpper (1953) from the Vienna Basin.

Eocaudina robusta (Deflandre-Rigaud, 1962)

(Pl. 3, Fig. 10)

1962. *Cucumarites robustus* sp. n.; M. Deflandre-Rigaud, p. 60, Text-figs 50—51.
1969. *Cucumarites robustus* Deflandre-Rigaud; H. Górka & L. Łuszczewska, p. 377, Pl. 77, Figs 1—4.
Material: Eight incomplete specimens (Coll. No. *H—22*).
Dimensions: Length 500 μ, width c 300 μ, diameter of perforations 25—60 μ.

Remarks. — The investigated specimens do not differ from the representatives of the species described by Deflandre-Rigaud (1962) from the Oxfordian of France.

Eocaudina speciosa (Deflandre-Rigaud, 1959) (Pl. 1, Fig. 1 and Pl. 3, Fig. 1)

1959. *Cucumarites speciosus* sp. n.; M. Deflandre-Rigaud, p. 192, Pl. 1, Fig. 4; Pl. 2, Fig. 6.
Material: Nine, well preserved specimens (Coll. No. *H—23*).
Dimensions: Plate diameter 225—250 μ, diameter of perforations 20—25 μ, number of perforations 20—30.

Remarks. — The investigated specimens do not differ from the holotype of the species *Eocaudina speciosa* (Deflandre-Rigaud). The specimen is similar to that of *Cucumarites scaber* Deflandre-Rigaud (*cf.* Deflandre-Rigaud 1959, Pl. 1, Fig. 3) in size and outline of plate as well as number and shape of perforations, differing in more uniform distribution of perforations and undulated plate margin.

Eocaudina subtrigonalis Kristan-Tollmann, 1964 (Pl. 3, Fig. 9)

1964. *Eocaudina subtrigonalis* sp. n.; E. Kristan-Tollmann, p. 86, Pl. 6, Figs 1—2.
Material: Two, well preserved specimens (Coll. No. *H-24*).
Dimensions: Length 400 μ, width 500 μ, diameter of perforations 10—50 μ, number of perforations 38—40.

Remarks. — The investigated specimens differ from the holotype (*cf.* Kristan-Tollmann 1964) in more regular plate outline, being almost subtriangular.

Eocaudina aff. *variabilis* (Rioult, 1965) (Pl. 3, Fig. 8)

1965. *Cucumarites variabilis* sp. n.; M. Rioult, p. 172, Pl. 3, Figs 8, 10.
Material: Seven, well preserved specimens (Coll. No. *H-25*).
Dimensions: Length 300 μ, width 200 μ, diameter of perforations 20—50 μ, number of perforations 8.

Remarks. — The investigated specimens are assigned to the species *Eocaudina variabilis* (Rioult) with reservation as they differ from the representatives of the species described from the Burdigalian of France by Rioult (1965) in less ovate plate outline and larger and more circular perforations.

Eocaudina lacrimaeformis sp. n. (Pl. 1, Fig. 3)

Holotype: The specimen presented in Pl. 1, Fig. 3; housed in the Author's collection.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).
Derivation of the name: Latin *lacrima* — tear; after a tear-like outline of the plate.
Diagnosis: Plate tear-shaped; its central area bearing four larger and five smaller perforations; a snout-like projection displaying three perforations.
Material: Three, well preserved specimens (Coll. No. *H-20*).
Dimensions: Length 300 μ, width 150 μ, diameter of perforations 10—30 μ, number of perforations 11—14.

Description. — Plate thick, tear-like in outline; its central area clearly pronounced, with 4 larger and 5 smaller perforations, and it gradually passes

into a snout-like projection with 3 perforations. This projection is of one-third of the whole plate length. All the perforations are round and loosely spaced. Periphery undulated.

Remarks. — The new species clearly differs from all the hitherto described species of the genus *Eocaudina* in a tear-like outline and massive appearance of the plate and arrangement of perforations.

Eocaudina sp. *A*
(Pl. 2, Fig. 16)

Material: One incomplete specimen (Coll. No. *H-33*).

Description. — Sclerite in the form of a flat, thin plate, irregularly rounded in outline. Perforations round and elliptical, varying in size; arranged in rows. Periphery finely undulated.

Remarks. — This badly preserved specimen is illustrated here, as it differs from all the remaining *Eocaudina* forms under description.

Eocaudina sp. *B*
(Pl. 2, Fig. 17)

Material: One, well preserved specimen (Coll. No. *H-26*).
Dimensions: Length 380 μ, width 150 μ, diameter of perforations 20—50 μ, number of perforations 28.

Description. — Plate perforated, flat, elliptical in outline, somewhat elongated at one end. Perforations elliptical, small on both ends of plate, increasing towards the central part, arranged in a very dense network with alternating rows. Periphery undulated.

Remarks. — The investigated specimen differs from the representatives of all the hitherto known species of the genus in perforations arranged in very dense network.

Eocaudina sp. *C*
(Pl. 1, Fig. 2)

Material: One, well preserved specimen (Coll. No. *H-27*).
Dimensions: Length 700 μ, width 375 μ, diameter of perforations 15—40 μ, number of perforations c 35.

Description. — Plate perforated, subrhomboidal in outline, with biconvex central part and flat peripheral part. Perforations circular or elliptical, variable in size, loosely and regularly arranged on surface of the plate. Periphery finely undulated.

Remarks. — The investigated specimen differs from the representatives of all the hitherto known species of the genus in size and outline of the plate and biconvex central part.

Genus *MORTENSENITES* Deflandre-Rigaud, 1952
Mortensenites kielcensis sp. n.
(Pl. 4, Fig. 15)

Holotype: The specimen presented in Pl. 4, Fig. 15; housed in the Author's collection.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).

Derivation of the name: From Kielce, the main city of the Holy Cross region.
Diagnosis: Plate multilayered, subrectangular in outline; layers tightly packed; perforations closely spaced in the upper and loosely spaced in the lower layer.
Material: Five, well preserved specimens (Coll. No. *H-28*).
Dimensions: Length 375 μ, width 250 μ.

Description. — Plate multilayered, subrectangular in outline; layers tightly packed. Perforations circular, elliptical, variable in size on the upper layer, very small and closely packed on the lower layer. Periphery incised.

Remarks. — The new species differs from all the hitherto described species of the genus *Mortensenites* in size and density of spacing of the perforations on the lower and upper layers of the plate.

Mortensenites multilaminaris sp. n.
(Pl. 4, Figs 13—14)

Holotype: The specimen presented in Pl. 4, Fig. 14; housed in the Author's collection.
Paratypes: The specimen presented in Pl. 4, Fig. 13.
Type locality: Korytnica, 24 km SSW of Kielce, southern slopes of the Holy Cross Mountains, Central Poland.
Type horizon: Middle Miocene (Badenian).
Derivation of the name: Latin *multi* — many, and *lamina* — layer; after multilayered structure of the plate.
Diagnosis: Plate perforated, multilayered, irregular in outline; layers loosely arranged; holes uniform in size throughout the plate.
Material: Six, well preserved specimens (Coll. No. *H-29*).
Dimensions: Length 200—425 μ, width 180—375 μ, diameter of perforations 8—20 μ .

Description. — Plate perforated, highly irregular in outline. Layers more or less uniform in size, loosely arranged one above another. Perforations large, elliptical, densely and uniformly distributed in every layer; perforations from different layers somewhat shifted in relation to one another. Surface of external layers finely frosted. Periphery incised.

Remarks. — The new species differs from the species *Mortensenites hemisphaericus* described by Kristan-Tollmann (1964, Pl. 7, Fig. 3) from the Badenian of Austria in more numerous and more densely spaced perforations as well as in their shape.

Family **Theeliidae** Frizzell & Exline, 1956
Genus *THEELIA* Schlumberger, 1891
Theelia cf. *muellendorfensis* Kristan-Tollmann, 1964
(Pl. 1, Fig. 12)

1964. *Theelia müllendorfensis* sp. n.; E. Kristan-Tollmann, p. 89, Pl. 3, Figs 5—7.
Material: One, well preserved specimen (Coll. No. *H-30*).
Dimensions: Diameter 175 μ, number of spokes 6.

Remarks. — The investigated specimen differs from the holotype only in less undulated upper side of the rim.

Family **Synaptitidae** Frizzell & Exline, 1956
Genus *CRONEISITES* Frizzell & Exline, 1957
Croneisites polonicus Górka & Łuszczewska, 1969
(Pl. 4, Figs 1—3)

1969. *Croneisites polonicus* sp. n.; H. Górka & L. Łuszczewska, pp. 366—367, Pl. 68, Fig. 7, Pl. 69, Figs 1—6, 8, 10 and Pl. 70, Fig. 4.

Material: Twenty one, well preserved specimens (Coll. No. *H-31*).
Dimensions: Length 225—260 μ, width 175—200 μ, diameter of main perforations 50—70 μ, number of perforations 10.

Variability. — Variability concerning the outline of plate changing from hexagonal (Pl. 4, Fig. 1) to subrounded (Pl. 4, Fig. 3).

Remarks. — The investigated specimens do not differ from those described by Górka & Łuszczewska (1969) from the "Sarmatian" deposits of the Holy Cross Mts (borehole Żrecze). They are similar to those of Recent holothurians of the species *Chondrocloea recta* (Semper) (*cf.* Erwe 1913, Pl. 8, Fig. 26a) differing in larger size of the plate and less numerous and smaller holes in central part of the plate. The holothurians *Chondrocloea recta* (Semper) are confined to the coasts of SW Australia, New Guinea, Philippines, Timor and Ceylon (Erwe 1913).

Undetermined forms
(Pl. 3, Figs 17—18)

Material: Four, well preserved specimens (Coll. No. *H-32*).
Dimensions: Length 375—425 μ, width 250—375 μ, diameter of holes 20—25 μ.

Description. — Plate flat, thin, somewhat bent, irregular in outline, with 2—3 small, circular to subtrianglular completely developed holes and over a dozen circular pits. Periphery straight, sometimes slightly incised.

Remarks. — The investigated specimens markedly differ from all the fossil holothurian sclerites hitherto described in small plate thickness and small number of holes. They are similar to sclerites of Recent holothurians *Thyone lechleri* Lampert (*cf.* Ludwig 1898, Pl. 2, Fig. 26b, d, e, f), differing in more irregular outline of the plate and the development of pits.

REMARKS ON ECOLOGY

The reconstruction of synecological conditions of ancient marine sedimentary basins on the basis of holothurian sclerites is relatively difficult and deceptive. The majority of Recent holothurians are characterized by wide bathymetric and climatic ranges (Hyman 1955), being highly sensitive to changes in water salinity, and all of them confined to waters of normal salinity (Frizzell & Exline 1955). The described sclerites *Calclamnella aquitanica* Rioult, *C. deflandreae* sp. n., *C. sanctacrucensis* sp. n., and *Croneisites polonicus* Górka & Łuszczewska are similar to sclerites of Recent holothurians distributed in tropical or subtropical seas (*cf.* Erwe 1913, Cherbonnier 1951). According to Frizzell & Exline (1955), various morphological forms of holothurian sclerites recorded in ancient deposits may be used for defining ecological types represented by then-living holothurians with some reliability. Consequently, the sclerites of circular outline (Theeliidae, Synaptitidae) that occur in the Korytnica basin should be ascribed to the holothurians burrowing in the sediments, whilst those of the type of perforated plates (Calclamnidae) and elongated perforated rods (Stichopitidae)

presumably belonged to the species either free moving on the sea bottom, or clinging to seaweed, such as kelp or marine grass.

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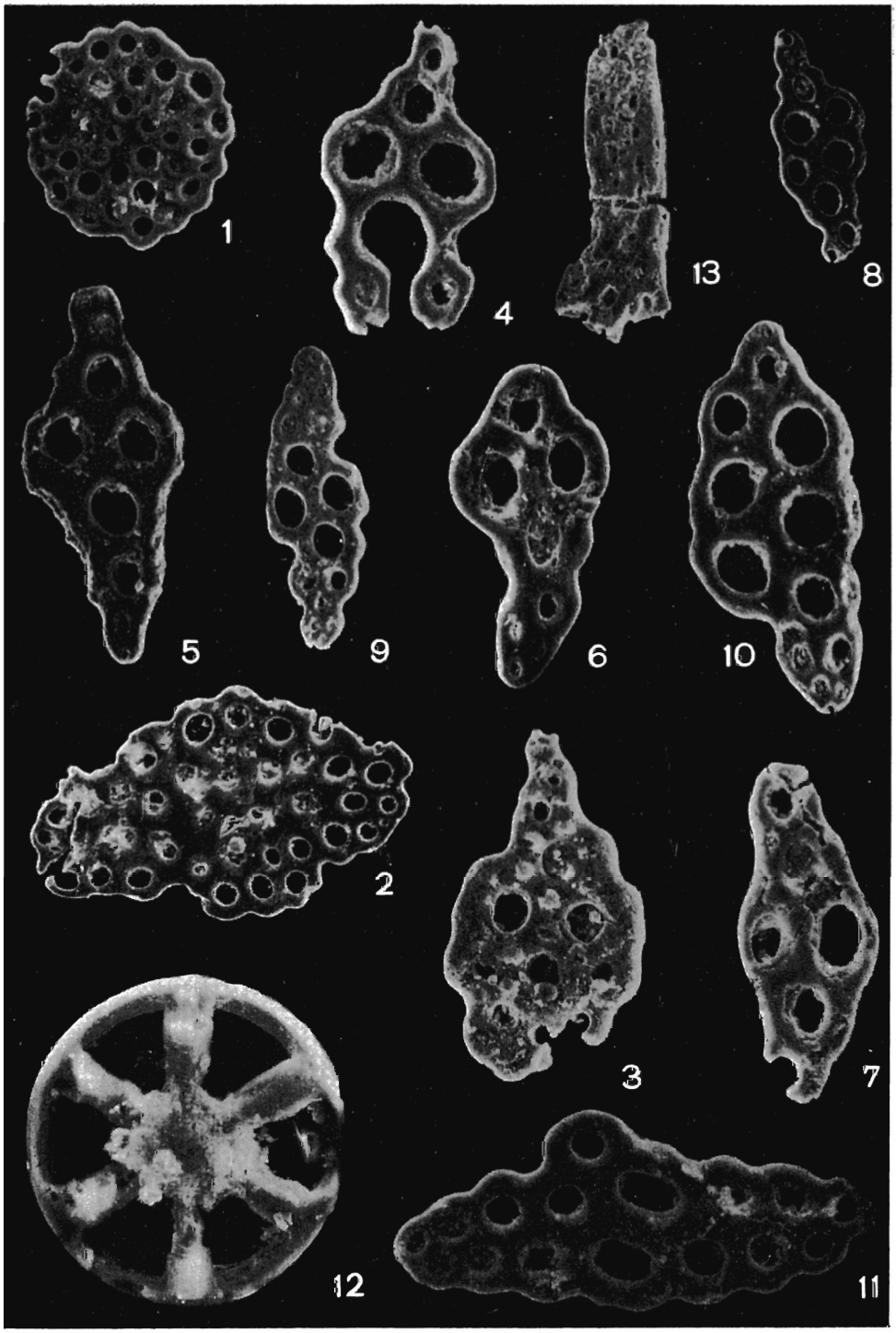
A. WALKIEWICZ

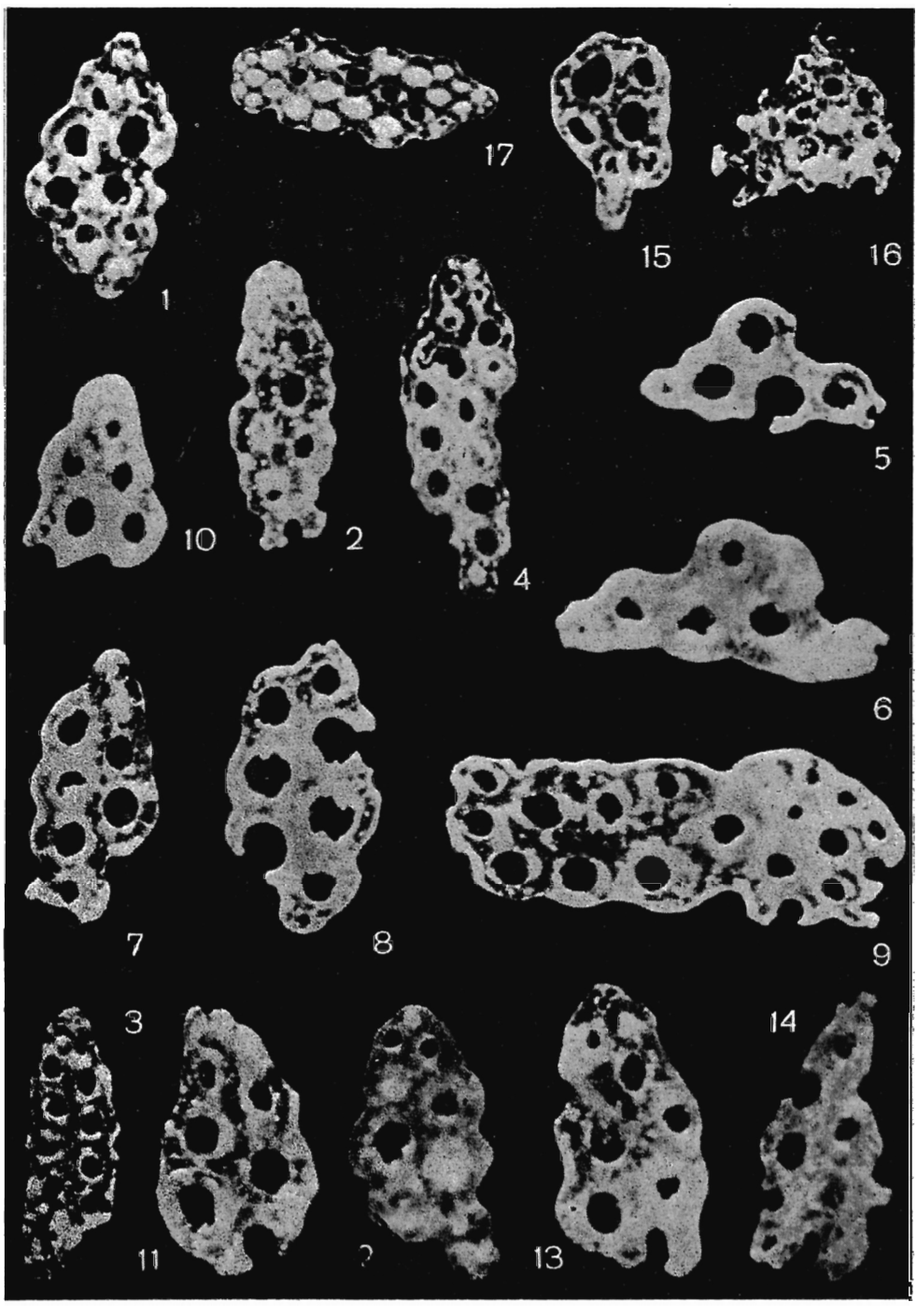
SKLERYTY STRZYKW Z IŁÓW KORYTNICKICH

(Streszczenie)

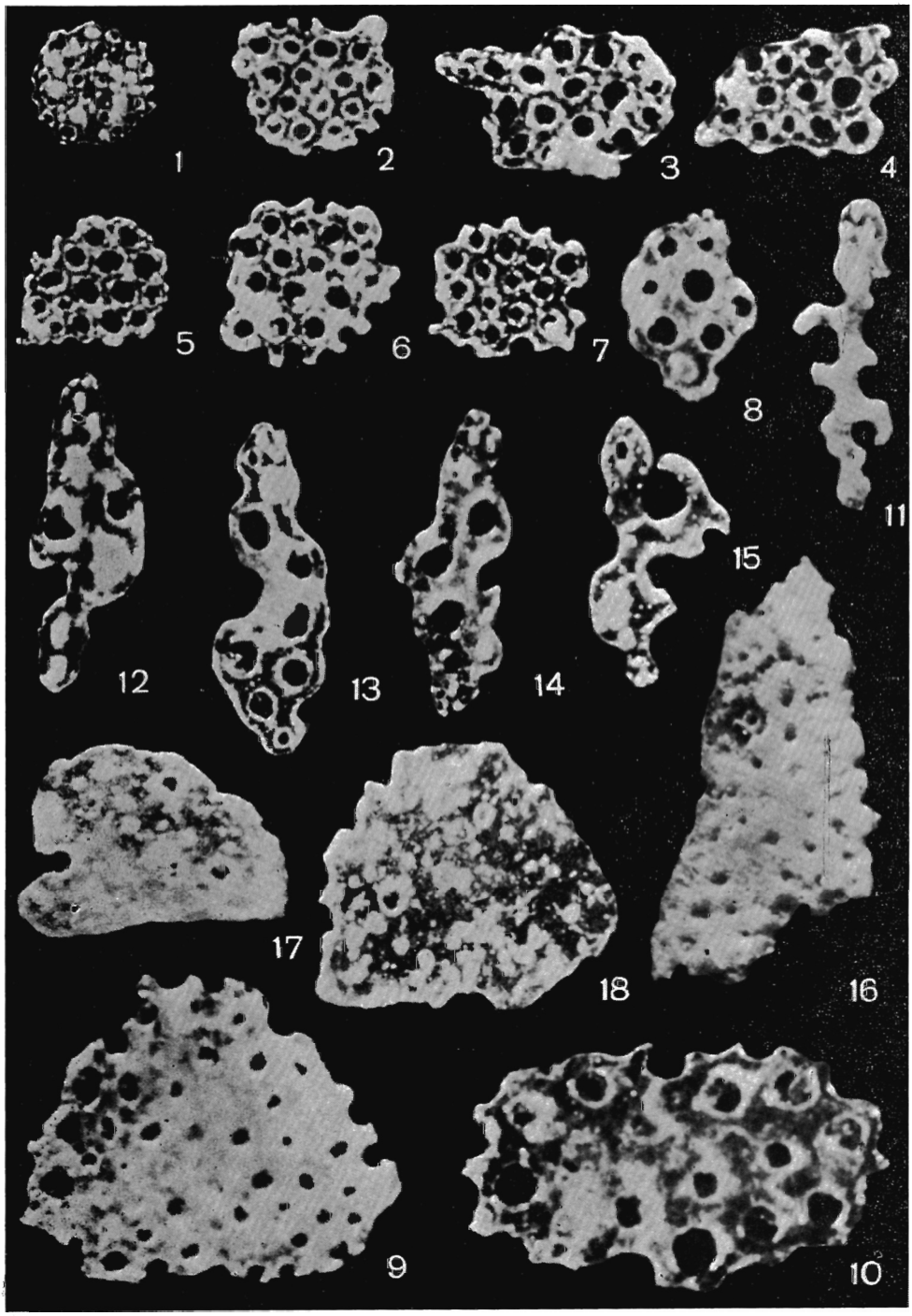
Przedmiotem pracy jest charakterystyka bogatego i dobrze zachowanego zespołu sklerytów strzykw z iłów korytnickich (*por.* fig. 1). Zespół ten (*por.* tab. 1, fig. 2—3 oraz pl. 1—4) obejmuje 32 formy reprezentujące 4 rodziny: Stichopitidae, Calcilamnidae, Theeliidae oraz Synaptitidae. W obrębie tego zespołu stwierdzono występowanie 11 gatunków dla nauki nowych: *Calclamna cruciformis* sp. n., *C. tricorniculata* sp. n., *Calclamnella clavata* sp. n., *C. deflandreae* sp. n., *C. korytnicensis* sp. n., *C. sanctacrucensis* sp. n., *C. trigonalis* sp. n., *Calclamnoidea tollmannae* sp. n., *Eocaudina lacrimaeformis* sp. n., *Mortensenites kielcensis* sp. n., oraz *M. multilaminaris* sp. n. Stwierdzono także obecność kilku okazów (reprezentujących 2 gatunki) redeponowanych z osadów kredowych. Badany zespół mioceński jest niewątpliwie znacznie bogatszy niż poznany dotychczas z Basenu Wiedeńskiego (*por.* Papp & Küpper 1953, Kristan-Tollmann 1964). Porównanie tego zespołu ze sklerytami współczesnymi pozwala stwierdzić, że w basenie Korytnicy występowały dwa ekologiczne typy strzykw — zagrzebujące się w osadzie, oraz swobodnie poruszające się bądź przyczepione do wodorostów (glonów lub traw morskich). Kilką badanych form wykazuje ponadto duże podobieństwo do sklerytów strzykw żyjących dzisiaj w morzach tropikalnych bądź subtropikalnych.



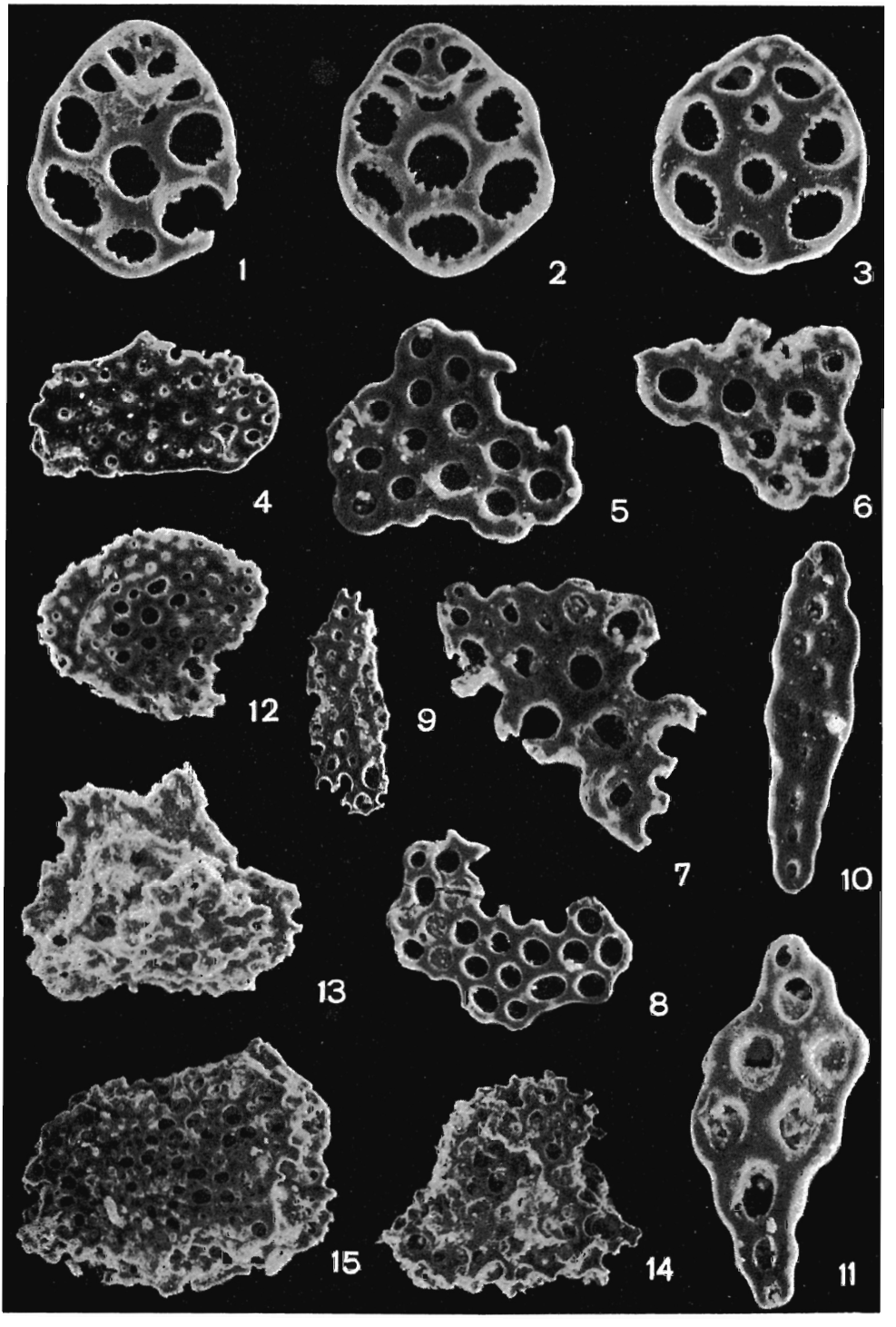
1 *Eocaudina speciosa* (Deflandre-Rigaud), × 120; **2** *Eocaudina* sp. *C*, × 70; **3** *Eocaudina lacrimaeformis* sp. n., holotype, × 160; **4** *Calclamna tricorniculata* sp. n., holotype, × 180; **5—7** *Calclamna cruciformis* sp. n. (5 presents the holotype), × 120; **8—10** *Culclamnella korytnicensis* sp. n. (9 presents the holotype), × 100; **11** *Calclamnella irregularis* (Schlumberger), × 180; **12** *Theelia* cf. *muellendorfensis* Kristan-Tollmann, × 270; **13** *Cucumarites* sp. *A*, × 120



1 *Calclamnella sinuosa* Rioult; 2—3 *Calclamnella irregularis* (Schlumberger); 4 *Calclamnella* sp. n.; 5—6 *Calclamnella deflandreae* sp. n. (5 presents the holotype); 7—9 *Calclamnella aquitanica* Rioult; 10—14 *Calclamnella trigonalis* sp. n. (11 presents the holotype); 15 *Calclamnella* sp.; 16 *Eocaudina* sp. *A*; 17 *Eocaudina* sp. *B*. All figures × 100



1 *Eocaudina speciosa* (Deflandre-Rigaud); **2—7** *Eocaudina kuepperi* (Deflandre-Rigaud); **8** *Eocaudina cf. variabilis* (Rioult); **9** *Eocaudina subtrigonalis* Kristan-Tollmann; **10** *Eocaudina robusta* (Deflandre-Rigaud); **11—15** *Calclamnella sanctacrucensis* sp. n. (*12* presents the holotype); **16** *Cucumarites* sp. *B*, × 90; **17—18** Undetermined sclerites. All figures × 100



1—3 *Croneisites polonicus* Górka & Łuszczewska: *1—2* convex side, *3* concave side, × 175; **4** *Eocaudina girondensis* (Rioult), × 100; **5—6** *Calclamnoidea tollmannae* sp. n. (*5* presents the holotype), × 180; **7** *Calclamnoidea goniata* Kristan-Tollmann, × 160; **8** *Calclamnoidea* sp., 120; **9** *?Calclamnoidea* sp., × 40; **10** *Calclamnella clavata* sp. n., holotype, × 120; **11** *Calclamnella sinuosa* Rioult, × 180; **12** *Elgerius* sp., × 190; **13—14** *Mortensenites multilaminaris* sp. n. (*14* presents the holotype); **15** *Mortensenites kielcensis* sp. n., holotype, × 120